Appendixes to ARI Research Note 2007-02:

The Army Science of Learning Workshop

Kathleen A. Quinkert
U.S. Army Research Institute

John E. Morrison, J. D. Fletcher, Franklin L. Moses, and Eric J. Roberts
Institute for Defense Analyses

TRADOC Scientific Coordination Office
Kathleen A. Quinkert, Chief

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THE ARMY SCIENCE OF LEARNING WORKSHOP: APPENDIXES

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APPENDIX A:

ACRONYMS AND ABBREVIATIONS

5VM	Five-Vector Model
AKO	Army Knowledge Online
AMC	Army Materiel Command
AOT	Assignment-Oriented Training
ARFORGEN	Army Force Generation
ARI	The U.S. Army Research Institute for the Behavioral and Social Sciences
BOLC	Basic Officer Leadership Course
CA	Civil Affairs
CBI	Computer-Based Instruction
CCC	Captain Career Course
CD	Compact Disk
CEP	Center for Effective Performance
CEU	Continuing Education Unit
CTA	Cognitive Task Analysis; Constructive Technology Assessment
DAAD	Deutscher Akademischer Austauschdienst (German Academic Exchange Service)
DHS	Department of Homeland Security
dL	Distance Learning
DoD, DOD	Department of Defense
DTIC	Defense Technical Information Center
ERNT	Executive Review of Navy Training
f2f	Face-to-Face
FM	Field Manual
FORSCOM	United States Army Forces Command
FY	Fiscal Year
GEL	Guided Experiential Learning
GM™	General Motors™
HF	High Frequency
HPI	Human Performance Improvement
HR	Human Resource
IBM	International Business Machines Corporation
IDA	Institute for Defense Analyses
IET	Initial Entry Training
ILE	Integrated Learning Environment
IMI	Interactive Multimedia Instruction
IN	Infantry
ITS	Intelligent Tutoring System
KSAT	Knowledge, Skill, Ability, and Tool
LO	Learning Objective
LST	Lightweight Satellite Transceiver
LVC	Live, Virtual, Constructive

M&S	Modeling and Simulation
MANPRINT	Manpower and Personnel Integration
MTT	Mobile Training Team
NCO	Noncommissioned Officer
NGO	Non-Governmental Organization
NKO	Navy Knowledge Online
NTIS	National Technical Information Service
OJT	On-the-Job Training
PCS	Permanent Change of Station
PSYOPS	Psychological Operations
QC	Quality Control
R&D	Research and Development
ROI	Return on Investment
ROTC	Reserve Officer Training Corps
SBCT	Stryker Brigade Combat Team
SCP	School for Command Preparation
SME	Subject Matter Expert
SOW	Statement of Work
TA	Technology Assessment
TDY	Temporary Duty
TRADOC	Training and Doctrine Command
TTP	Tactics, Techniques, and Procedures
USMC	United States Marine Corps
vRSR	Virtual Right Seat Ride
WLC	Warrior Leader Course

APPENDIX B:

WORKING GROUP PARTICIPANTS AND ORGANIZATIONS

Learning Model Working Group

Facilitators

Dr. Kathy Quinkert, U.S. Army Research Institute

Mr. Ron Stump, U.S. Army Research Institute

Stakeholder

Dr. Millie Abell, HQ, U.S. Army Training and Doctrine Command

Recorder

Dr. John Morrison, Institute for Defense Analyses

Participants

Dr. Robert Ainsley, Defense Acquisition University

Dr. Jan Cannon-Bowers, University of Central Florida

Dr. Richard Clark, University of Southern California

Dr. Abbas “Aubteen” Darabi, Florida State University

Mrs. Ruth Freiseis, U.S. Army Combined Arms Support Command

Dr. Paul Gade, U.S. Army Research Institute

COL Jim Markley, HQ, U.S. Army Training and Doctrine Command

COL Robert C. Morris, U.S. Joint Forces Command J9

BG Mark O’Neill, Deputy Commandant, U.S. Army Command & General Staff College

CAPT Matt Peters (USN, Ret), Defense Intelligence Agency (DIA)

Ms. Rachel Serio, HQ, U.S Army Training and Doctrine Command

Dr. Connie Wardell, U.S. Army Training Support Center

Dr. Jonathan Woods, U.S. Navy Human Performance Center

Train Soldiers Working Group

Facilitator

Dr. Scott Graham, U.S. Army Research Institute

Stakeholder

Mr. Michael Faughnan, HQ, U.S. Army Training and Doctrine Command

Recorder

Dr. Dexter Fletcher, Institute for Defense Analyses

Participants

Dr. Phillip Ackerman, Georgia Institute of Technology

Dr. Bob Bauer, U.S. Army Armor Center & School

Dr. Scott Beal, U.S. Army Research Institute

Dr. Herb Bell, U.S. Air Force Research Laboratory

Ms. Mary Cullinane, Microsoft Corp./Mr. Al Blocker, Microsoft Corp.

Dr. Fred Diedrich, Aptima Inc.

Dr. Tom Duffy, Indiana University

Dr. Jean Dyer, U.S. Army Research Institute

Mr. Alex Hoover, J7, Joint Warfighting Center

Mrs. Rosanne May, HQ , U.S . Army Training and Doctrine Command

Mr. Dean Norman, Naval Education and Training Command

COL(P) Joe E. Ramirez, Deputy Commander, Combined Arms Center for Training

CSM Jose Silva, HQ, U.S. Army Quartermaster Center & School

Dr. Mike Simonson, Nova Southeastern University

Mr. Bob Sottilare, U.S. Army Research, Development & Engineering Command

BG Michael Tucker, Deputy Commanding General, U.S. Army Armor School

Develop Leaders Working Group

Facilitator

Dr. Stan Halpin, U.S. Army Research Institute

Stakeholder

COL Bruce Reider, U.S. Army Command & General Staff College

Recorder

Dr. Frank Moses, Institute for Defense Analyses

Participants

Dr. Georgia Chao, Michigan State University

Mr. Al Crane, U.S. Army Capabilities Integration Center

Mr. Harry Crumling, HQ Department of the Army, G-37/TR

Dr. David Dorsey, Personnel Decisions Research Institute (PDRI)

Dr. Jon Fallesen, U.S. Army Command & General Staff College

Dr. Jay Goodwin, U.S. Army Research Institute

Mr. John Hennessey, Jr., HQ, U.S Army Training and Doctrine Command

COL Mike King, U.S. Command & General Staff College

Dr. Steven Kozlowski, Michigan State University

Dr. Robert Lord, University of Akron

COL Julie Manta, U.S. Army War College

Dr. Cindy McCauley, Center for Creative Leadership

MG David C. Ralston, Commanding General, U.S. Army Field Artillery Center & Fort Sill

LTC(P) Charles Rogerson, HQ, U.S Army Training and Doctrine Command

Mr. Don Vandergriff, U.S. Army Capabilities Integration Center (Forward)

Future Capabilities Working Group

Facilitator

Dr. Steve Goldberg, U.S. Army Research Institute

Stakeholder

Dr. Diana Tierney, HQ, U.S Army Training and Doctrine Command

Recorder

Dr. Eric Roberts, Institute for Defense Analyses

Participants

Dr. Robert Bjork, University of California Los Angeles

Dr. Jim Blake, U.S. Army PEO STRI

COL Kevin Brown, HQ, U.S Army Training and Doctrine Command

Dr. Bill Burnside, U.S. Army Research Institute

Dr. Patricia Chalmers, Joint Forces Command

Dr. Anna Cianciolo, Command Performance Research Inc.

Dr. Paula Durlach, U.S. Army Research Institute

Mr. Jack Fedder, HQ, U.S Army Training and Doctrine Command

Dr. Alice Healy, University of Colorado

Mr. Wayne Hodgins, Learnativity

Mr. Lou Iorizzo, U.S. Army Training Support Center

Dr. H. Chad Lane, University of Southern California

Mr. Adam Pease, Articulate Software

Mr. Scott Shadrick, U.S. Army Research Institute

COL Jim Shufelt, U.S. Army Training and Doctrine Command

BG Jim Warner (USA, Ret)

Executive Panel

GEN William S. Wallace, Commander TRADOC

LTG (Ret) Paul Funk

LTG (Ret) Larry Jordan

Mr. Robert Seger, DCSOPS&T

Mr. Jim Gunlicks, DA G3

Dr. Michelle Sams, Acting Director ARI

LTC Kevin McRee, TRADOC Commanding General’s Planning Group

APPENDIX C

Science of Learning Workshop Agenda

1-3 August 2006

Radisson Hotel ~ Hampton, Virginia

Co-Sponsored by: Commanding General, Training & Doctrine Command (TRADOC) and Deputy Chief of Staff , Army G-1

Hosted by: U.S. Army Research Institute for the Behavioral and Social Sciences with assistance from Institute for Defense Analyses (IDA)

Tuesday, 1 August 2006

Start	Activity	Activity leader
7:30	**REGISTRATION**	
	PLENARY SESSION -- Grand Ballroom A	
8:30	Welcome	Dr. Michelle Sams
8:45	Administrative Notes	Dr. Kathy Quinkert
8:55	How We Learn Versus How We Think We Learn: Implications for the Optimization of Army Training	Dr. Robert Bjork
9:35	Revolution in Training and Sea Warrior	VADM J. Kevin Moran
10:15	BREAK	
10:30	The Second Learning Revolution: How to Win World War IV	MG Robert Scales (USA, Ret)
11:10	Keeping TRADOC in Balance	GEN William S. Wallace
11:45	LUNCH -- On Your Own	
	WORKING GROUP SESSIONS (see room assignments below)	
13:00	Working Group Discussions	Working Group Facilitators
14:30	BREAK	
14:45	Working Group Discussions	Working Group Facilitators
17:00	ADJOURN FOR THE DAY	
17:00	SOCIAL -- Signals Sports Grill	

Working Group Meeting Rooms		
	Learning Model Working Group (Dr. Kathy Quinkert & Mr. Ron Stump Facilitators)	Grand Ballroom A
	Train Soldiers Working Group(Dr. Scott Graham, Facilitator)	Grand Ballroom B
	Develop Leaders Working Group(Dr. Stan Halpin, Facilitator)	Grand Ballroom C
	Future Capabilities Working Group(Dr. Steve Goldberg, Facilitator)	Peninsula Room A&B
Common Office Area Available to all Workshop Attendees		Peninsula Room C

Wednesday, 2 August 2006

Start	Activity	Activity leader
	WORKING GROUP SESSIONS CONTINUE	
8:00	Working Group Discussions	Working Group Facilitators
10:00	BREAK	
10:15	Working Group Discussions	Working Group Facilitators
12:00	WORKING LUNCH - Conference Area Foyer	
13:00	Working Group Discussions	Working Group Facilitators
14:30	BREAK	
14:45	Working Group Discussions/ **Executive Committee meets 1500-1700, NASA Boardroom (2nd Floor**)	Working Group Facilitators Executive Committee
17:00	ADJOURN FOR THE DAY	

Thursday, 3 August 2006

Start	Activity	Activity leader
	WORKING GROUP SESSIONS CONCLUDE	
8:00	Working Group Discussions Conclude and Outbriefs Are Prepared (take breaks as needed)	Working Group Facilitators
11:00	WORKING LUNCH - Conference Area Foyer	
	PLENARY SESSION -- Grand Ballroom A	
12:00	Learning Model Outbrief	Dr. Kathy Quinkert Mr. Ron Stump
12:35	Train Soldiers Outbrief	Dr. Scott Graham
13:10	Develop Leaders Outbrief	Dr. Stan Halpin
13:45	Future Capabilities Outbrief	Dr. Steve Goldberg
14:20	Closing Remarks	GEN Wallace/Dr. Sams
	WORKSHOP ADJOURNS	
14:30	**Executive Committee meets, NASA Boardroom(2nd Floor)**	**Executive Committee**

APPENDIX D:

SLIDES AND NOTES FROM KEYNOTE ADDRESSES

WELCOME ADDRESS: SCIENCE OF LEARNING WORKSHOP

Introduction

I am Michelle Sams, Acting Director of the U.S. Army Research Institute for the Behavioral and Social Sciences. We are pleased to host this Science of Learning Workshop on behalf of GEN Wallace and TRADOC.

The Army is undergoing major personnel, organizational, and training transformation to ensure a ready and relevant force. TRADOC has to take into account real world constraints, but wants to ensure that the way ahead is also well-grounded in the learning sciences to ensure effective and efficient training and leader development.

ARI met with GEN Wallace and members of TRADOC last spring. We covered many topics, such as distributed learning, simulation fidelity, performance measures, training transfer, and socialization. From this discussion, the idea was generated that ARI would host a workshop comprised of leading researchers for a broad and in-depth perspective on the science of learning, and top practitioners in industry, the Army and other Services to share their implementation success stories as well as lessons learned. We organized working groups and discussion topics around four major areas: learning models, training soldiers, developing leaders, and future capabilities. Each working group will identify relevant learning science findings, what works, what needs more exploration, and the potential benefit.

We kept the number of workshop participants small to foster active discussion, so while you'll see some familiar faces, we intentionally invited some new people for fresh ideas. There are many distinguished participants here, too many to name individually, but I would like to take a moment to acknowledge the members of the Executive Committee: GEN Hartzog, LTG Jordan, LTG Funk, Mr. Seger, Mr. Gunlicks, and LTC McRee. Our key note speakers are Dr. Bjork, VADM Moran, MG Scales, and GEN Wallace.

This will be an interesting week, as scientists tend to have a different basis than practitioners for judging the value of theories and research findings. Architects of learning environments, instructional designers, and other practitioners judge theories based on the extent to which some practical implications can be derived from them. Practitioners need to exploit. On the other hand, scientists want to explore, to seek truth. Scientists view research results as progressive rather than final answers. Their typical response to a direct question will invariably be "it depends". They are not being evasive. It is just that there is no single theory or strategy that addresses all learning goals and situations.

Paradigm Shifts in Psychology

Human behavior is complex and there have been and will continue to be major paradigm shifts in learning theory, shaped by scientific advances, as well as by changes in society, culture, and industry. These paradigm shifts fundamentally alter training and education. Three major paradigm shifts have occurred in the past century: Behaviorism, Cognitivism, and Constructivism.

Behaviorism

Psychologists in the early 1900s thru mid 60s focused on behaviorism. Behaviorism arose out of the classical conditioning experiments of Pavlov and was further shaped by scientists such as, Thorndike, Watson, and Skinner.

Application of behaviorism to education and training was influenced by the industrial age model which focused on achieving efficiencies in factories. The emphasis was on standardized methods evaluated by measures of time and accuracy. The basic tenet of behaviorism is that learning occurs through repetition and reinforcement. One learns via drill and practice. Learning strategies were based on the process of establishing behavioral objectives, measuring performance, and providing feedback.

In the education community, the focus was on memorization. Students memorized multiplication tables and drilled on verb conjugations in foreign languages. This learning approach also suited the Army at the time, as the world of warfighting was fairly predictable and largely physical. Soldier tasks needed to be well-rehearsed, and automatically carried out.

Cognitivism

While the roots of cognitivism were in the 1930s, with Tolman proposing that rats have a mental map, the paradigm really came to the forefront in the 1970s with the advent of computing technologies. The analogy was that humans receive, store, and retrieve information much in the same way that computers processed information. The focus was on analytical thought: decision-making, problem-solving, metacognition, pattern recognition, and critical thinking.

The basic tenet of cognitivism is that learning is an information management process, complex but systematic. Human memory and thinking capability were viewed to be limited, much as computer storage and RAM. Learning strategies were based on structured processes, such as part-task to whole task training.

In the education community, the focus was on the underlying thinking processes. The 'new math' emerged, with subsets and cardinality causing many parents bewilderment. Foreign language learning began to focus more on understanding how a language is constructed, such as its underlying grammar structure, rather than rely on rote memorization of verb conjugations. Students began to study in computer labs.

During the Cold War, warfighting became more of a chess game. Concurrently, in the Army, there was more emphasis on thinking skills, similar to expert systems in computers which conducted depth and breadth searches. The Army developed methods, such as the Military Decision Making Process, that focused on systematic course of action development, analysis, and comparison of alternatives.

Constructivism

While the roots of the constructivist approach were in the 1930s with Merrill, technological advances in 1980 - 90s brought it to the forefront. The computing world had become networked, with hyperlinks and virtual online environments that enabled distributed discussions and shared virtual interactive worlds.

The basic tenet of constructivism is that learning is not just passively received but actively constructed. Learning strategies focus on providing discovery learning environments that represent the real world. One learns via self-discovery or guided experiences, and collaborative construction of knowledge is through social negotiation.

In the education community, learning became more hands-on and integrated into activities relevant to real world. Students might learn math through simulated role-play, such as determining profit margins in a fictitious company. In foreign language learning, the strategies shifted from learning grammar structures to social and communicative immersion approaches.

Concurrently the warfighting environment became more complex and less predictable. The Army developed realistic training environments with similar complexities, such as in the Combat Training Centers and in role-playing simulations.

Future Paradigms

There are two major emerging (and perhaps opposing) forces that will make major impacts on the sciences and society in the next several decades.

One of the major forces will be scientific breakthroughs in technology; most notably in neuroscience, artificial intelligence, and nanotechnology. Cognitive neuroscience aims to understand the mechanisms that underlie "higher level" brain functions, such as language, learning and memory, attention, and emotion through the use of non-invasive imaging technologies. Discovering these mechanisms not only helps to understand how humans think but reverse engineering of the human brain may also help to inform the design of software intelligence. As nanotechnology advances, intelligent software agents will reside inside very small physical devices, such as nanobots. Some futurists have suggested that nanobots implanted in human brains will expand our sensory and cognitive capabilities, and perhaps even influence our emotions. The next paradigm shift in psychology might become “cyber-psychology”. Key research areas would likely be cognitive neuroscience, human-machine interface, and social networks of humans and non-human entities.

A second major (and possibly antithetical) force is a holistic approach to understanding human behavior. Its concepts in the psychological and health sciences are similar, but have different terms. In the health profession, the holistic approach is referred to as a biopsychosocial model or mind-body medicine. This approach views the biological, psychological, and social aspects of the human as a fully integrated system. Diagnosis and treatment addresses physical aspects but also includes cognitive, emotional and social aspects, such as stress, fear, trust, self-efficacy, resilience, and motivation. Humanistic psychology focuses on uniquely human issues, such as the self, self-actualization, health, hope, love, creativity, nature, being, becoming, individuality, and meaning -- in short, the understanding of what it means to be human.

Those who embrace the concept of uniquely human will likely to be at odds with those who welcome a symbiotic relationship with nanobots. Unease approaches the level of a pending sense of danger. They point out that intelligent machines will eventually exceed all human capabilities and might be permitted to make all of their own decisions without human oversight. How does one ensure that human values and quality of life take precedent over and control the ethics of a thinking machine? It remains to be seen whether these two major forces will spur on major rifts in science and society or they may possibly resolve their difference via a unique new paradigm. After all, neuroscience, computation and the physical sciences are merging in the technology world. Physiology, psychology, and sociology are merging in the mind-body world. All of these sciences might possibly evolve into a fully multi-disciplinary paradigm of human science.

Conclusion

Army training has evolved, not just due to changes in the warfighting environment, but is also influenced by paradigm shifts in the science of learning. The Army's goal is to develop leaders for the 21st Century, "The Pentathelete". Army leaders need to demonstrate integrity and character, think creatively, communicate effectively, build teams, manage and change large organizations. Training must focus not only the cognitive (thinking aspects) but also must include personality, emotional, and social aspects.

Learning theory does not provide a simple, single blueprint for effective learning. It is a complex picture with many puzzle pieces still missing. During these next several days at this workshop, the scientists will share what they do know (the enduring principles and emerging findings) that can help inform design decisions, the practitioners will share their lessons learned when facing challenge of applying this incomplete learning science puzzle, and most importantly the members of TRADOC and the Army will help shape the discussion and direction by sharing their requirements, constraints and vision for the future. Each one of you have been invited to participate because your knowledge, experiences, and insights will to help inform TRADOC as they design the way ahead for Army training and education. We welcome you and thank you for your participation.

How We Learn Versus How We Think We Learn: Implications for the Optimization of Army Training

© Robert A. Bjork
University of California, Los Angeles

Science of Learning Workshop
Radisson Hotel Hampton
Hampton, Virginia
August 1-3, 2006

The problem:

- Conditions of instruction that make performance improve rapidly often fail to support long-term retention and transfer,

  …*whereas*

- Conditions of instruction that appear to create difficulties for the learner, slowing the rate of *apparent* learning, often optimize long-term retention and transfer

Learning versus *performance*

- Empirical evidence:
  - Old evidence: Learning without performance:
    - "Latent learning" studies;
    - Motor skills studies
  - Newer evidence: Performance with little or no learning;
  - The bottom line:
    - What we can <u>observe</u> is performance;
    - What we must <u>infer</u> is learning;
    - …and the former is an unreliable guide to the latter.

Corresponding conceptual distinctions:

- Hull (1943):
  - *Momentary reaction potential versus*
  - *Habit strength*
- Estes (1955):
  - *Response strength versus*
  - *Habit strength*
- Bjork & Bjork (1992):
  - *Retrieval strength* versus
  - *Storage strength*

Manipulations that introduce "desirable difficulties" (Bjork, 1994) for the learner

- Varying the conditions of learning
- Providing "contextual interference" during learning (e.g., *interleaving* rather than *blocking* practice)
- Distributing or spacing study or practice sessions
- Reducing feedback to the learner
- Using tests (rather than presentations) as learning events

Before proceeding further it is important to emphasize that …

- The word *desirable* is important; there are many difficulties that are <u>un</u>desirable both during and after learning
- Desirable difficulties are desirable because
  - Responding to them (successfully) engages processes that support learning, comprehension, and remembering;
  - They become undesirable difficulties, however, if the learner is not equipped to respond to them successfully.
    - Generation effects as an example.

Roediger & Karpicke (2004)
(Passage on the sun or on sea otters, about 30 idea units in each passage)

Table 3

Mean number of times subjects were able to read the entire passage during 5-minute study periods in Experiment 2

	Study Period				
Condition	1	2	3	4	Sum
SSSS	3.4	3.5	3.6	3.7	14.2
SSST	3.2	3.5	3.6		10.3
STTT	3.4				3.4

Roediger & Karpicke (2004)

Table 5

Mean proportion of idea units recalled on the retention tests and forgetting scores in Experiment 2

	Retention Interval		
Condition	5 min	1 week	Forgetting
SSSS	.83	.40	.43
SSST	.78	.56	.22
STTT	.71	.61	.10

Varying the conditions of learning (Kerr & Booth, 1978)

Design

- Two age groups: 8-year-olds & 12-year-olds
- Task: beanbag toss to target on floor (occluded)
- Conditions of Practice:
  - Fixed: All practice at a fixed (criterion) distance;
  - Varied: Practice at criterion distance +/- one foot (never at the criterion distance)

Kerr and Booth (1978): Results

- Absolute Error (inches) on Final Test (3-feet distance for 8-year-olds)

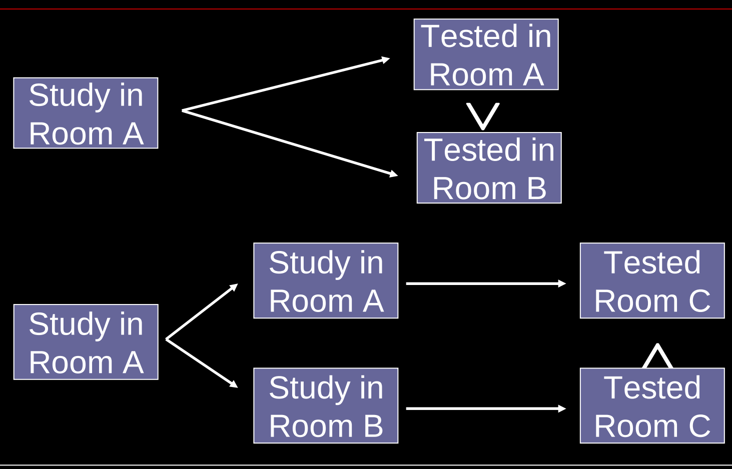
	Age of Participant	
Practice Condition	8 years	12 years
Fixed (criterion)	8.31	5.55
Varied (criterion +/- 1 ft)		

Kerr and Booth (1978): Results

- Absolute Error (inches) on Final Test (3-feet distance for 8-year-olds)

	Age of Participant	
Practice Condition	8 years	12 years
Fixed (criterion)	8.31	5.55
Varied (criterion +/- 1 ft)	5.42	4.63

Varying the environmental context of learning (Smith, Glenberg, & Bjork, 1978)



Blocked versus random practice
(e.g., Shea & Morgan, 1979)

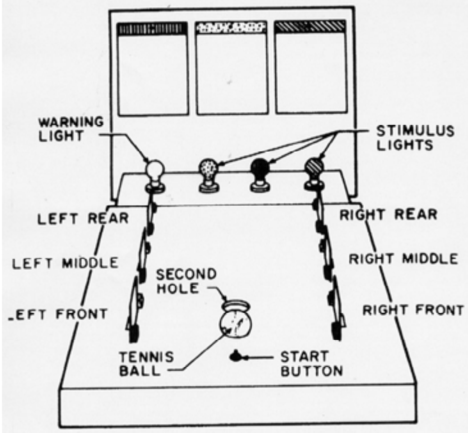


Figure 1. Diagram showing the apparatus used in the experiment form the perspective of the subject.

Shea & Morgan (1979): Results

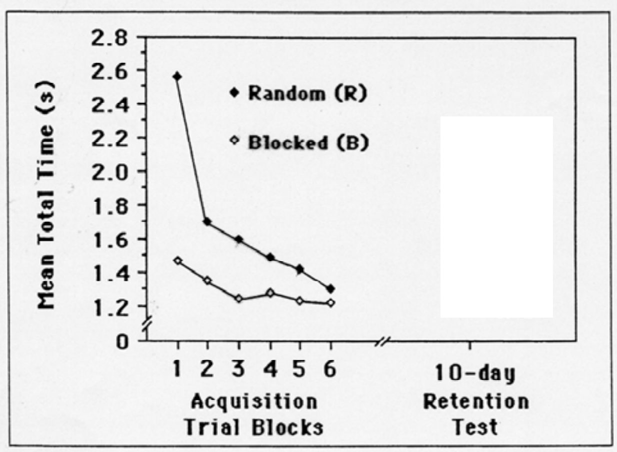
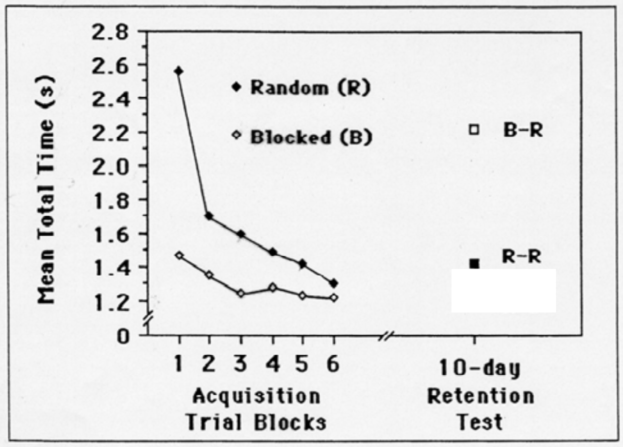


Fig. 1. Performance on movement speed tasks under random (R) and blocked (B) conditions in acquisition and, after 10 days, in retention tests under random or blocked conditions; in retention, the first letter indicates the acquisition condition, and the second represents the retention condition. Redrawn from Shea and Morgan (1979).



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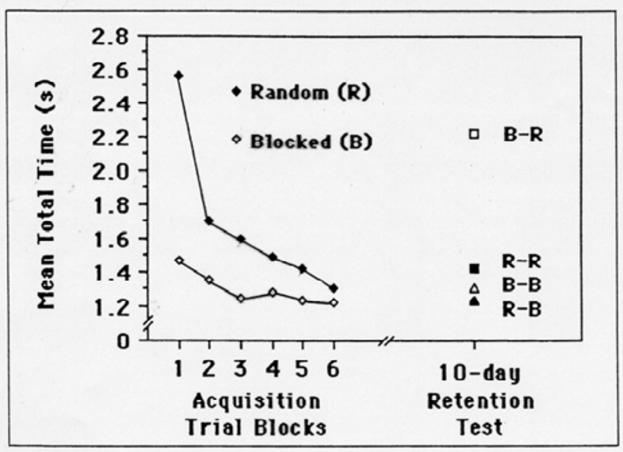
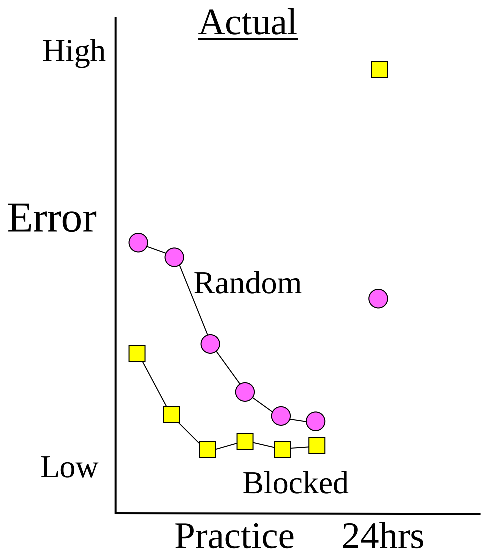
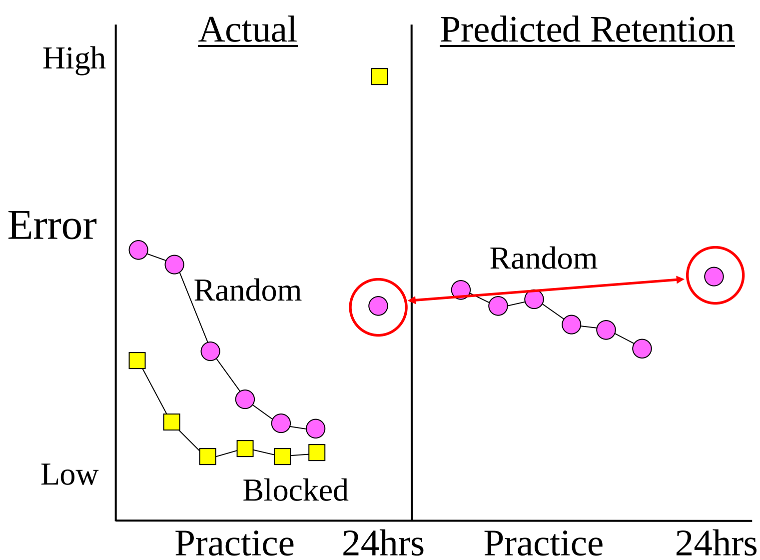


Fig. 1. Performance on movement speed tasks under random (R) and blocked (B) conditions in acquisition and, after 10 days, in retention tests under random or blocked conditions; in retention, the first letter indicates the acquisition condition, and the second represents the retention condition. Redrawn from Shea and Morgan (1979).

Simon & Bjork (2001)



Simon & Bjork (2001)



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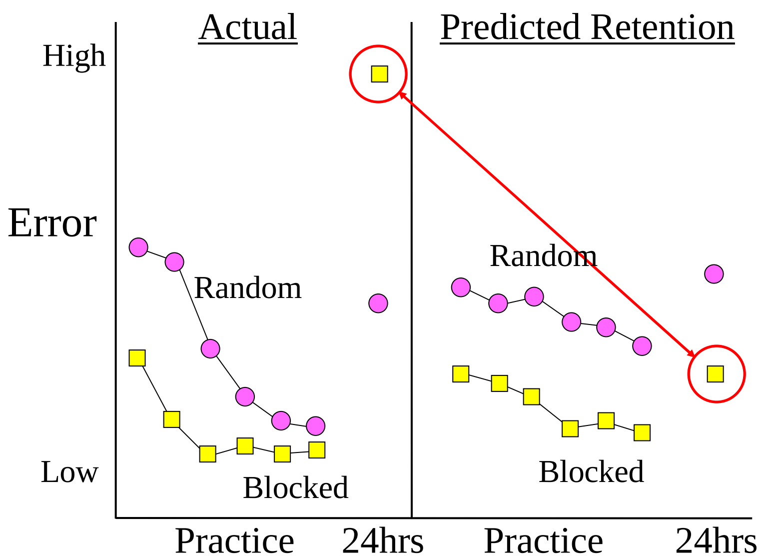
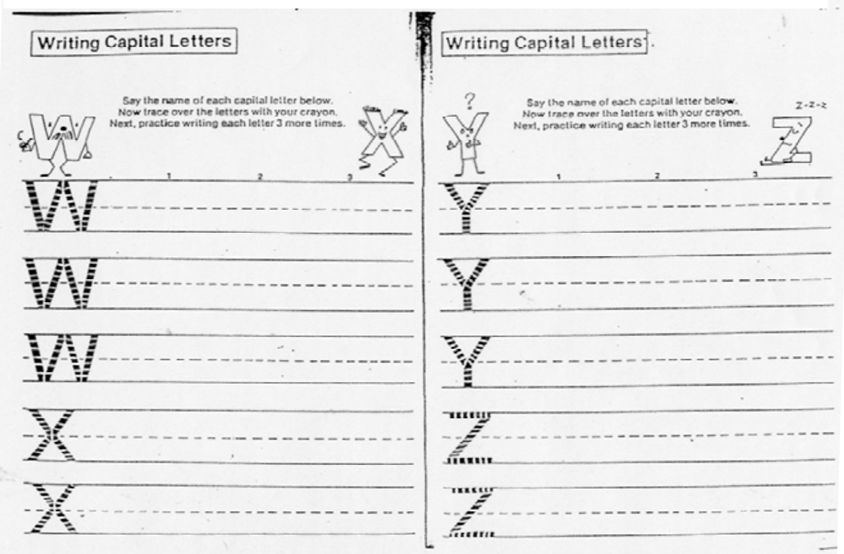


Contextual Variation

Ste-Marie, Clark, Findlay, & Latimer (2004)



From "My Creative Preschool Workbook" by Preschool Press, New York, New York: Playmore Inc., Publishers and Waldman Publishing Corp.

Distributing/Spacing of Practice

Baddeley & Longman (1979)

	Training Schedule		
1 x 1 hr	2 x 1 hr	1 x 2 hr	2 x 2 hr
Hours to Learn Keyboard			
34.9	42.6	43.2	49.7
Mean Satisfaction Rating 1 (Very Satisfactory) to 5 (Very Unsatisfactory)			
2.40	1.86	2.00	1.73

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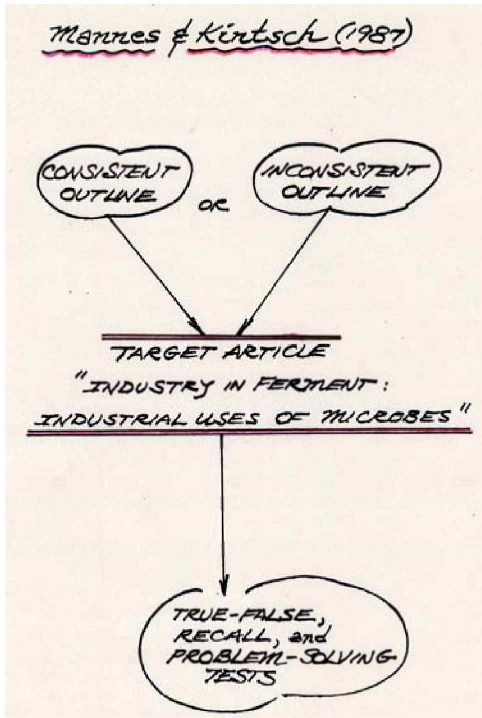

(Mannes & Kintsch, 1987)

Microbes

Although yeasts, molds, and bacteria don't require timecards or contracts, organizing them for factory-scale jobs is complicated and expensive. Microbes have been making beer and wine and bread and cheese for millennia. But it wasn't until 1912, more than four decades after their role in fermentation was finally understood, that bugs were put to work outside the food business.

That year Chaim Weizmann, a Russian chemist living in England who later became the first president of Israel, discovered a method for making butanol, a kind of alcohol. Weizmann used two species of Clostridium bacteria, one feeding on sugar and the other on starch, to make not only butanol but acetone. World War I helped create a ready market for these chemicals; butanol is used in the manufacture of synthetic rubber, and acetone is essential for making cordite, an explosive. But when peace returned, there was little demand for cordite, and eventually butanol became cheap to make from petrochemicals.

Today, with the major exception of the production of pharmaceuticals, industrial-scale fermentation is again largely confined to the manufacture of foods and beverages. Most of the things microbes can make are cheaper to produce synthetically, in particular by petrochemical processes that owe nothing to biology except the ultimate source of their raw materials, fossil fuels. But the range of things natural microorganisms could help produce is enormous: fuels, dyes, vitamins, the chemical precursors essential to the manufacture of everything from plastics to pesticides and thousands of other products.

Both economic and technical problems conspire to keep bugs from working as hard as they could. The complex business of taking a successful laboratory procedure off the bench and into the factory is called scaling up. And it applies equally to devising a process for making human pharmaceuticals a few grams at a time or to devising a thriftier means of producing inexpensive organic acids by the ton.

If biotechnology is to compete with the petrochemical industry, says Chaning Robertson, Stanford professor of chemical engineering, merely increasing the size of tanks and pipes is not the answer. Biochemical plants must be able to produce the same concentration of a given product in roughly the same amount of time. "In the traditional processes I looked at," says Robertson, "the productivities were orders of magnitude less than the typical petrochemical facility. You certainly wouldn't want to build a biochemical plant that was 10,000 times bigger." The size of even a small fermentation vat-a bioreactor in the jargon of the trade-is enormous compared to the modest quantities of chemical finally extracted.

So one major goal of biochemical engineers is to miniaturize the hardware wherever possible. Bioreactors vary from something the size of a beer keg to something looking more like a municipal water tank. Inside, vigorously stirred by paddles to keep the fermenting broth well blended, the bugs seethe and multiply into billions. A maze of

MICROBES CAN MAKE ANYTHI NG

I. MICROBES
A. MICROO RGANISMS CAN BE USED TO MAKE A POTENTIALLY LARGE NUMBER OF THINGS.
1. NATURALLY
A. THEORETICALLY, BUGS (MICR OBES) CAN BE CHOSEN TO PRO DUCE VIRTUALLY ANY SUBST ANCE ANY CELL MARES NATURALLY A ND SOME THEY DO NOT.
B. THEY HAVE BEEN USED TO MAKE WINE, BEER, CHEESE, AND BREAD FOR MANY YEARS.
C. BACTERIA ARE REGARDED AS THE SIMPLEST FORMS OF YEAST AND MOLD CONTAINI NG NO CHLORO PHYLL.
D. MOST SPECIES OF BACTERIA ARE NOT PATHOGENIC (DISEASE CAUSING) AND ARE IN NO WAY RELATED TO INFECTION (ALTHOUGH THERE ARE M ANY SPECIES OF BACTERIA WHICH CAN ALTER OR DESTROY PLANTS AND ANIMALS WHICH MAN EN JOYS OR DEPEN DS ON AND WHICH CAUSE DISEASE, OFTEN FATAL TO MAN HIMSELF. THESE ARE STUDIED MORE OFTEN THAN OTHER TYP ES)
2. ARTIFICIALLY -MORE RECENTLY HAVE BEEN PRO MPTED USING METHODS SUCH AS RECOMBIN ANT DNA 10 MAKE CHEMICALS LIKE BUTANOL AND ACETONE. THIS PRODUCTI ON IS OFTEN ACCOMPLI SHED IN VATS WHERE, THE BItS SEETH AND MULTIPLY INTO BILLIONS AS THEY ARE VIGOR OUSLY STIRRED BY PADDLES TO KEEP THE MIXTURE OF BUGS WELL BLENDED. BUGS LIKE BACTERIA BRING THINGS IN AND MIX THEN UP WITHIN THEMSELVES MAKING A PRODUCE IN THE PROCESS.
B. AS HO OTHER FORMS OF LIFE, BACTERIA REQUIRE WATER, MINERALS, VITAMI NS AND SOURCES OF CARBON AND NITROGEN FOR GR(3'TH AND BACTERIA CONVENIENTLY CAN BE CLASSIFIED INTO THREE MAJOR GROUPS ACCORDING TO THE MATERIALS THEY EMPLOY AS SOURCES OF ENERGY. SOME USE ORGANIC COMPOUNDS, SOME UTILIZE RADIANT ENERGY AND STILL OTHERS OXIDIZE INO RGANIC MOLECUL ES.
1. UNDER CO NDITIONS FA VORABLE TO GROWTH, BACTERIA MULTIPL Y IN GEOMETRIC PROGRE SSION: 2,4,8,16,32,64 WHEN FIRST TRAN SFERRED '10 A FAVORABLE ENVIR ONMENT, THERE IS A PERIOD OF ADJUSTMENT, FOLLOWED BY A MULTIPLICATION OF SOME CELLS, THEN OF NEARLY ALL CELLS, AND THEN A GRADUAL SLOWING DONN OF MULTIPLICATION UNTIL FI NALLY THERE IS NO NET INCREASE. DURING THIS TIME, BACTERIA HAVE ENLARGED AND DIVIDED MANY TIMES, PRODUCED VARIO US ENZYMES, CHANGED S OME OF THE CHEMICAL OF THEIR ENVIRONMENT, AND A BSORBED SOME SUBSTANC ES ALREADY PRESENT OR FORMED .
2. NEARLY ALL KNOWN ENZYMES ARE PRODUCED BY ONE OR ANOT HER KIND OF BACTERIA AND MANY NOT KNOWN OUTSIDE OF BACTERIOLOGY (THE STUDY OF BACTERIA) AR FORMED .
3. THESE BUGS H AVE NOT BEEN ALLOWED '10 DO AS MUCH AS THEY ARE CAPABLE OF BECA USE OF ECONOMICAL AND TECHNICAL REASONS. FOR ONE THING, ORGANIZING MICROBES FOR FACTORY -SCALE JO BS CAN BE VERY EXPENSIVE AND PRODUCTS CAN OFTEN BE MADE SYNTHETICALLY MUCH CHEAPER THAN BY ENLISTI NG MICR OORG ANISMS. TECHNICALLY, ORGANI ZING MICROBES FOR FACTORY-SCALE WORK IS QUITE COMPLICATED.
C. NATURAL VS WILD
1. NATURAL OR WILD OR GANISMS ARE MUCH STURDIER THAN THE ONES CREATED WITH RECOMBINA NT TECHNIQUES.
A. THE WILD BUGS TOLERATE A WIDER RANGE OF E NVIRO NMENTAL CONDITIO NS AND TEMPERATURES. IN FACT THE FEEBLE RECOMBINANTS NEED TO BE CODDLED IN AN E NVIRO NMENT MORE LIKE A REST HOME THAN A FACTORY.
B. WILD MICROBES THRIVE AT RO OM TEMPERATURE, THEY REPLACE THEMSELVES FASTER THAN THEY WEAR OUT AND THEY ARE NOT PICKY EATERS.

CHARACTERISTICS OF MICROBES

I. BACTERIA ARE REGARDED AS THE SIMPLEST FORMS OF YEAST AND MOLD CONTAINING NO CHLOROPHYLL.

II. BACTERIA CAN BE *CLASSIFIED ACCORDING* TO FOUR CHARACTERISTICS

A. MICROSCOPIC APPEARANCE AND STAINING REACTION (MORPHOLOGY)
1. MOST BACTERIAL FORMS RANGE IN SIZE FROM .5 TO 10 MICRONS IN LENGTH. A MICRON .001 MILLIMETER.
2. MORPHOLOGICALLY (IN FORM AND STRUCTURE), BACTERIA FALL INTO 4 CATEGORIES.
A. APPROXIMATELY SPHERICAL-COCCUS
B. ROD OR CYLINDRICAL-BACILLUS
C. RIGID COILED ROD-SPIRILI
D. FLEXIBLE HAIRLIKE-SPIROCHETE
3. COLONIES OF BACTERIA MAY BE TRANSLUCENT (CLEAR) OR OPAQUE; WHITE, VIOLET, YELLOW, OR COLORLESS ;SHINY OR DULL;AND VISCOUS, PASTY OR CRUMBLY IN CONSISTENCY.

B. PHYSIOLOGICAL CHARACTERISTICS (PRESENCE OF SPECIFIC PROTEINS AND CARBOHYDRATES)
1. BACTERIA CONTAIN NOT ONE BUT MANY ANTIGENS. ANTIGENS ARE ORDINARILY COMPLEX SUBSTANCES, WITH OR WITHOUT CARBOHYDRATES.
2. DIFFERENT SPECIES OF BACTERIA MAY HAVE ANTIGENS IN COMMON BUT IT IS NOT CLEAR TO WHAT EXTENT THIS SHOULD BE A BASIS FOR DEFINING A SPECIES, OR TO WHAT EXTENT IT SUBDIVIDES A SPECIES.

C. APPEARANCE OF GROWTH ON THE SURFACE OF SOLID MEDIA OR LIQUID MEDIA (METABOLISM)
1. BUGS LIKE BACTERIA BRING THINGS IN AND MIX *TEEM UP* WITHIN THEMSELVES MAKING A PRODUCT IN THE PROCESS. UNDER CONDITIONS FAVORABLE TO GROWTH, BACTERIA MULTIPLY IN GEOMETRIC PROGRESSION: 2,4,8,16,32,64 WHEN FIRST TRANSFERRED TO A FAVORABLE ENVIRONMENT, THERE IS A PERIOD OF ADJUSTMENT, FOLLOWED BY A MULTIPLICATION OF SOME CELLS, THEN OF NEARLY ALL CELLS (THEY REPLACE THEMSELVES FASTER THAN THEY WEAR OUT), AND THEN A GRADUAL SLOWING DOWN OF MULTIPLICATION UNTIL FINALLY THERE IS NO NET INCREASE. DURING THIS TIME, BACTERIA HAVE ENLARGED AND DIVIDE!) MANY TIMES, PRODUCED VARIOUS ENZYMES, CHANGED SOME OF THE CHEMICALS OF THEIR ENVIRONMENT, AND ABSORBED SOME SUBSTANCES ALREADY PRESENT OR FORMED.

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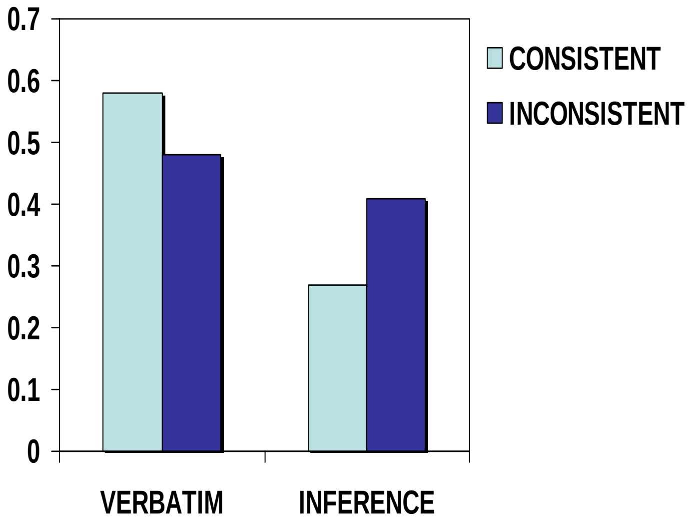
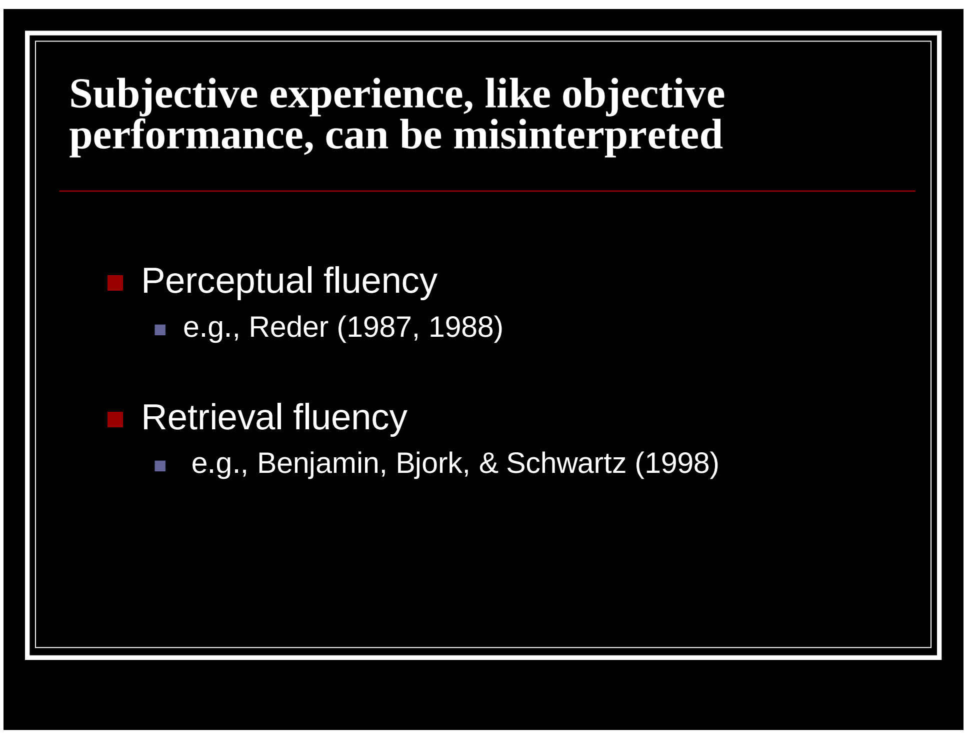
Mannes & Kintsch (1987)



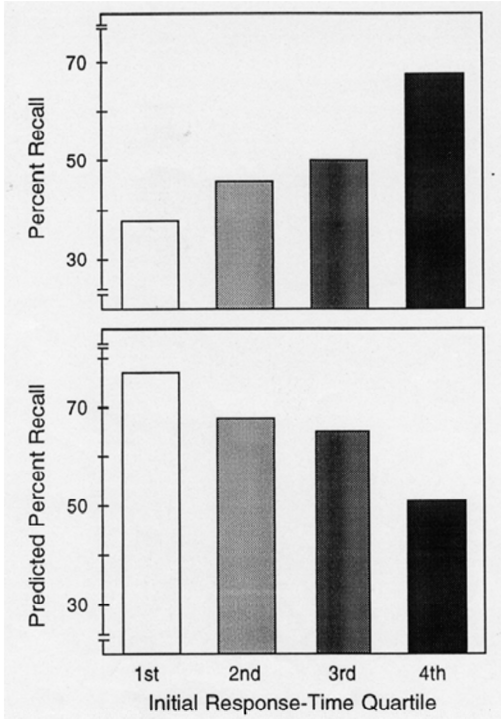


(Reder, 1987, 1988)

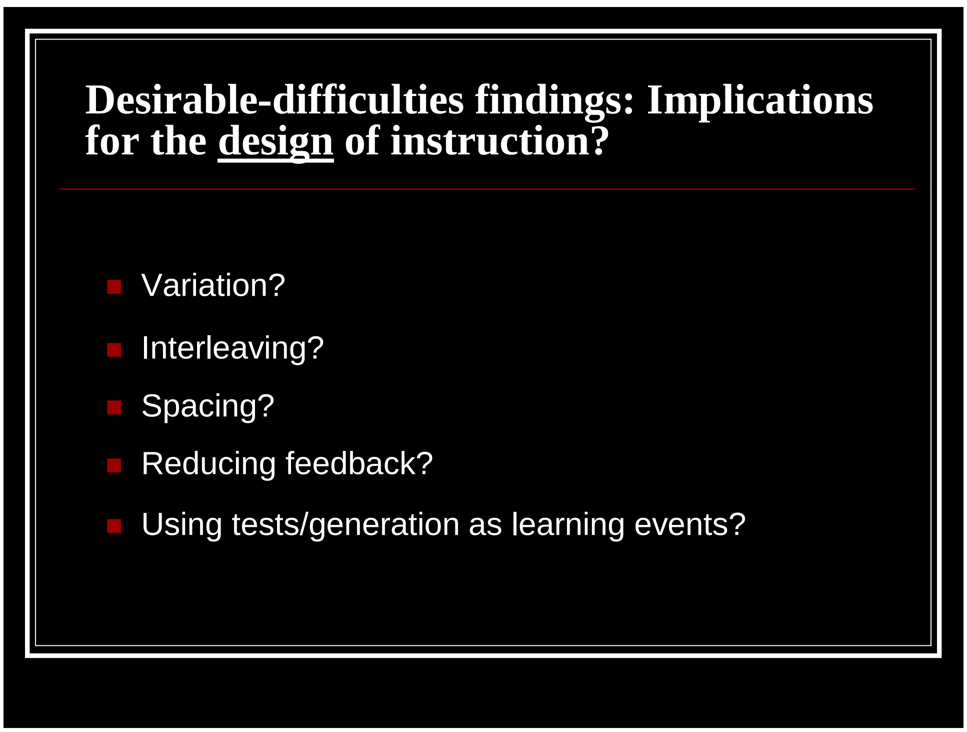
"What is the term in golf for scoring one under par?"

Benjamin, Bjork, and Schwartz (1998)

- Question phase (20 easy general knowledge questions)
  - E.g., "Who was the first president of the United States?"
  - For each question, participants
    - 1. hit enter button when answer "came to mind" (response time recorded);
    - 2. typed answer;
    - 3. predicted subsequent free recall of the answer
- Distraction (20 minutes of puzzle solving)
- Free-recall test for answers generated during the question phase



Percent Recall
70
50
30
Predicted Percent Recall
70
50
30
1st
2nd
3rd
4th
Initial Response-Time Quartile



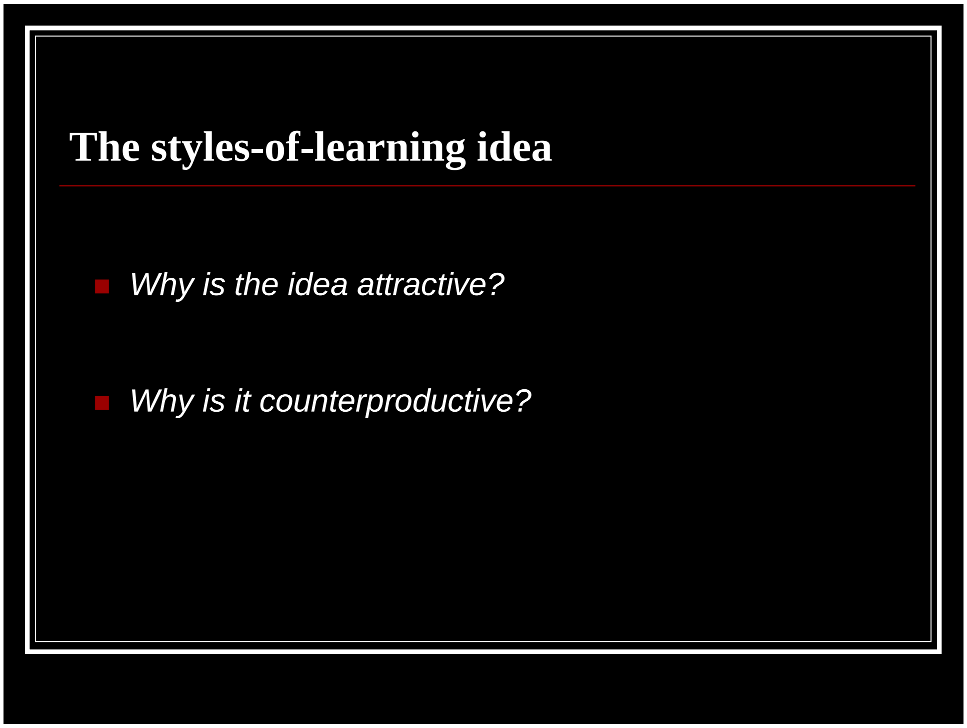
Desirable-difficulties findings: Implications for the design of instruction?
Variation?
Interleaving?
Spacing?
Reducing feedback?
Using tests/generation as learning events?

Desirable-difficulties findings: Implications for the evaluation of instruction?

- Students' evaluation of teaching?
- "Happy" or "smile" sheets in industry?
- Expectations as to how courses should be taught?
- Continuing education "courses"?

How we learn versus how we think we learn

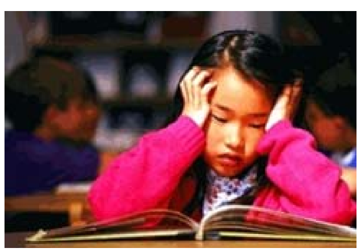
- Misconceptions
  - We have a faulty mental model of ourselves as learners (human memory versus a videotape recorder)
  - Intuition versus research: We are not, apparently, educated by the trials and errors of everyday living and learning
- Counterproductive attitudes and assumptions
  - Performance indexes learning
  - Efficient learning is easy learning
  - Individual differences and the *styles-of-learning* idea



Parents Of Nasal Learners Demand Odor-Based Curriculum

March 15, 2000 | Issue 36•09

COLUMBUS, OH–Backed by olfactory-education experts, parents of nasal learners are demanding that U.S. public schools provide odor-based curricula for their academically struggling children.



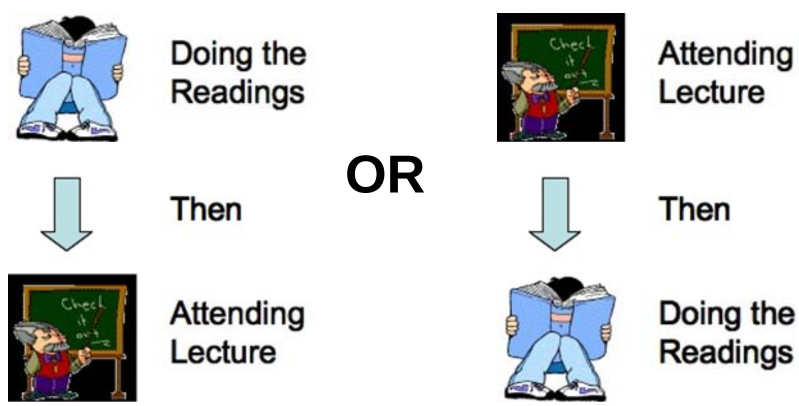
A nasal learner struggles with an odorless textbook.

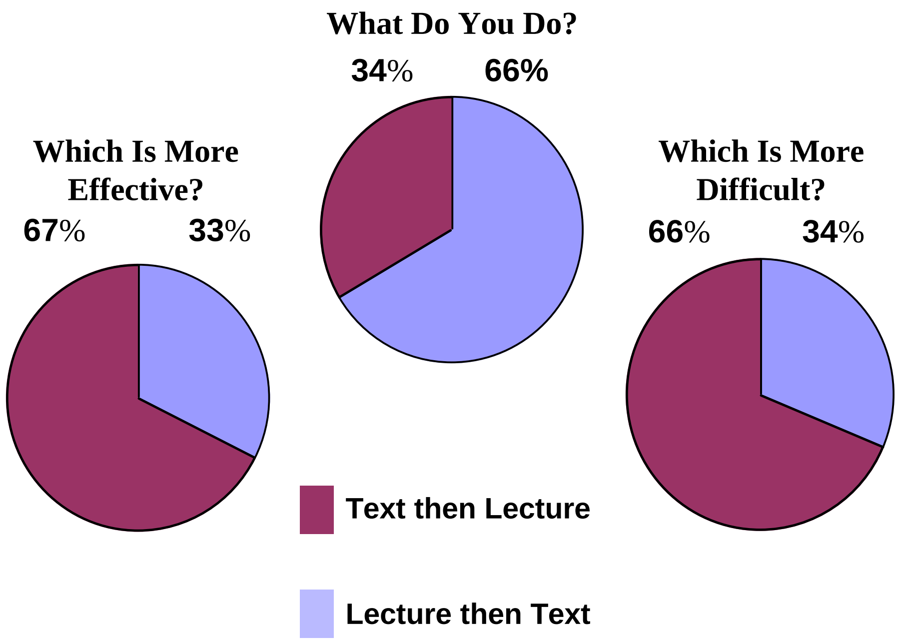
"Despite the proliferation of countless scholastic tests intended to identify children with special needs, the challenges facing nasal learners continue to be ignored," said Delia Weber, president of Parents Of Nasal Learners, at the group's annual conference. "Every day, I witness firsthand my son Austin's struggle to succeed in a school environment that recognizes the needs of visual, auditory, tactile, and kinesthetic learners but not him." … "My child is not stupid," Weber said. "There simply was no way for him to thrive in a school that only caters to traditional students who absorb educational concepts by hearing, reading, seeing, discussing, drawing, building, or acting out."

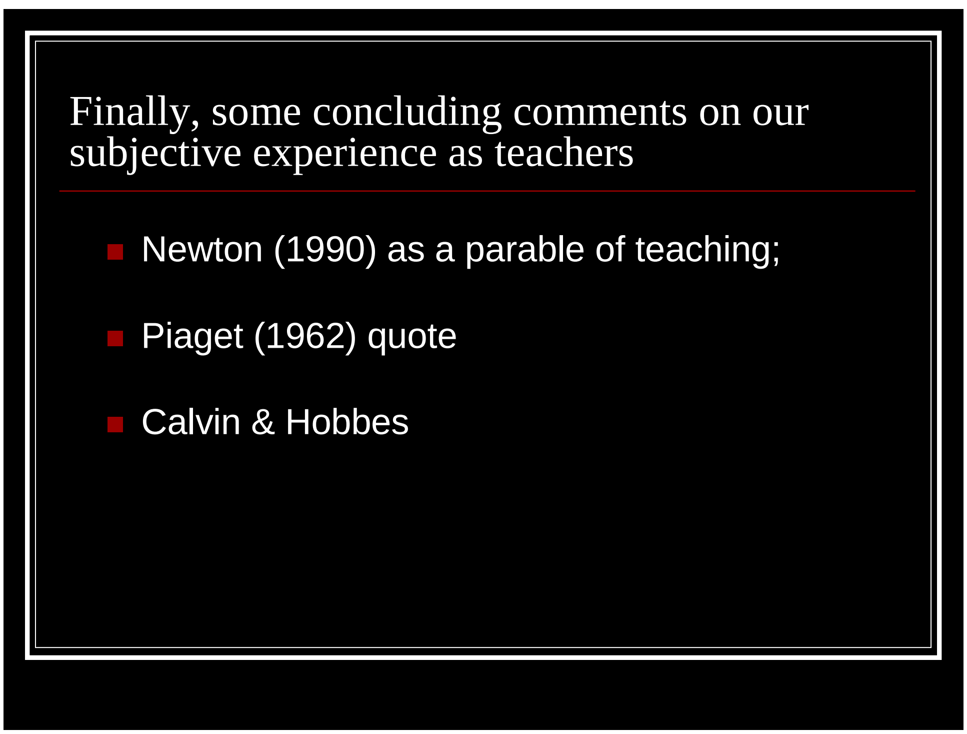
Individual difference *do* matter, and matter greatly

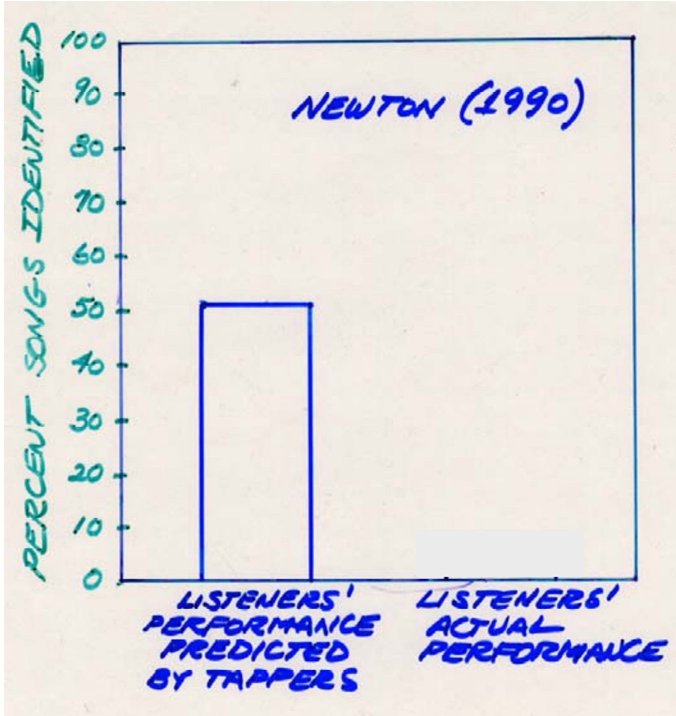
- New learning builds on--and depends on--old learning
- Personal, family, and cultural histories affect, among other things
  - Motivation to learn;
  - The degree to which learning is valued;
  - Aspirations and expectations with respect to learning;
  - The knowledge and assumptions brought to new learning
- Example: Lee and Bjork (2004)

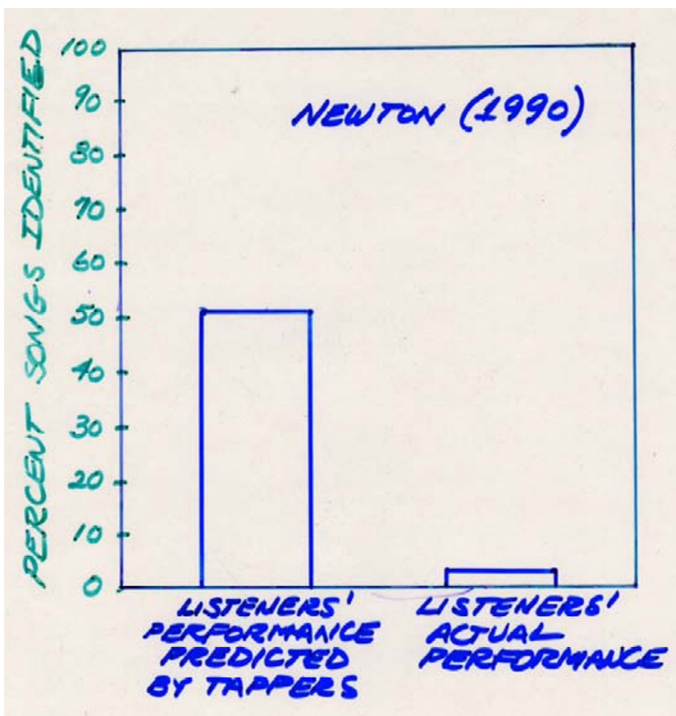
Which Order Is Optimal?




What Do You Do?
34%
66%
Which Is More Effective?
67%
33%
Which Is More Difficult?
66%
34%
Text then Lecture
Lecture then Text

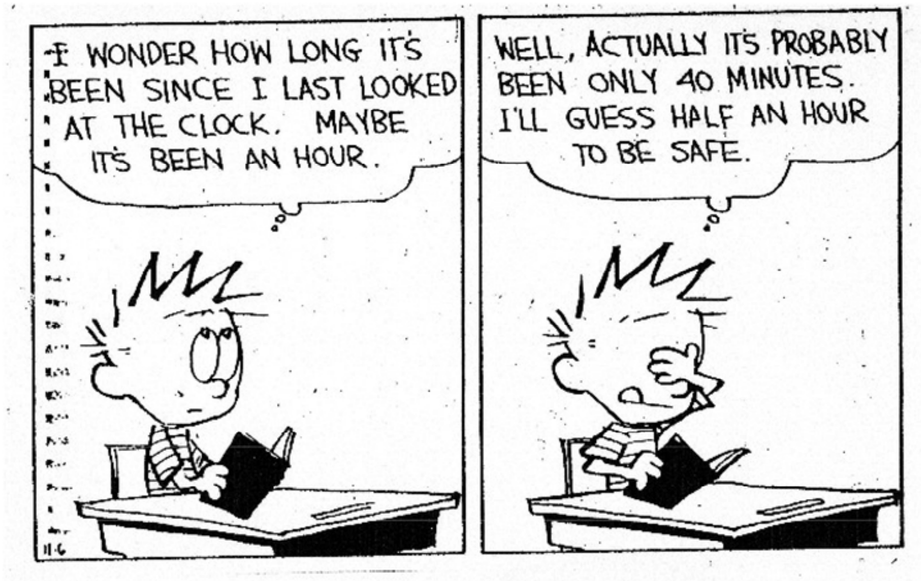

Finally, some concluding comments on our subjective experience as teachers
Newton (1990) as a parable of teaching;
Piaget (1962) quote
Calvin & Hobbes

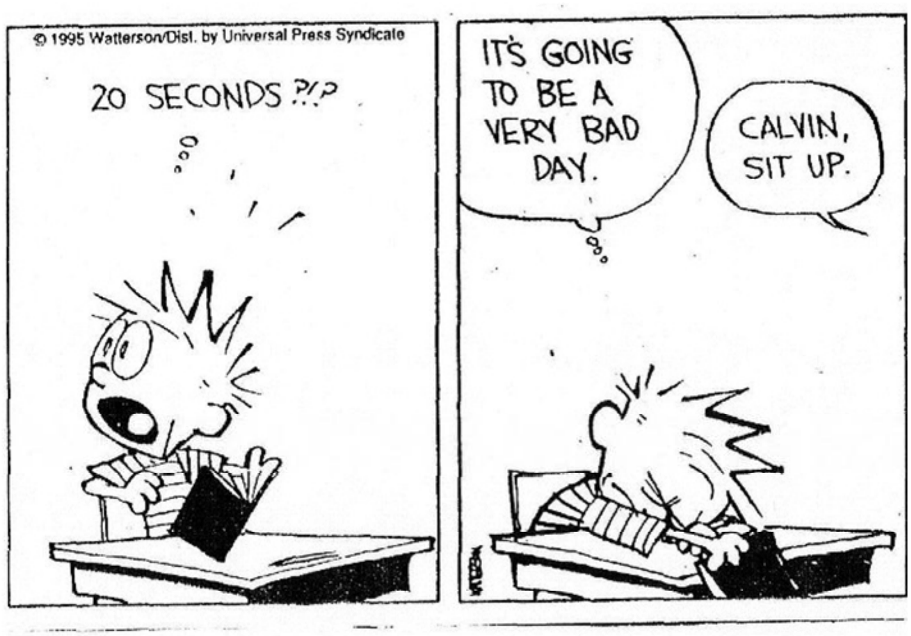

PERCENT SONGS IDENTIFIED
100
90
80
70
60
50
40
30
20
10
0
NEWTON (1990)
LISTENERS' PERFORMANCE PREDICTED BY TAPPERS
LISTENERS' ACTUAL PERFORMANCE


PERCENT SONGS IDENTIFIED
100
90
80
70
60
50
40
30
20
10
0
NEWTON (1990)
LISTENERS' PERFORMANCE PREDICTED BY TAPPERS
LISTENERS' ACTUAL PERFORMANCE

Piaget (1962)

"Every beginning instructor discovers sooner or later that his first lectures were incomprehensible because he was talking to himself, so to say, mindful only of his point of view. He realizes only gradually and with difficulty that it is not easy to place one's self in the shoes of students who do not yet know about the subject matter of the course."

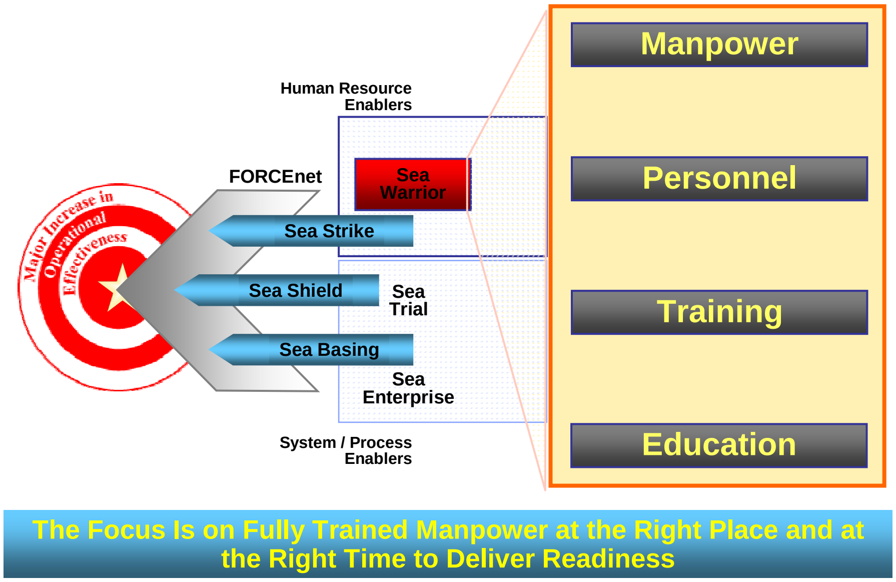

I WONDER HOW LONG IT'S BEEN SINCE I LAST LOOKED AT THE CLOCK. MAYBE IT'S BEEN AN HOUR.
WELL, ACTUALLY IT'S PROBABLY BEEN ONLY 40 MINUTES. I'LL GUESS HALF AN HOUR TO BE SAFE.


© 1995 Watterson/Dist. by Universal Press Syndicate
20 SECONDS?!?
IT'S GOING TO BE A VERY BAD DAY.
CALVIN, SIT UP.

Sea Warrior and the Revolution in Training: The Right Person, Right Place, Right Skill, Right Time, Best Value

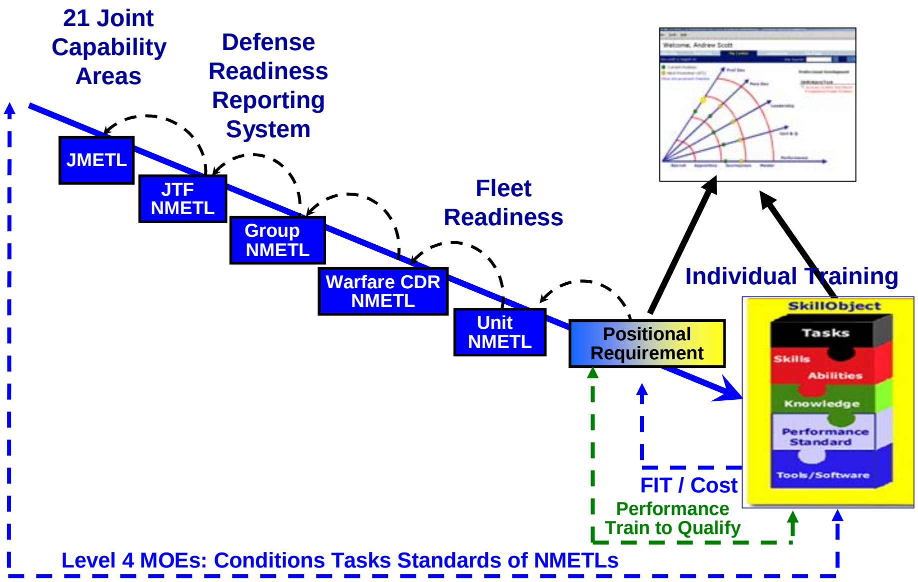
VADM Kevin Moran

SEA WARRIOR



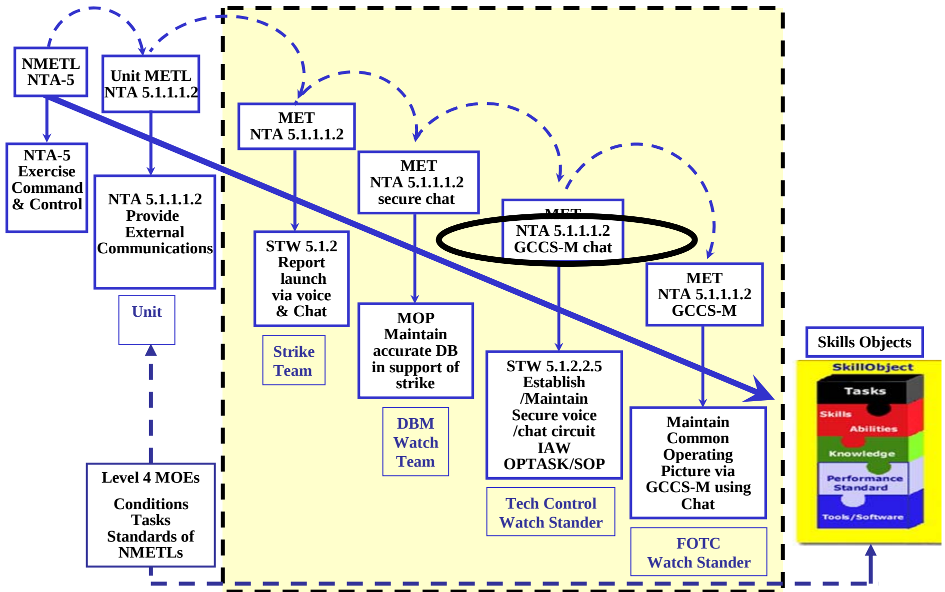
- **Under the direction of CNO Clark, the Navy embarked on a vision for how it was going to fight in the 21st Century called Sea Power 21.**
- **Sea Power 21 has 3 major Pillars: Sea Strike, Sea Shield and Sea Basing. Those pillars are supported and integrated through FORCEnet.**
- **Additionally, there are three major enablers to the vision: Sea Enterprise, Sea Trial and Sea Warrior. Sea Warrior is focused on how you prepare the work force to deliver Fleet readiness.**
- **The ultimate goal of Sea Warrior is to deliver the right Sailor, with the right training, to the right place, at the right time.**
- **The foundation of Sea Warrior is the Revolution in Training, which focused on what a Sailor needed to know, and when they needed to know it.**
- **The Revolution in Training built a data base of Knowledge, skills, abilities and tools (KSAT's) required for every rating in the USN at the apprentice, journeyman and master level. Those KSAT's were then linked to positions and will ultimately be connected to the Defense Readiness Reporting System. Task Force EXCEL, the Naval Personnel Development Command and the Naval Education and Training Command were responsible for delivering on the Revolution in Training.**
- **There were two major commands involved in Sea Warrior, CNP's organization and the Naval Education and Training Command (NETC). These were two major corporations with different cultures, different IT systems and different perspectives on risk. In order to deliver on the full vision of Sea Warrior, it became obvious a merger of these two organizations was necessary. That merger was blessed by the CNO and began in July of 2005 and is ongoing.**
- **During SECNAV's visit to Pensacola, he will visit the Center for Naval Aviation Technical Training and will get to see some of the significant changes that were made in the Revolution in Training in order to better prepare Sailors for the challenges they will encounter in the 21st Century Navy.**

SEA WARRIOR
Bringing It All Together

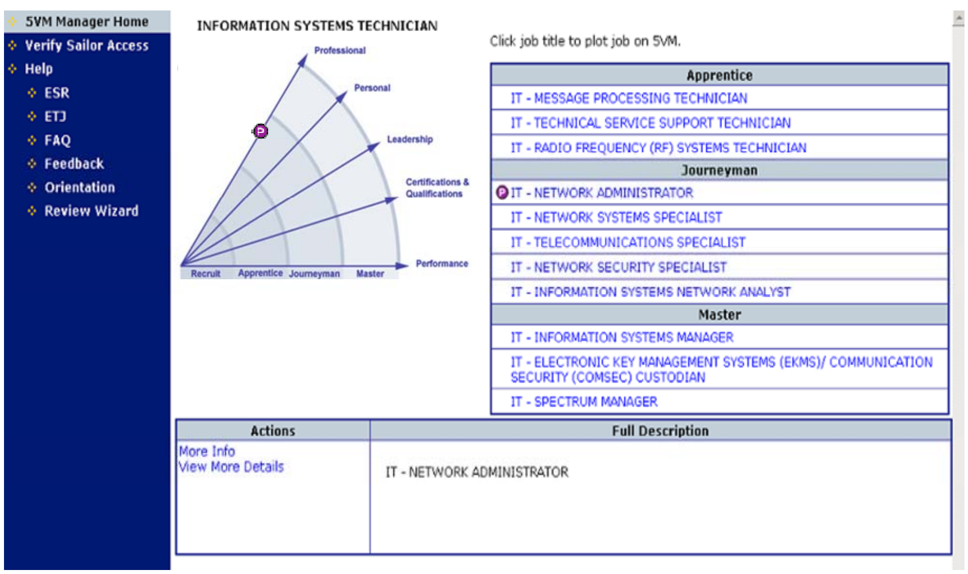


- **Once we finished building the SO's for the various ratings, we had to find a way to link them to the Navy's top line, which is readiness. DOD and the Navy are moving to the new Defense Readiness Reporting System (DRRS), which is based on the Joint Mission Essential Task List (JMETL's). FFC mapped the JMETL down to Navy Mission Essential Task List (NMETL's).**
- **We were able to connect the "Tasks" from the KSATs to the "Tasks" in the NMETL's.**
- **Once you make those connections, you need metrics to tell you how you are doing preparing Sailors to fit the positions. The Fleet looks at the conditions, tasks and standards of the NMETL's to gage performance of the units themselves.**
- **We in the MPT&E business look at "FIT", which is a comparison of the Rate, Rating and NEC required for a position compared to the qualifications of the Sailor actually in the position. We will then divide that by the cost to deliver that Sailor and we will have a productivity metric for the MPT&E part of the business.**
- **We are also moving toward performance based metrics in our school houses. In the near future, a Sailor will no longer take a multiple choice test to get a qualification. They will have to sit down on some simulation, or equipment and demonstrate key performance parameters before we will pass them on to the Fleet as qualified. You have to do that for optimally manned units like Littoral Combat Ship(LCS). LCS only has 75 racks on board, and will be one or two Sailors deep in critical positions. Each of those Sailors has to cross the brow an up and ready round if the ship is to be successful.**

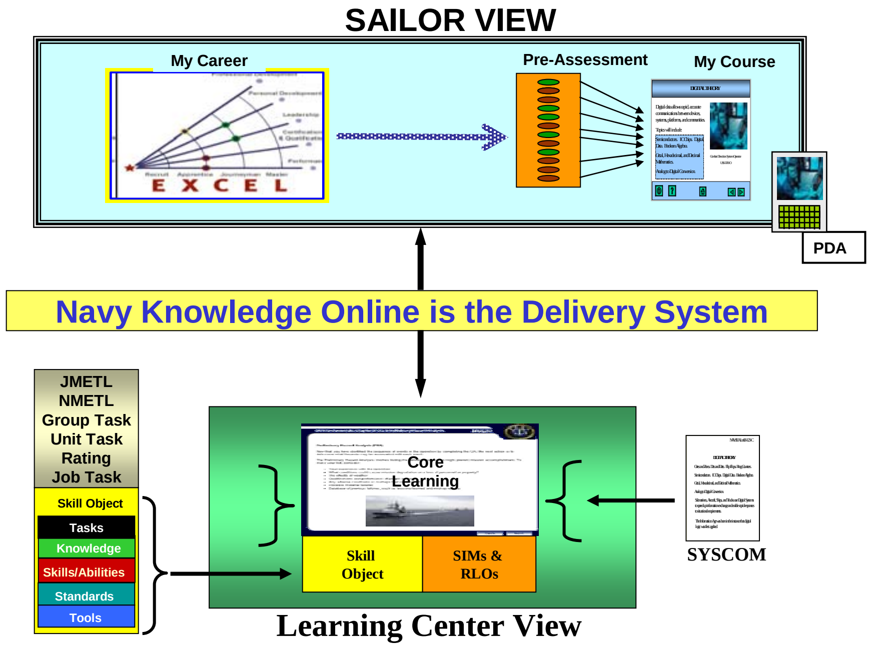
Fleet Process:
NMETL => Team => Watchstander => Skill Object



IT 5VM Example

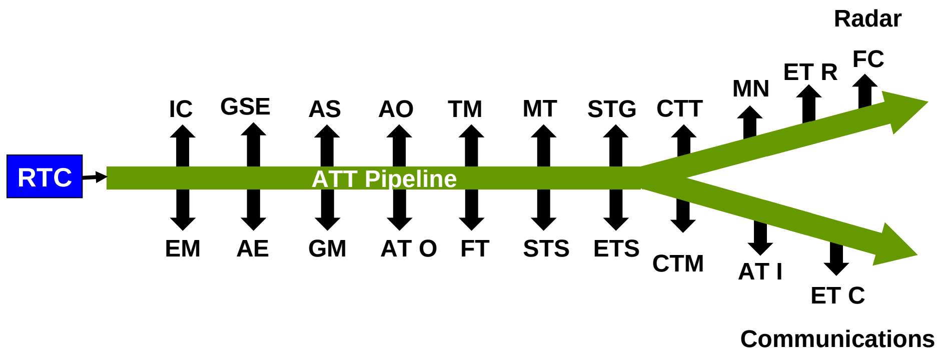


Integrated Learning Environment



- The Integrated Learning Environment (ILE) is the IT system that we will use to do the actual gap analysis between the SO's required for the position compared to what is actually in the Sailor's 5VM (resume). Once the gap is identified, we will pretest each individual to refine the gap.
- Once the gap is refined, the system will then reach into a meta data library and pull out Reusable Learning Objects (RLO's) to produce "my course," which is different than the course identified for the Sailor sitting next to him, or her. No longer will you check into a course on Monday and check out 6 weeks later. A large majority of the A school content is already on line and we are converting more and more every year.
- Navy Knowledge Online (NKO) is the portal used to deliver eLearning content for Sailors who are not in one of our school houses.
- The green block on the slide represents the SO required for the position and all the parts of the Navy that need to use and understand that data base. You will notice that we have the SYSCOM's on the slide. When a new system is procured, we get the Electronic Tech Manuals and the new training content associated with the system. We want the SYSCOM's to deliver the tech pubs, and the training content, in RLO format so that we can use the content and tech pubs from day one to teach in our school houses, to do maintenance and to place it on a PDA so that a Sailor is seeing the same content when they are actually out in the Fleet doing maintenance that they saw in the school house when they went through the training.
- Finally, the SO data bases should be used by the SYSCOM's to do manpower analysis for new units in order to determine the trade offs between manpower and technology. Either you pay for the up front costs associated with increased technology, or you pay the life cycle costs of the additional manpower.

Apprentice Technical Training and Associated "A" Schools



- Since implementation FY04, 25,000 Students have graduated
- To Date: Currently Mapped 20 Rating Paths
  - Projected FY06 IA Savings 1481.1 Man-Years / $86M

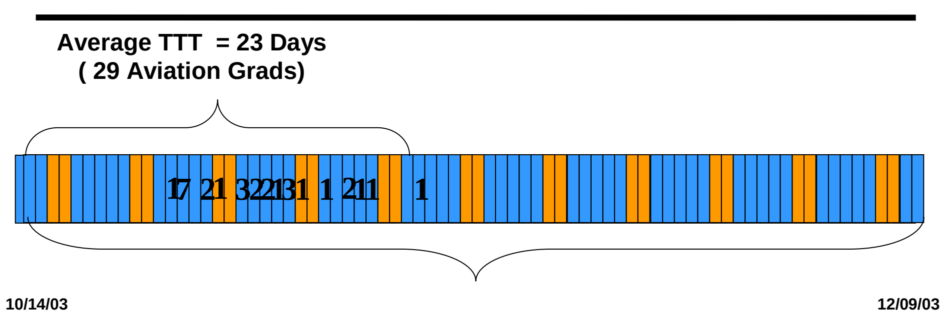
Apprentice Technical Training (ATT) Prototype Results (AT/AE) Pipeline

Start Dates

10/14/03 – 20 Students
10/16/03 – 9 Students

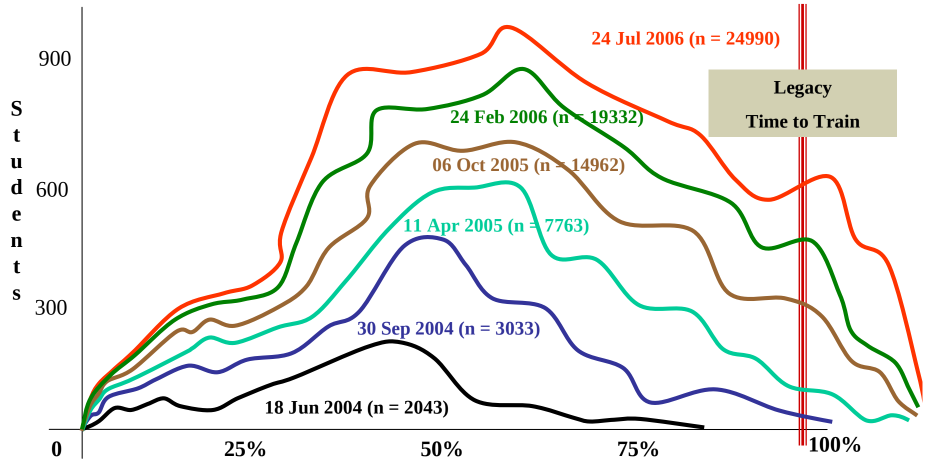
Averages

Outside Class (M-F) 9.0 hours
Outside Class (Weekends) 1.7 hours
Outside Class (Laptop): 5.3 hours

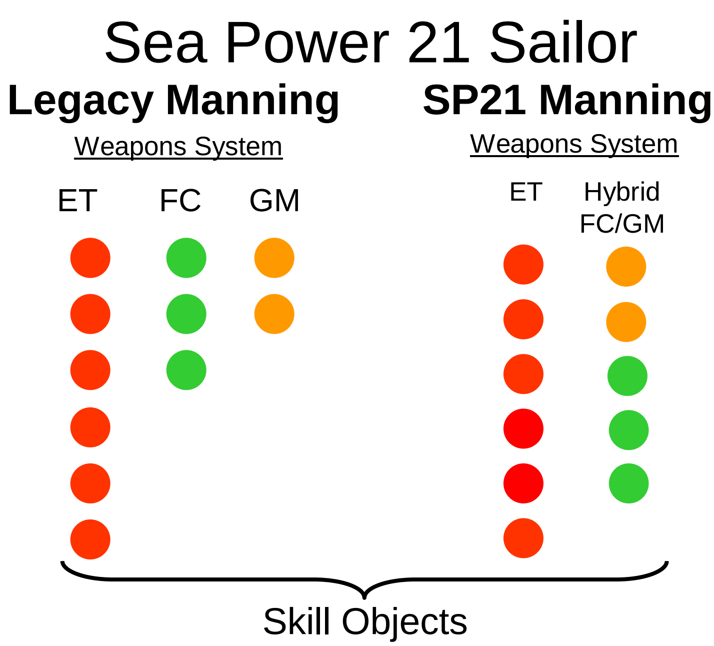


Legacy AV Core (54 Days)
Each Block = 1 Day (Brown = Weekend Day)

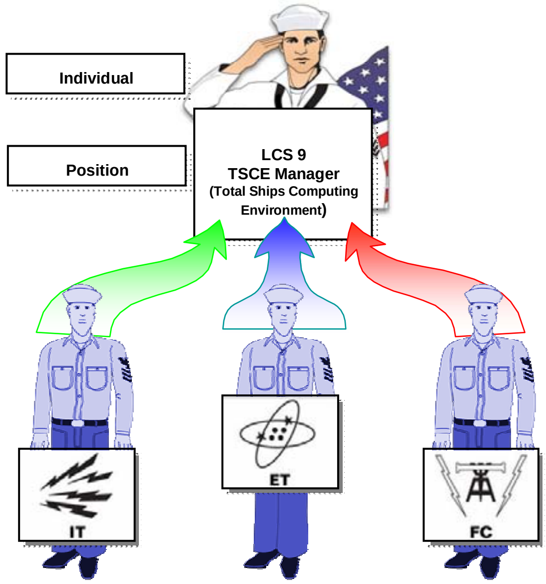
Time to Train Results
June 2004 – July 2006



Population (n) on 28 Jun 2006 = 24990 (**ATT**: 21211 **IC**: 697 **GM**: 818 **TM**: 218 **FC**: 1151 **ET**: 895)



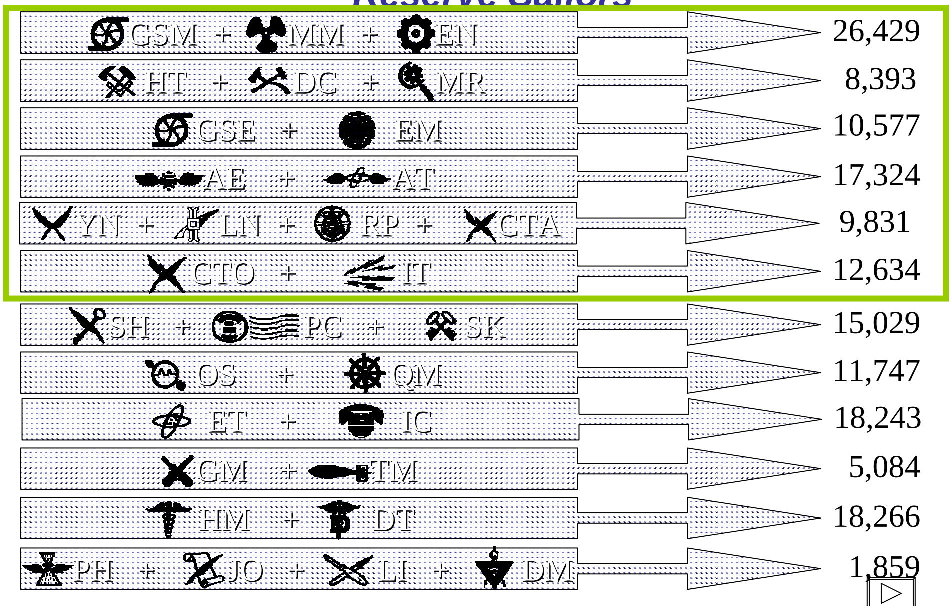
LCS Hybrid Sailor SkillObjects



ASSET MANAGEMENT AND DOCUMENTATION
AUDITING PROCEDURES
COMMUNICATIONS SECURITY INVENTORY MANAGEMENT
COMMUNICATIONS SECURITY MAINTENANCE
COMMUNICATIONS SECURITY MATERIAL CONTROL
HARDWARE CONFIGURATION
INFORMATION ASSURANCE
INFORMATION SECURITY MANAGEMENT
INFRASTRUCTURE PLANNING AND IMPLEMENTATION
INSTALLATION AND MIGRATION OF NETWORK ASSETS
INVENTORY MANAGEMENT
MESSAGE HANDLING PROCEDURES
MESSAGE PROCESSING ADMINISTRATION
MESSAGE SYSTEM CONNECTIVITY
MESSAGE SYSTEM OPERATIONS
RADIO FREQUENCY COMMUNICATIONS MANAGEMENT
COMMAND AND CONTROL SYSTEMS MAINTENANCE
COMMUNICATIONS SYSTEMS MAINTENANCE
COMPUTER SYSTEMS MAINTENANCE
ELECTRONIC EQUIPMENT ADMINISTRATION
ELECTRONICS SYSTEMS ADMINISTRATION
EHF EQUIPMENT MAINTENANCE
LF/HF RECEIVER EQUIPMENT MAINTENANCE
LF/HF TRANSMITTER EQUIPMENT MAINTENANCE
MAINTAIN CRYPTOGRAPHIC EQUIPMENT
MAINTAIN TACTICAL DATA EQUIPMENT
MESSAGE ROUTING SYSTEM MAINTENANCE
MULTIPLEXING EQUIPMENT MAINTENANCE
SATELLITE COMMUNICATION EQUIPMENT MAINTENANCE
UHF TRANSCEIVER EQUIPMENT MAINTENANCE
VHF RECEIVER EQUIPMENT MAINTENANCE
VHF TRANSMITTER EQUIPMENT MAINTENANCE
COMBAT SYSTEM MAINTENANCE
COMPUTER MAINTENANCE
COMPUTER PERIPHERAL SYSTEM MAINTENANCE
DISPLAY SYSTEM MAINTENANCE
MAINTAIN FIBER OPTICS
NAVAL MESSAGE HANDLING
NETWORK DIAGNOSTICS
NETWORK MAINTENANCE
NETWORK MANAGEMENT
NETWORK OPERATION
NETWORK SYSTEM ADMINISTRATION
NETWORK SYSTEM VERIFICATION
NETWORK SYSTEMS MANAGEMENT
SOFTWARE CONFIGURATION
TRAINING OPERATIONS

Proposed Rating Mergers:

Affects over 155,000 Active Duty and Reserve Sailors



- **Nearly 140,000 sailors in 31 ratings could feel the effects of planned job mergers in the next 18 months.**
- **Fewer, broader career fields**
- **Will help Navy planners slice 25,000 from the ranks over the next few years — and possibly another 20,000 by 2011.**
- **“It expands the billet base for each community, which in turn increases opportunity,” said Vice Adm. Gerry Hoewing.**
- **Hoewing said rating mergers are part of an overall manpower strategy that looks to rework the Navy’s “total force” of active, reserve and civilian workers.**
- **Navy’s overall manning objective is clear: fewer sailors in broadly based career fields.**
- **Naval Engineering: 3 separate ratings mergers**
    - **GSM + MM + EN**
    - **HT + DC + MR**
    - **GSE + EM**
- **5 new ratings proposed:**
    - **Diver (1,250 sailors)**
    - **Explosive Ordinance Disposal (1,020 sailors)**
    - **SEAL (1,750 sailors)**
    - **Special Warfare Combatant Crewman (486 sailors)**
    - **Helicopter Aircrew (3,100 sailors)**

- **Ratings defined:**
    - **GSM = Gas-Turbine System Technician (Mechanical)**
    - **MM = Machinist's Mate**
    - **EN = Engineman**
    - **HT = Hull Repair Techician**
    - **DC = Damage Controlman**
    - **MR = Machinery Repairman**
    - **GSE = Gas-Turbine System Technician (Electrical)**
    - **EM = Electrician's Mate**
    - **AE = Aviation Electrician's Mate**
    - **AT = Aviation Electronics Technician**
    - **ET = Electronics Technician**
    - **IC = Interior Communications Electrician**
    - **SH = Ship's Serviceman**
    - **PC = Postal Clerk**
    - **SK = Storekeeper**
    - **CTO = Cryptologic Technician (Communications)**
    - **IT = Information Systems Technician**
    - **OS = Operations Specialist**
    - **QM = Quartermaster**
    - **YN = Yeoman**
    - **LN = Legalman**
    - **RP = Religious Programs Specialist**
    - **CTA = Cryptologic Technician (Administrative)**
    - **GM = Gunner's Mate**
    - **TM = Torpedoman's Mate**
    - **HM = Hospital Corpsman**
    - **DT = Dental Technician**
    - **PH = Photographer's Mate**
    - **JO = Journalist**
    - **LI = Lithographer**
    - **DM = Illustrator-Draftsman**

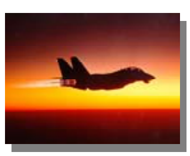
It’s a Total Force Solution

Domain / Work Elements		Global Job Title: Administrative Support — Military	Civilian	Industry
Classification		YN1 NETC	GS-0318: Secretary HPC	Administrative Supervisor
SkillObject		Correspondence Preparation	Correspondence & Reports	Manage Correspondence
Core Task		File Administrative Material	Maintains Office Records	Maintains Filing Systems
Primary Knowledge	K	Knowledge of clerical procedures such as managing files and records	Knowledge of priorities, duties, policies and program goals to maintain files and records	Knowledge of clerical procedures such as managing files and records
Primary Enabling Skill	S	Information Gathering	Plan & Organize Work	Information Gathering
Secondary Enabling Skill		Reading Comprehension	Use of English Language	Reading Comprehension
Primary Enabling Ability	A	Written Expression	Ability to interpret and apply rules	Written Expression
Secondary Enabling Ability		Oral Expression	Oral Communication	Oral Expression
Unique Knowledge		Customer and Personal Service		Problem solving principles and history of solving similar problems.
Tools/Software		Microsoft Word	Microsoft Word	Microsoft Word
Resources		Correspondence Manual	Correspondence Manual	Customer Satisfaction Manual

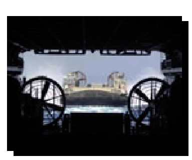
GWA WC

Sample data for illustration.

This is all about Fleet Readiness


If individual training doesn’t contribute to Fleet readiness, why are we doing it?



The Second Learning Revolution: How to Win World War IV

MG (RET) Robert H. Scales, PhD

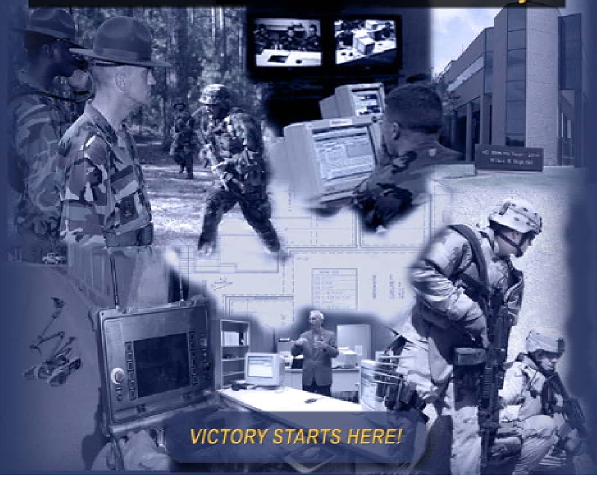
No Slides Provided

SCIENCE OF LEARNING WORKSHOP

GEN William S. Wallace

1 August 2006

TRADOC is the Architect of the Army



THE ARMY VISION

RELEVANT AND READY LANDPOWER IN SERVICE TO THE NATION

The Nation has entrusted the Army with preserving its **peace** and **freedom**, defending its **democracy** and providing **opportunities** for its Soldiers to **serve** the country and develop their skills and citizenship.

To fulfill our **solemn obligation** to the Nation, **The Army Vision is to remain the preeminent landpower on earth—the ultimate instrument of national resolve—that is both ready to meet and relevant to the challenges of the dangerous and complex 21st Century Security Environment.** The four means to achieve this vision are:

- Soldiers
- Leaders
- Modular Forces
- The Institution

Transformation is Ingrained in Everything we do... Today and in the Future

Relevant and Ready...Today and Tomorrow

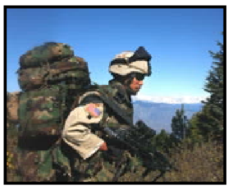
TRADOC VISION

ARCHITECT OF THE ARMY

Victory Starts Here! TRADOC is the Architect of the Army, and *"thinks for the Army"* to meet the demands of a Nation at war while simultaneously anticipating solutions to the challenges of tomorrow.

To shape both today's Army and the Future Combat Force, the Army's Architect:

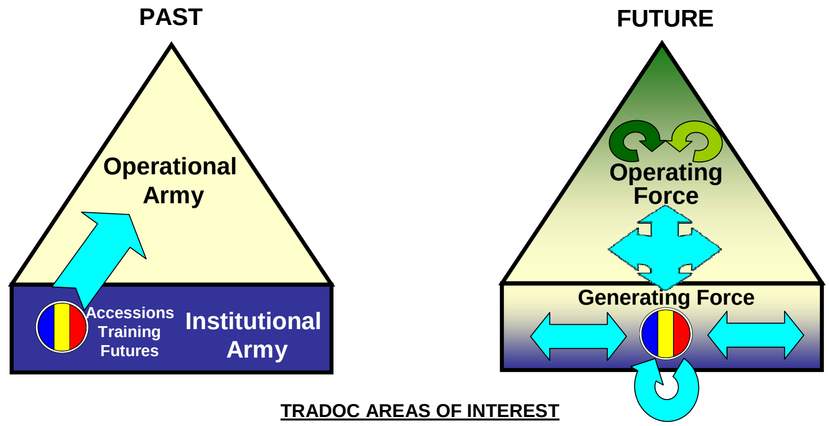
- Recruits and Trains Soldiers
- Develops Adaptive Leaders
- Designs today's Army Modular Force and the Future Combat Force
- **Maximizes Institutional Learning and Adaptation**



3

CONTEXT

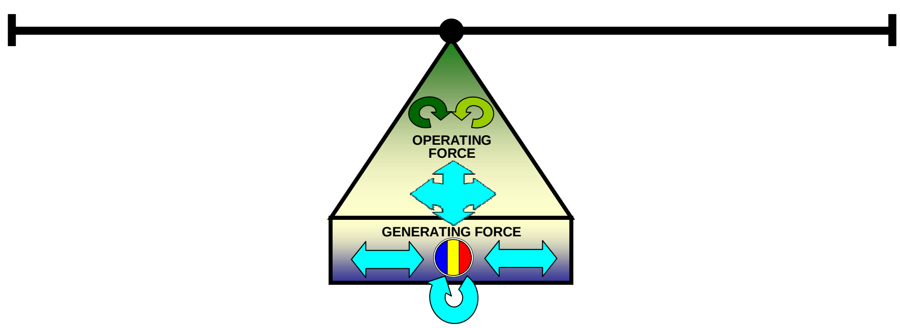
- Nation at war
- Protracted, full spectrum conflict
- Adaptive, asymmetric threat
  - Some niche capabilities better than ours
  - Use of commercial networks
  - Information Operations
  - No rules
- Tactical missions with strategic implications
- Cultural awareness impacts military operations
- Soldiers deploy shortly after arrival at first unit



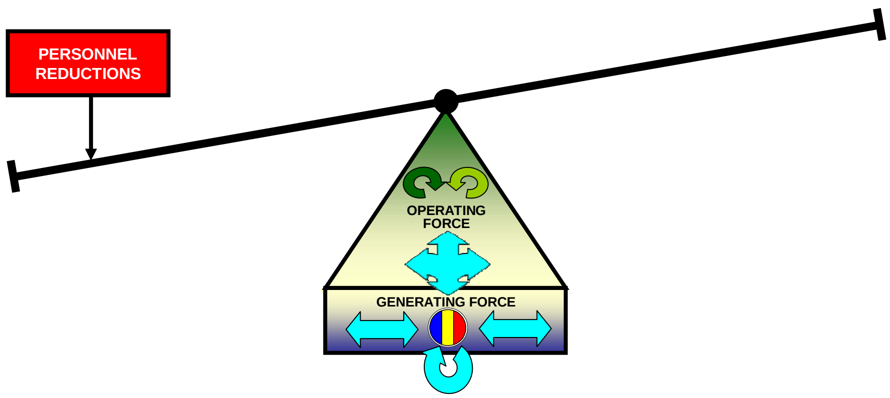
<u>TRADOC AREAS OF INTEREST</u>

- **ARFORGEN Support**
- **Adaptive Learning**
- **Reorganize for Excellence**
- **Requirements Process**
- **Generating Force**

KEEPING TRADOC IN BALANCE



KEEPING TRADOC IN BALANCE



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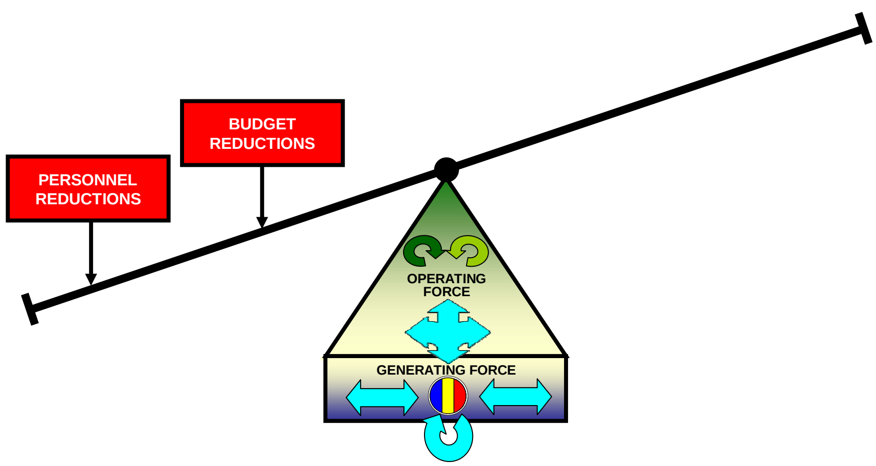
Victory Starts Here!

KEEPING TRADOC IN BALANCE



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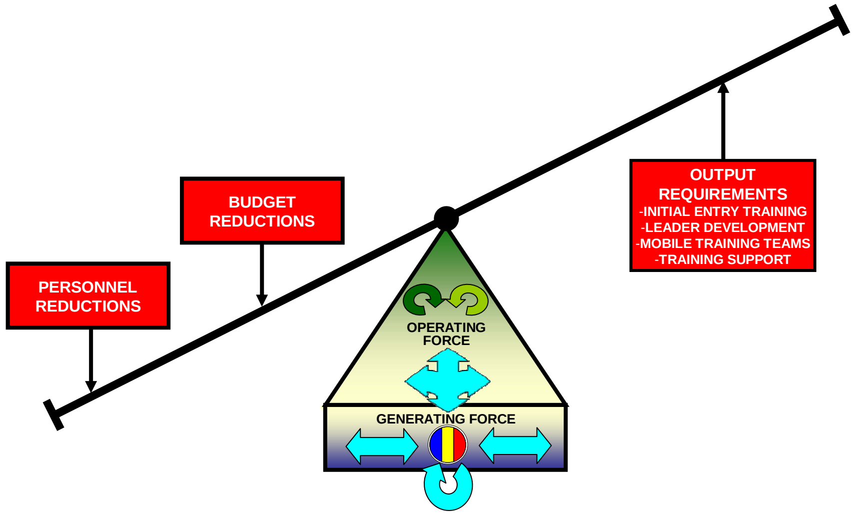
Victory Starts Here!

KEEPING TRADOC IN BALANCE



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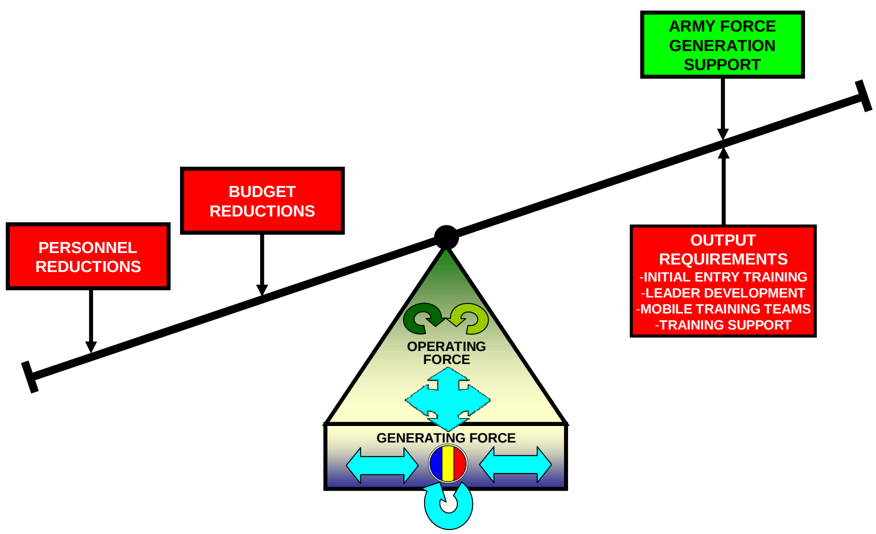
Victory Starts Here!

KEEPING TRADOC IN BALANCE



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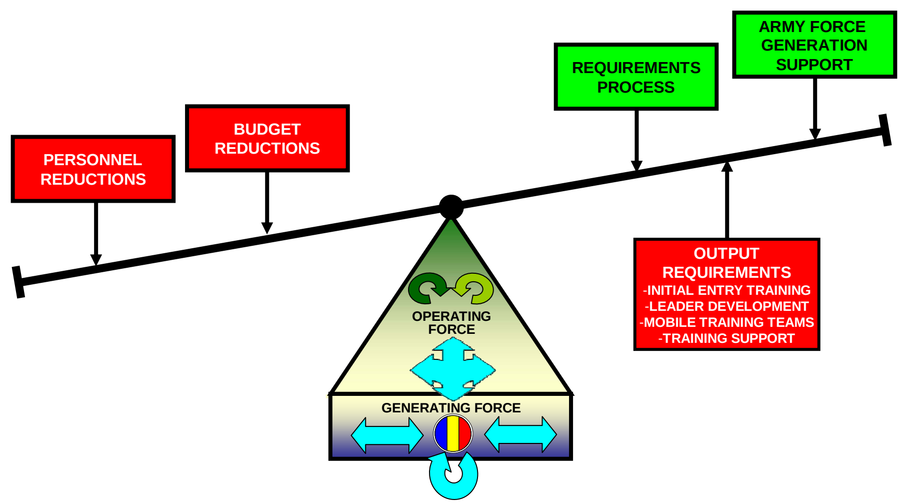
Victory Starts Here!

KEEPING TRADOC IN BALANCE



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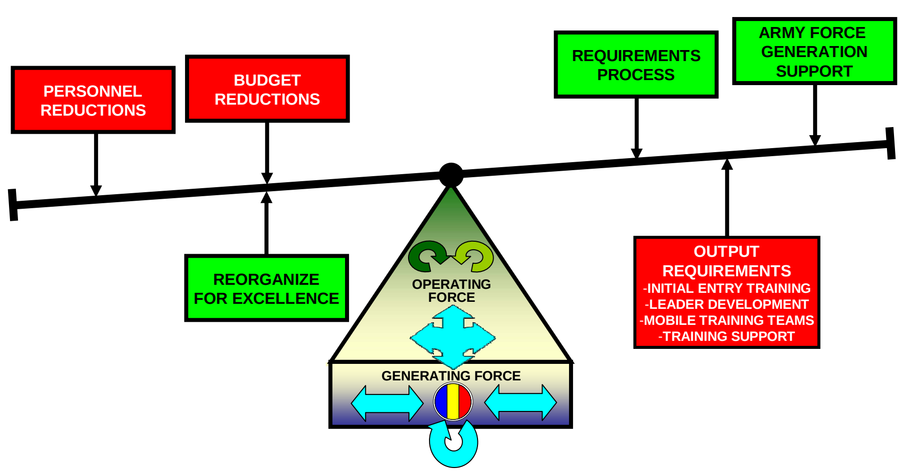
Victory Starts Here!

KEEPING TRADOC IN BALANCE



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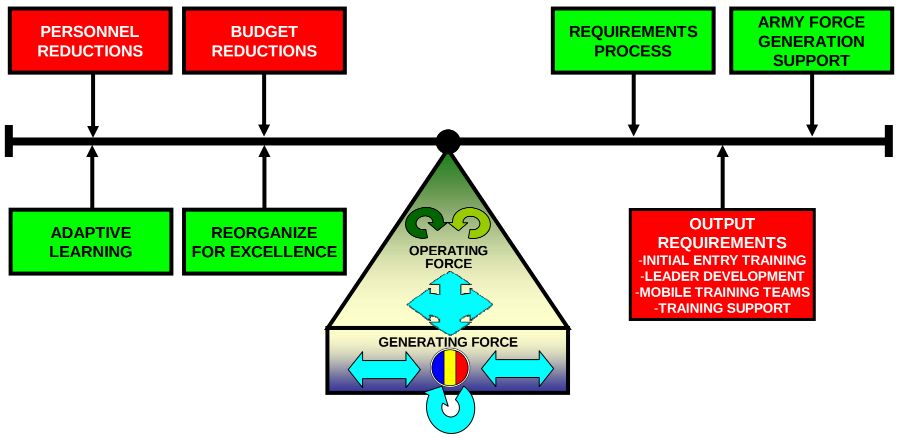
Victory Starts Here!

KEEPING TRADOC IN BALANCE



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Victory Starts Here!

APPENDIX E:

WHITE PAPERS

PAPERS FROM LEARNING MODELS WORKING GROUP

Learning Model

Science of Learning Workshop

U.S. Army Research Institute for the Behavioral and Social Sciences
And
Institute for Defense Analysis

Learning Model
Panel 1

Richard E. Clark

clark@usc.edu
Center for Cognitive Technology
http:\\cct.usc.edu
Rossier School of Education
University of Southern California
250 N. Harbor Drive, Suite 309
Redondo Beach, California 90277
July 13, 2006

The goal of this white paper is to encourage a dialogue that will identify and organize learning science findings and technologies to help the Army train soldiers and develop leaders. The objective of the science and technology identified is to accelerate learning and performance while maximizing effectiveness and minimizing resource requirements. The Army's current ISD - SAT training design strategy is based on learning models that are approximately 30 years old. If we retain the best of the past while adding the most effective current, research-based approaches we may achieve needed increases in both effectiveness and efficiency.

Overview

The first part of the paper will provide a very brief description of the three learning science models currently available in the social sciences to support training and leadership development. Then the discussion will turn to a description of some of the key learning factors and features of the most powerful training analysis, design and development models that appear to be based in the learning sciences. The "best practice" use of these models by other large scale institutions such as other branches of the military and large corporations will be briefly discussed. Next the discussion focuses on how individual, generational and cultural differences may (or may not) influence learning, motivation and performance during and after training. Finally, the paper concludes with recommendations for identifying critical features of the next generation of Army learning and performance systems along with conservative estimates of increases in effectiveness and efficiencies that might accompany their adoption.

Introduction
In the past two decades the National Research Council (NRC) has pursued a topic similar (but not identical) to the one addressed in this paper and have published a number of book size reports on learning, training and performance. The NRC has focused on the results of basic and applied research and evaluation in all of their reports.

The initial NRC strategy was to review the evaluation evidence for a number of “best practices” [1, 2] but soon changed their strategy to focus instead on “the implications of fundamental psychological or social psychological processes underlying performance” [3,4] The change was apparently due to the gradually developed view that best practice methods are not often effective - perhaps because they tend to be developed and implemented locally, fail to generalize and largely ignore well designed and relevant psychological process research which, if incorporated, would increase their effectiveness. At this juncture, there are approximately 50 learning and performance models (http://tip.psychology.org/theories.html) and over 100 instructional design models that compete for attention (http://carbon.cudenver.edu/~mryder/itc_data/idmodels.html).

This report will adopt the process approach suggested by the NRC. It begins with a very brief review of the three primary theories of learning that underlie much of the basic and applied research.

Three Learning Science Models:
In the past century, social scientists have adopted three different theories to understand learning. Each of the theories is connected to a number of “spin off” instructional models that focus on some but not all elements of the parent. While the models have developed roughly in the order listed below, some elements of all of these models persist today in training and educational design.

- *Behavioral models*[5] used a “black box” metaphor for our mind. Behaviorists attempted to gain insights about learning from the way that unobservable mental processes modified information (stimuli) input-output relationships. The careful measurement required by behaviorism helped develop clear specification of objectives, motivational components of treatments (reinforcement) and their performance consequences.

- *Cognitive models*[6] tended to use the linear computer as a metaphor for the mind. They assume that the mind manipulates symbols (through language) using mental “programs” that can be learned. Essential to the cognitive model are self-regulating metacognitive strategies such as planning and self-monitoring that help adults manipulate information and construct knowledge to achieve learning goals. From the perspective of cognitive models, effective instruction trains learners to develop learning strategies that help them achieve have, among other benefits, helped us provide effective instruction that supports the learning of conscious conceptual knowledge.

- *Connectionist models*[7] have adopted a metaphor for the mind as a series of parallel, interconnected, multilayered, neuronal-like subsystems or modules that work simultaneously but in parallel to achieve performance goals. Connectionist-based training methods focus on methods that support the gradual tuning and automating of context-bound mental modules that are implemented when specific internal or external conditions are present. Connectionist models have helped us understand how to support the development of automated and unconscious knowledge.

Applying Science of Learning Models to Training and Performance Improvement:
Each of the models has contributed valuable insights about learning and performance. Yet, past attempts to apply science of learning models directly to training have achieved mixed results. Behaviorists found that effective, complex learning required more than a "black box", objectives and schedules of reinforcement. Cognitivists have learned gradually that while people may use their own mental programs to construct their own somewhat idiosyncratic conceptual knowledge about topics, prescribing minimally guided learning strategies in problem-based or simulated settings does not result in effective learning strategies for most adults[8]. Connectionists struggle with the need to identify some type of mental integrating process that can direct and regulate learning and performance.

To capture the effective features of the models and pull them into a current training design system we turn next to an analysis of three types of variables or factors that are common to nearly all of the models.

Identifying Effective Prescriptions for Training Analysis, Design and Development:
A review of the large number of psychological processes that have been the subject of research over the years is outside of the scope of this paper. However, a number of research reviews in the past two decades[9, 10] have suggested that three major types of factors account for most learning from instruction: 1) Individual and group traits; 2) Learning task types; and 3) Training methods. The goal of an effective training design system is to provide prescriptive guidance such as:

- For trainees with X traits;
- Who need to succeed at learning tasks of type Y
- Provide training methods of type Z

Each of these factors will be briefly discussed and then related to the type of prescription described above for training analysis and design systems.

Individual, Group and Generational Traits Influencing Learning and Motivation
The best evidence to date is that three characteristics or traits of adults that have been found to influence their learning in research on instruction. Those traits are general ability, prior knowledge and self efficacy[11]. Soldiers are selected with ability levels that are adequate to learn under many training conditions so general ability will not be considered further. Training can usefully be adjusted to support individual and group differences in the two remaining factors, prior knowledge[12] and self efficacy[13.] Two generalizations about individual differences receive consistent support in the research on learning from training:

- *Prior Knowledge*: The less knowledge and experience trainees have learned about the subject matter or objectives of the training, the more guidance they need to learn and perform -- and vice versa. Experts do not need extensive support to learn new information in their area of expertise. Novices require strong guidance as they learn to be soldiers.

- *Self-Efficacy*: The less self-efficacy trainees have about their capability to learn and perform the objectives of the training, the more motivational support they require. Similarly, overconfident trainees may require training methods that encourage them to develop new knowledge.

Many other individual and group differences have been studied and a few have many supporters based on intuitive beliefs in their effectiveness. Many social commentators have claimed that the younger generation of soldiers have shorter attention spans and learn best from fast paced, interactive multimedia games or simulations. While this seems intuitively correct, there is no scientific validation for the claim. A recent, systematic, large scale study of individual, team and generational differences in business organizations not only failed to identify generational differences, it reported common factors accounting for the performance of adults at all age levels[14]. Similarly, claims that adults have different “learning styles” have not been supported despite a very large number of studies on this topic over many years[15].

Learning Task Types: Often ignored in discussions about learning is the long-standing claim that there are two broad classes of learning tasks and that each type requires different instructional methods or support:

- *Declarative tasks* where conscious, conceptual knowledge about “what and why” are required to succeed. Declarative knowledge tends to take the form of concepts (“What is this?”); processes (“How does it work?”); and principles (“What causes it to happen?”). Declarative learning is committed to memory in such a way that it can be recalled when it is needed.

- *Procedural tasks* where “when, where and how” is required to succeed. Procedural knowledge tends to take the form of sequences of actions and decisions that, when implemented under appropriate conditions; achieve simple and complex performance goals. Procedural knowledge is intended to be practiced until it automates and can be implemented without taking up space in working memory.

To some extent, different science of learning models can be said to favor one or the other type of learning task. Cognitive models tend to focus on the learning of declarative knowledge in the form of concepts, processes and principles about warfighting topics. Behavioral and Connectionist models tend to emphasize the learning and gradual automation of unconscious mental and physical procedural routines that support the actions and decisions necessary achieve warfighting performance goals while overcoming limits on working memory.

Task Analysis: The Dilemma of Automated Expertise:
Most of the information provided in Army training is captured from subject matter experts. This information is gathered during task analysis interviews and narratives in the form of “self reports”. Yet one of the consistent findings from the science of learning is that while experts have highly accurate and very efficient strategies for achieving problems related to their expertise, they are also largely unable to describe the strategies they use. Evidence suggests that when asked how to perform a task experts unintentionally leave out approximately 70 to 80 percent of the information needed by novices to achieve objectives[16]. The result is that trainees who leave training and join their units in the field require continuing training and are forced to learn from inefficient ‘trial and error’ experiences. To overcome this problem, an effective new

strategy for capturing both routine and complex expertise strategies has been developed called "cognitive task analysis"[17, 18].

- *Cognitive Task Analysis* (CTA) should be combined with traditional task analysis to capture automated and unconscious procedural knowledge from subject matter experts about their highly effective and efficient performance strategies. Effective training requires accurate and complete declarative and procedural information necessary to achieve all warfighting tasks. CTA slightly increases the front end effort required to design training with the benefit of decreasing training time and reducing trainee errors.

The evidence from the science of learning suggests that each of these two types of learning tasks requires different training methods for trainees who have different levels of prior knowledge[19]. Thus, the discussion turns next to the third factor, training methods.

Training Methods:
Training methods can be defined as events that are intended to support psychological learning processes or methods required to achieve learning objectives by trainees who are unable or unwilling to provide them for themselves. For example, all learning of new concepts (a declarative task) by lower prior knowledge trainees is aided by examples. Giving feedback during practice is a method intended to support trainee monitoring and correcting of their learning. All training methods are not effective for all trainees and tasks so the goal of a learning science is not only to describe effective methods but to specify their match with trainee traits and learning tasks.

Past research has helped describe the psychological processes that must be supported during learning and the way that instruction can provide guidance. One of the most promising recent approaches can be found in a review of several research-based training design systems by David Merrill[20] with support from the American Society for Training and Development. His review focused on five generalizations about the type of trainee experiences that appear to be essential for successful training:

Learning from training is increased when:

1. Trainees prior knowledge is activated as a foundation for new knowledge
2. Trainees are engaged in solving authentic, real world problems
3. New knowledge is demonstrated to the trainee
4. Trainees are required to apply new knowledge and receive feedback
5. New knowledge is integrated into the trainees world

All of these prescriptions are useful for every training lesson or course and, if adopted, each generalization describes criteria that must be achieved by all training methods for every lesson or course. For example, Merrill implies that we must always activate prior knowledge and that even though a rich variety of ways exist to achieve activation of prior knowledge (e.g. examples, metaphors, analogies and stories), effective methods must function to activate relevant trainee experience and help them apply it to new learning. Similarly, whether demonstrations are provided live by experts or asynchronously by multimedia animation may be less important than whether they are accurate, complete and clear to the trainee. Similarly, a variety of practice and test formats are valid provided that they meet measurement requirements, reflect the type of knowledge being learned and are gradually integrated into guided, “whole task” practice exercises that help transfer new knowledge and skills to the field.

Merrill specifically avoids prescriptions that are generally accepted such as the requirement to direct trainee learning by providing an objective that clearly describes what will be learned, the conditions where it will be applied and any relevant time or accuracy standards.

When integrated into the system described in this paper, we arrive at a series of more complete prescriptions such as:

- For low prior knowledge trainees who must learn procedural knowledge, provide strong guidance in the form of clear objectives, examples from their past experience with similar procedures, demonstrations based on CTA descriptions of the task, require part and whole task practice using authentic problems with immediate feedback that helps them correct their procedures and transfer them to the field.

- For high prior knowledge trainees who must learn procedural knowledge provide minimal guidance in the form of clear objectives, a CTA description (or demonstration) of a procedure for accomplishing the objective and a whole task practice problem they can use to develop their own version of a procedure for accomplishing the objective[21].

Declarative tasks may have slightly different prescriptive rules. Science of learning studies indicate that memory for concepts, processes and principles are the key goal of declarative learning. Wherever knowledge must be applied, procedures are involved. Thus declarative task learning prescriptions require a similar list of methods that are required to support recognition and recall of concepts, processes and/or principles. Most training will require the learning and integration of both declarative and procedural knowledge.

Critical Features of Army Training Design Systems

The next challenge is to integrate powerful science of learning prescriptions to upgrade the Army training design and development system. Merrill[20] and others have cautioned us to separate design, development and implementation of training because different problems must be solved at each stage from early blueprint to the decision about media for delivery of a completed training product. One possible format for a training design system that incorporates prescriptions based on psychological learning processes might look like the following:

Guided Experiential Learning Design[22]:

A list of the components of a training design for all courses and lessons for all learners and tasks required by the Army might ask for a blueprint for how to achieve the following:

1. **Objective**: What actions, conditions and standards will you learn in this course (lesson)?
2. **Reasons**: What are the benefits to you and your unit when you learn and apply? What are the risks of not learning or applying?
3. **Overview**: How is this course (lesson) structured and what training strategy is used?
4. **Declarative Knowledge:** Here are definitions and examples provided in this lesson of concepts, processes and/or principles from a CTA - you need to learn and be able to remember later.

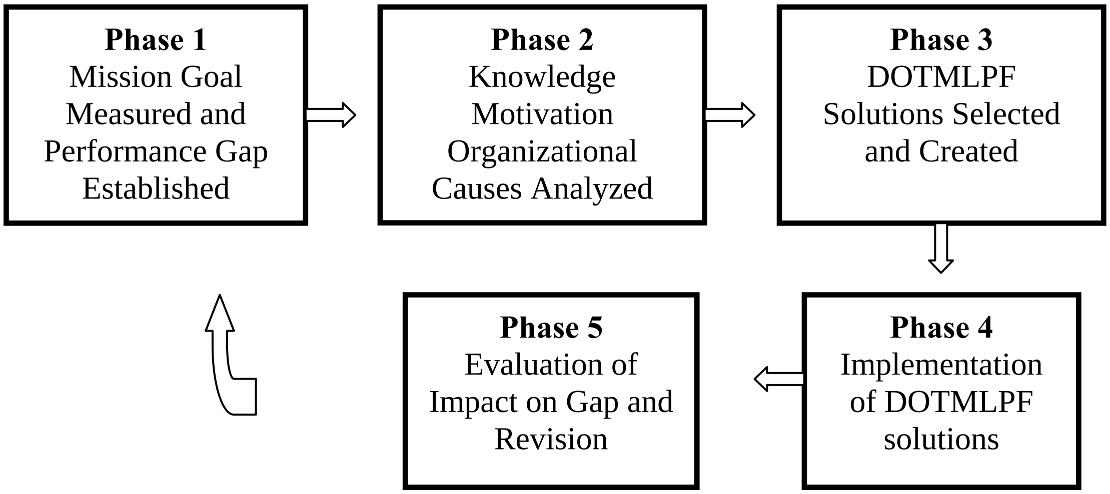
5. **Procedural Knowledge Demonstration**: In this lesson, observe this CTA based demonstration because you will be asked to apply it yourself after it is finished.
6. **Problem Solving and Feedback**: Now solve problems or objectives (derived from a CTA) that are similar to those you will encounter in the field. Use the procedure you observed in the demonstration. As you practice you will receive feedback about the parts of your strategy that are effective and parts that need to be revised.

Effectiveness and Efficiency Gains with Guided Experiential Learning Systems
Merrill[20] describes a comparison of three types of training design for the same task – an unguided, discovery design that was compared with a very well funded training that used an ISD-type design and distance delivery and a guided experiential learning approach. He reports that the guided experiential learning approach described above resulted in a 50 percent gain in learning and performance in about 55 percent less time when compared to the unguided approach - and approximately a 20 percent learning gain with a 15 percent time savings over an ISD-type approach.

Training and Performance Needs Analysis – Army Performance Improvement
Most of the professional associations representing trainers and performance improvement specialists have recently adopted a new technology for needs analysis. Past approaches tended to assume, often incorrectly, that training was necessary to correct a problem or achieve either collective or individual performance goals. The current approach makes the assumption that performance gaps are caused by at least three very different factors: 1) Knowledge gaps (requiring training); and/or 2) Motivational gaps (requiring motivational solutions); and/or 3) Organizational design and process gaps. This model has been adopted by both the Navy[23] and the Coast Guard[24] with positive results.

This "gap analysis" approach has been called "Human performance technology" (by the International Society for Performance Improvement[25]) or "Human performance improvement" (by the American Society for Training and Development[26]) but regardless of the name, the approach requires that all analysis begin with a collective and/or individual performance goal and a strategy for measuring goal achievement. In the next phase, the gap between the ultimate goal and current progress towards the goal are measured. In the third phase, an analysis of the contribution of the three possible causes of the gap (knowledge, motivation and organizational process) is conducted. In phase three interventions are selected, designed, developed and validated that have promise to close the gap. In phase four, implementation occurs at all levels required to close the gap and then in phase five, evaluation measures the local success of the programs implemented and their effect on the larger gap[27].

Model for Army Performance Improvement System



Conclusion;
This paper ends where an effective performance design system should begin – with a system that permits effective and efficient analysis of a mission problem that result in systematically identified solutions. Training is an important solution to many (not all) performance gaps. Obviously, full performance analysis requires a technology for identifying and solving both motivation and organizational design and process causes of performance gaps.

The goal of this white paper was to describe a prototype training design model that would be based securely on evidence from the science of learning. While readers may imagine many prescriptions or design features not described in this report, the attempt was made to offer a format for considering the key components of design that have promise to accomplish the goal of this exercise - identify and organize learning science findings and technologies that will help the Army train soldiers and develop leaders with the objective of accelerating learning and performance while maximizing effectiveness and minimizing resource requirements. Alternatives should be firmly based on evidence from the science of learning and show promise of meeting the Army's needs.

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Science of Learning Workshop

U.S. Army Research Institute for the Behavioral and Social Sciences
And
Institute for Defense Analysis

On Developing an Army Learning Model

Panel 1

Jan Cannon-Bowers

jancb@dm.ucf.edu
School of Film & Digital Media
University of Central Florida
Orlando, FL

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Background

There is little doubt that the roles and missions of the U.S. military have changed dramatically in recent years. From a human performance perspective, these changes are generating a reconsideration of outdated training and education principles and policies that can no longer meet the demands of the modern battlefield. In late 2000, the Navy launched its "Revolution in Training", led by then CNO ADM Vern Clark. Currently, the Army is undertaking a similar venture.

The purpose of this white paper is to initiate dialogue regarding the nature and format of an Army Learning Model that will provide the foundation for changes in Army training and education practices. What follows first discusses the purposes that such a model must serve, and then presents a description of the constructs and models adopted under the Navy's effort. It concludes with recommendations for how the Army might update, modify and ultimately adopt an overarching Learning Model based on best practices from the Navy work, industry and academia.

Requirements of an Army Learning Model

Since the term *model* can be interpreted in many different ways, the desire to generate an Army Learning Model also carries diverse meanings. One way to help sort out what type of model might be needed is to consider the role or purpose such a model might play in transforming Army training. There are at least two overarching purposes that a formalized Learning Model could serve for the Army. The first is as a *conceptual model or framework* for understanding and organizing the nature of soldier learning requirements and what the science of learning has to say about how best to meet these. In this sense, a Learning Model would be useful as a mechanism to classify the huge variety of tasks that soldiers must perform according to their implications for human performance and learning. The benefit of such a model is that it would make it easier to address seemingly diverse task/learning requirements by organizing and cataloging them according to their underlying human performance requirements and, in turn, what types of learning interventions are best for meeting them.

There are many existing learning models in the literature that could serve this purpose well; some of these are described in other white papers (see especially, Clark's) and will not be reviewed again here. There is also a huge literature on how people learn (again, documented well by other white papers and elsewhere); one so large in fact that it can only be meaningfully interpreted in light of the specific goals or objectives of a particular learning situation. In other words, posing the question "how do people learn in general?" is not necessarily meaningful unless more detail is provided regarding what types of competencies they are learning. Hence, some mechanism to taxonomize or classify task requirements and associated performance and learning requirements would be useful to guide Army education and training.

A second (albeit related) role of an Army Learning Model could be as an *implementation or process framework* to guide the development and assessment of learning interventions to meet training requirements. This type of model is related to the more purely conceptual type (described above), but actually goes further by specifying *how* to achieve effective and efficient learning, and how to ensure that it has occurred. In fact, such an implementation model could actually subsume the conceptual framework described above and also embed other models as needed (e.g., training needs analysis models, media/method selection models, evaluation models, etc). Moreover, once an overarching implementation model or framework is adopted, its specific contents can evolve as missions and roles change, or as the science of learning matures. For example, if new models of cognitive task analysis are validated and deemed useful, they can easily be incorporated into the appropriate phase of the implementation framework.

Another advantage of generating an implementation-based framework for Army learning is that it is a step toward ensuring that human performance and science of learning principles actually get translated into useful training practices. Too often, organizations (with good intentions) specify conceptual models that are well designed and describe adequately the organization's desired outcomes or intentions. Unfortunately, these models often lack guidance in how to achieve desired objectives and employees are left to try and sort it out on their own, typically with mixed results. Ultimately, sound implementation practices are essential for success; hence it seems prudent to spend time addressing this type of framework.

Point of Departure—The Navy's Human Performance Systems Model

In the fall of 2000, CNO Clark launched his so-called "Revolution in Navy Training". As a former schoolhouse commanding officer, ADM Clark was convinced that the entire Navy education and training enterprise was in need of overhaul. As a first step, he commissioned the Executive Review of Navy Training (ERNT), a group of senior Navy, DoD, academia and industry representatives charged with assessing the current state of Navy training, and compiling a list of best practices in education and training across the country. A comprehensive summary of this group's activities and findings was documented in a final report (citation). CNO Clark subsequently established Task Force EXCEL as a mechanism to implement and institutionalize many of the ERNT's recommendations. While this process is continuing, the impact of the ERNT and TF EXCEL can be seen widely across Navy education and training, including establishment of the Human Performance Center and Navy-wide adoption of many of the ERNT's recommendations.

One of the most useful developments of the ERNT was early establishment of, and adherence to a simple implementation framework that described, what was for the Navy, a new way of doing business in education and training. Called the Human Performance Systems Model (HPSM), this framework was an essential mechanism for communicating to Navy stakeholders and later the Fleet what needed to happen if learning in the Navy was to be transformed. This model is shown in Figure 1.

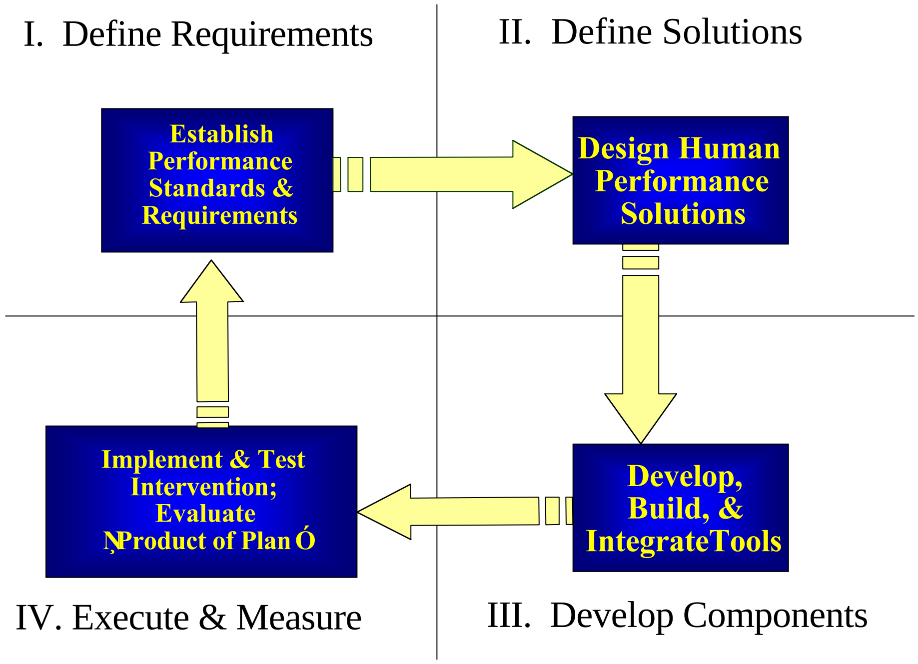

Figure 1: The Navy's Human Performance Systems Model

As will be obvious to any instructional designer, the HPSM is a simple representation of a sound approach to instructional system design. It begins with specification of requirements (and associated performance standards) in Quadrant 1, followed by design of performance and training solutions necessary to meet objectives (Quadrant 2), development of instructional systems (Quadrant 3) and finally, deployment and evaluation of training outcomes to ensure that requirements are being met (Quadrant 4). Each of these is described in more detail in subsequent sections.

There were many advantages to adopting and popularizing the HPSM across the Navy. First of all, its simplicity allowed it to communicate well. Rather than a confusing array of boxes and arrows, the HPSM was able to organize much information into a format that is easy to understand and remember. It also provided end-to-end guidance, beginning with initial specification of job task requirements, consideration of multiple human performance solutions, development and implementation of solutions, and evaluation of training outcomes.

In addition, the HPSM allowed for incorporation of multiple perspectives and required participation from operational commands as well as training experts. For example, the Navy conceptualized Quadrant 1 as a Fleet-owed process; in other words, specification of task requirements and standards was meant to be left in the hands of operators, with human performance specialists providing support as needed. Further, it helped to establish roles and responsibilities within the Navy training enterprise. For example, as noted, Quadrant 1 became a Fleet process, whereas Quadrant 2 was led by the HPC; Quadrant 3 by the Navy Personnel Development Center; and Quadrant 4 jointly by both the Fleet and HPC.

Perhaps the simplicity of the HPSM—just noted as a strength—is also its greatest weakness. In fact, the ERNT acknowledged that any attempt to streamline an area as complex as human learning and instructional design would certainly not do it justice, and the HPSM is no exception. However, despite the fact that it over-simplifies the instructional design process, it was effective as an overarching or guiding framework for Navy Training. Furthermore, as noted, the HPSM (or a framework like it) can be used as a vehicle to house other (more detailed) models and frameworks, which can provide the detail lacking in the top level.

It should also be noted that the point here is not to suggest that the Army adopt the HPSM; rather it is to argue in favor of adopting some sort of overarching implementation model or framework that describes both the desired outcomes of Army training as well as processes needed to achieve them.

Quadrant 1—Defining Requirements

There is a large literature on how to generate job/task requirements, which will not be reviewed here. Many sound techniques exist to establish task requirements, and the Army has a long history of employing these. Regardless of which method is employed, the following data are needed as output from Quadrant 1: detailed task descriptions, metrics and/or standards associated with acceptable performance; and description of the context in which the task occurs. The task analysis must also incorporate information about whether the tasks are performed at the individual, small group/team or large group/organization level.

Quadrant 2—Designing Performance Solutions

Quadrant 2 is by far the most involved from a human performance standpoint. It includes several processes that are associated with traditional instructional or training system design (e.g., training needs analysis, media selection), with an explicit consideration of contextual factors and cost/benefit or utility analysis. Figure 2 is a slightly modified version of the ERNT's original conception of processes involved in Quadrant 2. What is new to the version here is the addition of the arrow representing the process of "generating learning objectives that consider learner characteristics and training context" (second arrow from the bottom left). This process was implied, but not called out in the original conceptualization.

As illustrated in Figure 2, the prescribed process begins with translation of task requirements into a set of competencies (knowledge, skills, attitudes and other personal characteristics). Once these are generated, they must be further transformed into learning objectives. Again, there are many strategies in the literature that are designed to help accomplish these goals. Further, the conceptual learning model of the sort described above would be useful as a means to organize and classify task demands, competencies and associated learning objectives according to common human performance demands. At this point, it is also necessary to have a good understanding of the learners' attributes and the conditions under which performance occurs because these affect the design of potential solutions.

The next step in the process is to apply principles from the science of learning and human performance so that an informed decision can be made regarding how best to intervene. It is important to note that the ERNT very strongly believed that training solutions were only one mechanism to improve human performance. Hence, the Quadrant 2 process was geared toward analyzing the requirements and then considering a host of performance-enhancing interventions besides traditional training (including job or equipment redesign, changes to personnel selection practices, job aids, and the like). In many cases, several potential interventions could be identified as potentially beneficial.

Once possible solution options are generated they must be subjected to a cost and utility analysis. Much evidence in the learning sciences suggests that well specified learning objectives can actually be trained using a variety of methods (for example, traditional classroom or computer-based approaches). Therefore, at least in some cases, the choice of a learning intervention strategy may well be driven by cost or time factors (with all else being equal). In fact, in the human performance world, the acquisition mantra of "better, faster, cheaper" applies in the sense that our goal is to achieve effective performance in the least amount of time and at the lowest cost possible. Whereas in physical system design the precision of measurement is typically greater than with human performance (e.g., it is often possible to assess the cost and time associated with an increment of improved performance), these concepts still apply.

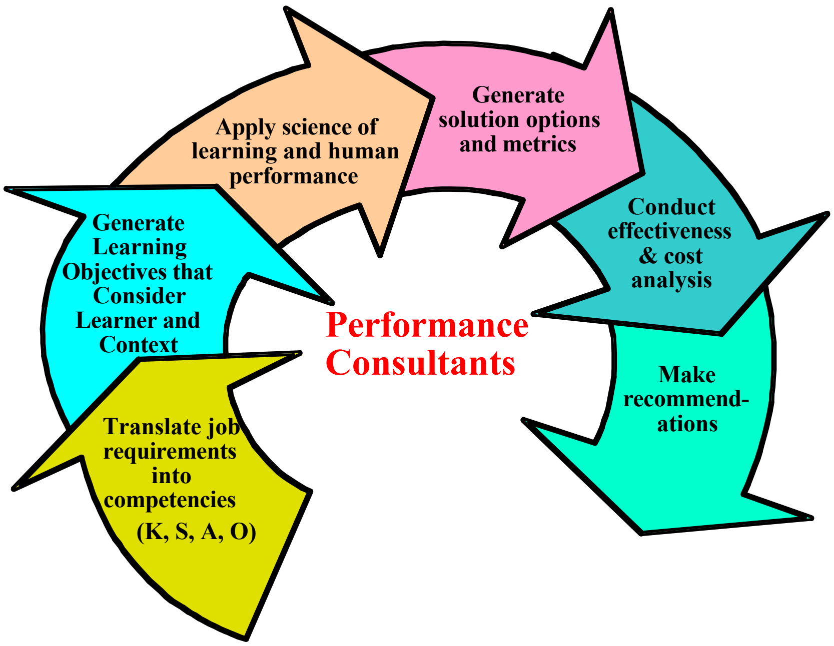

Figure 2: Quadrant 2 Processes

The final step in the process is for recommendations to be made to operational commands regarding the best intervention (or interventions) that can meet the operational demand. The ERNT envisioned that a cadre of trained human performance consultants or specialists would conduct Quadrant 2 analyses and make recommendations (labeled "performance consultants" in Figure 2).   The idea was to embed performance consultants into Fleet learning centers so that training requirements could be continually reviewed and performance deficiencies identified and addressed.

Quadrant 3—Develop Interventions and Build Tools

From a human performance perspective, the challenge in Quadrant 3 is to ensure that recommendations made (and endorsed) in Quadrant 2 are actually developed as intended.   This implies that human performance experts are an important part of the learning system design process. Too often, recommendations for sound interventions are not translated well by developers (who typically lack training in human performance issues) so that products are suboptimized.

Quadrant 4—Implement and evaluate training effectiveness

To close the loop of instructional design, the effectiveness of newly deployed interventions must be assessed. Once again, the opportunity exists here to embed an evaluation model (or models) that can specify how and what is measured. The prevailing training evaluation model—developed by Kirkpatrick some 50 years ago—advocates a multi-phase process that considers reactions, learning, behavior change and results (Kirkpatrick, 1976).

Since its inception, this model has received considerable attention and modification (citations), but is still foundational to many training evaluation schemes. More recent thinking has endorsed the inclusion of more cognitively-based measures of performance (Kraiger et al., 199x) and issues such as the manner in which training transfer is affected by various conditions within training and back on the job (e.g., Baldwin & Ford, 198x).

Despite the choice of evaluation model or strategy, the metrics, performance measures and standards of performance used to assess effectiveness should be tied directly back to Quadrant 1 output. In fact, if Quadrant 1 processes were fully completed, the operational commands should have generated a list of performance standards/metrics that describe effective performance of the task.

Recommendations for the Way Ahead

This paper has provided a rather pragmatic (versus academic) view of how a learning model could serve to help transform Army Training by relating the Navy's experience in a similar situation. As a member of the ERNT and leader of the Human Performance Cell of Task Force EXCEL (which later became the Human Performance Center), I would offer the following recommendations:

1. Develop an implementation framework that describes the mechanisms to achieve desired outcomes. This framework can specify major steps or phases in the process, and imply organizational roles and relationships. It can have more specific models or frameworks embedded in it.
2. Strive to keep the framework simple for use more as a communication tool than as an academic or conceptual one. I believe that much of our success in TF EXCEL was due to the fact that a wide variety of individuals--from operational sailors and senior Naval officers to training specialists and engineers--could understand and remember the model. It eventually became a galvanizing mechanism across Navy training.
3. If possible, develop a framework that can account for human performance interventions other than training. I say this because, prior to TF EXCEL, the knee-jerk response to any performance problem in the Fleet was "more training", regardless of whether the issue was training related or not. In many cases, simpler, cheaper and/or more effective interventions would have been generated if the process of assessing performance problems/needs had included non-training options.
4. Carefully specify the nature and format of the output needed at the end of each phase, and avoid advocating single-point solutions if possible. This strategy affords the opportunity to allow for multiple models or approaches to coexist within a phase (e.g., one task analysis method might be better suited to a particular task type than another, so both can exist within the Requirements phase of the process). It also allows flexibility--models or approaches can be updated or replaced when necessary--and does not demand adherence to a single approach. Moreover, highly detailed, conceptual models can be embedded within the structure in a way that is useful to learning experts but not unduly confusing lay people.

Instructional Design Implications for Training Complex Tasks

A White Paper

Prepared by

A. Aubteen Darabi

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Contact Information:

A. Aubteen Darabi, Ph.D.

The Learning Systems Institute

4619-C University Center

Florida State University

Tallahassee, FL 32306-2540

email: adarabi@lsi.fsu.edu

Website: http://www.lsi.fsu.edu/faculty/darabi

Abstract

This paper argues that training professionals are no longer concerned solely with training procedural tasks because of increased skills requirements of the job market. The skills and competencies demanded from the workforce in today's job market deal with performing complex tasks with many interacting components that cannot be simultaneously understood in one training session. Training programs dealing with this type of tasks should consider the complexity of these tasks in relation to the human cognitive architecture. Cognitive Load Theory (CLT) presents an explanation of this relationship and how task complexity may cause cognitive overload in trainees. CLT proposes to reduce cognitive load through an appropriately designed training and instruction program. A particular model specifically developed based on this theory will be discussed.

Introduction

Instructional and training tasks are no longer simple procedural tasks as they mostly were couple of decades ago. Increasingly, today's jobs require complex skills learners must have to be able to perform in the market and thus they are increasingly facing the challenge of learning complex tasks. For job incumbents to perform effectively, they must be able to integrate the necessary knowledge, skills and attitudes. To prepare the workforce for more demanding job requirements, training and instruction theorists as well as practitioners are increasingly focusing on the use of complex 'real-life' tasks (Merrill, 2002). These complex tasks happen to have many components and usually cannot be mastered in a single session. The tasks' complexity, the results of these interacting components (van Merriënboer, 1997), therefore, increases the cognitive load on learners' cognitive system.

Implication of this development, moving from simple to complex tasks, is an issue to be addressed by training and instruction scholars. Many of these scholars, because of the cognitive load involved in training and performing these tasks, have addressed the issue in the context of cognitive load theory (Sweller, 1988; Sweller, van Merriënboer, & Paas, 1998; van Merriënboer & Ayres, 2005; van Merriënboer & Sweller, 2005) and inventing relevant instructional models (van Merriënboer, 1977).

Cognitive Load Theory (CLT)

CLT is based on the idea that in designing any instruction or training, human cognitive architecture should be a major consideration. According to this theory, the cognitive architecture consists of a limited working memory. This working memory interacts with a comparatively unlimited long-term memory. Complexity of a task represented in the new information provided in instruction and training may cause a heavy load on this interaction depending on the content, design, and structure of the instructional material. CLT distinguishes between three types of cognitive load depending on the process causing the load (Sweller, 1988; Sweller, van Merriënboer, & Paas, 1998).

1. *Intrinsic load* is caused by task "element interactivity." This load varies, depending on the number of elements that must be simultaneously processed in working memory. For instance, coordinating many constituent skills represented in performing a task typically results in a higher intrinsic load.

2. *Extraneous load* is the undesirable extra load resulting from poorly designed instruction and training. Having learners search for information in their instructional materials, for example, causes extraneous cognitive load that does not necessarily contribute to learning.

3. *Germane load* relates to the design processes that directly contribute to learning. For instance, learners' efforts to abstract the information presented in training or learning topics and connect them to what they already know, are processes used for schema construction and rule automation. These efforts will result in germane cognitive load.

The CLT's basic assumption is that by designing appropriate instruction and training, designers can reduce the extraneous load to allow learners to free working memory capacity that they may use to engage in conscious cognitive processing of new information. For learning to occur, CLT argues that the total cognitive load (intrinsic, extraneous and germane cognitive load) cannot exceed the available working memory resources (Sweller, 1988; Sweller, van

Merriënboer, & Paas, 1998)

According to the premises of this theory, complex tasks would easily become a great concern for training. Given that most of the tasks in daily professional workforce life fall in this category, one can recognize the cognitive load issues involved in their training. Based on the assumptions of the CLT, cognitive overload is unproductive and, to avoid it, well-designed instruction and training should decrease extraneous load and optimize germane load. In certain training situations dealing with very complex tasks, such as with the Army or Navy, even removing the sources of extraneous cognitive load, would not necessarily result in an efficient training. In these situations, the element interactivity of the complex tasks is still so high that one must additionally attempt to balance intrinsic load and germane load.

van Merriënboer (1997) presents an instructional design model on how to achieve this balance in designing instruction. The model, called the Four-Component Instructional Design model (abbreviated 4C/ID-model) is based on findings of empirical research in the instructional systems literature. van Merriënboer, Kester, and Paas (2006) review some of these findings and offer other methods of achieving this balance. They argue that optimal instructional methods for practicing simple tasks are different from methods for practicing complex tasks and highly structured methods, that at first sight seem most efficient for teaching complex tasks, yield low transfer of learning. The authors continue that, in order to decrease the intrinsic load, one should introduce learning tasks with lower element interactivity early in training (sequencing) and use strategies to induce germane load from the start of the training program.

To elaborate on this notion van Merriënboer et al. (2006) discuss the training of simple vs. complex tasks, citing research findings confirming that many instructional methods that work well for simple tasks do not work well for complex tasks, and vice versa. Summarizing these findings, the authors state that an important method affecting learning is practice variability. They argue that the ways a learning task is practiced (random vs. blocked practice) can make a difference in learning and transferring those skills. They agree with the idea that in learning complex tasks, especially by low-expertise learners, learners do not benefit from a random practice schedule because of the high cognitive load associated with this type of practice.

van Merriënboer et al. (2006), continue their discussion on providing feedback in the contexts of training simple and complex tasks. They conclude that a reduced amount of feedback is typically beneficial to learning of simple tasks. But, for the complex tasks, it seems that element interactivity of the training tasks does not leave enough cognitive resources for learners to develop their own internal monitoring and feedback mechanisms. Thus, learners will benefit from guidance and feedback.

“Transfer paradox” is another phenomenon referred to in the literature (van Merriënboer, de Croock, & Jelsma, 1997). The authors state that, contrary to research findings recommending structured practice for complex tasks, they have found cases where training practices have a positive impact on learning and performance but not on retention and transfer. This paradox addresses the findings that particular instructional methods are often selected to minimize acquision time, but not to increase transfer performance.)

van Merriënboer et al. (1997) offer practice variability and feedback as techniques or methods recommended for inducing germane load in a training and instructional environment. But one cannot increase the germane load involved in instruction without reducing learners understanding. The germane load is mainly determined by the nature of the tasks and the expertise of the learner. However, because in most of the domains the learner must ultimately be presented with the tasks in their full complexity in order to reach complete understanding, the authors suggest lowering intrinsic load early in learning and inducing germane load right from the start. The first method involves sequencing the tasks or subtasks from low-to-high element interactivity that frees up cognitive capacity for using some germane load inducing method.

Implications for Instructional Design

van Merriënboer's 4C/ID model (1997; van Merriënboer, Clark, & de Croock, 2002; Van Merriënboer, Kirschner, & Kester, 2003) claims that there are four components of the complex task learning environment that can basically describe that environment:

1. *Learning tasks*: the backbone of training program, tasks with real-life features.

2. *Supportive information*: the information that helps the learner with problem solving and reasoning dimensions of the tasks. It supposed to help learner determine how the domain is organized and how problems in the domain can be systematically approached.

3. *Procedural information*: to perform the routine aspects of the learning tasks, learners need this information. It focuses on procedural steps and tells the learners what steps must be taken under what condition.

4. *Part-task practice*: provides learners with additional opportunities to practice the routines. It is used for developing very high level of automaticity.

The 4C/ID-model, further prescribes three ideas that correspond with the issues discussed earlier focusing on reducing extraneous load and enhancing germane load. The following is a description of the ideas focusing on ordering or sequencing of learning tasks (van Merriënboer et al., 2006):

• According to the 4C/ID model, learning tasks must be ordered in task classes with the tasks of lower element interactivity presented earlier in training rather than later. The model recommends that even the first task class should contain whole and meaningful tasks so that the learners may quickly develop a holistic vision of the whole task. The tasks classes are essentially equivalent because they can be performed with the same body of knowledge.

• When learners start to work on a new and moré complex task class, their performance must be limited only to learning the elements that are important to the training. They will be later more open to other elements as they make progress (worked examples, completion tasks, and then conventional problem solving tasks).

• Combining the ordering of the tasks from simple to complex is probably the most important of these principles. These learning tasks, when supported by scaffolding learners within a task class, will increase the germane cognitive load.

The other components of the 4C/ID-model are more concerned with two dimensions of transfer of skills (van Merriënboer et al., 2006). Supportive information mainly provides the general or abstract information for the learners to be able to solve new problems in situations different from the training program. Procedural information and part-task practice, on the other hand, enable learners to explain the application of knowledge elements or 'cognitive rules' that are shared between the practice and the transfer situation.

It is noteworthy that an instructional design software has been specifically developed for using this model. ADAPTit, as it is called, is a relatively user-friendly software with vendor support that is available to individual and organizational practitioners of complex design and $C/ID users.

Conclusion

This paper argued that training and learning tasks are becoming more complex because of the demand of the job market. In order for workforce members to perform in today's environment, they must master complex skills to be able to compete in the world of technology that is increasingly becoming more complex. This has implications for both instructional designers and trainers. The 4C/ID model (Van Merriënboer, 1997) presents one example on how to deal with the design and development of the training required for these complex learning tasks.

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Corporate Learning Models

Matthew T. Peters
Defense Intelligence Agency (DIA)
Office of Learning & Career Development
HCL, Building 600
Bolling Air Force Base
Washington D.C. 20340-5100
matthew.peters@dia.mil

Human capital is one of the top strategic resources for the 21st Century. This occurred because jobs have become increasingly complex at the same time the workforce has become more discretionary. With a world-wide labor market and low unemployment rates in the United States, potential employees are much more selective, increasingly mobile and contemplative. Employee impact to the bottom line increased over the past decade as the basic character of work, the workforce, and the workplace itself have changed. Sustaining a high performance workforce in this highly competitive environment will require corporate commitment to change some fundamental process, policy and organizational constructs in the training arena. But, how exactly are these key factors changing?

The basic character of work in large organizations has evolved over the past decade. Technology has eliminated a growing number of traditional "blue collar" jobs, and the remaining jobs are becoming increasingly complex. Computerized production lines have replaced the manual labor intensive design of earlier decades. Jobs have become more specialized; simple tasks have been outsourced - many sent overseas. These operations have placed increased premium on specialized skills, leadership and management with a commensurate growth in training pipeline costs.

The character of the workforce has changed as well. The "baby boomer" generation is approaching retirement age, and younger generations (Generation X/Y) behave differently from their predecessors. "Baby boomers" entered the workforce in an era of large industrial plants with great stability in the workforce. It was common to remain in the same company and job field for an entire career, and employees expected to be scheduled for all necessary training. The younger generations have different expectations. They demand more from their organizations, and seek more direct control of their jobs. They seek excitement and regular feedback. They have a tendency to "job hop," changing jobs 6-7 times during their first decade in the workforce, as they aggressively seek increased responsibilities and compensation. Younger generations also learn differently. They grew up using computers and are comfortable "googling" information. In a general sense they prefer training on demand, in manageable "chunks" directly related to the task at hand, rather than sitting in a classroom.

Finally, the workplace itself has transitioned from the Industrial age to the Information age. Driven by technology and globalization, organizations are no longer centralized in single geographical locales. Corporate offices and productions lines are widely distributed many on a world-wide scale, based on economics. Employees from a wide array of cultures and backgrounds are working 24/7 across many time zones. Matrix architectures are in vogue as organizations meld global, diverse workforces and products.

Traditional corporate training models, which typically funnel large student cohorts through centralized residential facilities using standardized courses and Subject Matter Expert (SME)-based instructors, have a difficult time excelling in this new workplace. It is logistically challenging and expensive to ferry employees long distances to attend basic skill courses. It is difficult to sustain alignment between current job requirements and training curricula. It is also hard to prevent duplicate and redundant offerings as organizations grow in both size and number of locations. Conversely, leadership has recognized that their current investments employee learning and career developments are inadequate, and have become top reasons for employee dissatisfaction and attrition. These factors have become catalysts to change and revolutionize training. It also highlights a tremendous opportunity to improve organizational effectiveness and efficiency – with direct impact to the “bottom line” if done correctly.

So - how do training professionals change to support this new organizational imperative? Top organizations have shifted from a pure training system to a more robust architecture focused on both learning and performance. This transformation has significant implications from a cultural perspective as it changes the character of human capital from a “lesser included” commodity to the key ingredient of success. To put this in context, training has historically operated as an “overhead” function. Courses have been developed to support either corporate priorities, such as leadership and executive development, or in response to specific business line demands (i.e. “I need a course!”). This has relegated training to the “strategic” domain where senior leadership have philosophically supported and appreciated its contributions. However, the lack of direct links to business outcomes have forced corporate training to operate from a “supply model” construct where courses were either mandated (basic skills, ethics, sexual harassment, etc), or had to “sell themselves.” Neither of these approaches is particularly efficient as the former becomes overcapitalized while the latter becomes underutilized. Without that direct connection to performance, managers will continue to view training as a cost (i.e., lost labor) versus a benefit which puts training programs at risk when resources become constrained.

The key to transforming the training function is to embrace a commitment to workplace learning and performance. Simple to say, but hard to accomplish as it changes the fundamental role trainers have filled in organizations for years. Chief Learning Officers (CLO’s), a relatively new title, and other training executives are attempting to change those workplace dynamics. The CLO title itself connotes new roles and responsibilities for the training executive. First coined by Jack Welsh at General Electric, the CLO position was established to lead and manage all education and training throughout the organization. Top-notch CLO’s focus on training, learning and performance simultaneously to achieve the best results. In the training domain they are concerned about managing training in the most cost effective manner. In the learning domain they are concerned about properly matching the learning media and methodology to the particular job requirement. Finally, in the performance domain they work to develop a close and collaborative partnership with their clients/customers to enhance workplace productivity and total return on investment (ROI). These direct linkages to business outcomes can transform learning and performance programs into a “demand” construct where other corporate leaders aggressively resource and support analytical efforts and curricula because they can see and measure the positive impact to their business efforts.

This occupational field is still early in its transition process. Its progress is highlighted by the mismatch in perspectives and priorities between the CEOs/COOs and CLOs as documented in the 2006 American Society of Training Development (ASTD) CLO benchmarking study. That study documented the fact that CLOs are working to directly link training/learning investments to business outcomes. They are building performance improvement capabilities to address all environmental issues (tools, processes, rewards, etc) that affect performance (“You can put the best person in a bad system, and the system will win every time”). However, CEOs/COOs writ large are apparently still comfortable with treating training as a strategic capability, and assume the function is successfully meeting its mission unless senior business line leaders complain.

What are the characteristics of a 21st Century Learning and Performance Improvement team? At a macro-level those organizations have (a) established a direct link between job requirements and performance; (b) steadfastly measure results; (c) focus on the personal and professional development of their learning workforce; (d) embrace the performance improvement discipline of considering all factors that affect job performance; (e) have rigorous Learning Models to match the best learning method/modality to the desired skills and/or competencies; (f) encourage innovative practices, and support robust Research and Development (R&D) programs that are isolated from daily production efforts; (g) aggressively champion quality control programs; and (h) deliver tailored courses via enterprise-wide learning systems. Let’s explore each these concepts …..

- Job Requirements.

  The need to directly link job requirements to performance outcomes must be coordinated with both the human resources (HR) organization and the business line managers/SMEs. These requirements typically fall in two different domains – those behaviorally-based (such as leadership) and those skill-based (such as operating equipment). Different terminologies are used throughout the industry, with some organizations focusing on Job Task Analyses (JTA’s), others Cognitive Task Analysis (CTA’s), while still others build Competency models. Regardless of the terminology the two most overriding factors are:
  (a) Ensuring that the proper individual/office is approving the requirement; i.e. not simply an advocate or SME, but someone with power to properly support and resource the capability; and
  (b) Defining the performance outcomes to the appropriate degree of accuracy and fidelity to allow the deployment of proper learning systems. The degree of granularity can also be a concern; most organizations attempt to make a direct link to job performance by identifying the specific Knowledge, Skills, Abilities and Tools (KSATs) necessary to accomplish key job tasks.

Lesson Learned. Typically there is a different perspective from management and labor on how to best accomplish a specific individual task. A combination of governing directives and instructions, coupled with focus groups, surveys and observing workplace performance (best practices) should produce the most accurate picture.

♦ Measure Results.

Everyone is familiar with the saying "Any road will work if you don't know where you are going!" That philosophy is as true in business as it is in personal life. It is also important to recognize that anything can be measured – the key is to identify the most important products and processes, determine the measures that define those products and processes, and then set appropriate metrics to drive the desired business outcomes.

As discussed above, benchmark organizations today are focusing simultaneously on training, learning and performance. Metrics can be input or output based; they can also be either leading or lagging indicators – a mixture of each, across the training, learning, and performance domains, provides the best exposure. Metrics can, and should be, cascaded into organizational level dashboards to monitor the effectiveness and efficiency of the corporate training effort.

- Performance Improvement.

Leading companies have recognized that job performance is a function of many different factors besides training, and that responding to the "I need a course!" request without fully understanding the performance deficiency can be frustrating and unproductive. At first this can be a challenge because the training professional wants to please the client – who typically has not only suggested a course, but also provided the desired course length, location, and learning methodology. However, it is important to note that only 10-15% of all performance deficiencies can be attributed directly to a deficiency in workers' knowledge and/or skills. The vast majority of performance deficiencies are attributed to environmental causes (poor tools, workplace, rewards/incentives, etc). These investigations typically lead the performance analyst to many different business units in the organization (e.g. Human Capital, Acquisition, Operations, etc) that may have unintentionally become misaligned. The learning and performance professional should partner with the client (many successful practitioners employ the "5 Whys?" method) to more clearly define the problem, correctly identify the root cause(s), and recommend "blended solutions" to systemically improve performance. Tremendous returns accrue from these efforts - the industry benchmark falls in the 8:1 range, and returns in the 200-300:1 range are not uncommon. It is also worth noting that in ASTD's BEST study the top organizations committed an average of 43% of their learning resources to non-learning performance improvement efforts.

Examples

(a) In the late 1990's the city of Washington D.C. was concerned about damage to the granite facing of the National memorials caused by pigeon guano. The initial solution was to buy new granite facing, and hire hunters to eliminate the pigeons. Fortunately, others queried why the pigeons were flocking to the memorials in the first place. Over time park personnel came to realize that the pigeons were eating spiders, which were building webs at the top of the memorials to catch moths, which were attracted to the lights. Park personnel eventually discovered that the moths only flocked for two hours a night and if the lights were turned off during those few hours the entire chain of events could be disrupted. Turning the lights off for a couple of hours each night was a lot less expensive than refacing all of the memorials, and saved some electrical costs as well.

(b) An early Navy performance problem focused on the inability of aircraft controllers to coordinate tactical aircraft operations. A lack of confidence had fractured the relationships between ground-based controllers and aircraft commanders. The initial recommendation was to provide additional training the controllers, but leadership elected to conduct a Human Performance Improvement (HPI) analysis to better understand the issue. The analysis highlighted problems in the fidelity of both requirements and metrics, the selection of personnel, the initial systems training, the proficiency training, the acquisition processes, and the evaluation process. Performance was improved, and millions of dollars were saved annually by different organizations across the Navy.

- Learning Model.

  Industry leaders have established criteria to guide the selection of learning methods/modalities in their organizations. While traditional classroom training remains the primary learning platform, it is no longer the defacto solution. These criteria serve as internal Learning Models which help decision enablers decipher the wide array of media available in the learning domain. However, while many choices are available (classroom, simulated, games, Job Aids, eLearning, mLearning (PodCasts, Electronic Performance Support Systems (EPSS), etc)), the wrong selection could have grievous results. For example, would you train a heart surgeon via eLearning courses? Or, would it be ideal to fly 5,000 employees from India to Kansas to take an 8-hour course on catalog sales?

  Industry is also attempting to apply adult learning theory which postulates that adults need material that is interesting, timely and directly relevant to their jobs. Front loading all the material they may need in the first 3-5 years on the job during indoctrination training is not effective. Learning processes and systems need to be modified to allow learning modules to be delivered when necessary for either job task completion or continued personal and professional development. Gains have also been realized by tailoring media to different learning styles, e.g., Navy SEALS versus nuclear technicians. Unfortunately there is no "one size fits all" template. New employees, and military recruits, come in all shapes and sizes from a learning perspective. Enlisted personnel and Officers are typically high school and college graduates respectively, but study habits, reading skills, computer aptitude, and motivation vary widely. The challenge is to blend all the different choices (synchronous/synchronous delivery, practice and experiential learning, etc) to best "fit" the learner, the team, and the organization.

Unfortunately, the paucity of validated results [of different learning media to performance outcomes] makes media selection is a challenge today. That creates a vulnerability that is preyed upon by many different players. Contractors and consultants tend to specialize in particular media and always promise wonderful results. Comptrollers and business managers focus on cost, and will favor any intervention that reduces cost regardless of the product’s projected learning effectiveness. Professional associations (ASTD, Training Directors, etc) showcase examples of successful interventions, but don’t do much in the way of comparing and contrasting different learning media. eLearning has become the “intervention dejour” much like electronic classrooms were popular 10 years ago, but simply changing chalkboard lesson plans into PowerPoint slides may not improve student learning, retention, and most importantly on the job performance. Clearly the goal is to tailor learning solutions to employees, in the form and/or fashion that best matches their learning aptitudes, in the most cost effective manner, but what are the heuristics for evaluating and integrating the best available evidence from multiple sources?

The same logic can be applied to the entire training enterprise. Many organizations are outsourcing large sections of their training programs. Others outsource only a portion, for example eLearning development, Modeling & Simulation, or games. Different approaches can be pursued based on the type of learning efforts, for example centralizing behaviorally-based programs (such as leadership) while decentralizing skill-based programs (perhaps those aligned to specific business lines). Hybrid structures are becoming more prevalent. Those organizational decisions should be based on the most economical approach to cultivate client relationships while delivering the best possible product.

- Workforce Development [for Learning Professionals].

  The professional community that works in this field needs to evolve as well. In many respects the Instructional System Design (ISD) community [and the ADDI (Analysis, Design, Develop and Implement) model] was shaped in 1960s when the focus was on residential classroom in an industrial setting. Many training practitioners today could be characterized more as SMEs who are teaching in a classroom on their second career rather than “learning professionals” who have a dedicated career continuum. Instructor development, career development and quality control are needed to expand their repertoire and proficiency. Even the current focus on eLearning has bore-sighted on web-based learning versus capturing the entire spectrum of learning and performance.

  Perhaps a better question would be to consider what this community should be expected to accomplish? The workforce skills and methodology to conduct tasks across the training, learning and performance domains are significantly different from those required to conduct the basic curriculum design and development tasks of the past. These practitioners need to lead teams, confront change, and operate in a wide variety of business environments. From the corporate perspective their backgrounds need to be more diverse than just training, including Industrial Organizational Psychology, Operations Research, Manpower Analysis, etc. This implies a multi-disciplinary workforce capable of engaging clients and customers throughout the entire organization.

How do we develop a professional learning community? How do we evolve from curriculum developers to business consultants that focus on business outcomes? The shift more towards learning and performance will increase the marketability of professionals in this field. Recent studies have indicated a 25-50% salary increase for workers in the performance improvement versus curriculum development field. The educational system is beginning to adjust by gradually shifting from pure ISD curricula to include more Performance Technology and business disciplines. There are also a number of professional associations that do an excellent job of functions as defacto long-term community of practice ("professional home"), but is there a better approach?

<u>A Challenge</u>

The average age of the Navy's Instructional Systems Design (ISD) workforce at the beginning of the Revolution in Training was over 50 years old; the average time of service exceeded 20 years.

- <u>Innovation/R&D</u>.

  The ability to stay abreast with emerging concepts, processes and tools requires an entirely new set of partners and processes. Tremendous investments can be made to build an eLearning infrastructure, but what happens when technology breakthroughs make virtual reality the new "game in town?" Organizations need to create a culture that encourages and rewards innovation, and institutionalizes the processes and policies that empower those programs. They need to benchmark best practices from across industry to ensure their techniques remain abreast with new and emerging learning theories, tools and practices. They need an active dialogue between researchers and practitioners. They also need to protect those long-term, the "out of the box," risk-taking, exploratory efforts from the day-to-day business challenges that would siphon resources and energy.

  The ability to remain agile and responsive is crucial. Organizations should network with associations that focus on research. The federal government sponsors many programs; academia focuses on research as well. UCLA's CRESST foundation's and UCF's Human Performance Research Centers' work in the education and team performance domains are notable. Similar efforts are beginning now in the gaming domain. Defense organizations have the added benefit of capitalizing on UARCs, with funding being provided by government and laboratories coordinating with defense customers to identify and work the highest priority areas. The Navy sponsored Learning Strategies Consortium (LSC) has provided a good forum to develop relationships and share ideas.

  It is also important to ensure innovation projects contribute to the "bottom line." Projects should address real world business problems, and a notable percentage of these emerging concepts, tools and methodologies should be transition to daily business operations in a timely manner.

<u>Lesson Learned</u>: The U.S. Navy's R&D and regular operations funding were managed by the same senior program managers. Unfortunately, all training R&D and innovation funding were

redirected to support other priorities in recent years. Manpower R&D funding and operational accounts were managed separately, and R&D funding was not redirected.

- Enterprise-wide Learning System.

  Enterprise-wide learning systems are required to deliver these new learning tools and interventions to a geographically dispersed workforce. Technological advances have produced highly capable Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) are able to perform a wide array of functions to support the overarching HC effort. The ideal system would be one that properly meta-tagged all learning modules so they could be reconfigured to meet both standardized and emergent course requirements by different clients throughout the organization. Reusable learning objects can significantly reduce development time, allow standardization (eliminate redundancy and duplication), and enable the concepts of both "just in time training" and of "chunked learning."

  The use of technology continues to increase in industry. ASTD studies indicate roughly 25% of learning interventions were web-based in the 2003-2004 timeframe. While LMS/LCMS can significantly reduce long-term recurring cost by reusing knowledge, they are also aligned with the dynamics of the geographically dispersed 21st century workforce. Learners can access learning modules on demand shifting the dynamics more to the user versus the organization. A reduction in cost per learning hour received, and an increase in the content reuse ratios would indicate that economies of scale are being achieved.

Example: In the U.S. Navy common learning modules across different professional communities can be shared to significantly reduce development costs, improved standardizations, etc (e.g. Oceanography between the aviation, surface and submarine communities).

- Quality Control.

  Every business line needs an effective feedback and quality control program, and the training enterprise is no different. Work is constantly changing so it is important to have frequent surveys, conferences, etc to ensure learning programs remain on target.

Lesson Learned. Despite regular curriculum reviews Navy enlisted initial pipeline courses a comprehensive JTA process determined that roughly half of all curricula were not directly mapped to a validated job requirement. In an extreme case some courses were being taught that had no connection to current work.

In summary, those organizations that are best able to align individual and team job requirements with proper learning proper methods and modalities will consistently achieve the best business results. Those results may differ by industry sector or business focus – in the military it would equate to mission readiness or effectiveness; in the corporate world it would manifest itself as increased stock prices, sales volume, etc. Either way, workforce proficiency has become a "force multiplier," and leaders need to view learning as an investment. They need to transition from a "supply" model to a "demand" model that fully integrates learning into the business process. They need to establish, advertise and promote a standard learning architecture based on validated requirements/metrics. They need to adopt a Learning Model that ensures the appropriate learning methodology is applied to the specific job/level of performance. They need strong business processes to develop, field and maintain learning and performance improvement services in the most effective and efficient manner. As learning becomes more integrated with work, the learning activities and impact will become more transparent. Finally, they need to establish processes to continually evaluate and align the learning architecture.

This transformation will take time. Organizations have established cultures that resist change, and many practitioners in those organizations have been successful mastering the old ways of doing business. They will be uncomfortable with new approaches, especially without appropriate motivations and incentives. A dedicated change management team working directly with senior leadership is recommended. Challenging the status quo to open the realm of the possible is helpful; as is focusing on the "Sense of Opportunity" to energize employees. For example, does the organization mandate minimum learning time per employee? Does the organization provide dedicated learning facilities? Does the organization reward leaders whose personnel complete learning events? Most importantly, how do CLO's and training executives lead the transformation?

The AT&L Performance Learning Model

11 July 2006

THE SETTING: Influential Factors

The Department of Defense's Acquisition, Technology, and Logistics (AT&L) workforce currently consists of over 134,000 Department of Army, Department of Navy, Department of Air Force and Defense agency professionals serving in 13 acquisition, technology, and logistics career fields. The AT&L community is undergoing tremendous transformation. To help guide this transformation, USD (AT&L) established six strategic goals:

- **High Performing, Agile, Ethical Workforce**
- Strategic and Tactical Acquisition Excellence
- Focused Technology to Meet Warfighter Needs
- Cost-effective Joint Logistics Support for the Warfighter
- Reliable and Cost-effective Industrial Capabilities Sufficient to Meet Strategic Objectives
- Improved Governance and Decision Processes

The **first goal** focuses on the workforce and the processes they use to do their job. This focus on our people is critical because of the major challenges facing them:

- Projected loss of experience and knowledge from retirement
- Need to adapt to revolutionary advances in information technologies
- Necessity of streamlining infrastructure
- Participating in the fundamental transformation of the Department of Defense

At the root of these challenges is major demographic turbulence. In 2005, almost half of the total workforce were eligible to retire, and by 2007 the number reaches 70%. A replacement generation must be rapidly brought on and trained. See pages 10-12 of the AT&L Human Capital Strategic Plan at http://www.dau.mil/workforce/hcsp.pdf for more details.

Effective and efficient training, as well as the capability to train significantly more students, are key to the continued success of the AT&L community. Therefore, the Defense Acquisition University, the AT&L corporate university, has the mission and vision to focus efforts on delivering the learning products the AT&L community needs, when and where needed. The **mission** is to provide practitioner training and services to enable the AT&L community to make smart business decisions and deliver timely and affordable capabilities to the warfighter.

The skill sets required by the new business environment of the 21st century can no longer be served by the traditional training methods of the 20th century. For the workforce to meet their challenges, they must have convenient and economical access to learning products 24 hours a day, 7 days a week – the concept of anytime, anywhere learning. DAU is at the forefront of transforming the classroom environment of the 20th century into the total learning environment of the 21st century. DAU has embarked on a contribution-based strategic planning process that calls for using a performance learning model to plan and deliver career-encompassing certification training, targeted performance support, and job-related continuous learning. DAU created a revolutionary Performance Learning Model (PLM) that focused on career-long learning and included four main thrusts aligned with the DAU mission: certification and assignment-specific training, continuous learning, performance support and knowledge sharing / communities of practice.

The AT&L Performance Learning Model – giving the workforce more control over career-long learning opportunities

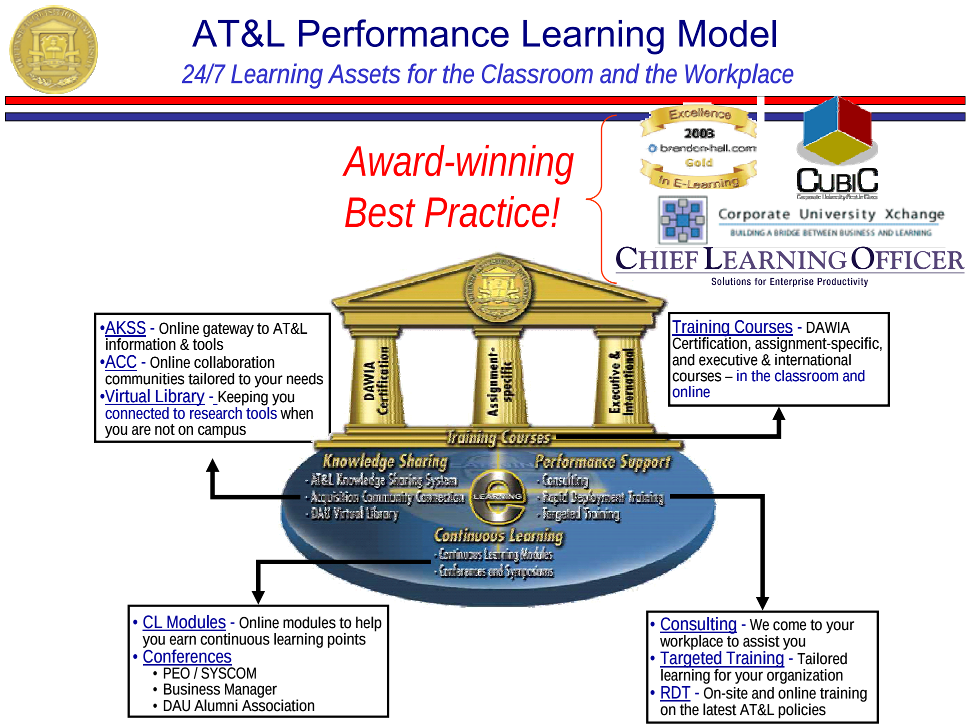


Figure 1. The AT&L Performance Learning Model (PLM)

With the implementation of the PLM (Figure 1), the workforce members have more control over their career-long learning opportunities. Major components of the PLM include:

- **Certification and Assignment-specific Training** – DAU offers more than 88 certification courses spanning 13 career fields. DAU delivers training through an appropriate mix of classroom, web-based, and hybrid offerings.
- **Continuous Learning** – The DAU Continuous Learning Center (CLC) provides over 150 self-paced modules that keep the DoD AT&L workforce abreast of policy and procedures.
- **Performance Support** – Through on-site consulting, targeted training, and online knowledge sharing tools, DAU continues to support students and their organizations after the classroom experience.
- **Knowledge Sharing** – Through the AT&L Knowledge Sharing System and Communities of Practice the DoD AT&L workforce and its industry partners have an easily accessible and enhanced means to learn, share what they have learned, and use this knowledge to improve performance.

The PLM extends the concept of learning beyond the classroom itself (Figure 2). Whether through distributed learning with web-based courses and continuous learning modules, or performance support linking the workforce to expert practitioners, or 24/7 access to acquisition resources with the AT&L Knowledge Sharing System, DAU is accelerating the transformation of the DoD AT&L learning environment. The PLM is a key enabler for achieving the first of

USD (AT&L)'s strategic goals. With the PLM as a foundation, the DoD AT&L workforce has a more flexible, responsive, and agile learning environment.

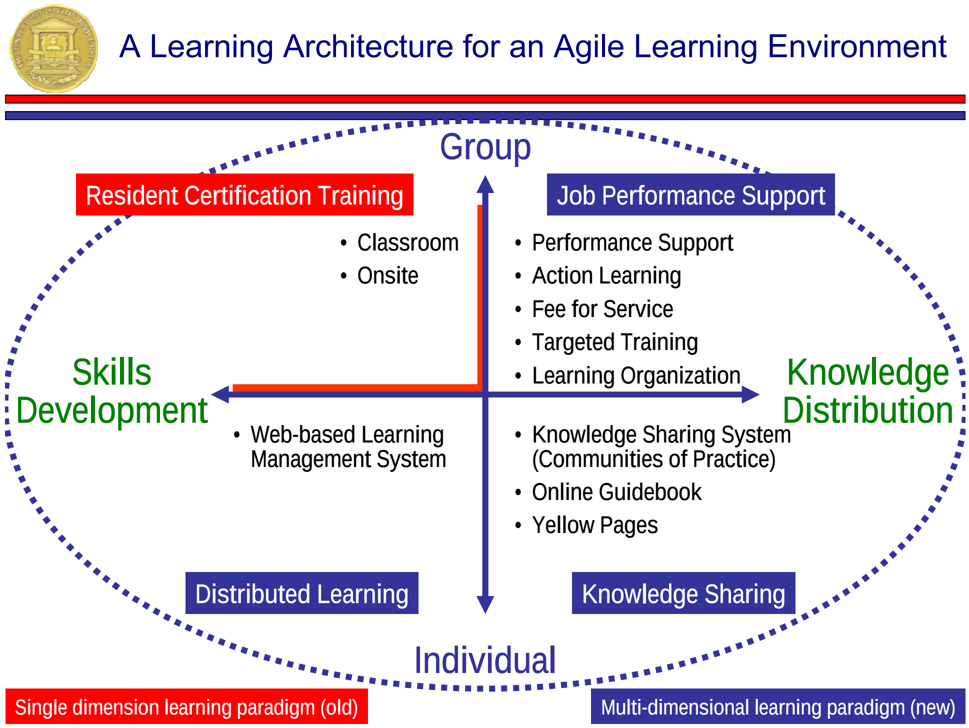


Figure 2. AT&L Agile Learning Environment

ALIGNMENT: The Key To Success

In FY 02, DAU embarked on a contribution-based strategic planning process that enabled the university to rapidly transform and provide the very best learning products in the most cost effective manner.

The DAU Strategic Planning Process is all about leadership alignment, performance and results, not just promises. The products resulting from this process consist of a Strategic Plan, Supporting plans,

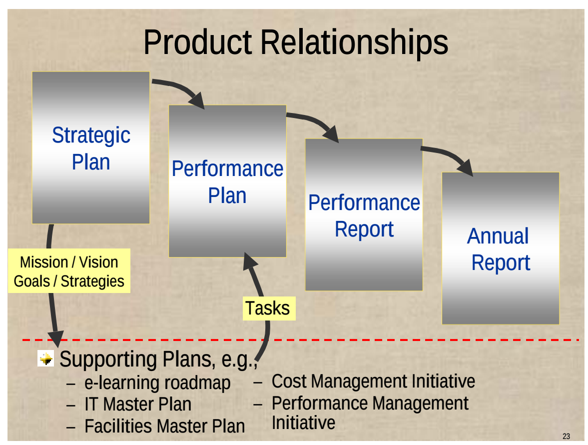


Figure 3. DAU Strategic Alignment

Annual Performance Plan, Annual Performance Report, and Annual Report. Additionally, faculty and staff performance plans and evaluations are based on their contributions to achieving the tasks in the performance plan.

- The ***FY 2006 – 2011 Strategic Plan*** was published in September 2005. This plan establishes the mission and vision for the University and sets forth long-term strategic goals and strategies. (See http://www.dau.mil/about-dau/docs/Strategic_Plan.pdf for the Strategic Plan.)
- ***Supporting Plans***, such as the e-learning Roadmap, IT Master Plan, and Facilities Master Plan provide the tactical planning in critical areas to ensure the success of the Strategic Plan. These operational level plans feed into the Performance Plan.
- The ***Performance Plan*** is directly aligned with the mission, vision, and strategic goals established in the DAU Strategic Plan.   Each year's Performance Plan contains *performance tasks* that specify what is to be

accomplished for that specific year and *performance targets* (metrics) that specify measures of progress for what we expect to achieve. Each performance target is intended to drive behavior toward accomplishment of the strategic goals.

- At the end of each year, a ***Performance Report*** will provide the DAU leadership and all members of the DAU team an accounting of that year's progress measured against established performance targets
- Finally, the ***DAU Annual Report*** will draw from the Performance Report and will share with their stakeholders and customers their accomplishments for the preceding year. (See http://www.dau.mil/about-dau/docs/ANNUAL_REPORT.pdf for the FY 05 Annual Report.)

Our corporate university's strategic goals, supporting plans, and performance tasks are all focused on implementation of the new Performance Learning Model. This model brings new learning products, technologies, and services to provide the learners with the most effective, job-relevant learning solutions anytime-anywhere, timely performance support, and knowledge sharing opportunities.

Key to executing the Performance Learning Model is the Supporting Plan, *DAU Performance Learning Roadmap* (See http://www.dau.mil/pubs/pdf/DAU_Performance_Learning_Roadmap.pdf). This roadmap provides a framework for integrating e-learning across the PLM, thereby helping to achieve DoD AT&L's institutional learning goals. The Roadmap contains strategies for e-learning and establishes specific metrics for each. Additionally, these strategies link to performance tasks in DAU's Annual Performance Plan.

THE EVIDENCE – Measuring the effectiveness of the Performance Learning Model

Certification and Assignment-specific Training.

Certification and assignment-specific training is the cornerstone of the DAU's mission. The Functional Advisors and Functional Integrated Product Teams are working with DAU to transform curriculum to meet the needs of the 21st century AT&L workforce. For example, in the restructuring of the Program Management curriculum, a 14 week on-site Level III course was transformed into a hybrid course requiring 50 hours of internet-based training and 6 weeks in residence. The overall restructuring of the Program Management curriculum resulted in a reduction of annual student training weeks from 36,000 to 10,000. This returns 300 annual work years, or $17.4M, of productivity to the DoD AT&L workforce.

Since 1999 (Figure 4), over 263,000 students have completed distributed learning classes. In FY 05, DAU offered 21 on-line courses and 6 hybrid courses with graduates numbering over 75,000. On-line instruction time has increased from 23,468 hours in 1999 to over 2.2 million hours in 2005. Student throughput has increased 8.5 times in six years.

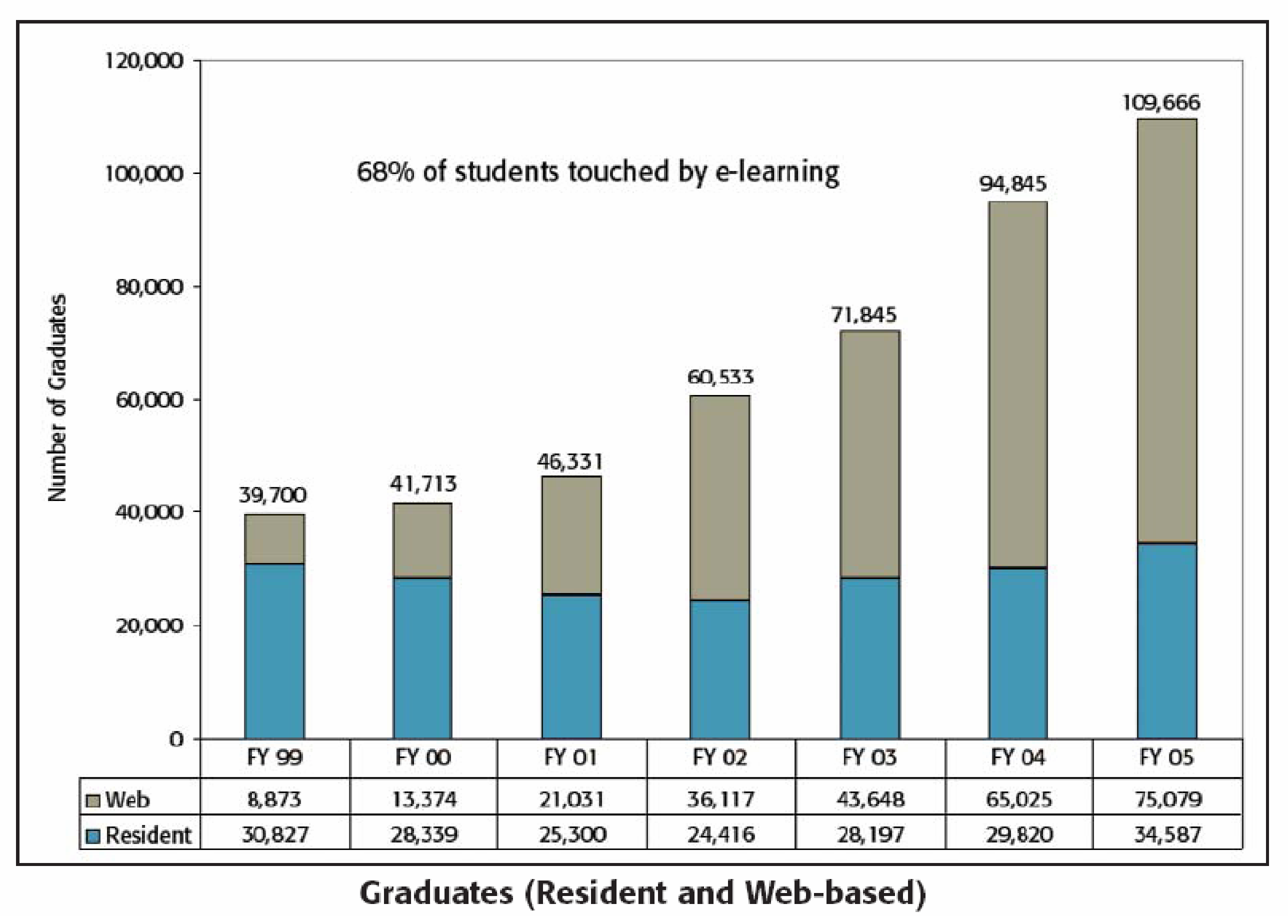


Figure 4. DAU Annual Graduates (FY99-FY05)

Continuous Learning: DoD policy calls for the DoD AT&L workforce to operate as a continuous learning community. Members of the workforce are required to have 80 continuous learning points every two years. In response to this, DAU formally launched the Continuous Learning Center (CLC) in July 2001. It now has over 150 modules on line. All modules in the CLC offer the workforce the opportunity to meet their continuous learning requirements while keeping abreast of current initiatives in acquisition. Additionally, the CLC includes conference and workshop listings, associations and organizations, a library and the user's ability to track continuous learning points (CLP). CL completions have grown steadily since 2001 with 168,463 completions in 2005 (Figure 5). This excludes any number of CL modules that were engaged via the "browse" mode.

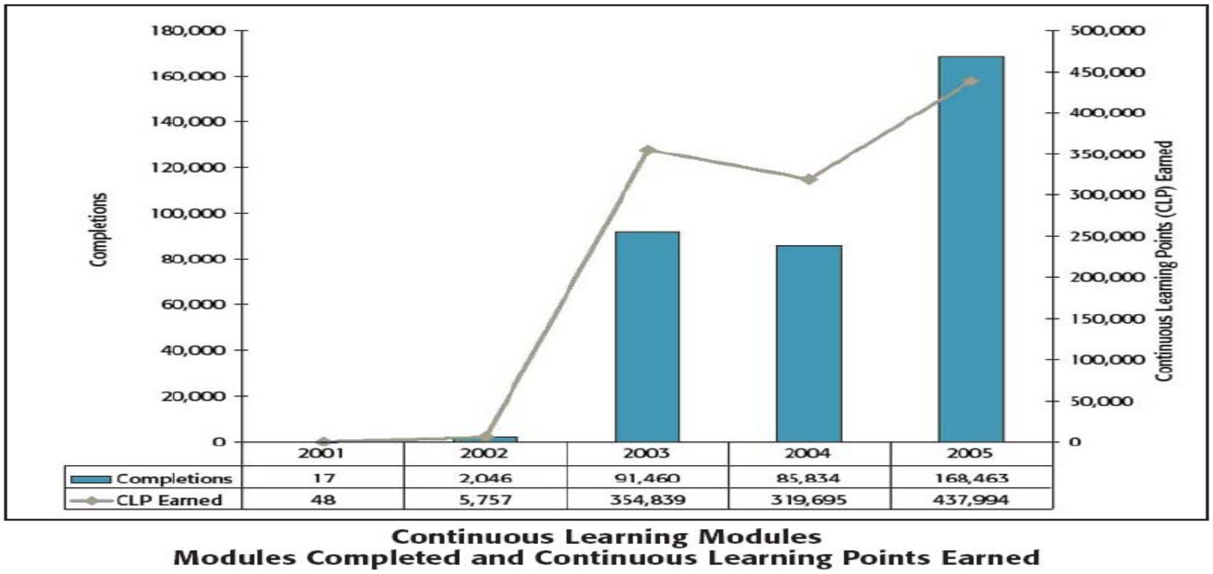


Figure 5. DAU Continuous Learning Modules (CLMs)

Performance Support: One way DAU provides support to the AT&L workforce once they have completed their course is through performance support. The AT&L community has continuing access to DAU's seasoned faculty to assist them in planning organizing, staffing, controlling, and leading their organizations. Whether on-site or on-line, DAU provides expertise, analysis, advice, knowledge, and information in the form of consulting and targeted training to the DoD AT&L community. DAU's subject matter experts are able to bring the latest in cutting-edge process improvements to the acquisition system. Likewise, by being on the "front lines" of today's complex procurements, our faculty maintains exposure to field techniques and issues. They can immediately infuse course instruction, continuous learning modules, or communities of practice with lessons-learned from consulting efforts, creating an invaluable synergy between curriculum, knowledge sharing, and performance support. This synergy enhances and expands the learning experience of the workforce.

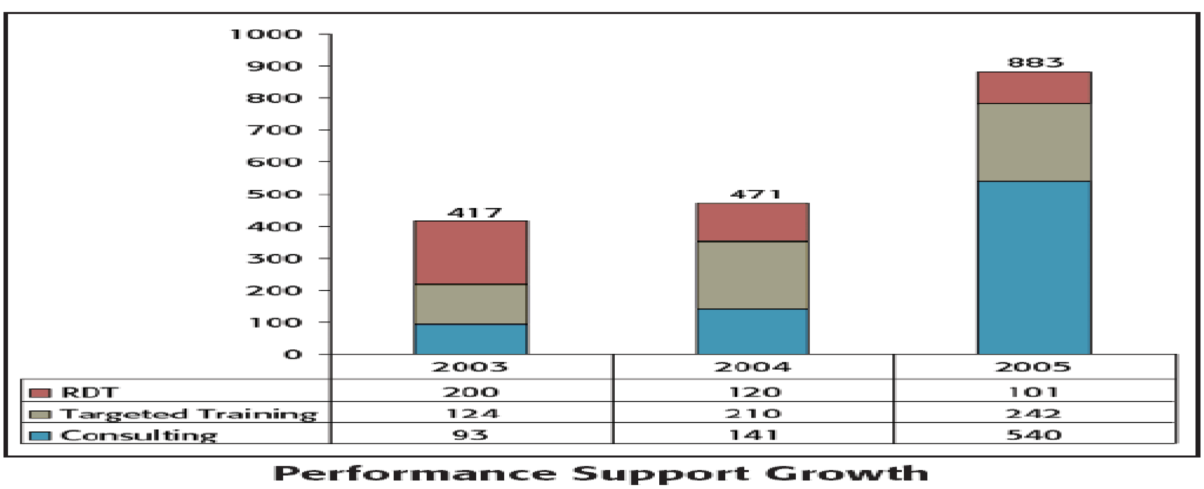


Figure 6. DAU Performance Support (FY 03-FY 05)

Rapid Deployment Training Initiative: A recent expansion in our Performance Support efforts is the creation of a Rapid Deployment Training Initiatives. When policy changes, teams create new learning material and place it in a digital repository within five days of the change. With this initiative, the workforce will have almost near real-time access to changes that affect their job. Learning products are available through various electronic media as well as through mobile training teams providing on-site instruction.

Knowledge Sharing / Communities of Practice: Another way DAU continues to support the AT&L workforce beyond the course itself is through knowledge sharing initiatives. DAU has developed an AT&L Knowledge Sharing System (AKSS) to provide the DoD AT&L community with a single entry point to acquisition resources. This site contains links to mandatory and discretionary reference material, a glossary and acronyms listing, "Ask a Professor," news and publications, education and training, Acquisition Events, other related web sites. The Acquisition Community Connection (ACC) houses a variety of Communities of Practices in career fields or business process areas. These communities offer a forum for connecting individuals from various organizations who are facing similar problems and issues. This ready access to peers, expert help, and lessons learned provides fertile ground (Figure 7) for workforce innovation and fosters the transfer of best business practices across the DoD AT&L workforce.

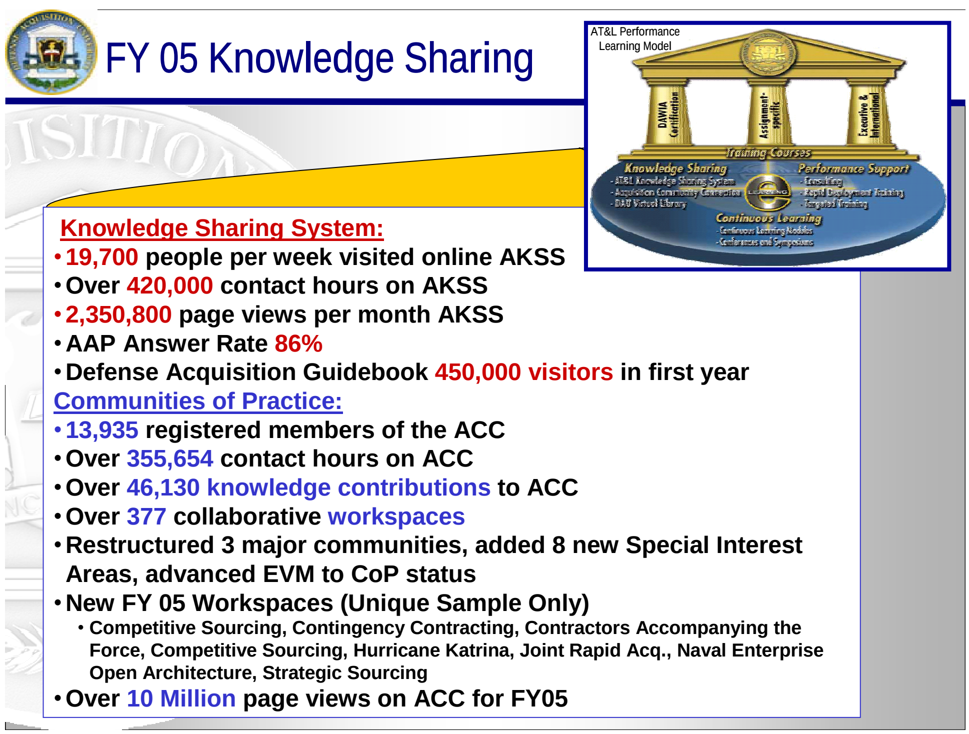
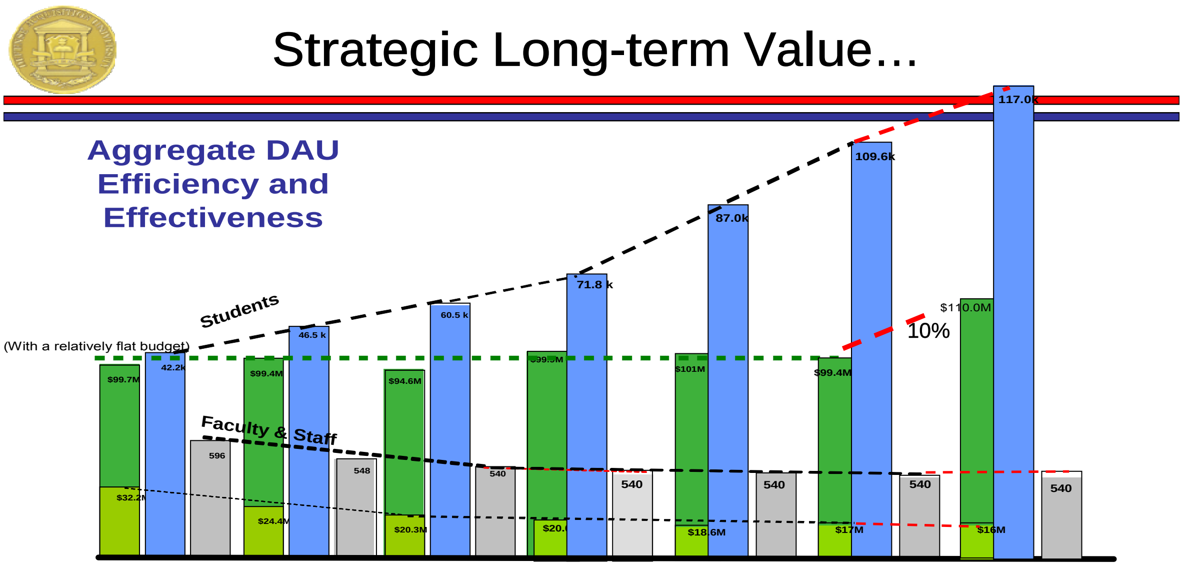


Figure 7. AKSS & ACC Metrics

Conclusion: The Performance Learning Model is USD (AT&L)'s best business practice for developing and implementing an enterprise-wide learning / e-learning strategy. The strategy is to provide premier career-long learning options for the DoD AT&L workforce and help them add value in their vital support to the warfighter. With the PLM in place, DAU delivers quality products to a workforce of over 134,000 worldwide. The growing number of on-line graduates

(Figure 8) indicates a more responsive learning environment that makes training cost avoidances possible as well as reduces time away from the workplace. With an effective strategic planning process, DAU is able to redirect training cost avoidances into curricula modernization and e-learning initiatives that have returned a significant number of work years to the workforce.



Legend	FY00	FY01	FY02	FY03	FY04	FY05	FY06
Student Travel	32.2	24.4	20.3	20.0	18.6	17.0	16.0
Total Budget	99.7	99.4	94.6	99.9	101.0	99.4	110.0
Faculty and Staff	596.1	548	540	540	540	540	540
Students	42,239	46,520	60,485	71,841	87,0974	109,666	117,000

- ✓ Student Travel Costs Down 45%
- ✓ Faculty & Staff Down 10%
- ✓ Student Throughput Up 178%

Figure 8. Value of the AT&L Performance Learning Model (PLM)

When we compare trends in four key areas (student throughput, total budget, student travel budget, and number of faculty and staff) we see a significant return on investment in DAU as our training provider. Since 1997, DAU's budget has remained relatively flat. Yet, we have dramatically increased the number of students trained even with a reduction in faculty and staff and student travel costs. Over this time, the average cost per student has declined 32% -- a reduction of $1,000 per student.

The transformation of the Defense Acquisition University into a corporate university and the implementation of a career-long learning focused Performance Learning Model played a key role in better equipping and supporting the AT&L workforce. As a result, over 134,000 AT&L workforce members are receiving the right learning products at the right time and place to help them make smart business decisions and deliver timely, affordable, and effective capability to the warfighter.

Proposed Army Learning Model for Professional Military Education (PME)

Prepared for Army Research Institute's Science of Learning Workshop

1-3 August 2006

Millie Abell
Chief, Learning Strategies Division
DCSOPS&T
HQ Training and Doctrine Command

The US Army Headquarters Training and Doctrine Command's (TRADOC) Challenge

According to the 15 May 06 memorandum from TRADOC's Deputy Commanding General on Transforming TRADOC – Enabling the Army Vision, TRADOC has reached the point where it must now absorb significant manpower reductions by streamlining its organizations and the manner in which they operate. TRADOC must initiate business practices that maximize limited funding and manpower for the coming years. For this reason, the Deputy Chief of Staff for Operations and Training (DCSOPS&T) proposes a three-phase model that not only leverages instructional technology, but also takes advantage of research in adult learning theory to improve instructional design and to strengthen learning skills.

The model is designed for Professional Military Education as opposed to Initial Military Training, with initial focus on implementation within the Captains Career Course. The model is designed to reduce Soldier time in resident instruction with no loss in performance. This paper describes the three phase model, the rationale for increasing the use of technology-based instruction, and the Guided Experiential Learning framework for designing and delivering instruction. In this paper, technology-based instruction is referred to as distributed learning (dL), regardless of whether such instruction is presented within residence at a TRADOC school or delivered to the learner at the home station.

Three PhaseLearning Model for Professional Military Education: An Overview

The model covers the phases of individual learning preparation, collective learning synergy, and transfer of learning to the job.

Phase I/Individual Learning Preparation via dL at the TRADOC Schoolhouse. Phase I allows Soldiers to complete mandatory training and diagnostic testing via dL at the TRADOC school, with the option to complete this phase at the Soldier's home station, as mission requirements permit. The rationale for allowing Soldiers to complete dL at the school stems from the fact that TRADOC has no control over whether unit commanders will be able to allow Soldiers the time they need to complete preresident instruction at their home stations. According to Wlodkowski, Mauldin, and Gahn (August, 2001), adult learners who work full time often find it difficult to persist in a course, and attrition results. In *E-learning and the Science of Instruction*, for example, Clark and Mayer (2003), cite dropout rates estimated at upwards of 35 percent.

Whether instruction is completed at a TRADOC school or the home station, Phase I covers three areas. First, it requires Soldiers to learn fundamentals such as facts, principles, and basic nomenclature so that they begin Phase II resident instruction as a homogeneous group in terms of their entering level of knowledge. Secondly, schools will also administer a required Fast Track Qualification Test to identify students for placement in an accelerated version of the course. The test will assess learners in three areas: prior knowledge of course content, learning strategies, and level of self-efficacy. Thirdly, if a course contains common content that is not fully integrated with whole task practice in Phase II (e.g. branch history, equal opportunity), TRADOC will allow Soldiers time to complete this common content within one month after returning to their home stations.

Throughout Phases I and II, schools will also implement dL on Saturdays, expanding the training week by eight hours but reducing the total number of weeks by an equivalent amount. While this schedule expands the training week to 48 hours, formal classroom instruction will not exceed eight hours per day. DCSOPS&T recommends maximizing the amount of dL delivered on Saturday so that the burden on instructors will not increase.

Phase II/Collective Learning Synergy: TRADOC Classroom Instruction. Phase II blends face-to-face (f2f) and dL instruction while the student is in residence at a TRADOC school. DL, for example, may be scheduled for evenings and planned weekday periods, and again, Saturday instruction should make significant use of dL as appropriate. The Phase II f2f component emphasizes integration of whole-task practice through use of shared challenging exercises that build task cohesion. It will do this not only through the current Field Training Exercise (FTX), but also through additional planned periods of hands-on, integrated practice.

In addition, more dL will be included at the end of Phase II so that learners can depart early and complete remaining instruction at their home stations if they so choose. This culminating dL block at the end of Phase II will be different than the dL found in Phase I. For example, the dL scheduled at the end of Phase II will provide learners with complex scenarios that allow them to solve problems by considering issues from multiple perspectives that require learners to analyze, synthesize, and evaluate content.

Phase III/Transfer of Learning: Homestation. Phase III allows students to finish, upon return to their home stations, any mandatory training not completed earlier. Secondly, schools will also provide job aids and dL sustainment packages to Soldiers upon request in order to minimize performance degradation. Some evidence suggests, for example, that learning which is not applied within 30 days decays (Pike, July 2001), thus Soldiers will need ongoing support for job tasks. In addition, schools will ensure that graduates' supervisors have the opportunity to provide feedback on Soldier performance via electronic surveys so that course content and instructional strategies will continually improve.

Projected Learning Model Efficiencies. In projecting efficiencies achieved through implementing the model, TRADOC analyzed a hypothetical 20 week course, and calculated course length reductions based on the following factors: (1) Saturday classes alone reduced course length by over 16 percent; (2) dL achieved a 30 percent efficiency with traditional students and a 40 percent efficiency with accelerated learners, and (3) f2f instruction with accelerated learners achieved a ten percent efficiency. In addition, TRADOC estimated course lengths based on five assumptions about the amount of instruction that could be delivered via dL, i.e. a 50 percent, 40 percent, 30 percent, 20 percent, and ten percent of the 20 week course conversion to technology. For example, TRADOC projected that with Saturday classes and a conversion of 50 percent of the course to dL, the standard version of the course could be reduced to 14.2 weeks and the fast track version for accelerated learners could be reduced to 12.5 weeks.

Rationale for Increasing Use of Technology

Efficiencies Generated by Technology. In his chapter entitled *Evidence for Learning from Technology-Assisted Instruction*, Fletcher examines research comparing individual tutoring (one instructor, one student) with traditional instruction (one instructor, 30 students). In evaluating Benjamin Bloom's research from the University of Chicago, Fletcher concludes:

> Such a difference in instructional presentation might be expected to favor one-on-one teaching. What is surprising is how much it matters. Across these studies, the difference in student achievement amounted to two standard deviations. This difference is roughly equivalent to raising achievement of 50^{th} percentile students to the 98^{th} level of achievement (Fletcher, 2003, 82).

Bloom (1984) not only found that learners taught conventionally performed two standard deviations below those who were tutored, but learners spent more time on task when tutored -- over ninety percent of instructional time was spent on tasks during tutoring, while only sixty-five percent of instructional time was spent on task during conventional classroom instruction. Moreover, tutored students held more positive attitudes than those taught conventionally. Through one-on-one tutoring, Bloom felt more students could achieve higher levels of performance, and he referred to the search for instructional methods that are as effective as in f2f tutoring as “the 2 Sigma Problem” (Bloom, 1994, 4).

In reviewing the *meta-analyses* by Kulik, Fletcher (2003) found learner performance can move from the 50th percentile upwards using technology and he went on discuss its impact on learners. For example, based on a meta-analysis of 233 studies involving technology which incorporated text, graphics, some animation, and some individualized interaction, researchers found learner performance was raised from the 50th to the 65th percentile. In analyzing 47 studies of multimedia instruction, which used video as well as more animation, more audio and more elaborate interactions, learner performance went from the 50th to the 69th percentile. Going beyond multimedia and looking into 11 studies of intelligent tutoring systems that tried to duplicate a one-on-one learner-tutor dialogue, Fletcher found learner performance went from the 50th to the 80th percentile, with more recent studies (N=5) indicating performance can move from the 50th to the 85th percentile.

Fletcher claims computers cost-effectively deliver instruction in part because technology saves time when learners do not cover content they have already mastered. The following table from Fletcher’s chapter summarizes research findings of time saved using technology.

Time Savings Using Instructional Technologies

Studies	No. of Findings	Average Time Savings
Orlansky & String (1977) (Military Training)	13	54%
Fletcher (1991) (Higher Education)	6	31%
Kulik (1994) (Higher Education)	17	34%
Kulik (1994) (Adult Education)	15	24%

(Fletcher, 2003, 88)

In line with this data, Corbett’s 2001 report of research from Carnegie Mellon University supports the advantages of computer tutors, finding that learners using technology completed instruction in one-third the time of those who were not tutored, while surpassing Bloom’s two-Sigma, or standard deviations goal that had been realized by students interacting with human tutors. Fletcher and others caution educators that it is not technology *per se* that impacts learner performance; rather, it is the quality of instructional design that makes a difference in learning. Instructional design is key, and is the rationale for DCSOPS&T selecting the Guided Experiential Learning framework that will be discussed later.

When to Use DL or F2f Instruction. In their publication “Heuristics for Selecting Distance or Classroom Settings for Courses,” Clark, Bewley, and O’Neil (2006) state that no published studies exist on the way instructional designers actually choose an instructional medium, and the authors suspect models are infrequently used. To select a medium wisely, designers must first identify the instructional methods necessary for the learning objectives, as well as the medium that can deliver the instruction least expensively.

There are limits to the content technology is able to deliver, and DCSOPS&T is providing instructional designers with Clark, Bewley, and O'Neil's three criteria for considering whether material can be delivered via dL or f2f. First, if sensory input beyond the audio visual is necessary (i.e. taste, touch, smell), instruction should be kept in a f2f environment. Secondly, if complex conditions are required for instruction, such as simulating a riot, and electronic media cannot adequately depict these conditions, instruction should be kept in a f2f environment as well. Thirdly, if the learner is engaged in whole-task practice of a complex task, then an instructor must observe, evaluate, and provide feedback. For practice of complex tasks, a medium must allow synchronous observation of the learner as well as audio and visual feedback from the instructor to the learner. If a medium is inadequate for this, the practice should be kept in f2f instruction.

Guided Experiential Learning (GEL): A Framework for Instructional Design and Delivery

In 2000, the Secretary of the Army's Distance Learning/Training Technology Subcommittee reviewed numerous instructional design guidelines that DCSOPS&T consolidated from research in training and education for distribution to Army trainers. While the subcommittee agreed that the guidelines were valid and useful, it was recommended that these norms be subsumed within an overarching framework. Such a structure would ensure the major events of instruction were included in Army training, and that a construct was in place into the DCSOPS&T could incorporate new guidelines as academia's research in learning progressed. For this reason, DCSOPS&T recommends GEL as the framework for designing and delivering instruction. GEL is founded on Cognitive Load Theory, which Clark, Nguyen, and Sweller (2006) consider relevant to all content, all instructional media, and all learners. The goal of Cognitive Load Theory is to acquire knowledge and skills more efficiently by not overloading the learner's working memory.

In his March 2005 presentation to Army trainers, Dr. Richard Clark described how human mental architecture makes learning difficult in order to protect us from scrambling experience and erasing memories. For example, working memory allows the learner extremely limited thinking space – approximately three +/- two ideas at one time. For this reason, instruction (especially for novice learners) must be crafted to ease the load on working memory. In designing and delivering efficient instruction, GEL advocates the following sequence of events: (1) using a job relevant problem so that instruction will be meaningful to learners; (2) activating prior knowledge to see how instruction can build on what learners already know, and to identify misconceptions learners have about the content; (3) explicitly demonstrating and explaining processes, procedures, or problem solving; (4) providing learners with practice and feedback on increasingly difficult problems, and (5) ensuring transfer to new instances, for example, by varying the context of problems.

The more expert a learner is, the less guidance he will require from the instruction (Clark, Nguyen, and Sweller, 2006). For example, GEL advocates that instruction provide novice learners with worked examples that offer step-by-step demonstrations/explanations on how to solve problems or perform procedures. As instruction progresses, novices may benefit from completing examples that are already partially worked. Finally, as novices acquire greater expertise, they move on to full practice. A student who enters the learning environment with significant expertise, however, requires less guidance and may, for instance, benefit more from seeing one worked example before moving directly to full practice. Discerning between novice and expert learners is critical to GEL and is the rationale behind the model's fast track for accelerated learners.

Army trainers and educators should not assume that proven instructional techniques such as well designed advanced organizers, lectures, Socratic questions, case studies, role plays, etc., are incompatible with GEL. Rather, GEL provides the framework for sequencing the five instructional events identified previously, i.e. providing job-relevant problems, activating prior knowledge, demonstrating, practicing, and transfer to new instances. GEL also helps trainers and educators determine the amount of guidance or scaffolding learners require. Proven instructional techniques, however, should be used as appropriate within these events. For example, Socratic Questioning is an appropriate technique for teaching critical thinking, because it guides the learner in probing for assumptions, for reasons and evidence, and for implications and consequences (Wlodkowski, 1999). Within the GEL framework, Socratic Questioning may be used as a technique in guiding the learner's practice in thinking critically. As the learner internalizes this technique and becomes more expert in self-questioning, the instructor's assistance can be lessened and eventually eliminated for experts.

Summary

Resource constraints require that TRADOC initiate practices that maximize limited resources. For this reason TRADOC's DCSOPS&T proposed a three-phase model that leverages instructional technology and that takes advantage of research in adult learning. The proposed model for Professional Military Education is designed to reduce Soldier time in resident instruction with no loss in performance. This paper described the three phase model, the rationale for increasing the use of dL, and the broad GEL framework that provides a sequence for fundamental events of instruction and a structure for using a host of proven instructional techniques.

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PAPERS FROM TRAIN SOLDIERS WORKING GROUP

Science of Learning Workshop
Train Soldiers Panel

Knowledge Types, Training, and Measurement

Phillip L. Ackerman
Professor of Psychology
Georgia Institute of Technology
Atlanta, GA

July 3, 2006

Types of Knowledge

Traditional overviews of knowledge start with Ryle's (1949/2000) separation of two kinds of knowledge, namely declarative knowledge (knowing that) and procedural knowledge (knowing how). Although categorizing knowledge in this fashion is useful for many purposes, these two categories do not capture a third key source of knowledge, called "tacit knowledge" by Polanyi (1966/1983), or "knowing with" (Broudy, 1977). In addition, although procedural knowledge is relatively well encapsulated, declarative knowledge is often not well encapsulated, as will be discussed below. Each of these different aspects of knowledge requires a different means of expression, and similarly often requires a different method or methods of assessment. This paper will provide a brief overview of the these three main types of knowledge, and a review of measurement issues and challenges associated each type of knowledge.

Knowing That. Factual knowledge about the world around us represents much of the traditionally described essence of declarative knowledge. This knowledge can be discrete (such as the name of one's commanding officer or the foreign language equivalent of the command to "stop your car here!"), or it can represent a set of principled or organized knowledge (such as the layout of major veins and arteries in the human circulatory system, the positions played in a soccer game, the rankings of different 'hands' in poker, and so on). Much of the information that we might need to recall on a day-to-day basis is declarative in nature (e.g., the names of our team members, the passwords needed to log-on to our e-mail or other computer accounts). However, there is a great amount of declarative knowledge that is taught in educational settings that will not be ordinarily encountered in other situations. For many individuals, knowledge acquired of trigonometry or European History will be rarely, if ever required for solution of a problem that arises on the job or off the job. However, many declarative facts may be critical for the individual's survival (e.g., which mushrooms are poisonous; how one should handle unexploded ordnance). Unfortunately, for many declarative facts, it is often difficult to estimate how likely it is that they will be needed at some future date, and how far off in the future the information will be required to be available. The inability to determine the utility of declarative knowledge means that the learner sometimes may have to take the need to acquire facts at face value.

Knowing How. Procedural knowledge is typically associated with sequences of actions (e.g., operating an automobile or disassembling and assembling a weapon). In some cases, knowledge of a sequence can be represented as declarative knowledge, such as when one follows a manual for assembling a piece of equipment. When the sequence of actions must be completed in a short period of time and/or with high levels of precision, such as when a surgeon removes a patient's appendix, declarative knowledge alone is not ordinarily sufficient for accomplishing a task. That is, *knowing* the sequence needed to perform the task (e.g., field stripping a weapon) is not the same thing as being able to perform the sequence in a competent manner. It is with this kind of example that the different nature of procedural knowledge (in comparison to declarative knowledge) becomes clear. Procedural knowledge is acquired through consistent and extensive practice.

Knowledge may be represented in a declarative fashion when learning starts, such as when a driving instructor provides a schema for the novice driver to follow (e.g., insert the key, make sure the car is in ‘Park’ or ‘Neutral,’ start the car, check the mirrors, look left, right and forward before releasing the parking brake, and so on). Even these instructions, though, presume a high level of knowledge on the part of the learner, in that the instructor presumes that the learner knows how to open the car door, how to orient the limbs to sit in the car seat, and so on. Once learned to a skilled level, these kinds of procedural knowledge are not usually mediated by explicit cognitive articulation. That is, the learner has effectively “automatized” the process of these intermediate, but critical, steps in the process of getting into the car prior to the task of driving.

Knowing With

By the time individuals reach young adulthood, they have acquired large amounts of knowledge that are not readily decomposed into declarative or procedural categories. Much of this knowledge is “tacit” in that it is not usually spontaneously articulated nor is it often easily accessible to verbal reports. Broudy (1977) noted that the educated individual “thinks, perceives, and judges with everything that he has studied in school, even though he cannot recall these learnings on demand” (Broudy, 1977; p. 12; see also Bransford & Schwartz, 2000 for a discussion of knowing with and transfer).

Polanyi’s “tacit knowing” and Broudy’s conceptualization of “knowing with” share similarities with Gestalt principles of perceptual organization and problem solving (e.g., see Köhler, 1947). This type of knowledge has overlap with subsequent proposals of a third kind of knowledge, such as the Wagner and Sternberg (1985) concept of “tacit knowledge” and the Baltes and Staudinger (2000) concept of “wisdom.” However, in both of these examples, the domains of knowledge are considerably more narrowly defined than that proposed by Polanyi and Broudy. Specifically, Sternberg’s operationalization of tacit knowledge is occupationally or academically specific, and it relates to particular strategies for success, mostly involving interpersonal interactions. The Baltes construct of wisdom has been *operationalized* in contexts that are limited to novel problem solving, far beyond any specific training content.

Measurement Issues

Knowing That. There are two traditional approaches to the assessment of declarative knowledge, namely: (a) recall and (b) recognition. In early modern psychology, the approach to assessing declarative knowledge was through measurement of recall. An examiner poses a question of factual knowledge, and the examinee responds with the answer (e.g., “What is the capital of Georgia?”; see Binet & Simon, 1905). However, this kind of assessment was found to be inefficient, in terms of scoring the results of a test of declarative knowledge. Starting with the Army Alpha Test in 1917 (e.g., see Yerkes, 1921), when 1.7 million men completed ability tests, and with the introduction of job-specific ‘trade tests’ (see Hull, 1928), there was a shift from testing recall to testing recognition knowledge. That is, in recognition testing, the examinee might be presented with the same question (“What is the capital of Georgia?”), but instead of being required to provide the answer, the examinee needed only to pick out (or recognize) the correct answer from a list of possible alternatives (e.g., [a] Albany, [b] Atlanta, [c] Macon, [d] Savannah). The advantage of recognition tests was that they could be scored by machines in a quick and efficient manner. In the following 90 years of declarative knowledge testing with large groups of examinees, recognition testing has become the dominant format for assessment.

However, there are two potentially important shortcomings with this kind of assessment, as follows: (1) First, many of these tests are speeded, and as such, introduce an additional source of variance (reading speed and comprehension) that may or may not be related to the individual's actual knowledge; and (2) Second, and perhaps more importantly, the real-world often does not provide the individual with a set of explicit choices in which all he/she needs to do is "recognize" the correct answer. That is, if the soldier needs to shout "stop this car" in a foreign language, he or she is not in a situation where recognition of the correct phrase is going to yield the required knowledge -- it is strictly a recall problem.

Over the past 20 years, advances in computerized assessment systems have made it possible to automate the assessment of typed natural language (at least when there is relatively constrained vocabulary), and so it has increasingly become feasible to assess recall-level declarative knowledge with an automated system. However, the degree to which this kind of system is successful depends on the match between the examinee's typing or spelling accuracy and the sophistication of the scoring system to accommodate various levels of disfluency on the part of the examinee (e.g., presumably giving credit for answers of "Atlanta" "Altanta" and maybe even "Hotlanta"). Similarly, voice recognition software has made great advances in the past 10-15 years, so that accuracy has increased almost to a level that provides for accurate scoring of verbal recall responses to declarative knowledge questions. Whether software has evolved sufficiently to make this an efficient means for declarative knowledge assessment is an open question, especially for knowledge domains that require responses more complex than a single word or a phrase of a few words. It certainly has not reached a state where the examinee could interact with the computer using natural language responses for more complex concepts. Widespread testing with verbal/vocal responses is likely to be some ways off in the future, but clearly this is an important goal for assessing recall of declarative knowledge.

Knowing How. Because procedural knowledge almost always has a substantial component of motor involvement, a "hands-on" approach to assessment is usually the most appropriate means of knowledge assessment. There are a few exceptions to this approach, such as using a declarative knowledge test for procedural knowledge (e.g., 'write down all the steps for disassembling/assembling the M240B'). However, there are few situations when a declarative knowledge test for a procedural skill provide for an adequate substitution, mainly because: (a) speed and accuracy of carrying out the activity is a critical component of procedural knowledge that is not captured by the declarative knowledge test; and (b) declarative knowledge is not *sufficient* for expressing the procedural skill (e.g., knowing the steps for brain surgery is not sufficient for being able to carry out brain surgery).

There are two ends of a fidelity continuum in assessment strategy for procedural skills. The high-fidelity approach dictates that the assessment must be done with a real-world situation (where the examinee actually performs the entire set of sequences that were to-be-learned, using the exact equipment that would be used on the job). For example, a high-fidelity assessment of the skill to operate a vehicle would require the presence of the vehicle and a course for the examinee to demonstrate his/her skill. The low-fidelity approach dictates that only the most critical aspects of the input components need to be presented to the examinee, and only the most critical aspects of the output skill components need to be acted-out by the examinee. A low-fidelity approach to the same vehicle operation situation might use an off-the-shelf PC with minimal efforts toward creating a realistic visual and auditory stimulus presentation, and might have a joystick and keyboard represent the steering wheel and other controls, respectively.

General statements about the need for a high fidelity system for procedural knowledge assessment are not warranted, given the relatively sparse existing research on the topic. It could be said that, ceteris paribus (that is, everything being equal), higher fidelity systems (or simulations) are usually better than lower fidelity systems (or simulations) for reliable and valid assessment of procedural knowledge. However, although the preceding statement is reasonable at face value, there have been a few documented situations when simulations turn out to be more "perfect" than operational situations, and thus some loss of ecological validity is possible even with a high-fidelity simulation (or, for example a field test course that is different from the operational environment). If the procedural skill to-be-learned needs to be robust (rather than brittle), medium-fidelity simulations may in fact be more useful for assessing the 'operational' procedural skill of the trainee.

The importance of the issue of level of stimulus/response fidelity in procedural knowledge assessment should not be underestimated. It is probably the most critical issue facing those who wish to extend training from on-site to remote locations (e.g., e-learning and assessment). For skills that closely mimic the use of a computer with standard input and output capabilities (e.g., operating a remote aerial vehicle; monitoring security displays), attaining a high degree of fidelity in the training and testing environment is easy and seamless with a standard off-the-shelf PC. As skills require more precise physical action sequences, significant muscle/strength involvement, kinesthetic feedback, and so on, it becomes very difficult to adequately assess procedural skills in the absence of the real-world system or a high-fidelity simulator.

A challenge for the efficient training and assessment with procedural skills is how to best instantiate both when actual physical practice is impractical or impossible (e.g., when the necessary apparatus is not available to the subject, or when the cost of access to the apparatus is prohibitive). One alternative intervention is to use a form of *mental practice* for skill training. As noted by Richardson (1967), "mental practice refers to the symbolic rehearsal of a physical activity in the absence of any gross muscular movements." The central advantage to mental practice is that it requires no physical apparatus for implementation (e.g., see Druckman & Bjork, 1991; Hinshaw, 1991-1992). Mental practice has been implemented in several different applications, from the most basic (e.g., asking the trainees to imagine performing the task, without any aids), to elaborate (e.g., using printed instructions and using audio prompts for the trainee to listen to during the mental practice). In the context of sequential psychomotor tasks (such as CPR), mental practice can be implemented with several of these different formats. In general, the central requirements of mental practice involve the imagined enactment of the sequence of actions involved in implementation of the skill. The most important consideration is that the individual have initial training to a level that reaches a rough level of competence before being transferred to a mental practice situation, in order to minimize proceduralization of erroneous sequences. In the absence of actual enactment of the skill (as would occur in a final hands-on testing situation), it is likely that self-assessments are going to be one main source of information about the individual's training progress in a mental practice scenario. The validity of self-assessments is a key issue, and will be discussed in more detail below.

Knowing With. Assessments of tacit knowledge have largely failed to deliver on their initial promise, for three primary reasons, namely: (1) The knowledge domains have been relatively narrowly defined occupational or educational knowledge, *not* the kind of knowledge that is broadly functional; (2) The kind of tacit knowledge assessed requires determination of the ‘correct’ answer by a consensus opinion, rather than an objective reference of correct or incorrect information or effective vs. ineffective knowledge; and (3) relatively little demonstration of criterion-related validity. Measurements of wisdom have been similarly disappointing in demonstrated value for criterion-related validity, mainly because they focus on the solution of highly novel problems that may not be expected to benefit from training, and because they have not been designed for the purposes of training assessment.

A large literature on topics related to “knowing with” has developed over the past few decades, mostly in the critical thinking and problem solving domain. That is, much of the training/educational research that focuses on developing critical thinking skills involves assessment of problem solving, where the prior knowledge is not *directly related* to the problem to-be-solved. The overarching difficulty that has yet to be resolved is to determine how to assess other aspects of knowledge and problem-solving orientations that are acquired through indirect instruction. In some ways, this discussion goes back to the controversy of formal discipline that raged at the beginning of the 1900s. However, it is clear that the issue is far from settled. Identifying which courses of general instruction yield improved application of these general orientations and problem solving strategies remains very much a challenge for the educational/training community.

Additional Considerations for Assessing Declarative Knowledge.

The traditional methods of assessing declarative knowledge are adequate for assessment of rote memorization of facts. However, they are lacking when it comes to the kinds of applications that are normally the actual target behaviors that the training is intended to address. There are two important concerns that need to be addressed in a more formal sense: (a) knowing vs. using knowledge and (b) training for transfer. Each will be briefly discussed below.

Knowing vs. using knowledge. One of the most frustrating experiences, familiar to all trainers and educators, is the circumstance that arises when the trainee has demonstrated that he/she has the knowledge necessary to solve a task, but does not engage that knowledge in an appropriate situation. There are many reasons why this occurs, from a failure on the part of the individual to recognize the problem as requiring specific knowledge, to a highly time-pressured situation that does not provide for a more considered response, to lack of motivational effort (e.g., when one uses a nearby implement rather than going to retrieve the proper tool). What looks to outside observers like a ‘lack of common sense’ (and even to the individual in retrospect, when things go wrong), is partly attributed to the failure of the individual to apply what he/she knows to the task at hand. Some investigators have referred to this phenomenon as “mindfulness” (e.g., see Langer, 1989).

When (training and) assessments are developed that go beyond rote memorization, and move to more in-depth measurement of “principled knowledge structures,” it may be possible to provide a more accurate sense of whether the trainee is likely to engage the task with the knowledge learned, or to use some shortcut that may not be as effective. The fundamental point is that “knowing” is not the same as “using” knowledge. Measurement of training success should be attentive to both aspects, keeping in mind that “knowing” is generally necessary, but not sufficient, for “using” knowledge.

Training for Transfer. The formal study of transfer-of-training has been going on for more than 100 years, but there is still much to be learned about what knowledge and skills transfer, and how wide the transfer spreads. The traditional approach to transfer assessment is to provide an initial training task, followed by some new task (whether close or distant in content).

The degree of transfer is assessed with a variety of different procedures, such as with a comparison between the time it takes learners to acquire the transfer task in control and transfer conditions (e.g., see Gagné, Foster, & Crowley, 1948). There are differences in the various methods for assessing the degree of transfer of training, but these differences are generally seen as relatively minor, in operational practice.

Determining *which* tasks to use as criteria for transfer assessment represents a much more salient problem for practice, especially when the goal of initial training goes far beyond the simple recall or recognition of factual knowledge. In turn, it is difficult to articulate a set of *initial* training goals when the ultimate criteria represent far transfer conditions that are not specified a priori. As transfer becomes increasingly distant in content and context from initial training, the task is more likely to be determined by "knowing with" kinds of knowledge than it is to be determined by straightforward declarative knowledge. Also, there are significant individual differences in terms of how far initial training transfers. For example, higher-ability individuals tend to show better distant transfer than lower-ability individuals (partly due to the capability of individuals to infer that knowledge may be used directly or indirectly [such as reasoning by analogy] to the new situation). Training programs that are narrow, in the sense of providing a large degree of structure, or drill and practice, may be relatively more beneficial for lower-ability individuals and near transfer, but may further limit distant transfer (e.g., see Sullivan, 1964). In this context, the challenge for future research and application pertains to the determination of the criterion space for transfer, and the assessment of mean and differential effects at varying degrees of near and far knowledge/skill transfer.

Self-Assessments (and self-regulated learning).

Although organizational-level assessment of knowledge and skills is both necessary and desirable (in terms, for example, of certifying an individual's competence to perform certain activities or operate specific machinery), certifications are often fixed (once one passes a end-of-course test, one is deemed capable of performing the activity) or are re-assessed at regular, but relatively long intervals (e.g., re-certifications on the firing range). However, it is important to note that there are substantial individual differences in performance even at initial certification, and there are different skill deterioration patterns for different skills and for different individuals, especially when the skill is not exercised on a frequent basis (such as learning a foreign language in school and then not using the knowledge over the next couple of years). Frequent organizational testing is expensive, and it is difficult to anticipate when refresher courses or activities are going to be available or needed by the individual. One potential supplement or alternative to a strict schedule of organizational testing is the use of self-assessments. That is, have the individual perform a "skill check" of the knowledge and skill he/she has acquired over the course of various training programs. If the individual can identify areas of skill deterioration, then the individual can self-regulate the maintenance of his/her training (in a fashion no different than a regular physical checkup or a pre-trip check of an automobile's mechanical systems).

There have been discussions in the literature regarding whether or not individuals are accurate judges of their own skills (e.g., see Ackerman, Beier, & Bowen, 2002; Krueger & Dunning, 1999; Krueger & Mueller, 2002). However, contrary to the pessimistic notions of Dunning and his colleagues, it has been found that with attention to several critical measurement components, both reliable and valid self-assessments can be performed (e.g., see Ackerman & Wolman, 2006; Mabe & West, 1982). The most critical components of the self-assessment situation are that of: expectation (that an individual would be later assessed on objective tests), relative judgments (i.e., self-estimates in reference to others or the population at-large), and experience (of actually completing the objective measures). Much work remains to be done to develop a set of self-assessment measures for the relevant military tasks, but the extant literature provides an extensive theoretical and empirical framework for future research and application.

Once a set of accurate self-assessment measures have been developed, it will be possible to keep the individual soldier in the training/skill maintenance loop, so that self-regulated learning (e.g., see Winne, 2001; Zimmerman, 2001) is maximized. That is, there is good potential for a system where the process of self-assessment leads to self-evaluation (determining discrepancies between current state and goal state [competency]), and then to organizationally-provided support for self-regulated refresher training (e.g., whether via electronic delivery, classroom delivery, or peer-training). With an adequate support apparatus, this self-regulated training/refresher system may have a significant effect on overall force effectiveness, as well as an increase in task-oriented motivation on the part of the individual soldier, who would become a more active partner in the training process.

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White Paper

Best Practices for Teaching Online:

A Literature Review and a Model for Course Design

Michael Simonson, Ph.D.
Professor
Instructional Technology and Distance Education
Fischler School
Nova Southeastern University
1750 NE 167th St.
North Miami Beach, FL 33162
simsmich@nova.edu

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INTRODUCTION

Distance education is defined by the Association for Educational Communications and Technology (Schlosser & Simonson, 2003) as:

> *Institution-based, formal education where the learning group is separated, and where interactive telecommunications systems are used to connect learners, resources and instructors.*

Distance education has two major components, distance teaching and distance learning. Distance teaching is the efforts of the educational institution to design, develop and deliver instructional experiences to the distant student so that learning may occur. Education, and distance education, is comprised of teaching and learning. This task force concentrated on distance teaching.

QUALITY INSTRUCTION FOR DISTANCE EDUCATION – THE LITERATURE

Distance education has been practiced for more than 150 years, passing through three phases: first, correspondence study, with its use of print-based instructional and communication media; second, the rise of the distance teaching universities and the use of analog mass media; and third, the widespread integration of distance education elements into most forms of education, and characterized by the use of digital instructional and communication technologies. Peters (2002) has suggested that “the swift, unforeseen, unexpected and unbelievable achievements of information and communication technologies” will require “the design of new formats of learning and teaching and [will cause] powerful and far-reaching structural changes of the learning-teaching process” (p. 20). Peters’ views are well-accepted, but there is also consensus that the most fruitful way of identifying elements of quality instruction may be to re-examine “first principles” of distance education and mediated instruction.

Perhaps the first of the “first principles” is the recognition that distance education is a system, and that the creation of successful courses—and the program of which they are a part—requires a “systems” approach. Hirumi (2000) identified a number of systems approaches but noted a concept common to all: that “a system is a set of interrelated components that work together to achieve a common purpose” (p. 90). He described a system that involved the efforts of faculty, staff, administrators, and students, and consisted of eight key components: curriculum, instruction, management and logistics, academic services, strategic alignment, professional development, research and development, and program evaluation.

Bates (in Foley, 2003) proposed 12 “golden rules” for the use of technology in education. These “rules” offer guidance in the broader areas of designing and developing distance education:

1. Good teaching matters. Quality design of learning activities is important for all delivery methods.
2. Each medium has its own aesthetic. Therefore professional design is important.
3. Education technologies are flexible. They have their own unique characteristics but successful teaching can be achieved with any technology.

4. There is no “super-technology.” Each has its strengths and weaknesses; therefore they need to be combined (an integrated mix).
5. Make all four media available to teachers and learners. Print, audio, television, and computers.
6. Balance variety with economy. Using many technologies makes design more complex and expensive; therefore limit the range of technologies in a given circumstance.
7. Interaction is essential.
8. Student numbers are critical. The choice of a medium will depend greatly on the number of learners reached over the life of a course.
9. New technologies are not necessarily better than old ones.
10. Teachers need training to use technology effectively.
11. Teamwork is essential. No one person has all the skills to develop and deliver a distance-learning course, therefore, subject matter experts, instructional designers, and media specialists are essential on every team.
12. Technology is not the issue. How and what we want the learners to learn is the issue and technology is a tool. (p. 833)

A number of these “rules” are overlapping. Three of them (1, 2, and 11) address course and program design. Any examination of “first principles” should first examine instructional design. While it has been noted that instructors, even those new to distance education, can learn to adapt courses and create materials for online delivery (Ko & Rossen, 2003), and the author-editor model has long been an element of correspondence study programs, “what is strikingly missing in these arrangements, usually, is an instructional designer and many good features of the instructional design approach” (Moore & Kearsley, 1996, p. 104). The team-based approach to distance education course development is generally regarded as more likely to result in high-quality materials, experiences and, hence, more satisfactory teaching and learning experiences (Hirumi, 2000).

Bates’ triumvirate of subject matter expert, instructional designer, and media specialist is the standard core of the course design team, which may be expanded—one source (Hanna, Glowacki-Dudka, & Conceicao-Runlee, 2000) has suggested as many as eight members—based upon the particular needs of the program and the media employed. No one approach to course design is ideal; as Moore & Kearsley (1996) noted, the course team approach results in “materials [that] are usually much more complete and effective. Furthermore, [it] tends to emphasize the use of multiple media in a course” but is “very labor-intensive and therefore expensive, and it involves a lengthy development period” (p. 106). Of the two approaches, “the author-editor approach is the only one that makes economic sense if courses have very small enrollments or short lifetimes, while the course team approach is justified for courses with large enrollments and long-term use” (p. 107).

That the course-team approach to course design and development is time-consuming is illustrated by a model developed by Hirumi and colleagues at the University of Houston-Clear Lake (UH-CL). That elaborate approach, which received considerable recognition in the field, required 18 months for course design, development, piloting, and revision.

Foley (2003) has noted “there are general principles of good design that can be applied to all distance learning activities” (p. 831) but noted the following influences:

- the target audience of the activity
- the content of subject matter to be delivered and
- the outcomes or objectives desired (p. 831)

Other considerations having “profound effects on the design of the learning activities” (p. 831) include:

- the cost effectiveness of the system,
- the opportunity costs of alternative systems and methods,
- the availability of technology to the provider and to the learners,
- the geographical location of the learners, and
- the comfort level of the learners with any technology that is used (p. 834)

Foley notes that these factors apply equally well when designing instruction for any give audience, from children to adults.

When designing the World Bank’s Global Development Learning Network, “results of more than 30 years of research on adult learning were applied to the distance learning programs” (p. 832). The criteria included:

1. They are based on clearly established learning needs and built around succinct statements of outcome.
2. They are based on a variety of teaching and learning strategies and methods that are activity based....
3. Effective distance learning materials are experiential...they address the learner’s life experience....
4. Quality distance learning programs are participatory in that they emphasize the involvement of the learner in all facets of program development and delivery
5. Successful distance learning programs are interactive and allow frequent opportunities for participants to engage in a dialogue with subject matter experts and other learners.
6. Learner support systems are an integral part of any successful distance-learning program. (p. 832)

The Indiana Partnership for Statewide Education (IPSE) (2000) proposed “Guiding Principles for Faculty in Distance Learning:”

- Distance learning courses will be carefully planned to meet the needs of students within unique learning contexts and environments.
- Distance learning programs are most effective when they include careful planning and consistency among courses.
- It is important for faculty who are engaged in the delivery of distance learning courses to take advantage of appropriate professional developmental experiences.
- Distance learning courses will be periodically reviewed and evaluated to ensure quality, consistency with the curriculum, currency, and advancement of the student learning outcomes.
- Faculty will work to ensure that incentives and rewards for distance learning course development and delivery are clearly defined and understood.

- An assessment plan is adapted or developed in order to achieve effectiveness, continuity and sustainability of the assessment process. Course outcome assessment activities are integrated components of the assessment plan.
- Learning activities are organized around demonstrable learning outcomes embedded in course components including; course delivery mode, pedagogy, content, organization, and evaluation.
- Content developed for distance learning courses will comply with copyright law.
- Faculty members involved in content development will be aware of their institution's policies with regard to content ownership.
- The medium/media chosen to deliver courses and/or programs will be pedagogically effectual, accessible to students, receptive to different learning styles, and sensitive to the time and place limitations of the students.
- The institution provides appropriate support services to distance students that are equivalent to services provided for its on-campus students.
- The institution provides its students at a distance with accessible library and other learning resources appropriate to the courses or programs delivered via technology. It develops systems to support them in accessing and using these library and other learning resources effectively.
- It is important to provide the appropriate developmental experiences for faculty who are engaged in the delivery of distance learning experiences.
- The institution implements policies and processes by which the instructional effectiveness of each distance-learning course is evaluated periodically.
- Timely and reliable technical support is vital to the success of any distance-learning program.
- It is recommended that a system of faculty incentives and rewards be developed cooperatively by the faculty and the administration, which encourages effort and recognizes achievement associated with the development and delivery of distance learning courses.
- The institution will communicate copyright and intellectual property policies to all faculty and staff working on distance learning course development and delivery.
- The institution complies with state policies and maintains regional accreditation standards in regard to distance learning programs.
(www.ihets.org/learntech/principles_guidelines.pdf)

Commonalities between these principles and those suggested by other authors and organizations may be readily perceived. For instance, careful planning and the need for teacher training are cited by Bates (in Foley, 2003), and the emphasis on the unique needs of students in a variety of contexts is mentioned by Foley (2003). The IPSE principles make an important contribution by highlighting need for consideration of copyright law and policies, intellectual property ownership, faculty incentives, and state policies and accreditation standards.

Because education (including distance education) is a system, each of its elements interacts with other elements, making difficult the isolation of elements. Interaction (its type, quantity, quality, timing, etc.) for instance, cannot be separated from instructional philosophy, choice of media, and other factors.

Whatever media are selected to facilitate instructor-student and student-student interaction, it should be recognized that these forms of mediated discussion should not completely replace the face-to-face element in courses. As Peters (1998) noted, those who believe that new, digital media will "supply the interactivity and communication lacking in distance education...cherish a hope here that will prove to be serious self-delusion" (p. 155). Peters' comments on the topic [in the context of videoconferencing, a relatively rich "high bandwidth" form of communication], trenchant and incisive, are worth quoting at length:

> Communication mediated through technical media remains mediated communication and cannot replace an actual discussion, an actual argument, the discourse of a group gathered at a particular location. Mediated communication and actual communication stand in relationship to one another like a penciled sketch and an oil painting of the same subject. What takes place in a discussion between two or more people can only be transmitted in part electronically. ... A virtual university that does without face-to-face events by referring to the possibility of videoconferencing can only ever remain a surrogate university. ... There is no doubt that to a certain extent [videoconferencing] will improve the structure of communication in distance education – but it cannot ever take the place of personal communication in distance education. (p. 155)

Peters' views on virtual communication have not been significantly modified with time. More recently (2002), he has noted that the losses inherent in mediated communications are serious:

> They reduce, surround, parcel out, spoil or destroy experiences gained at school or university. For this reason, it may be concluded, learning in virtual space will never be able to replace completely teaching in real spaces." (p. 104).

The effective use of a variety of media to facilitate communication, combined with critical quantities of well-structured face-to-face instruction and learning, have characterized many distance-delivered programs. They are two key elements of the NSU/ITDE Model of Distance Education, what has been called "the best of both worlds" (Schlosser & Burmeister, 1999).

As important as is the appropriate selection and use of technologies of instruction and communication, Moore (1998) has noted that these technologies are not critical elements in shaping students' satisfaction with their distance courses. Rather, satisfaction is determined by "the attention they receive from the teachers and from the system they work in to meet their needs..." (p. 4). Those needs, "what all distant learners want, and deserve" include:

- content that they feel is relevant to their needs
- clear directions for what they should do at every stage of the course
- as much control of the pace of learning as possible
- a means of drawing attention to individual concerns
- a way of testing their progress and getting feedback from their instructors
- materials that are useful, active, and interesting (p. 4)

At the same time, it should be noted that frustration with the use of complex, inadequate, malfunctioning equipment, as well as perceptions of emotional distance engendered by the use of distance education technologies, have negatively affected students' attitudes toward—and, in some cases, achievement in—distance education.

Bates' seventh "golden rule," that "interaction is essential," is well-accepted by the field, and is a central element in most definitions of distance education (see, for instance, Keegan, 1996, and Schlosser & Simonson, 2003). Keegan (1996) noted that distance education must offer "the provision of two-way communication so that the student may benefit from or even initiate dialogue" (p. 44). Initial provisions for interaction were primarily for student-instructor interactions but with the availability of expanded communication technologies in the 1990s came an increasing emphasis on additional forms of interaction. Three forms of interaction are widely recognized by the field: student-content, student-instructor, and student-student. It is this third form of communication, reflecting, in part, andragogical and constructivist perspectives, that has increased dramatically with the rise of online education.

Concurrent with the expansion of online education and the diffusion of new communication technologies, there arose the mistaken belief that, if interaction is important, "the more interaction there is in a distance education class, the better" (Simonson, 2000, p. 278). As Simonson (2000) has noted, early research in the field had "demonstrated clearly that the provision for interaction was critical" (p. 278), but later research indicated as clearly that "interaction is not a magic potion that miraculously improves distance learning" (278). Indeed, "the forcing of interaction can be as strong a detriment to effective learning [as is] its absence" (p. 278).

When quantifying and qualifying student-teacher and student-student interaction, perceptions may be less than reliable. In a study comparing distance students' perceptions of interaction (as compared with observations of their interaction), Sorensen and Baylen (2000) noted that students accurately noted that: across-site interaction was very low, that within-site interaction was very high, that interaction changes with instructor location, that remote site students participate less, and that group activities increase interactions. However, students perceived that less interaction occurred over time (when, in fact, interaction increased), and that technology inhibits interaction (when, more accurately, it seems to create different patterns of interaction (p. 56).

Although Sorensen and Baylen examined interaction in the context of an interactive television course, their findings have implications for other distance education modalities. The researchers concluded that a sense of community formed among students at the distant sites, but interaction increased when the instructor was present at a given distant site. Having instructors rotate among sites encourages interaction. Interaction was hampered when students were unable to see or hear their distant classmates. Allowing constant displays of distant students would likely increase interaction. Maintaining distant students' attention "appears to be a more difficult task than perhaps in the traditional class" (p. 56). Sorensen and Baylen noted that "varying activities and including hands-on exercises and small and large group discussions were instructional methods appreciated by the students" (p. 56). Students in the Sorensen and Baylen study expressed satisfaction with the "distance learning experience," but suggested that the course include "at least one opportunity for students to meet face-to-face" (p. 57).

Distance-teaching institutions (and their students) have a wide variety of instructional and communication media from which to choose. These two categories (instructional and communication) may be, to some extent, addressed separately, but they are often one and the same. Bates' fourth "golden rule," that there is no "super-technology," is well accepted and understood by experienced instructional technologists and distance educators, but often less so by those new to the field (and many, many of today's practitioners fall into this latter category). For this reason, it is important to invoke the findings of Clark (1983), who noted, two decades ago, that "media do not influence learning under any conditions" (p. 446). Indeed,

> The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition. (p. 446)

Clark's conclusions have been bolstered by Russell (1999), whose well-known "No Significant Difference Phenomenon" articles have summarized the conclusions of decades of media-comparison studies.

If, as Clark (citing hundreds of studies and decades of research) maintains, the application of any particular medium will neither improve student achievement nor increase the speed of learning, what criteria might a distance-teaching institution apply in the selection of media for the delivery of instruction and the facilitation of communication? Cost (to both the institution as well as to the student) is an obvious criterion. Less obvious, perhaps, are the culture of the institution and expectations of students (or potential students).

At a very practical level, Ko and Rossen (2003) suggested that, prior to selecting media and instruction for online education, the institution's resources be assessed and the following questions asked:

- What's already in place (what, if any courses are being offered online; who is teaching them, etc.)?
- What kind of hardware and operating system does your institution support?
- What kind of network has your institution set up?
- What kind of computer support does your institution provide? (p. 19)

As Ko and Rossen noted, "the tools an institution uses and the support it offers very much influence the choices [the instructor will] need to make" (p. 18).

Other guidelines for selection of media for synchronous communication, in the context of one "best practice" in distance education—collaborative, problem-based student work groups—have been offered by Foreman (2003). Foreman notes the usefulness of a wide variety of synchronous technologies: chat, telephone conference, Web conferencing and application sharing, voice-over-IP, virtual classrooms, and videoconferencing. Of the technologies at either end of the spectrum—chat and videoconferencing—"neither works especially well as a tool for collaborative teamwork" (para. 5) because chat is slow and awkward, and because videoconferencing is expensive, is frequently of low technical quality, and often fails to capture many of the visual cues so helpful for communication.

Telephone conferencing, however, "is highly effective for organizing small-team distance learning experiences" (para. 6), as it "provides immediacy, a high rate of information exchange, and complex multi-person interaction facilitated by a familiar audio cueing system." Foreman recognizes that telephone conferencing can be expensive, but counters that significant savings may be realized through inexpensive three-way calling options—which, "despite its name, four or more people can use...at once" (para. 7)—available through most telecom providers.

Commercially-provided Web conferencing, combining telephone and Web technologies, overcomes the limitations of voice-only technologies through the provision of "application sharing," but its telephone component is costly. Voice-over-IP is a promising technology but, at its current level, is "intrusive and clumsy" because of sometimes-lengthy lag time and overall low fidelity (para. 15).

Virtual classrooms focus on synchronous teacher-student and student-student interaction through application-sharing and voice-over-IP. Virtual classrooms have been available for several years, but only recently (as with Elluminate's "V-Class" product) has usability advanced to a level considered acceptable by many. Foreman suggests that this final category is most promising, as it can:

> ...create inexpensive cyberspaces where geo-distributed students can perform their learning work through the preferred medium for intense communication—talk. Their talk will focus on shared screen objects...that facilitate the dialogue.... Under the best circumstances, the students will divide the work, perform it separately, and then gather online to share their findings and integrate them into a deliverable product that can be assessed by the instructor. This is the decentered classroom taken to a logical extreme by an emerging technology. (para. 21)

Adams and Freeman (2003) have noted the benefits of the virtual classroom, noting that the interactions within them "in addition to allowing for the exchange of information, provide participants with a shared feeling of presence or immediacy that reinforces their membership in the community."

In the end, all of the above criteria are considered and, frequently, a pragmatic approach is adopted. As Bates recommends in his fourth "golden rule," "each [medium] has its strengths and weaknesses, therefore they need to be combined (an integrated mix)" (Foley, p. 843).

The literature abounds with guidelines for distance education and identified "best practices" of distance education. Sometimes these are based on careful research but are, in the overwhelming majority of cases, the products of practitioners relating practices that have proven successful for that author. Still, some common threads have emerged.

Graham, Cagiltay, Lim, Craner, and Duffy (2001) offered seven lessons for online instruction:

1. Instructors should provide clear guidelines for interaction with students
2. Well-designed discussion assignments facilitate meaningful cooperation among students.
3. Students should present course projects.
4. Instructors need to provide two types of feedback: information feedback and acknowledgment feedback.
5. Online courses need deadlines.
6. Challenging tasks, sample cases, and praise for quality work communicate high expectations.
7. Allowing students to choose project topics incorporates diverse views into online courses. (http://ts.mivu.org/default.asp?show+article&id=839)

In his eighth "golden rule," Bates notes that "student numbers are critical." While this observation is made in the context of cost and media selection, student numbers are, indeed, critical in at least two other respects: class and working- (or discussion-) group size. Distance education has been embraced, in some quarters, as an opportunity to reduce costs by increasing class sizes. The literature clearly indicates that there are practical limits beyond which the quality of instruction and learning are compromised. As Hanna, Glowacki-Dudka, and Conceicao-Runlee (2000) noted, "demand for interaction defines the size of face-to-face classrooms and the nature of the interactions within those classrooms; the demand for interaction has a similar effect upon online classrooms" (p. 26). Palloff and Pratt (2003) suggest that experienced online educators can "handle" 20 to 25 students in an online course, while "instructors who are new to the medium, or instructors teaching a course for the first time, should really teach no more than fifteen students" (p. 118). Chat sessions should be smaller, with perhaps 10 to 12 students (Palloff & Pratt, 2003), and work/discussion groups might have four or five members (Foreman, 2003; Hanna, Glowacki-Dudka, & Conceicao-Runlee, 2000).

On a larger scale, institutions of higher education should understand that distance education is not the "cash cow" that some have mistakenly suggested (Berg, 2001). Indeed, the development and support of distance education courses and programs is normally more expensive than similar traditional courses and programs. When exceptions are occasionally noted, it is usually found that a difference in scale could explain the savings, as in the University of California-Davis study that found that preparing and offering a large (430 students) general education course at a distance than the cost of the same course delivered traditionally (Sloan-C, 2002). A second exception is the instance of the very large distance-teaching universities, such as the British Open University, where large enrollments and a long "product cycle" reduce the unit cost per student to about half that common among traditional graduate programs (Moore & Kearsley, 1996).

Care should be taken when schools search the field for suitable models. As Garon (2002) has noted "...academic attempts at providing universities online have been marketing failures and academic distractions. New York University, Temple University, and other famous universities have closed their virtual doors" and "highly touted start-ups such as Columbia University's Fathom.com and Western Governors University...[have] dramatically downsized the attempts to provide online degrees..." (para. 2). Garon cites two successful for-profit institutions—the University of Phoenix and DeVry University, while noting that their success may be because, given their model for instruction, they "are much closer to large, national community colleges than traditional four-year colleges, but the model serves their community of adult learners well" (para. 6). Schools, then, should clearly identify the type of students they wish to attract, the needs of those students, and the type of university they aspire to be.

Distance education is a broad field with a long history. It is important to remember that, the views of some authors notwithstanding, there is no one "right" way to conduct distance education. At the same time, it would be foolish to ignore the insights and recommendations of longtime practitioners of distance education, as well as those whose field is the study of distance education. Distance education has experienced a marked expansion and, to a certain extent, reinvention in the past few years (coinciding with the rise of the Web and entrepreneurial forces in education). However, it should be borne in mind that online education is not the sum of distance education, that the field existed long before the Web, and that enduring principles of education did not become obsolete with the development of new, electronic technologies.

LITERATURE BASED RECOMMENDATIONS FOR DISTANCE DELIVERED INSTRUCTION

These recommendations are based on the current literature of the field of distance education, some cited above. These recommended guidelines are intended to provide ways to organize courses and be guiding principles that will make courses with equal numbers of semester credits equivalent in terms of comprehensiveness of content coverage, even if these courses are offered in different programs, cover different topics, and are delivered using different media.

A. Organizational Guidelines

In traditional university courses, the 50-minute class session in the building block for courses. Usually, 15 classes were offered for each semester credit. In the online training sector, the building block is often called the learning object. A learning object consists of a lesson, study work, and assessment.

Distance delivered courses do not have class sessions. It is proposed that the field use the *topic* as the fundamental building block for instruction. Government, military, and corporate trainers use the phrase learning object rather than topic. Topics are organized into *modules* that are further organized into *units* that are roughly equivalent to a semester credit traditionally offered using 15, 50-minute class sessions.

When courses are planned, the designer will use the Unit, Module, and Topic/Learning Object Approach (U – M – T Approach), as explained next:

Unit/Module/Topic Guideline:

- Each semester credit (750 minutes of face to face instruction) = 1 Unit
- Each Unit = 3–5 Modules
- Each Module (~200 minutes of face to face instruction) = 3–5 Topics
- Each Topic (~50 minutes of face to face instruction or one class period) = 1 Learning Outcome

A typical 3-credit course has 3 units, 12 Modules, 48 topics, and 48 learning outcomes

Working definitions of Unit, Module, and Topic are:

Unit – A unit is a significant body of knowledge that represents a major subdivision of a course's content. Often, one unit of a course would represent four or five weeks of instruction, and would be equivalent to a semester credit. For example, a unit in an educational statistics course might be Descriptive Statistics.

Module – A module is a major subdivision of a unit. A module is a distinct and discreet component of a unit. Generally, a unit such as Descriptive Statistics might be divided into 3–5 major components, such as Statistical Assumptions, Measures of Central Tendency, Measures of

Variation, and the Normal Curve. Modules generally are the basis for several class sessions and are covered in about a week of instruction and study.

Topic/Learning Object – A topic is an important supporting idea that explains, clarifies, or supports a module. A topic would be a lesson or an assignment. Topics in a module on Central Tendency might be Median, Mode, and Mean. The Topic/Learning Object is often designed to require one hour of work working with the lesson which is usually make up of an objective, multimedia content, and a summary. Students are also expected to study in addition to "online instruction." Study means reading papers and texts, watching videos, or reviewing materials.

These terms (Unit – Module – Topic/Learning Experience) can be used in a variety of ways. Of importance is the idea that topics form modules and modules form units, and units are the main sub-divisions of courses.

<u>B. Assessment Guidelines:</u>

Assessment is defined as the determination and measurement of learning. In Education, assessment is used for grading. Assessment is directly related to learning outcomes. Normally there is at least one learning outcome for each topic.

- 1 major assignment per unit
- 1 minor assignment/2-3 modules

A typical 3-credit course has the following assessment strategy:

- *1 examination*
- *1 10- page paper*
- *1 project*
- *3 quizzes*
- *3 small assignments (short paper, article review, activity report)*
- *graded threaded discussions, emails, and chats*

Learning Outcome – A learning outcome is observable and measurable. Learning outcomes are a consequence of teaching and learning—of instruction and study. Often, learning outcomes are written with three components: conditions under which learning is facilitated (instruction), observable and measurable actions or products, and a minimum standard of expectations. Usually, there is at least one learning outcome for each course topic. For example, a learning outcome for a topic dealing with the median might be:

> *After studying the text, pages 51–53, reviewing the PowerPoint with audio presentation on measures of central tendency, and participating in synchronous chats, the Child and Youth Studies student will satisfactorily complete the objective test dealing with measures of central tendency at the 90% level.*

<u>C. Content Guidelines</u>

Traditionally, instructors have offered content by making presentations during face-to-face instruction. Additionally, readings in textbooks and handouts are required of students.

In distance teaching situations, readings in texts, handouts, and information on the Internet are often used to deliver content. For high quality courses, there should be an emphasis on the use of various forms of visual media to offer instructional content. Videos, visual presentations with accompanying audio, and other graphical representations of important topics are important to the well designed course. A variety of delivery systems for content should be considered, including the use of compact disks, electronic files posted to Web sites, and streaming.

Content is organized for students into *topics/learning objects*. Topics are combined into *modules* of similar topics and modules are used to form *units*.

Modules might have 3-5 topics presented in the following ways:

- readings in the text or other written materials
- videos supplied on CD, DVD, or streamed
- audio recordings of speeches or presentations supplied on a CD, as an email attachment, or streamed
- recorded presentations using PowerPoint with prerecorded audio
- synchronous chats with content experts

D. Instruction/Teaching Guidelines

The pace of instruction for learners is a critical concern to the distance educator. Because many distance education students are employed full-time, it is important to offer instruction in a way that complements their other responsibilities. These guidelines relate to the pace of instruction and the need for continuing interaction between instructors and students.

- 1 module per week
- Instructor email to students each week
- 1 synchronous chat per week
- 2-3 threaded discussion questions per topic, or 6-10 questions per week
- Instructor comments on discussions as part of threaded discussion board
- Progress reports (grades) submitted to students every two weeks

These course design guidelines are based on the literature of distance education and are derived from the analysis, review, and study of quality courses delivered at a distance.

The simplicity of the Carnegie Unit has made it the standard for course design, primarily because it was easy to apply. It is easy to count class sessions in order to determine if a course "measures up." Distance Education, with few if any face-to-face sessions, does not have such an easily applied standard. The Unit, Module, and Topic approach is being applied in courses and seems to be quickly and accurately applied while establishing a standard of quality. Try it out in your courses and write an article for Distance Learning.

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White Paper

Distance Education Compendium:
A Baker's Dozen of Concept Papers for the Distance Learning Teacher and Leader

Michael Simonson, Ph.D.
Professor
Instructional Technology and Distance Education
Fischler School
Nova Southeastern University
1750 NE 167th St.
North Miami Beach, FL 33162
simsmich@nova.edu
www.nova.edu/~simsmich

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Preface

Distance Education, e'learning, online instruction, and virtual schools have become catch phrases in training and education. Much has been said about the phenomenon of using communications technologies to reach learners where they are, and when learning is needed. And, much is also being written about distance education. Three journals regularly publish articles and papers about the various aspects of distance education. The *American Journal of Distance Education* is the oldest, and publishes three times per year. The *Quarterly Review of Distance Education* has been in existence since 1999, and *Distance Learning: For Teachers, Trainers and Leaders* is in its third year of publishing four issues each year.

This white paper contains a "baker's dozen" of short papers derived from editorials written in either the *Quarterly Review of Distance Education*, or *Distance Learning*. All were modified for this compendium, and all were written by the editor of these two journals, Michael Simonson. The short papers introduce and discuss important topics for the educational or training leader who is adopting some aspect of distance education.

Michael Simonson
2006

Paper #1 - Distance Education Enters the Mainstream

Enrollments in distance education courses have risen 19 percent between 2003 and 2004 according to a report authored by Allen and Seaman (2004). Their monograph, supported by the Sloan Foundation, was titled *Entering the Mainstream* and is a follow-up to a similar study reported last year titled, *Sizing the Opportunity*.

Authors of *Entering the Mainstream* collected data using a survey collected from 1,170 institutions of higher education – 585 public, 536 private nonprofit, and 49 for-profit. Among the interesting conclusions offered in the report were the following:

- Slightly more than half of all colleges rated online learning as essential to their overall strategy.
- 1.9 million students were studying online in the fall of 2003.
- Just over 40 percent of responding institutions agreed that students were at least satisfied with their online courses, as compared to traditional classroom courses.
- Baccalaureate institutions had the lowest online enrollments and lowest opinions about online learning.
- The larger the institution, the more likely it believed that online education is critical.
- Administrators predicted that online enrollments will grow 24 percent in the next year, with the greatest growth in private, for-profit colleges.
- The majority of academic leaders believed that online learning quality is already equal to or superior to face-to-face instruction.

John Flores, Executive Director of the United States Distance Learning Association, commented on the study's findings. Flores indicated that his Association is seeing similar growth patterns and reactions consistent to those reported by Allen and Seaman. Distance Education is particularly attractive to older students more likely to be working and less able to attend traditional residential colleges.

Of critical interest to distance education professionals were the study's findings about the perceptions of quality of online instruction. If instruction offered to students at a distance, quality must be of paramount importance. Ultimately, students want to learn, they want to develop skills and competencies, and they demand effective teaching. Entering the mainstream is a goal obtained only if quality is there in the mainstream, also.

Allen, E. & Seaman J. (2004). *Entering the mainstream: The quality and extent of online education in the United States, 2003 and 2004.* Needham, MA: Sloan Center for Online Education at Olin and Babson Colleges (http://www.sloan-c.org/resources/survey.asp)

Paper #2 - Barriers to Distance Education

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Berge and Muilenburg (2000) first reviewed the literature and identified sixty-four (64) potential barriers to the implementation of distance education. This list in itself is interesting and could be used for additional research. Next, a survey was developed and a list of several thousand persons involved in distance education, instructional technology, and training was identified. The survey was sent to this large group and over 2500 responses were received. Of those responding, 1150 were teachers or trainers, 648 were managers, 167 were administrators in higher education, and the remaining responders were researchers and students.

When the data were analyzed, eleven strongest barriers to the implementation of distance education were identified. Their rank order is:

1. Increased time commitment
2. Lack of money to implement distance education programs
3. Organizational resistance to change
4. Lack of shared vision for distance education in the organization
5. Lack of support staff to help course development
6. Lack of strategic planning for distance education
7. Slow pace of implementation
8. Faculty compensation/incentives
9. Difficulty keeping up with technological changes
10. Lack of technology-enhanced classrooms, labs or infrastructure

Additionally, the least important barriers to implementation were identified by Berge and Muilenburg. They were:

54. Competition with on-campus courses
55. Lack of personal technological expertise
56. Lack of acceptable use policy
57. Lack of transferability of credits
58. Problems with vase distances and time zones
59. Technology fee
60. Tuition rate
61. Local, state or federal regulations
62. Ethical Issues
63. Existing union contracts
64. Lack of parental involvement

Berge and Muilenburg concluded their paper by identifying the need for cultural change within organizations involved or contemplating involvement with distance education. Five of the top barriers related directly to organizational culture.

- Organizational resistance to change
- Lack of shared vision for distance education in the organization
- Lack of strategic planning for distance education
- Slow pace of implementation
- Difficulty keeping up with technological change

Distance education requires an organization to rethink its philosophy of education and training. Resistance to change is overcome by developing a shared vision that sets the stage for a strategic plan that dictates the rate of implementation. Everett Rogers in his landmark work, Diffusion of Innovations, has discussed these ideas for years. Innovation, something new, will diffuse through an organization when it is perceived has having a relative advantage, is compatible with existing values and experiences, is not perceived as overly complex, can be tried or experienced first on a limited basis, and has observable impact.

Berge, Z. & Muilenburg, L. (2000). Barriers to distance education as perceived by managers and administrators: Results of a survey. In M. Clay (Ed.), Distance Learning Administration Annual 2000.

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Paper #3 - Effectiveness of Distance Education

> According to the 248 studies that were compiled by Russell (2000), there is no significant difference between distance learning and traditional classroom learning. In other words, distance learning (can be) considered as effective as face-to-face learning, and our results support this conclusion. (Dean, et al., 2001 p. 252)

Russell (2000) and Dean (2001) reported results that are indicative of the research on the field of distance education. Most who are deeply involved in the field of distance education are unsurprised by these summaries of the research. As a matter of fact, it is very clear that instruction delivered to distant learners is effective and that learning outcomes can be successful attained when offered to students at a distance (Hanson, et al., 1997; Anglin and Morrison, 2000).

In 1983, Clark clearly stated that the media used to deliver instruction had no significant impact on learning. Clark stated that:

> The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in nutrition…only the content of the vehicle can influence achievement (Clark, 1983, p. 445)

After more than a decade of criticism and attempts to refute his review of over fifty years of instructional technology research, Clark (1994) once again reviewed the research on technology used to deliver instruction and said that:

> It is likely that when different media treatments of the same informational content to the same students yield similar learning results the cause of the results can be found in a method which the two treatments share in common…give up your enthusiasm for the belief that media attributes cause learning. (p. 28)

Since Clark's widely distributed comments, a number of researchers have attempted to find fault with his premise. They have not been successful. It is currently the consensus that "media are mere vehicles" and that we should "give up (our) enthusiasm" that the delivery media for instructional content significantly influences learning.

Unfortunately, some have misinterpreted the no significant differences phenomenon and assumed that instructional technology and distance education do not promote learning. This is incorrect. Actually, the evidence is quite clear that students of all ages can learn from instruction delivered using technology, and that distance education works.

Distance education may be defined as "institutionally based formal education where the learning group is separated and where telecommunications technologies are used to connect learners, resources, and instructors" (Simonson, 2003, p. 28).

This definition has four components. First it is institutionally based. This is what differentiates distance education from self-study. Most now feel that the institution that offers instruction at a distance must be accredited and, (in the U. S.), probably by one of the regional accrediting associations.

Next, distance education is formal, meaning that instruction is designed and administered similarly to other forms of education. Design of instruction to be delivered to distant learners is probably the most significant determinant of learning outcomes. Well-designed and developed instructional experiences are required (Simonson, et al., 2003) in order for distance instruction to be successful.

Third, telecommunications technologies, or distance communications systems, are used to deliver instruction. Increasingly, this means use of the Internet, but other technologies are also in wide use, such as interactive television, audio, and print.

Finally, distance education involves learners, resources, and instructors. Instructors are critical to modern definitions of distance education. The teacher should work with designers, technical staff, and other support persons. However, the direct involvement of a teacher is critical.

In 1997, Hanson, et al. summarized the research on distance education in a publication of the Association for Educational Communications and Technology. This widely distributed review concluded that:

> …comparative research studies on achievement tend to show no significant difference between different delivery systems and between distance education and traditional education…several recent studies indicate a significant higher achievement level in those learning at a distance…the accepted position is that the delivery system affects no inherent difference on achievement. (p. 22)

In other words, it is not the fact that instruction is delivered in a traditional, face-to-face environment or at a distance that predicts learning. (Anglin & Morrison, 2000; Berge & Mrozowski, 2001; Darwazeh, 2000).

A recent report on distance education by the National Center for Educational Statistics (Sikora & Carroll, 2002) provides information on the rapid growth of distance education. In 1999-2000, eight percent of all undergraduates and ten percent of all graduate students participated in distance education, and the vast majority reported high levels of satisfaction with their distance education experiences. The majority of students were "equally satisfied" with their distance education courses compared to their regular courses.

It is clear from the research literature that distance education works (Hanson, et al., 1997, for example). Why it works and how it works is important, however. The following conclusions about instruction delivered to distant learners are directly related to effectiveness.

- Training in effective instructional strategies is critical for teachers of distant learners.
- Distance Education courses should be carefully designed and developed before instruction begins.
- Visualization of ideas and concepts is critical when designing instruction to be delivered to distant learners
- Adequate support systems must be in place to provide the distant learner with access to resources and services.
- Interaction between the instructor and students and among students must be possible and encouraged.
- Assessment should be designed to relate to the specific learning outcomes of the instructional experiences.

In summary, distance education can be as effective as any other category of instruction. Learning occurs and knowledge is retained. Students report that they have learned and they feel their distance learning experiences are as successful as more traditional education. The keys to successful distance education are in the design, development and delivery of instruction, and are not related to geography or time.

Anglin, G., & Morrison, G. (2000). An analysis of distance education research: Implications for the field. *Quarterly Review of Distance Education, 1*(3), 189-194.

Berge, Z., & Mrozowski, S. (2001). Review of research in distance education. *American Journal of Distance Education, 15*(3), 5-19.

Clark, R. (1983). Reconsidering research on learning from media. *Review of Educational Research*, *53*(4), 445-459.

Clark, R. (1994). Media will never influence learning. *Educational Technology Research and Development*, *42*(2), 21-29.

Darwazeh, A. N. (2000). Variables affecting university academic achievement in a distance versus conventional education setting. *Quarterly Review of Distance Education*, 1(2), 157-167.

Dean, P., Stah., M. Swlwester, D., & Pear, J. (2001). Effectiveness of combined delivery modalities for distance learning and resident learning. *Quarterly Review of Distance Education, 2*(3), 247-254.

Hanson, D., Maushak, N., Schlosser, C., Anderson, M., & Sorensen, M. (1997). *Distance education: Review of the literature*, (2nd ed). Washington, DC: Association for Educational Communications and Technology.

Russell, T. (1997). The no significant difference phenomenon. http://teleeducation.nb.ca/phenom.

Sikora, A., & Carroll, C. (2002). *A profile of participation in distance education, 1999-2000*. Washington, DC: National Center for Educational Statistics.

Simonson, M., Smaldino, S., Albright, M. & Zvacek, S. (2003). *Teaching and learning at a distance: Foundations of distance education,* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Paper #4 - Changing Role of the Teacher

TEACHER AS SKEUOMORPH…Teacher as What?

John Howells' new book, *Management of Innovation and Technology* (2005) is not the easiest book to read. It is, however, quite interesting. In the first chapter he discusses skeuomorphs. A skeuomorph, in case you have forgotten, is an element of design that has lost its original function but is nevertheless retained. An example is the square on top of a Doric Column. Originally, columns were made of wood, so they were topped with a wooden square to distribute the stress. Marble and stone columns did not require this square, but for esthetic purposes it was retained, thus becoming a skeuomorph. Other examples are watch pockets on jeans, plastic dinnerware made to look like stoneware (including the imperfections), and the consumer version of the Hummer, made to look like the original, but certainly not ready for the next war.

In distance education, especially online instruction that is asynchronous, the role of the teacher is significantly different, even unrecognizable when compared to traditional classroom instruction. In classrooms, teachers present information, talk, draw on the board, demonstrate, and take apart; they "do it all." The classroom teacher has a critical and necessary role. Without the teacher in the traditional classroom, teaching and learning—education—would not occur.

Conversely, in an asynchronous, online course the instructor does none of these traditional things. True, many of our instructional tools allow us to simulate the classroom and the functions of the classroom teacher, but it is not the same.

We have kept the teacher, but is the teacher's function really critical? If we look at the teacher's changing role superficially, as some do, one might conclude that teachers have no real purpose anymore; they are skeuomorphs.

Admittedly, the word is a little hard to deal with, but then so is the idea that teachers have lost their original function. However, if we are realistic, we recognize that teachers are becoming designers, organizers, motivators, and assessors, among other things; roles that teachers have long been advocating as vital to the education process, even more important than presenting.

And finally, recognizing that teaching as we have known it is losing its original function is an important—albeit first—step. As distance education leaders, we can take an important, positive role in identifying the new teacher.

Howells, J. (2005). *The management of innovation and technology*. London: Sage.

Paper # 5 - Quality in Distance Education

Coal Slurry Ponds and Quality Indicators

I have a friend who says her default cable TV viewing is the History Channel. This is what she tunes in when there is not anything else she wants to watch. She says that almost every program is interesting. She even mentioned a recent broadcast that was about Coal Slurry Ponds – those ponds used to hold the water runoff from coal cleansing operations. Apparently there are hundreds of these ponds in the coal mining regions of Pennsylvania and West Virginia. She said she turned on the History Channel and the next thing she knew she was sitting down and watching the entire program—she is now an expert on Coal Slurry Ponds—go figure!

Actually, there is something in the coal slurry pond example of importance for distance educators, too. Most of us have watched the History Channel—a polished editing of what appears to be old, public domain films tied together with an artful narration. Almost always the programs are informative, persuasive, and entertaining – they are well done, and by TV production standards, at a very low cost.

Recently, there has been in the distance education field a groundswell of interest in what some call “best practices” and others label as “quality indicators.” Research has been conducted, reports have been written, and a few courses have even been redesigned. In most instances the list of quality indicators includes the following characteristics:

- The course is designed in a logical and intuitive manner, which usually means “chunking of topics,” often into learning objects, modules and units
- Multimedia are used to present content
- Delivery of content is visually appealing, even attractive
- The course is content rich—a great deal of information about the course’s topic is included
- The course provides for easy, quick, and meaningful interaction
- The course is structured but allows for self pacing
- Designers and Instructors are constantly critiquing and revising the course

Lists of “best practice” are often concluded with summary statements about the course being informative, interesting, even inspiring, and certainly memorable. Well designed courses, like programs on the History Channel, draw the learner in and keep them engaged. The “story” is interesting and keeps the learner motivated.

And finally, high quality distance education is OBVIOUS. You really do not need check lists, or rating scales. When you see quality you know it. If Coal Slurry Ponds can be presented in a way that is informative and interesting, then…..!

Paper # 6 - Planning for Distance Education

Toilet Paper to Tooth Brushes: Planning the Online Course

A few days ago, the History Channel had another of its many provocative programs. This one discussed the history of **toilet paper**! Without going into the details, it was an intriguing and interesting show—and the Sears Roebuck Catalog was the star. The show presented a nice model for how to organize information in an interesting and informative way.

Planning the online course is a challenge to many, especially those who do not have an instructional design background. Here is an easy and effective approach for course design.

First, a typical college level course should have 45-60 topics. These topics, sometimes called learning objects in government military and training, are the building blocks for the course. Topics can then be organized into modules, modules are finally organized into units. This is called the U-M-T approach to course design (Simonson, 2006).

In other words, a unit of instruction has 3-4 modules, and each module of instruction has 3-4 topics. Topics are important ideas that students examine, or activities that students complete.

A topic or learning object in an online course is often expected to require one hour of student effort. The learning object is organized into a lesson, comprised of an objective, multimedia content, and a summary. Next, the learning object includes student study of readings, videos, and other materials. Finally, a typical learning object or topic contains some type of assessment, such as a test, assignment, or activity.

Organizing topics within a module can be simplified by following the ARCS Model (Keller, 1987). The ARCS model has been used for decades and is an effective strategy for organizing portions of a course. The first topic in the ARCS model is used to gain the *attention* of the learner and focus it on the critical issues to be studied. The second topic stresses *relevance*. Next, there is an activity to help build *confidence* in the student. Finally, there is *satisfaction* building. This is repeated for each module.

Keller’s ARCS module, combined with the U-M-T approach to online course design, may not yield as intriguing a story as the history of toilet paper, but applying these approaches gives the distance teacher a head start at designing an effective online course.

And finally, the History Channel is advertising another “don’t miss program – The history of the tooth brush – Coal Slurry Ponds, toilet paper, and now tooth brushes – wow!.

Keller, J. (1987). The systematic process of motivational design. *Performance and Instruction*, 26(9), 1-8
Simonson, M. (2004). Coal slurry ponds and quality indicators. *Distance Learning*, 1(2), 50.
Simonson, M., Smaldino, S., Albright, M. & Zvacek, S. (2006). *Teaching and learning at a distance: Foundations of distance education. 3rd*. Upper Saddle River, NJ: Prentice-Hall.

Paper # 7 - Time Commitment for an Online Course

The most widely recognized standard for college courses is the "Carnegie Unit" which is based on student time in class. This approach expects that for every semester credit of college credit there should be 750 minutes of in-class work; which normally translates into 15, 50 minute class sessions during a semester. Therefore, a three semester college level course would have 2250 minutes of class time; this translates into 45, 50 minute class sessions, or three class sessions per week during a 15 week semester.

The general guideline for student out-of-class effort is somewhere between one hour to three hours outside of class for every hour in class. These are 50-minute hours.

This out-of-class time would be dedicated to readings, assignments, projects, and preparation for examinations, for example. Thus, for a three semester college level class a student would spend on average 4500 minutes outside of class (using an average of 2 hours outside of class for every hour in class); this translates into six hours outside of class each week.

In a traditional, classroom-based college level course, a student might be expected to spend, on average, three hours (50-minute hours) in class, and 6 hours (50-minute hours) outside of class, each week for 15 weeks.

If a student in a traditional course is expected to spend approximately 135 hours (of 50-minutes each) in class and studying each semester, then an online student might be also expected to dedicate a similar amount of time to an online class; 135 hours per semester, or 9 hours per week for 15 weeks.

Certainly, some students would dedicate considerably more time to a class in either a traditional or online environment, and some students might do acceptable work in less time. However, a general guideline would be to expect an online student to commit about 9 hours per week to each 3-semester credit class in which they enroll.

Paper # 8 - Organizing the Online Course: The 5 x 5 Rule

Many are struggling with a process for organizing newly designed courses that are to be delivered to distant learners. Originally, many merely took their existing, traditional courses and converted them. The rationale behind this process was that the course had been taught (often for many years) to students in a classroom and now the same content and assignments were to be offered in an online environment. This strategy was accepted and worked, primarily because it made sense.

As the field of distance education has matured, the old approach of converting existing courses to distance delivery does not always work, especially as totally new courses or significantly revised courses are designed. There are few easily applied benchmarks available to the designer of online courses.

Easy is a key word here. Online design models often are complex, convoluted and not easily applied, especially by a regular instructor. Looking back, one beauty of the Carnegie unit, long the standard for course design, was its simplicity. For every credit there had to be 750 minutes of face to face instruction, which easily translated into 15, 50 minute class sessions, or one a week for a 15 week semester. Three credit courses met three times a week for a 15-week semester. The designer just had to fill those 45 class sessions with content.

Well, the old (and certainly outdated) Carnegie model is not easily applied in an online environment. What does the designer do when looking for an easily understood "model" for course organization? First, it may not be a good idea to look for an easy model. Unfortunately, when the dean or department head (or general) says, "convert your courses" the instructor may be in a difficult situation.

Here is one approach, called the **5 x 5 Rule**. It goes like this, for every college credit (sometimes called units for multi credit courses) there should be five modules of content, and for each module there should be five topics (often called learning objects in the private sector). Thus, a one-credit college course would have 25 significant topics, each with its own behavioral objective. A three-credit course would have 15 modules and 75 topics. The instructor just has to identify the seventy-five topics and prepare learning experiences related to each.

Assessment is critical to the success of any course, especially an online one. A typical course with 3 units (credits) organized into 15 modules and 75 topics might have one or two objective tests to examine student's understanding of basic concepts and definitions (open book tests are often used for this kind of assessment). Next, practical projects could be used to determine learning for groups of modules. Four projects for a 3-credit course seems to be the norm. Finally, a portfolio of student projects for the course might be prepared and submitted as the final assessment activity for the course. If possible, students should present or share their portfolio project to the entire class.

Simple, perhaps even simplistic, but also an approach that has its roots in instructional design theory and one that can be readily and quickly applied. Actually, the editors of the Qua*rterly Review* would encourage articles critiquing this approach or presenting other techniques for organizing courses for online delivery.

Paper #9 - Policy Issues for Distance Education

Recently, professors from all public universities in a midwestern state were required to sign a policy statement dealing with intellectual property and the development of online courses. Two ingredients of this policy statement were notable. First, all efforts of faculty were considered "works for hire" and were entirely the property of the university system. Second, failure to sign this statement was to be considered a statement that the professor was intending to resign their position. Excluded were textbooks written by professors. The two-page policy statement apparently was prepared by central administration with little or no constructive input by faculty.

Policy is defined as a written course of action, such as a statute, procedure, rule, or regulation, which is adopted to facilitate program development (King, et.al., 2000). Distance education policy is the written course of action adopted by institutions to facilitate the development of distance education programs. Policies provide a framework for the operation of distance education. They form a set of agreed-on rules that explain roles and responsibilities. Policies can be compared to laws of navigation, rules of the road, or language syntax. They provide a standard method of operation, such as “no wake zone”, “keep to the right”, or “subject and verb must match”. Policies give structure to unstructured events and are a natural step in the adoption of an innovation, such as distance education. One key indicator that distance education is moving into the mainstream is the increased emphasis on the need for policies to guide its effective growth.

Berge (1998), and Gellman-Danley and Fetzner (1998) have proposed models for distance education policy. These models have been reported and evaluated a number of times in the literature (King, et.al., 2000; King et.al., 1998), and seem to provide a useful framework for an investigation of distance education policy.

Policy Categories

Often in the literature, policies are divided into seven categories (King, et.al., 2000: Gellman-Danley & Fetzner, 1998).

> Policy Area #1: Academic - The key issues in this area deal with academic calendars, accreditation of programs, course quality, course and program evaluation, Carnegie units, grading, admission, and curriculum review and approval processes.
>
> Policy Area #2: Fiscal, Geographic, Governance - The key issues in this area deal with tuition rates, special fees, full time equivalencies, state mandated regulations related to funding, service area limitations, out-of-district versus in-district relationships, consortia agreements, contracts with collaborating organizations, board oversight, administration cost, and tuition disbursement.
>
> Policy Area #3: Faculty – The key issues in this area deal with compensation and workloads, design and development incentives, staff development, faculty support, faculty evaluation, intellectual freedom, and union contracts.
>
> Policy Area #4: Legal – The key issues in this area deal with intellectual property agreements, copyright, and faculty/student/institutional liability.
>
> Policy Area #5: Student – The key issues in this area deal with student support, academic advising, counseling, library services, student training, financial aid, testing and assessment, access to resources, equipment requirements, and privacy.
>
> Policy Area #6: Technical – The key issues in this area deal with system reliability, connectivity, technical support, hardware/software, and access.
>
> Policy Area #7: Philosophical – This key issues in this area deal with the acceptance of distance education based on a clear understanding of the approach, organizational values and mission, and visions statements.

Integrated policies for distance education are preferred (King, et.al., 1998). In other words, policies that provide guidance and direction to the educational systems should seamlessly include and incorporate the concept of distant delivery of instruction. Students should be defined by their enrollment in a course or program, not by whether they are distant or local learners (Simonson, 2003). Initially, distance education policies will probably need to be separate from existing policies. Ultimately, they should be integrated to indicate that distance education is a routine and regularly occurring component of the educational enterprise. Policies are merely tools to facilitate program integrity.

Berge, Z. (1998). Barriers to online teaching in post-secondary institutions: Can policy changes fix it? *Online Journal of Distance Learning Administration*. 1(2). http://www.westga.edu/~distance/Berge12.html.

Gellman-Danley, B. & Fetzner, M. (1998). Asking the really tough questions: Policy issues for distance learning. *Online Journal of Distance Learning Administration,* 1(1). http://www.westga.edu/~distance/danley11.html

King, J., Lacy, D., McMillian, J., Bartels, K. & Fredilino, M. (1998). The policy perspective in distance education: A futures landscape/panorama. Invited paper presented at the 1998 Nebraska Distance Education Conference. Lincoln, NE.
http://www.unl.edu/NN21/jking.html.

King, J., Nugent, G., Russell, E., Eich, J. & Lacy. D. (2000). Policy frameworks for distance education: Implications for decision makers. *Online Journal of Distance Learning Administration* 3(2).
http://www.westga.edu/~distance/king32.html

Simonson, M., Smaldino. S., Albright, M., & Zvacek, S. (2003). *Teaching and learning at a distance: Foundations of distance education, 2nd*. Upper Saddle, NJ: Prentice-Hall.

Paper #10 - Intellectual Property and Distance Education

If it is intellectual, can it be property
Carol Twigg, Executive Director of the Center for Academic Transformation, has written and spoken extensively in the area of intellectual property and ownership of online courses and course materials. A reading of the abstract of her excellent monograph “Intellectual Property Policies for a New Learning Environment” is a requirement for any serious distance educator (Twigg, 2000). It is well-written, informative and thought provoking.

Reading Twigg’s monograph gets one to thinking about the two words – intellectual and property. Intellectual has a number of definitions, but most deal with the idea of the use of the intellect, and the showing or possessing of intelligence. Intellect, by the way, is the power of knowing and understanding.

Property, on the other hand, refers to things that are owned or possessed. Usually property means things like land or objects that a person legally owns.

So, intellectual property is “intelligence that is legally owned.” Or, is it?

The source of the millennium, the wikipedia (can you believe doctoral students are citing the wikipedia? Go figure!), defines intellectual property (IP) as:

“a legal entitlement which sometimes attaches to the expressed form of an idea, or to some other intangible subject matter. This legal entitlement generally enables its holder to exercise exclusive rights of use in relation to the subject matter of the IP. The term *intellectual property* reflects the idea that this subject matter is the product of the mind or the intellect, and that IP rights may be protected at law in the same way as any other form of property."

Somehow, the wikkipedia definition seems different that what is meant when the two words defined separately.

Twigg writes eloquently about course and course materials ownership, and draws several conclusions. Of the most interesting is the statement that "…there is a radically different – and infinitely simpler – solution if we treat the intellectual property issue not as a legal issue but as an academic issue," (29). The question of ownership becomes less contentious and more collegial when the rights of faculty and institutions are satisfied equally.

And finally, Seneca probably had it right two thousand years ago when he said, "The best ideas are common property."

Twigg, C. (2000). Intellectual property policies for a new learning environment. Retrieved February 25, 2006, from http://www.center.rpi.edu/PewSym/mono2.html)

Paper #11 - Distance Learning Leaders – Who Are They?

Recently, a program of study leading to a certificate as a distance learning leader was held at Nova Southeastern University. At the core of the six week long program was the definition offered of a leader.

> A distance learning leader is a visionary capable of action who guides an organization's future, its vision, mission, goals, and objectives. The leader guides the organization and its people who have faith in the leader, and have a clear understanding and acceptance of the organization's worthwhile and shared vision and goals. A distance learning leader has competence in knowing, designing, managing, leading and visioning distance education.

The whole idea of training to develop leaders is an interesting one. The military trains its officers to be leaders during intensive sessions such as the U.S. Marine Corps' Basic School, a six month immersion in all that one could imagine for the new junior Marine Officer. The Navy has the Surface Warfare Officers School in Newport, RI, which is a series of schools for officers of various ranks who attend several times during their naval careers. Without exception these schools are months long, and totally dominate the time and the thoughts of those in attendance. Then, we have West Point, Annapolis, and the Air Force Academy—certainly colleges, but also designed to produce military leaders.

Are we naïve to think we can prepare leaders of distance education organizations in two days and six weeks of online follow up? Or, are there a common core of skills, competencies, and ideas that can be taught, shared, and learned that will produce a new leader. Certainly the idea of certification programs to prepare leaders is becoming wide spread, and if the marketplace decides, then these many and varied programs must be doing something right..

And finally, as Walter Lippmann said "the final test of a leader is that [the leader leaves behind] in others the conviction and the will to carry on…the genius of a good leader is to leave behind a situation which common sense, without the grace of genius, can deal with successfully." If distance education – distance teaching and distance learning – is to become mainstream, then many leaders in a multitude of locations will be needed. Informed leaders who believe in high quality and in the rigorous application of sound teaching principles to the learning process.

Paper #12 - Technology Planning and Distance Education

Most have heard about, and some have read, the U.S. Department of Education's National Educational Technology Plan, titled "Toward a New Golden Age In America Education." (http://www.ed.gov/about/offices/list/os/technology/plan/2004/plan.pdf).

One recurring theme of this plan is the importance today and in the future of distance education/e'learning/virtual schools. According to the report "About 25 percent of all K-12 public schools now offer some form of e-learning or virtual school instruction. Within the next decade every state and most schools will be doing so…traditional schools are turning to distance education to expand offerings for students and increase professional development opportunities for teachers (34-35)."

The report goes on to list and explain seven major recommendations. These seven are:

1. Strengthen Leadership
2. Consider Innovative Budgeting
3. Improve Teacher Training
4. Support E-Learning and Virtual Schools
5. Encourage Broadband Access
6. Move Toward Digital Content
7. Integrate Data Systems

The plan's 46 pages are supplemented by lists of federal activities that support the use of technology in education.

It is interesting that this plan often identifies some aspect of distance education as critical to the future of education. Virtual schools are given special attention as important to the future of American education. It is also significant that the importance of leadership is stressed in the plan and is the first of the seven recommendations. It is implied that without enlightened leaders effective technology implementation will not occur, and without technology schools will continue to fail.

The Plan is a starting point. Schools and organizations might use the Plan as they develop their own strategy for encouraging e'learning and distance education. Certainly, more specifics and clear direction for implementation than found in the USDE Plan would be needed.

Distance Education has become mainstream – widely practiced, generally understood, and critically important. Distance teaching and learning are innovations, even today, although these two components of distance education are soon to become regular and expected aspects of education. Our field must now live up to this long sought after importance.

And Finally, in this era of grading and rating schools and training organizations, it is obvious that the school that does not include instructional technology and distance education in its vision for the future and its planning for today is a school that is outdated and out of touch – a school that is failing.

The Baker's Dozen - Implementing Distance Education: Eight Steps for Transforming an Organization

A distance learning leader is a visionary capable of action who guides an organization's future -- its vision, mission, goals, and objectives. The leader guides the organization and its people who have faith in the leader, and have a clear understanding and acceptance of the organization's worthwhile and shared vision and goals. A distance learning leader has competence in knowing, designing, managing, leading, and visioning distance education (Simonson, 2004).

One question distance learning leaders ask is "how do I transform my organization so it successfully adopts appropriate distance education applications?" John Kotter (1999) wrote clearly and forcefully about organizational transformation. By considering his ideas and relating them to distance education, a strategic distance education transformation can be implemented. By carefully managing the process an organization can reduce mistakes and multiply successes.

Here are the steps in the process.

<u>First, establish a sense of urgency</u>. Most likely this will be by identifying the major opportunities offered by adopting distance education strategies. Outcomes should be identified, such as more, and more diverse, students, cost savings, more compelling instruction, and even more satisfying interaction with learners.

<u>Second, form a powerful planning group</u>. The team that develops the plan for an organization must have enough power to lead the effort, and have the correct opinion leaders so the members of the organization will be changed. Change comes because of manager's directions, and because of opinion leader's influence.

<u>Third, create a vision</u>. Visioning is one of the most important but most poorly understood aspects of the change process. The vision directs the transformation effort and is a "rallying cry" for the organization.

<u>Fourth, communicate the vision</u>. The planning group is the key here. Opinion leaders and powerful managers can present the vision, but they must also "live" the vision. Changes should be observable. Trainers and teachers should see changes in their leaders.

<u>Fifth, give power to those who act on the vision</u>. Risk taking should be encouraged and the activities and actions of those who adopt distance education should be supported.

<u>Sixth, plan for and create short term wins</u>. Visible, early, and impressive distance education events and activities should be orchestrated by the planning group. If trainers and teachers can see the relative advantages of adopting distance education strategies they will be more willing and more ready to try on their own.

Seventh, combine and collect successful distance education activities to produce more change. Hire, promote, and encourage those who practice distance education, and continue to support ongoing activities.

Eighth, incorporate distance education successes. Clearly show how distance education events are connected to the organization's mission, and to other educational and training activities. Continue to develop new leaders to insure a succession of support.

A leader can control change, an inevitable process. The eight steps described above will help start the distance education transformation – if it is not already too late!

Kotter, J. (1999). Making change happen. In Hesselbein, F. & Cohen, P. *Leader to leader*. New York: Drucker Foundation.

Simonson, M. (2004). Distance learning leaders – Who are they? *Distance Learning*. 1(3), 48. Greenwich, CT: Information Age Publishing.

Microsoft U.S. Partners in Learning

Executive Summary

Despite real improvements in access to, and use of, information and communication technology (ICT) in education, many students and teachers still lack basic access to technology and training. The result is a widening ICT skills gap that contributes to disparities in the quality of life, competitiveness, and economic development. Microsoft Corporation's commitment to education in the United States, which is long-standing and proven, is about providing innovative tools, programs, and practices to help students and educators realize their full potential. Through the Partners in Learning initiative, Microsoft takes that commitment to the next level by focusing its resources—people, partnerships, services, philanthropy, and products—on stimulating positive change in education.

Partners in Learning seeks to address the digital inclusion issues facing education today by facilitating access to technology and training. Microsoft recognizes the need for students, teachers, and administrators not only to master the technical skills needed to use technology successfully, but also to understand how technology can be integrated throughout the academic environment to help make teaching and learning more rewarding for teachers and students.

Investing in 21st Century Teaching and Learning

The call for education reform has intensified in recent times as a direct result of increasing economic, technological, and societal demands outside of school and an ambitious, digital generation of students inside of school. Government and education leaders are discovering that an education system designed decades ago may not be sufficient to prepare today's students for tomorrow's challenges. New technologies, changing demographics, and economic globalizations are forcing leaders to confront long-held assumptions about education while raising the following additional questions:

- What does a school with rigorous curriculum that students are actually excited to attend look like?
- What implications do emerging economic and demographic shifts have for the U.S. public education system?
- What skills and knowledge do students need to have to be prepared for college and then to be successful in the workplace?
- How can schools increase not just access to technology, but also the capabilities of individuals to use these tools effectively?
- What assumptions about the way students are educated must change to reach this current generation of students?
- Is it possible to create a system of education that adapts to the individual student's needs instead of the individual student adapting to the system's needs?
- What new capabilities are needed to bring about this systemic reform?

The answers to these questions will not be found by bolstering Industrial Age structures, methods, and systems. The Council on Competitiveness succinctly summed up the challenge by stating, "To thrive in this new world, it will not be enough─indeed, it will be counterproductive─simply to intensify current stimuli, policies, and management strategies and to make incremental improvements to organizational structures and curricula."[1] Instead, leaders must think anew with institutions about tools and strategies that will adequately address today's challenges.

Microsoft's new Partners in Learning program was created in part to help leaders work through these questions to design 21st century education systems. Microsoft understands that there are no easy answers to these questions, which is why the Partners in Learning program aims to help individuals and organizations develop the capacity needed to adapt to the increasingly complex world in which we live.

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[1] Council on Competitiveness, *Innovate America*, December 2004.

A critical aspect of building this capacity involves developing a shared vision for what a changed education system could look like. Through the Partnership for 21st Century Skills, a coalition of education groups and businesses, Microsoft has been working intensively to identify the elements that define 21st century teaching and learning. These elements include the following:[2]

1. **Emphasize Core Subjects:** The foundation for 21st century learning begins with mastering the basic skills found in the core subjects such as reading, math, and science. This learning foundation also includes encouraging high-school students to take more rigorous courses such as those outlined by the America Diploma Project and the State Scholars Program.

2. **Emphasize Learning Skills:** Learning skills are comprised of information and communication skills; critical-thinking and problem-solving skills; and interpersonal and self-directional skills.

3. **Use 21st Century Tools to Develop Learning Skills:** Students who lack access to and the ability to use digital technology will increasingly be at a disadvantage in work and life. Schools must promote "digital inclusion" where the focus is not just on simply increasing access to technology, but more important, helping individuals develop the capacity to use those tools to support their developing learning skills.

4. **Teach and Learn in a 21st Century Context:** Students need to learn academic content through real-world examples, applications, and experiences both in and out of the classroom.

5. **Teach and Learn 21st Century Content:** The challenges of the 21st century society require students to develop better global awareness; financial, economic, and business literacy; and civic literacy.

6. **Use 21st Century Assessments that Measure 21st Century Skills:** Policymakers and schools must develop new strategies and tools to assess student mastery of these skills and knowledge.

These elements build on the work already underway to hold schools accountable for ensuring that all students can achieve high academic standards. They also complement the recent call for more rigorous high-school courses to help ensure students are better prepared for college. But these elements go a step further to describe a set of expectations that are benchmarked not just against other states, but against competing nations and the needs of a 21st century society. And as explained later, these elements describe the type of education today's generation of students expects to receive.

Microsoft is seeking partners that can make this vision become a reality. Through its Partners in Learning program, Microsoft is committed to investing its resources–people, partnerships, services, philanthropy, and products–to help these partners develop models of a 21st century education system.

The Challenge of a Changing Economy

The United States faces new challenges created in transitioning from a manufacturing-based economy to an Innovation Economy based on knowledge, services, and ideas. In this Innovation Economy, the most valuable assets are not physical materials or natural resources, but human capital–the skills, capabilities, and education of individuals. Economic growth is driven by brainpower instead of the horsepower that came to define the mass production era of the Industrial Age.

National and state leaders are wrestling with the reality that the same telecommunication networks that integrate nations into the global economy also bring new competitors to their doorstep. *While in the past, people went to where the jobs were located, jobs today go to wherever the skilled people are located*. Previous competitive advantages such as geographic location are no longer sufficient for future success since financial investments and new jobs can go nearly anywhere that talent is located.

[2] Partnership for 21st Century Skills, Learning for the 21st Century, June 2003.

As a result of this shift to jobs going where the talent is, a region's competitive advantage will increasingly be linked to the quality of its education system and the capability of that system to cultivate the skills required by emerging industries. Those communities that can attract, educate, and, perhaps most important, retain highly-skilled, diverse individuals will thrive while those that do not will see their economy and quality of life steadily erode. *State leaders are discovering that their economic counterparts are not just neighboring states, but increasingly other nations like India and China who are rapidly developing a highly skilled workforce*. Remaining competitive in this global economy requires leaders to understand that tomorrow's economic growth is driven by today's student achievement gains.

For students to be competitive in the new Innovation Economy, their education system, with deliberate speed, must not only do a better job teaching the core subjects, but also equip them with the advanced skills required by new jobs. According to Federal Reserve Chairman Alan Greenspan, "Basic credentials, by themselves, are not enough to ensure success in the workplace. Workers must be equipped not simply with technical know-how, but also with the ability to create, analyze, and transform information and to interact effectively with others."[3]

New skills are also needed to master the growing number of technology tools being deployed at home, school, leisure, and work. When individuals cannot benefit from the opportunities provided by these technologies, it excludes them from competing for new jobs or participating in other aspects of society. The resulting skills gap contributes to other disparities, including competitiveness, economic development, intellectual development, and overall quality of life. Microsoft believes that "digital inclusion" involves not just increasing access to technology, but more important, teaching individuals the technical skills that allow them to integrate that technology into what they do at home, school, leisure, and work.

Despite this need for more advanced skills, the U.S. education system remains unchanged for the most part. Former U.S. Secretary of Education Rod Paige noted "The way we organize schools and provide instruction is essentially the same as it was when our founding fathers went to school. Put another way, we still educate our students based on an agricultural timetable, in an industrial setting, but tell students they live in a digital age."[4] During a recent speech before the nation's governors, Bill Gates, Chairman of the Board and Chief Software Architect of Microsoft Corporation, described the challenge in even more urgent terms: "Our high schools were designed 50 years ago to meet the needs of another age. Until we design them to meet the needs of the 21st century, we will keep limiting—even ruining—the lives of millions of Americans every year."[5] Partners in Learning grew out of this desire to redesign schools to better serve the needs of today's youth.

The Challenge of a Changing Class of Students

The pressure for schools to change is also coming from another source—students themselves. While there are similarities between this generation and previous ones, there are also startling differences. The students arriving at schools today have fundamentally different attitudes, expectations, and experiences compared to previous generations.

Current research is helping us better understand this current generation of students. These studies are helpful in depicting broad generational characteristics and growing trends; but they may not describe the experience of every young person. As such, educators still must approach each student for who they are—an individual with unique experiences, strengths, and needs. Nevertheless, it is still helpful to try and understand some of the broader generational themes that help to describe today's youth.

Born between 1980 and 2000, they are a generation nearly as large as the Baby Boomers, yet they are also the most ethnically diverse generation America has seen.[6] They are often referred to as Generation

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[3] Greenspan, Alan. "The Evolving Demand for Skills." Speech delivered at the U.S. Department of Labor National Skills Summit, April 11, 2000.
[4] U.S. Department of Commerce, Visions 2020, September 2002.
[5] Gates, Bill. Speech delivered at the National Education Summit on High Schools, February 26, 2005.
[6] McKennam, Kevin. "Selling Online to Generation Y." Property/Casualty Insurance January/February 2005. March 12, 2005. <http://www.namic.org/pcimagazine/050102/genY.asp>

Y, NetGen, the Digital Generation, and the Echo Boomers. But an ABC News poll of teens found that their preferred name of choice was "the Millennials."[7]

As with all generations, the Millennials have been shaped by their times. Neil Howe and William Strauss have remarked that, "They're the 'Babies on Board' of the early Reagan years, the 'Have You Hugged Your Child Today' sixth graders of the early Clinton years, and the teens of Columbine."[8] They are the "child" in the No Child Left Behind Act of 2001 and the first generation to grow up in the post-9/11 world.

Millennials have led heavily structured lives with parents shuffling them from one activity to another all under the watchful eyes of teachers, coaches, tutors, and music instructors. The wide-ranging child protection laws and safety products that came out of the 1980s have made Millennials one of the most sheltered generations. They are self-confident and optimistic. Many are their family's computer information officer (CIO) and believe that education is cool, parents are role models, and integrity is admirable. Researchers are finding the Millenials as describing themselves as ambitious, optimistic, influential, and unique especially in growing up in a more digital age:

- **Ambitious:** Almost 82 percent of teenagers say they are certain to attend college compared to only 50 percent in 1966.[9] Eighty-eight percent have specific goals for the next five years and 78 percent believe they will achieve their life goals.[10]

- **Optimistic:** Three quarters of teenagers feel optimistic about the future. Only six percent believe that life will be worse when they are 21 compared to 25 percent of teens in 1966.[11] Almost 80 percent believe they will be better off financially than their parents.[12]

- **Influential:** Nearly 80 percent of teenagers feel that their voice counts and 83 percent believe that they can make a difference in the world.[13] Teens also influence their parents' purchasing patterns. An astonishing two-thirds of online 17-year-olds say that they have influenced the purchase of their family's car.[14]

- **Unique:** More than 69 percent of Millennials feel their generation is unique compared to only 50 percent of Baby Boomers.[15] This sense of uniqueness is reinforced by an increasing number of products and services customized to fit their specific needs and attitudes.

- **Growing Up Digital:** Millennials are perhaps best known for having come of age with the Internet. Researchers are finding that the Millenials have spent their entire lives surrounded by computers, cell phones, video games, MP3 players, DVDs, and digital video recorders:

    - 90 percent of students between the ages of 5 and 17 use computers.[16]

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[7] Howe, Neil and Strauss, William. Millennials Rising. New York: Vintage Books, September 2000. P. 12
[8] Howe, Neil and Strauss, William. Millennials Rising. New York: Vintage Books, September 2000. P. 4
[9] Geraci, John and Larry Brown, ed. "Then (1966) and Now (2002): How Have Teenagers Changed?" Trends & Tudes, November 2002. March 12, 2005. <http://www.harrisinteractive.com/news/newsletters_k12.asp>
[10] Allerton, Haidee. "Generation why: They promise to be the biggest influence since the baby boomers." Training & Development, November 2001.
[11] Geraci, John and Larry Brown, ed. "Then (1966) and Now (2002): How Have Teenagers Changed?" Trends & Tudes, November 2002. March 12, 2005. <http://www.harrisinteractive.com/news/newsletters_k12.asp>
[12] "Managing Generation Y," Business Week Online. September 28, 2001. March 12, 2005 < http://businessweek.com/smallbiz/content/sep2001/sb20010928_113.htm> Book excerpt from Martin, Carolyn Ph.D., and Tulgan, Bruce. Managing Generation Y: Global Citizens Born in the Late Seventies and Early Eighties. HRD Press, 2001.
[13] Youth Intelligence and OTX, "Teens and Politics." November 8, 2004. March 13, 2005. <http://www.trendcentral.com/trends/trendarticle.asp?tcArticleId=1224&tcCatId=5>
[14] Gerci, John, Silsbee, Peter, Fauth, Sarah, and Campell, Jennifer, Understanding Youth: What Works and Doesn't Work When Researching and Marketing to Young Audiences Interactive Power. Harris Interactive 2000; Harris Interactive Inc. "Nickelodeon Online/Harris KidPulse," July 2000.
[15] Keeter, Scott, et al. "The Civic and Political Health of the Nation: A Generational Portrait." The Center for Information & Research on Civic Learning and Engagement (CIRCLE). September 19, 2002. August 7, 2003. <http://www.civicyouth.org/research/products/youth_index.htm>.

- Nearly 97 percent of students between the ages of 12 and 18 routinely use the Internet—more than any other age group.[17]
- In 2003, the time spent using the Internet exceeded the time spent watching TV for 13 to 24-year-olds.[18]
- Children's cell phone ownership has increased 111 percent since 2001.[19]
- 74 percent of online teens use instant messaging.[20]
- One in five of those under age 30 have an MP3 player compared to only one in seven of younger Baby Boomers (ages 40–48).[21]

Millennials have come to expect technology to be a part of their environment. It is an extension of the way they communicate with each other, entertain themselves, and interact with the world. Not surprisingly, researchers are finding that Millennials also turn to technology as an extension of the way they learn:

- Nearly 94 percent of online teens use the Internet for school research.[22]
- 85 percent of 14 to17-year-olds and 77 percent of 10 to 13-year-olds go online to do schoolwork.[23]
- More than 60 percent of students say the Internet is very or extremely important for their schoolwork.[24]
- 12 percent of 9 to 13-year-olds turn first to the Internet to learn about health issues before they turn to a parent or teacher.[25]

The experiences of this generation have shaped what they expect from their education system. They understand that education is critical for their future success and attaining their ambitious goals. Millennials are not afraid of taking difficult courses, but they do want to be engaged in ways that demonstrate the relevancy of what they are learning. To pursue their own interests, students want more options and choices with their courses and activities. Students have become accustomed to products and services customized not just for their age group but also for their individual interests and, as a result, want to have an education that is customized to their unique strengths and needs. And perhaps the most obvious expectation is that technology will be an integral part of their education. The call for digital inclusion is the loudest from the digital generation itself.

Are Schools Meeting the Challenge?

At a time when education is more important than ever before, many organizations are reporting gaps in the U.S. education system:

- **Achievement Gap:** African-American students scored on average 30 points lower than white students in the National Assessment of Education Progress (NAEP) fourth-grade reading exam.

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[16] U.S. Department of Commerce. Economics and Statistics Administration. National Telecommunications and Information Administration. A Nation Online: How Americans are Expanding Their Use of the Internet. February 2002. August 7, 2003. <http://www.esa.doc.gov/nationonline.cfm>

[17] Cole, Jeffrey I., et al. Surveying the Digital Future, Year Four USC Annenberg School Center for the Digital Future, September 2004.

[18] "Born to be Wired: The Role of New Media for a Digital Generation; A New Media Landscape Comes of Age: Executive Summary." Yahoo! and Carat Interactive. July 2003. August 7, 2003. <http://biz.yahoo.com/bw/030724/245198_1.html>.

[19] Spectracom press release. "Kids' cell phone ownership grows," September 3, 2004.

[20] Lenhart, Amanda, Lee Rainie, and Oliver Lewis. Teenage Life Online. Pew Internet & American Life Project. June 20, 2001. August 7, 2003 <http://www.pewinternet.org/reports/toc.asp?Report=36>.

[21] Raine, Lee. "iPods and MP3 Players storm the market" Washington, D.C.: Pew Internet & America Life Project, February 14, 2005. March 13, 2005. <http://www.pewinternet.org/PPF/p/1047/pipcomments.asp>

[22] Amanda Lenhart, Lee Rainie, and Oliver Lewis. "Teenage Life Online: The Rise of the Instant-Message Generation and the Internet's Impact on Friendships and Family Relationships." Washington, D.C.: Pew Internet & America Life Project, 2001.

[23] U.S. Department of Commerce, A Nation Online: How Americans are Expanding Their Use of the Internet. Washington, D.C.: NTIA and ESA, February 2002.

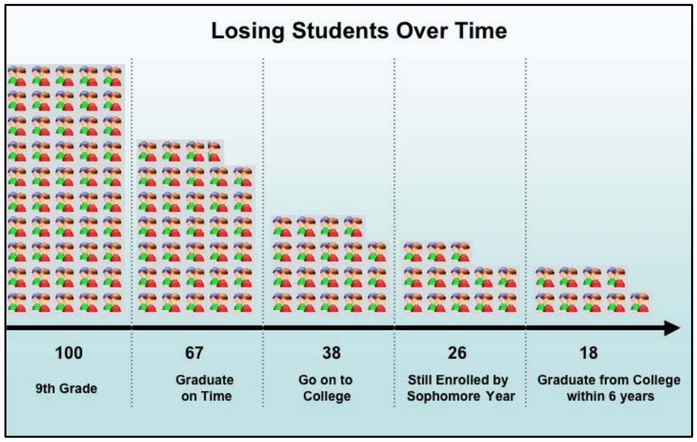
[24] Cole, Jeffrey I., et al. "Surveying the Digital Future, Year Four" USC Annenberg School Center for the Digital Future, September 2004. March 13, 2005. <http://www.digitalcenter.org/downloads/DigitalFutureReport-Year4-2004.pdf

[25] Homeier, Barbara, MD. "KidsPoll: Children Chime in About Health Literacy and Where They Go for Answers." KidsHealth.org. January 14, 2005. March 13, 2005. <http://kidshealth.org/breaking_news/health_literacy_kidspoll.html>

By the time African-American students reach eighth grade, only 12 percent can read proficiently and only 7 percent are proficient in math.[26]

[26] Paige, Rod, "Naked Partisans," Wall Street Journal July 15, 2004.

- **Students Leaving the System:** Despite 82 percent of teenagers saying they are certain to attend college, far fewer actually do. For every 100 students who enter the ninth grade, only 67 will graduate from high school on time, only 38 will immediately enter college, only 26 of those students will still be enrolled for their sophomore year, and only 18 will graduate from college within six years.[27]



- **Advanced Placement:** Forty percent of high schools do not offer advanced placement courses.[28]

- **Graduation Rate:** Nearly 30 percent of high-school students drop out of high school.[29]

- **Unprepared for College:** The percentage of students who left high school with the skills and qualifications necessary to attend college is estimated to have only been 34 percent in 2002.[30] Approximately 61 percent of students who attended a public two-year college and 25 percent who first attended a four-year college required at least one remedial course.[31] Only 18 percent of college professors feel that most of their students come to college extremely or very well-prepared, with just three percent saying extremely well.[32]

- **Math and Science:** Less than 15 percent of U.S. students have the prerequisites even to pursue a scientific or technical degree in college.[33]

While these gaps increase in the United States, observers are finding that other nations are increasing both the capacity and quality of their education systems in an effort to attract Innovation Economy jobs.

- The results of other nations' efforts are evident in recent assessments that show international students outperforming their American peers. On the Third International Mathematics and Science Study (TIMSS), American nine-year-olds scored above the international average, 13-year-olds near the average, and 17-year-olds significantly below the average.
- According to the latest results from the Program for International Student Assessment (PISA), America's 15-year-olds performed below the international average in mathematics literacy. Students in 25 out of the 38 comparison countries outperformed American students in their ability to apply mathematical concepts to real-world problems.[34]

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[27] Ewell, Peter, Jones, Dennis and Kelly, Patrick, Conceptualizing and Researching the Education Pipeline. Boulder, Colorado: Center for Higher Education Management Systems, Summer 2003.

[28] Spellings, Margaret. "Leaving No High School Student Behind." Prepared Remarks for Secretary Spellings at the National Association of Secondary School Principals Annual Convention. February 25, 2005.

[29] Green, Jay, Ph.D., Winters, Marcus. Working Paper: Public High School Graduation and College-Readiness Rates: 1991–2002. Manhattan Institute for Policy Research. February 8, 2005.

[30] Green, Jay, Ph.D., Winters, Marcus. Working Paper: Public High School Graduation and College-Readiness Rates: 1991–2002. Manhattan Institute for Policy Research. February 8, 2005.

[31] U.S. Department of Education, National Center for Education Statistics. (2004). The Condition of Education 2004 (NCES 2004–077). Washington, DC: U.S. Government Printing Office.

[32] Peter D. Hart Research Associates/Public Opinion Strategies. Rising To The Challenge: Are High School Graduates Prepared For College And Work? February 2005.

[33] Competitive paper or PCAST report

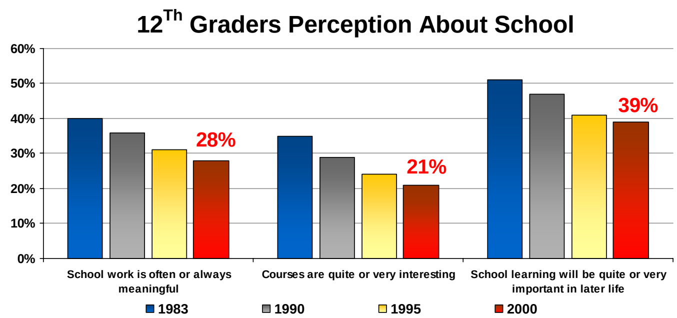
[34] Lemke, M., Sen, A., Pahlke, E., Partelow, L., Miller, D., Williams, T., Kastberg, D., Jocelyn, L. (2004). International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results from the U.S. Perspective. (NCES 2005–003). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

- China alone graduates more than 220,000 engineers a year compared to the United States' total of 60,000.[35]
- Not surprisingly, the nations who are improving the quality of their education systems are the same who are experiencing substantial economic growth. According to Goldman Sachs, India has a growing middle class of 200-million people, and the average income has already risen by 60 percent.[36]

As industries are reorienting themselves for the Innovation Economy and unique needs of the Millennials, are schools making the adjustments needed to better serve this generation?

Researchers have only recently begun asking students about their school experience, but the results only contributed to the evidence of a growing disconnect between school systems and the students they serve:

- Less than one-quarter of high-school graduates feel that they are significantly challenged and face high expectations to graduate from high school.[37]
- An overwhelming majority of graduates say that they would have worked harder if their high school demanded more of them and set higher academic standards.[38]
- Only 28 percent of 12th graders say that schoolwork is often or always meaningful—down from 40 percent in 1983.[39]
- Only 21 percent of 12th graders say that their courses are very interesting.[40]



The purpose of the Partners in Learning program is to invest in and promote new models of education that respond to these demands and help every child reach their full potential. Partners receive support to develop new approaches to education that keep students engaged in their education while equipping them with 21st century skills. Partners in Learning also strives to address the unique expectations Millennials have of schools, such as ensuring that they have access to, and the capability to effectively use, advance technology tools as part of their learning environment.

Partners in Learning: Leadership to Help Transform Teaching and Learning

The recent education reform movement in the United States has raised expectations for all students, from all races, incomes, and backgrounds. Not only does society believe that all students can learn and achieve high standards, society is now holding the education system accountable if the students fail to do

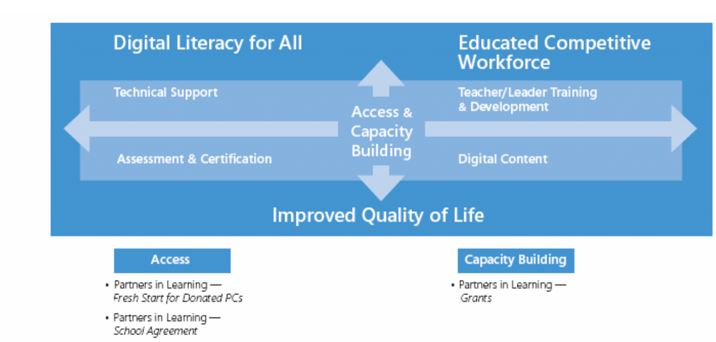
[35] Flannery, Russell. "Hiring Hall." Forbes. July 26, 2004.

[36] Cooper, Kathryn. "India is catching the Chinese dragon." TimesOnline. February 6, 2005. March 13, 2005. <http://business.timesonline.co.uk/article/0,,9556-1471469_2,00.html>

[37] Peter D. Hart Research Associates/Public Opinion Strategies. Rising To The Challenge: Are High School Graduates Prepared for College and Work? February 2005.
[38] Peter D. Hart Research Associates/Public Opinion Strategies. Rising to the Challenge: Are High School Graduates Prepared for College And Work? February 2005.
[39] U.S. Department of Education, National Center for Education Statistics, The Condition of Education 2002, NCES 2002-025, Washington, DC: U.S. Government Printing Office, 2002.
[40] U.S. Department of Education, National Center for Education Statistics, The Condition of Education 2002, NCES 2002-025, Washington, DC: U.S. Government Printing Office, 2002.

so. So for more than a decade, Microsoft has worked with communities, educators, and young people to support education reform and expand the world of learning through technology.

But the new challenges confronting schools require new approaches to education. Schools need help in developing the capabilities for promoting digital inclusion and supporting 21st century teaching and learning. The Partners in Learning initiative was created by Bill Gates and Microsoft CEO Steve Ballmer—in consultation with a worldwide panel of advisors from government education ministries and institutions—to bring fresh ideas and new perspectives to the education reform discussion.



With the Partners in Learning program, Microsoft is taking its commitment to education to the next level by investing its resources—people, partnerships, services, philanthropy, and products—in stimulating positive change in education in the United States and other countries. Partners in Learning is unique because of its focus on developing the individual and organizational capacities needed to support 21st century teaching and learning, digital inclusion, and education reform. Guided by local advisory boards, these investments offer the opportunity to provide innovative, 21st century models in the way the education system prepares teachers, designs schools, delivers instruction, and turns around low-performing schools.

During a five-year period, Microsoft is investing millions of dollars in cash grants, in technology, and in human capital to assist state and local governments and education communities in developing partnerships that advance the use of technology to improve education. In addition, these partnerships will have access to the expertise of Microsoft's employees to help with their own innovation efforts.

The U.S. Partners in Learning program is composed of two primary efforts:

1. **Investments:** Partners in Learning provides investments, during five years, to develop and implement public/private partnerships that will help increase the capacity of schools to use technology as part of their education reform efforts. These partnerships will be designed around the components considered vital towards digital inclusion in schools: teacher and school leader training; assessments and certifications; digital content and curriculum integration; technology support; and research and reporting. Ultimately, these programs will seek to provide models of 21st century teaching and learning.

   Three investment models are available to fund public/private partnerships:

   - **National Program:** For governments and education leaders who are interested in partnering with Microsoft to deliver curricula, tools, and resources to assist leaders.

   - **State Innovation Partnerships:** Microsoft has established five-year public/private partnerships, with selected states, to build innovative solutions for the areas listed above that have yet to be developed or deployed by the state due to resource limitations. The end result will be a broad and diverse set of models that can serve as blueprints for other schools or educators.

   - **Mid-Tier Project Partnerships:** Many of the most innovative education projects are driven by organizations at a local and regional level. However, limited resources prevent many of these projects from growing, scaling up, and serving a broader community. In response, under this model, Microsoft is partnering and investing in opportunities to build out and scale proven, successful models for increasing digital inclusion.

2. **Fresh Start for Donated PCs:** Computers that are donated to schools often lack installed or properly licensed operating system software. To remove this barrier to computer use and increase access to technology, Fresh Start for Donated Computers provides primary and secondary (K–12) schools with the Microsoft® Windows® 98 Second Edition or Windows 2000 operating system licenses for donated computers at no charge. More than just a one-time giveaway of technology, Partners in Learning is a long-term commitment by Microsoft to partner with government, schools, and teachers to support the systemic changes needed.

Conclusion

Microsoft believes that we can help every child reach their full potential. The investments made through Partners in Learning now are creating a multitude of resources—leadership training, teacher development, curriculum and assessments tools, and school-based technology support—that can help communities establish sustainable models for digital inclusion and 21st century teaching and learning.

The actions taken by governments, schools, and businesses now will determine the future. The essential principle guiding Partners in Learning is a belief that education transforms lives, families, communities—and, ultimately, states, nations, and the world in which we live. Microsoft invites you to join us in this discussion and advancing the agenda of 21st century learning.

Examples of State Projects
Washington A partnership with the State of Washington strives to transform teacher preparation to help ensure teachers are ready to teach in modern classrooms. New digital tools and assessments are being developed to help individualize instruction with a particular focus on the Washington Assessment of Student Learning (WASL) and 21st Century Skills.
Michigan Michigan teachers are benefiting from the creation of online grade-level content expectations mapped to specific curriculum. Training is provided through a Leadership Institution to help the lowest performing schools develop the capacity to implement research-based school improvement strategies.
Florida With greater accountability comes the need for more sophisticated data systems. Through this partnership with the State of Florida, classroom level “Digital Dashboards” linked with classroom-level, district-level, and state-level data are being created to give teachers a “whole-system view” of their students. Teachers can see warning signs of student achievement decline and receive recommendations for appropriate interventions that can be immediately applied. The partnership is also piloting a teacher–to–teacher peer coaching model to infuse daily professional development into the life of the schools.
Virginia Some of Virginia’s most challenged schools will soon benefit from a new program that creates “Turnaround Specialist” Principals. This executive education program, designed by the University of Virginia’s education and business schools, is specifically designed to build a cadre of experts charged with turning around consistently low-performing schools.
Pennsylvania Microsoft has partnered with the School District of Philadelphia to create a model “School of the Future.” This 700-student high school incorporates innovative planning and technology solutions in all aspects of the school development—from its architecture to curriculum. A college of education curriculum is being developed to help others learn how to use the team strategies, materials, and processes that were used to build the School of the Future.
New Mexico The partnership with the State of New Mexico focuses on closing the achievement gap of at-risk students through data-driven decision making and improving teacher quality with respect to 21st century teaching and learning. The partnership is also working to redefine and increase parental involvement through using new technologies.

Microsoft Corporation • One Microsoft Way • Redmond, WA 98052-6399 • USA

Engineering "Force Multipliers" for Training and Education

Science of Learning Workshop, Train Soldiers Panel

Submission Date: July 18, 2006

Prepared by:

Daniel Serfaty
Frederick Diedrich
Kathleen Hess
Jeff Beaubien
Jason Sidman
Tad Brunyé
Aptima, Inc.
12 Gill Street, Suite 1400
Woburn, MA 01801
Serfaty@aptima.com
Tel. 781.496.2411

1. Introduction

In the current operational environment, the ability to rapidly adapt to changing conditions is critical for mission effectiveness. There is a need to move seamlessly between combat conditions and routine stability operations, from kinetic to non-kinetic engagements. Moreover, given the increasing emphasis on expeditionary warfare, our forces are challenged with the need to adapt to uncertain mission constraints and complex culturally diverse situations. Our forces must be able to deploy anywhere in the world on short notice, have the ability to engage an unknown culture, and perform missions ranging from disaster relief to combat. Under this new context, it is no longer sufficient to train for a particular mission in a particular part of the world. *Instead, it is necessary to bring current lessons into the classroom as rapidly as possible so that the educational system keeps pace with evolving mission contexts.*

At the same time, the Army needs to prepare for a variety of additional stressors on the educational and training structure. For instance, given the high operational tempo and the ever-present potential for cutbacks in the future, it is possible that there will be reductions in training resources, leading to larger and/or shorter in-person classes. Likewise, as personnel are increasingly deployed around the world, it will be necessary to enhance the ability to foster distributed learning and embedded training technologies. Collectively, then, the Army is challenged with a critical issue affecting how soldiers will learn in the future:

- *How can the Army enable training and education that is increasingly relevant to the modern operational context, increasingly reliant on fewer resources, and increasingly distributed?*

In other words, there is a need similar to that on the battlefield, where force multiplier technologies are needed to enable fewer personnel to do more in varied ways – *Alternative learning approaches are needed that can act as effective "force multipliers" for training and education by enabling superior learning that can occur anytime, anywhere, leading to increasingly effective operational personnel.*

The answer to this complex issue no doubt lies in the creative use of novel learning technologies and approaches such as distance learning, games, immersive simulations, automated feedback, interactive multimedia instruction, and intelligent tutoring. For instance, distance and blended learning opportunities, as well as intelligent tutoring systems, can provide opportunities to learn when direct access to instructors is limited. Similarly, technologies such as games have the potential to address current lessons learned to the extent that they incorporate ongoing input from the field and to the extent that they provide mechanisms to easily author content.

However, although increasing reliance on alternative instructional technologies seems an inevitable method to address learning in the future, given the range of potential technologies, it is essential to address issues such as:

- How do you determine the best fit between the teaching technology and the task to be learned?
- How can we assess the costs and effectiveness of alternative technologies?

In this manuscript, we address these issues by focusing on the broader educational context in which these technologies must be embedded. Whether interactive multimedia, games, or immersive simulations, we argue that these technologies will only be effective to the extent that they address the right objectives to be learned, through technologies that enable the right conditions and feedback for learning. *Only then will these technologies truly become force multipliers for training and education.*

2. The Objectives, Conditions, & Measures (OCM) Framework

To promote effectiveness, an essential first step in selecting a novel learning technology – whatever that technology may be – is to carefully consider the knowledge, skills, and abilities to be learned. While this is not a novel argument, it remains a critical one, for too often technology drives training development in the absence of deep consideration of what the training is actually supposed to accomplish. As a general rule, training that involves a stronger needs analysis tends to produce more positive gains in learning (Bennett & Arthur, 1996).

Accordingly, over the years, a number of techniques have been developed to ensure that training content adequately addresses the critical competencies that are required for effective performance. These techniques go by various names, such as Instructional Systems Design (ISD; Goldstein, 1993) or the Systems Approach to Training (SAT; Kozlowski & Salas, 1997). In all cases, there is an emphasis on understanding the organization's readiness for training; the knowledge, skills, and abilities (KSAs) that are required; and an analysis to identify which personnel are likely to benefit most.

Within this larger context, as part of the Defense Advanced Research Projects Agency's (DARPA) DARWARS program, Aptima and its colleagues at BBN Technologies formalized the Objectives, Conditions, and Measures (OCM) Framework as a method to address the training design issue, beginning with training objectives (e.g., Weil, Hussain, Brunyé, Sidman, & Spahr, 2005). As shown in Figure 1, the approach starts with a consideration of objectives, which should be directly linked to the required mission critical competencies. These objectives must then be matched to appropriate training experiences (e.g., taking a particular role in a specific scenario, or doing a specific multimedia exercise, which addresses a target set of skills). The important step here is to specify the characteristics or conditions of the learning environment and tasks to make sure they match the training needs by creating opportunities to learn and practice the critical skills (What is the fit between teaching technology and the content to be learned?). Simply put, if the correct opportunities are not created, learning of the required skills will not occur. Finally, trainee responses within the learning environment need to be identified, mapped to objectives, and recorded. Measures can and must be made based on performance and then they must be extracted to provide meaningful assessment and feedback. This process therefore serves to embed the training technology – whether novel or old, in-person or distributed – in a sound framework that creates the learning environment. *We contend that this type of design is and will be <u>the</u> essential step in ensuring that novel training approaches become effective*.

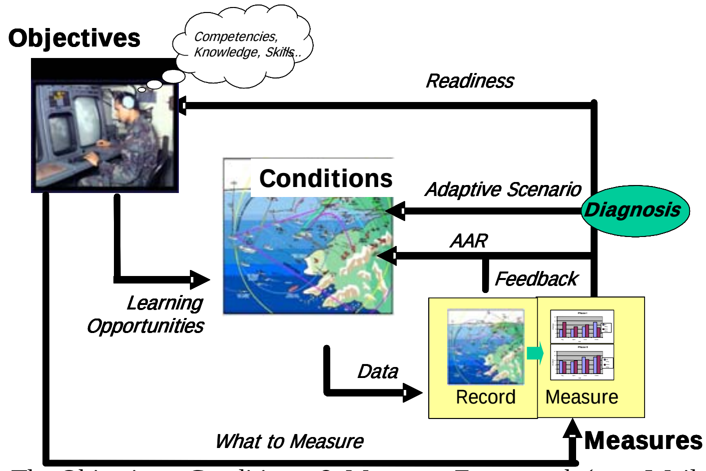


Figure 1. The Objectives, Conditions, & Measures Framework (e.g., Weil et al., 2005).

3. An Example: The Potential of Gaming Technology

Game-based training applications are becoming increasingly relevant for military training, largely due to their ability to promote engagement as well as training anytime, anywhere. *Yet, despite their potential, significant challenges remain – both technical and non-technical – in the effort to move from gaming to training.* Hence, games serve as a useful example to illustrate some of the key challenges facing the introduction of novel learning approaches.

For instance, in an effort sponsored by DARPA to evaluate the requirements for making games into training systems, Aptima and BBN technologies studied the potential of an existing, off-the-shelf game to provide training on teamwork skills such as communication, back-up, monitoring, and leadership (e.g., Freeman, MacMillan, Haimson, Weil, Stacy, & Diedrich, 2006; Weil et al., 2005). The game evaluated was Neverwinter Nights by Bioware Corporation, supplemented with a Voice Over IP capability for verbal communication (Figure 1). The game provided a fantasy-based setting in which a Platoon at Ft. Benning played roles ranging from archers to wizards.


Figure 2. The game Neverwinter Nights (Bioware Corp.) employed to study teamwork skills training.

Findings indicated that the game did indeed provide opportunities to practice teamwork skills – for instance, the soldiers engaged in acts in which coordination and communication between players with different capabilities was essential to success. Yet, results also indicated that much had to be done to engineer effective learning – the research team manipulated the capabilities of the characters in order to ensure that the players had to work together to defeat the enemy (i.e., only the combined capabilities of a wizard and an archer would be effective). Similarly, the game scenario had to be authored to create the right learning events – pilot testing revealed that it was not sufficient to merely jump into the game, for opportunities that forced teamwork had to be created. In other words, the training *conditions* had to be carefully created, and moreover, *measures* of the performance for feedback were essentially absent from the game and had to be added (in this case, through observers).

As this example illustrates, then, technical challenges such as authoring do indeed remain – games cannot simply be used effectively right off the shelf. Moreover, beyond technical issues, there is also a related challenge to find ways to bring current lesson learned in to the training environment. *The ability to easily author is necessary because of the evolving operational environment – static scenarios and environments that don't change over time will not suffice*. So, in addition to the technical challenges, to make tools such as games – and other novel learning technologies -- really relevant, we must address issues such as:

- *How can interaction between deployed and instructional personnel be fostered and sustained to move current lessons learned into training as rapidly as possible?*
- *What are best practices, and how can dialogues between these communities be engineered most effectively to support relevant learning?*

As these questions illustrate, there are both technical challenges and organizational challenges that must come together to make tools like games both relevant and effective distributed learning technologies.

4. Determining the Fit Between the Technology and the Tasks to be Learned

As the above examples illustrates, it is possible for games to support distributed learning, and ultimately, the introduction of current issues. Yet, more generally it is essential to ask how to match technologies such as games to the objectives to be learned, *for it is critical to match the right conditions, through the right technologies, to the training needs*. To maximize learning, it is essential that we understand not only technology, but the appropriate application of technology.

Interaction between the student and the actual training system (whether it is some form of technology or face-to-face) is an important predictor of training effectiveness (Fox, 1988; Keller & Katsuaki, 1988); therefore, training developers need to better understand when and how to incorporate technology into training to provide courses which are not only engaging, but also pedagogically sound. Specifically, we need to determine what factors to consider when planning, designing, and delivering training programs, especially with regard to whether or not to use technologies of different types. The incorporation of technology into training must be accomplished systematically, with training objectives always at the forefront.
Currently, however, there is little practical guidance on when and how to effectively incorporate technology across the broad range of potential training applications. The various aspects of technology (e.g., computer games – including the gaming strategies employed, the exciting look and feel of such games, and innovative user interaction techniques) must be studied in the context of training effectiveness. The goal is to help training developers apply technology

systematically by relating specific learning objectives to different aspects of technology to maximize training effectiveness.

For instance, working with NAVAIR, Aptima began to investigate when and how to use technology to improve training effectiveness. Specifically, we sought to determine what aspects of computer games made them so motivating, and how (and when) these aspects may be used to increase motivation to participate and learn. To begin, we identified the following six dimensions of gaming as possible motivating factors (Garris, Ahlers, & Driskell, 2002):

- Fantasy: "imaginary or fantasy context, themes, or characters."
- Rules/Goals: "clear rules, goals, and feedback on progress towards goals."
- Sensory Stimuli: "dramatic or novel visual and auditory stimuli."
- Challenge: "optimal level of difficulty and uncertain goal attainment."
- Mystery: "optimal level of informational complexity."
- Control: "active learner control."

Garris et al. (2002) also stressed that game characteristics must be paired with the learning content. For instance, Kraiger, Ford, and Salas (1993) identified the following types of learning outcomes; skill (performance of technical or motor skill), declarative (knowledge of the facts and data required for task performance), procedural (knowledge about how to perform a task), strategic (ability to apply rules and strategies to general, distal, or novel cases), and affective (beliefs or attitudes regarding an object or activity). Building on this, in an attempt to understand how gaming attributes can engage the student but not inhibit training, Aptima developed a matrix linking Garris' six dimensions of games to learning outcomes identified by Kraiger, Ford, and Salas (Table 1). Note that the relationships depicted in this matrix are based on our best guesses, and represent hypotheses. For instance, one hypothesis represented in the table is that in a setting that has many fantasy elements, there may be very positive effects on the ability to learn to solve novel problems, which may even transfer to the real world. Who other learning outcomes, however, high levels of fantasy may be less conducive to learning. Alternatively, an environment that is low in sensory stimuli (not very engaging) may have limited or negative effects on enhancing affective outcomes. While this representation is simply a start, and likely to be incorrect, it represents the types of analyses that should – and can – be done to systematically think about how to evaluate the fit between learning needs and likely outcomes.

We argue, therefore, that depending on the specific type of learning outcome in which you are interested, certain gaming dimensions may add to or detract from the learner's ability to achieve their goals. Similarly, like games, we suspect that across learning technologies, there are similar tradeoffs between aspects of the technologies and learning effectiveness depending on the specific objectives:

- *A challenge for the future, then, is to conduct research into the fit between attributes of various learning technologies and the content to be learned.*

Similar to Table 1, validated guidelines need to be developed to guide the selection of when, and when not, to apply different classes of technology. In other words, we need to develop principles for pairing the training conditions to the objectives.

Table 1. The relationship between gaming dimensions and learning outcomes

Gaming Dimensions

Learning Outcomes	**Fantasy**	**Rules/Goals***	**Sensory/ Stimuli**	**Challenge ***	**Mystery**	**Control**
	Hi: no activity outside the game that corresponds to reality Lo: every activity maps directly onto reality	Hi: having fixed constraints with precise rules governing activities, capabilities, and behavioral options. Lo: characterized by no constraints.	Hi: presences of sights and sounds that intoxicate the senses. Lo: the lack of sensory stimuli.	Hi: optimal level of complexity. Lo: no complexity.	Hi: inability to predict what is coming next. Lo: ability to predict the future	Hi: being able to exercise authority. Lo: having little control
Skill: development of technical or motor skills	Hi: Neutral	Positive	Hi: Negative	Positive	Hi: Neutral	Hi: Positive
	Lo: Neutral		Lo: Positive		Lo: Positive	Lo: Neutral
Declarative Knowledge: knowledge of facts and data required for task performance	Hi: Neutral	Positive	Hi: Negative	Positive	Hi: Neutral	Hi: Positive
	Lo: Neutral		Lo: Positive		Lo: Neutral	Lo: Neutral
Procedural Knowledge: knowledge concerning how to perform a task	Hi: Neutral	Positive	Hi: Negative	Positive	Hi: Negative	Hi: Positive
	Lo: Neutral		Lo: Positive		Low: Positive	Lo: Neutral
Strategic Knowledge: ability to solve new problems	Hi: Positive	Positive	Hi: Negative	Positive	Hi: Positive	Hi: Positive
	Lo: Neutral		Lo: Negative		Lo: Negative	Lo: Negative
Affective Outcomes: feelings of confidence, self-efficacy, attitudes and preferences	Hi: Positive	Positive	Hi: Positive	Positive	Hi: Positive	Hi: Positive
	Lo: Neutral		Lo: Negative		Lo: Neutral	Lo: Negative
Transfer Outcomes: ability to apply training in the actual job setting	Hi: Negative	Positive	Hi: Negative	Positive	Hi: Neutral	Hi: Positive
	Lo: Positive		Lo: Positive		Lo: Neutral	Lo: Neutral

Assumptions:
* Curvilinear Relationship : meaning moderate levels of variable are the best for all outcomes
** Challenge dimension interacts with trainee characteristics, such as skill level (novice/expert)
*** Assuming Learning Outcome variable is high

5. Effectiveness and Costs of New Technologies

As the previous analysis suggests, ultimately the most critical issue to ask about new technologies and approaches relates to the classic issue of transfer of training and how best to measure it. We must also measure the extent to which the training is cost effective, for ideally, the training will have beneficial effects on mission outcomes at minimal cost. *While there are a* *variety of technologies potentially available, it is important to assess the extent to which they ultimately have a positive impact on mission effectiveness, while striving to balance the creative introduction of current lessons learned and the need for distributed learning.*

Transfer can be defined as the application of basic and conceptual knowledge, skills and attitudes acquired during training to the environment in which these constructs are normally exercised (Muchinsky, 1991). Thus, whether we employ immersive simulations, games, or interactive multimedia, the ultimate issue is whether these approaches serve to improve mission effectiveness in the field. At a first pass, the answer to this transfer question may seem relatively easy to address. For instance, in the context of the OCM framework, do the objectives addressed in the training and educational setting map to the competencies critical for mission effectiveness? If so, and if learning has indeed occurred in the training environment, then it would seem that transfer should occur. Indeed, as argued above, adherence to the OCM framework should ultimately promote transfer.

However, even with diligent adherence to the OCM framework and well-defined competencies, the research literature clearly indicates that there are a variety of factors that impact transfer. In fact, substantial research has been conducted over the last few decades on transfer of training (e.g., Hays, Jacobs, Prince, & Salas, 1992). One of the cores issues in this literature has always been the extent to which the training conditions and the operational environment share critical features. Early research proposed that successful transfer only occurred when the simulated and real tasks had common elements (Thorndike, 1906). The argument is that the simple exclusion of a few common core elements between training and operational environments limits training transfer (Chase & Ericsson, 1982; Tulving, 1983). However, the exact nature of the critical elements has been challenged, and this debate continues today (e.g., Singley & Anderson, 1989). Whether correct or not, it is the case that fidelity is often cited as a primary determinant of positive transfer, and it remains critical to assess training in this regard.

Building on this large base of work, Aptima is therefore currently working with the Air Force Research Laboratory to develop the Performance Effects Related to Force Cueing Manipulation (PERFORM) tool to provide training designers, acquisition professionals, and researchers the ability to predict performance outcomes resulting from simulator fidelity manipulations within the Air-to Air Combat domain (Estock, Gildea, Alexander, & Nash, 2006). As shown in Figure 3, the tool allows users to manipulate the categories and levels of fidelity of a particular simulator configuration to explore the anticipated effects on knowledge and skill acquisition. The unique aspect of this approach is that it systematically strives to consider fidelity manipulations (*conditions*) within the context of particular competencies to be learned (*objectives*) and the properties of particular training scenarios (also *conditions*). So, for instance, in principle the tool can account for the fact that changes in fidelity must have an impact within the peculiarities of a particular scenario (e.g., in a trivial example, enhanced modeling of a particular weapon system will not matter if the scenarios in use do not call for use of that weapon system). At its core, the PERFORM tool works by making predictions on the basis of algorithms built off of the literature and from subject matter expert input, combined with mappings between scenarios and competencies.

Figure 3. Prototype interface of the PERFORM tool.

The strength of the PERFORM tool lies in the consideration of simulator fidelity with scenario and competency information. It attempts to evaluate learning effectiveness in the context of conditions and objectives, and as a result, provides an example of how tools can be constructed to assess training effectiveness. That being said, however, it is important to emphasize that because there is relatively limited real data that links fidelity manipulations to transfer, the output metrics in PERFORM are based largely on learning effectiveness – they do not speak directly to transfer per se – and strict studies of transfer await further work. Accordingly, in terms of challenges for the future, we argue that:

- *While we perceive PERFORM to be a positive step given the explicit linking to conditions and objectives, more research is needed to validate the approach, seek direct evidence for transfer, and to expand beyond immersive simulation to explore other methods in different contexts.*

Moreover, it is also essential in this context to consider gains in training, and ultimately operational effectiveness, in light of costs given the potential for future reductions in spending and staffing. For instance, if a training approach is advocating the introduction of additional staff to integrate current lessons learned, it will be critical to know that such a move is justified by gains in real effectiveness. In short, what is the return on investment?

Quantifying the effectiveness of training and development programs is a relatively new field. Although much has been written about this in the business literature, the scientific literature has been slow to adopt this technique. One technique that has gained favor in a related domain – personnel selection – is utility analysis (Judiesch, Schmidt, & Mount, 1992). Utility analysis calculates the dollar value of performance improvements by weighting a new hire's salary by the expected gain in his/her performance (traditionally expressed in standard deviation units) that results from using a valid selection mechanism (one which screens out undesirable candidates). The resulting dollar figure is then multiplied by the number of new hires to provide an overall estimate of the performance gain that is realized by the organization.

Unfortunately, utility analysis is based on a linear, additive formula – thereby masking correlations and feedback loops among likely predictor variables. New techniques, such as system dynamics models can potentially adequately represent these factors. In addition, they have the potential to create a user interface that allows the user to play "what if?" games, for example by changing the number of trained employees and training programs, to assess the

Army's true return on their human capital investment. In the case of the PERFORM tool, for example, it should be possible ultimately to link hypothetical changes in fidelity to costs. While the calculations may not be perfect, it should be possible to assess relative costs and improvements. In this case, we therefore see that challenges for the future must include:

- *The creation of tools for different learning approaches that not only assess transfer based on data and deep theoretical principles, but that also incorporate cost as an explicit factor, thereby promoting calculation of return on investment.*

6. Conclusions

As outlined in this manuscript, novel advances in training and educational technologies hold great promise, ranging from gaming applications to immersive simulation environments. As a variety of pressures come to bear, these approaches clearly have the potential to address how the Army can enable training and education that is increasingly relevant and distributed. *In this sense, novel tools can indeed become force multipliers for training and education – they can potentially compensate for fewer resources and distributed personnel, and ideally, they may even be able to deliver soldiers field that are better prepared for the immediate operational environment.*

However, while numerous challenges for the technologies themselves remain, we have argued that some of the most important challenges lie in the larger training context:

- Novel tools must be embedded in the context of thorough training needs analyses, which result in well-developed mappings between objectives, condition, and measures.
- To truly realize continual introduction of lessons learned, technologies must be easily authorable, and the involvement of experts in the current operational environment must be facilitated and sustained to enhance relevance.
- Novel methods to evaluate fit of technology to training needs, as well as training effectiveness in light of costs, need to be established to guide research and procurement.

Answers to questions such as these will provide the insight necessary to move novel technologies from innovative tools to true force multipliers for training and education

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Technology and Learning:
Pedagogical Considerations in the Application of Technology.

Thomas Duffy
Learning Sciences, Indiana University
Bloomington, IN
duffy@indiana.edu

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Asking about how we match training technology to the task or content could suggest that there is something "educational" that is inherent in the technology. It could also suggest that learning of "things" (task or content) should be done in isolation. I think both of these assumptions require consideration. While some of the thoughts may seem obvious, I think they are worth reminding ourselves of.

Technology and Learning: Basic Considerations

There is nothing inherently educational in technology – as with all instruction, it is the design of the learning environment that is important. While I think we all know this, we nonetheless place the emphasis on the technology or technological affordances – we need to build simulations or games – rather than on the pedagogical principles we seek to achieve. As a consequence, we too often build technological solutions that are not based on any model of learning or pedagogy. Indeed, my colleague has talked to designers of training simulations who did not have any idea of how or even if learning should be scaffolded in the simulation..

Of course different technologies offer different affordances for achieving pedagogical goals, and I will consider those. But first, let me address the second issue – the assumptions about learning. What is our best understanding of how people learn and what impact does that have on the design of training? First some propositions about learning.

The goal of the learner is a primary determinant of what is attended to and what is understood from what is attended to. In instructional design we typically "give" the learner a goal – but it is not this nominal goal that is central, it is the goal the learner brings to the situation. If the learner is studying to pass a test of a traditional sort, then his focus is on what will be tested, not on the use of the information outside of the classroom. This leads to not only different material being attended to but also to different organization of one's understanding of that material – it is organized for test taking not application or use. Noel Entwistle and his colleagues have demonstrated the impact of the assessment (or "application") expectations on how an individual uses learning resources and on what is learned. Clearly what is learned from a field manual studied in the classroom is quite different from using the field manual in the field (or in simulated exercises). This is one reason we find virtually no correlation between performance in initial school-house training and job performance but a reasonably high correlation between performance in laboratory courses and field performance (Navy research). Of course this issue also relates to the business managers' legendary comment about new hires not being able to apply what they presumably “covered” in school.

We can help establish student goals before learning by giving them some work experience. I find two lines of research illustrate this very nicely. First, some older research sponsored by ONR involving a complex assembly task – assembling a helicopter out of Lego blocks. Subjects could see the assembled helicopter and had all the pieces in front of them for assembly. One group received a video demonstrating the assembly process and then attempted to assemble. A second group did not receive the video, i.e., they attempted the task without any instruction. There was no difference in the performance of these two groups – the video was not of any help. However, when the subjects first tried to assemble and were then shown the video and *then* allowed to return to the task, performance was significantly enhanced by the video. Students needed to know what they didn’t know before help was useful. While they adopted the goal of assembling the helicopter, that was a nominal goal – the situated experience was needed to help them establish specific goals.

Bransford and his colleagues at Vanderbilt did a related series of studies around an introductory Psychology course. There were four instructional conditions designed to teach a chapter. In one condition, students received a lecture on the chapter with the lecture being presented twice to provide a practice effect. Another group was given the description of a research study related to the topic of the chapter and then asked to analyze the data from the study and draw conclusions (basically, participating as a researcher), and they were asked to do that twice. This can be thought of as learning by doing with no guidance or support – analogous to Kirschner, Sweller, and Clark’s “minimally guided instruction”. A third group received the lecture and then the data analysis task. Finally, a group received the data analysis task and then the lecture. This latter group outperformed the other three groups – and the difference was of practical significance. The first three conditions can be thought of as reflecting: a traditional didactic approach (lectures); a minimally guided instructional approach (go do it); a didactic approach with practice (learn it and then apply it). None of these were as effective as the fourth group which can be thought of as experiential learning with guidance or as scaffolded experiential learning. Clearly a key in this fourth condition was providing an experience to the learners that would engage them in the issue and help them establish the goals for what they needed to understand (what they did not know) in order to do the task.

Context is important and hence whole to part training is important. Traditionally we have thought about learning facts, procedures, problem solving, etc. and have discussed instructional strategies for each. The thinking was that we learned a basic concept or skill and then we would be able to apply it in any context. What we have come to understand is that learning and understanding are situated. How we understand a concept depends on the context in which it occurs, i.e., the context in which we are “doing”. Rand Spiro’s cognitive flexibility theory and the work related to is has found that when experiences are limited there is a greater probability of either a failure to transfer or an overgeneralization of what was learned. He has emphasized the importance of experiencing a concept in many different contexts as well as in many variations of the same context (criss crossing the landscape) to begin to develop the richness of the understanding.

In recognizing the importance of context, Stinson (2004) argued that too many business mangers are trained in specific fields (finance, marketing, etc) and therefore can only see a business problem from that particular perspective. Like traditional end of chapter problems, the problems they encountered in their education took only one point of view. To over come this limitation of perspective, and help assure graduates will be able to take a whole business perspective, Stinson designed a problem based (and blended learning) approach to MBA education in which the problems were whole business problems (e.g., Will Apple Computer regain a significant share of the personal computer market?) rather than finance problems, marketing problems, personnel problems, etc.

Spiro and Stinson have focused on the cognitive factors – the concepts and skills related to the business world. But context includes more than just other concepts. It includes the time demands (fluid responses; rapid decision making), emotions (stress, empathy, fatigue, trust), and communication (team coordination); and situational cues (all the environmental cues). All of these factors interact, impacting what the individual learns. The failure to provide the relevant context will impact the nature of what is learned.

Of course, field exercises provide the richest and most authentic context and simulations provide the next most authentic context. However there is a tendency to use these as culminating events. That is, the strategy tends to be moving from part to whole with the field exercise being the end product where everything comes together. Or, another way to think about it is that the traditional approach is "learning about" as preparation for "learning to do" – very similar to the way textbooks "teach" the content and then give practice applying it. However, both the contextual issues and the impact of the learner's goals we have been discussing suggest that the learning must move from whole to part. Learners must have a sense of the larger context and the demands of that context as drivers for learning the specifics.

Complex learning environments can be overwhelming; scaffolding is essential. John Sweller has emphasized the impact of limited STM capacity on the design of instruction. Randy Engles has made similar arguments in relation to individual differences in immediate memory capacity. While their emphasis on memory systems is an important one, we must also remember that there are limitations in our attentional and perceptual systems and even our tactile systems as well.

As environments become too complex, the cognitive system is overwhelmed: we cannot maintain attention, we do not notice things, and we cannot manage the flow of information. Based on this, Sweller has argued that we need to provide well-defined, didactic learning environments. However, the fact that our cognitive systems have limitations does not negate the importance of context and learners goals in the learning process. Hence, we cannot (excuse me) throw out the baby with the bathwater. Rather, we need to understand how to effectively scaffold the cognitive systems in complex learning (or work) environments.

We know that as expertise develops, patterns become more noticeable to the individual and there is chunking of information. That is, expertise mitigates the effects of the limited cognitive systems. This is a further argument for the importance of scaffolding the learning process in the complex environments. Noticing those patterns and chunking are only going to develop – and hence expertise is only going to develop -- if the variables are all present and their salience noted However, the experiential effect on the cognitive processing also suggests that different types of scaffolding are needed for experts and novices. In a review of research on the consequences of learner's differing levels of expertise on cognitive load, Kalyuga, Ayres, Chandler, & Sweller (2003) found that providing excessive or insufficient support could actually hamper the learning process. . Jamie Kirkley, a graduate student of mine, is currently conducting an experimental study for the Army examining the impact of using expert and novice scaffolds to support decision-making in a simulation-game environment.

Reflection is important to indexing and transferring the learning. Too often when learners are involved in a project, the focus is on the nitty-gritty of the project – on *doing*. They complete the exercise and move on without considering what they have learned. A similar issue arises in the use of games – they will learn the strategies as they apply to the game, but do not consider the more general application. Reflection is a critical component in experiential learning environments. It is through reflection that the learner's consider what they have learned and what they still need to learn as well as how they performed as learners (and as team members) and how they can improve their performance.

The Army understands the importance of end of exercise reflections: after action reviews have been a very important component of the learning from field exercises. In my work with the Ohio University MBA program, students reported the need for lengthy reflection periods. In this program, students worked in teams for six weeks on a whole business problem. After the problem was over, students reported they needed more than a day for reflection – they proposed a whole week for reflection. They saw reflection as not only reviewing what was learned but also going off and finishing learning stuff they had to go over quickly. In essence, the demands of the problem forced them to move forward before they fully understood a concept and they wanted to be able to go back and review.

But reflection is not just an end of project review process. It should be a very significant part of the learning process itself. As Alan Schon discusses, the goal is to develop the reflective practitioner who, eventually, is assessing the context and just past actions and making adjustments automatically, i.e., demonstrating expert behavior. In my own work with problem based learning, one of the most powerful interventions I can make as a facilitator is to ask someone in the group to summarize the thinking so far without looking at notes. Similarly, in some research he did for the Air Force, Alan Lesgold, in working with training on a simulation, found that it was very often effective to simply ask learners to pause and think.

I suspect that one of the better strategies for supporting reflection is through "what-if" questions. This is implicit in Rand Spiro's flexibility theory but was defined more explicitly in the Vanderbilt work with Jasper.

While reflection is widely recognized as important, we really know very little about the reflective process and how to incorporate it in the learning process.

Implications for Training.

Integration. Of course there are many other factors related to learning that I could discuss, but I single these out as key for the consideration of the design of learning environments. Here I will summarize the implications for instructional design and also offer some examples that I think reflect these key factors.

The factors described above suggest an experiential learning approach – one in which learning begins in the whole context and then the parts are learned to support the overall goal and objective. Thus the learning is from whole to part and it is learning by doing. The goal is not to "teach" the learner in the sense of covering the content or directing learning requirements, but rather to provide support for the learner's work. After all, the goal is for the learner to perform well,

There may be a requirement for automaticity of responses, and hence memorization and practice. Tools are supplied to support that learning but it remains under learner control. That is, we provide the tools to support the learner's work in the complex environment.

Careful use of guided problem solving is needed to reduce the cognitive load and the frustration of working in the complex environment. Scaffolding means that the support can be faded as learning progresses. Failure to remove the support can reduce learning as the work of Krajeck and others has shown – the learner becomes dependent on the support. Unfortunately we do not know as much as we might hope about effective scaffolding.

Application. There are many ways to apply these concepts to training – technology applications represent only a subset. The Navy, some years back, moved to a training system that was integrated with work on the job. Initial training was minimized and sailors were sent to the job site as quickly as possible. They were then returned to training as their experience and expertise grew. There were multiple cycles of training and work.

One might imagine the use of distance education technologies as a means of even more strongly integrating training and work. As job experiences progresses, the Soldier can be assigned to more relevant training. This may be for jobs he has been around (hence he has the contextual experience) but has not done or ones he has begun and needs a more advanced understanding or skill level.

A minimal starting place is to give the individuals the task before learning about it, so they have some sense of what they know. Bransford has developed the AMIGO model reflecting this approach. However, as he applies it, it is still an academically oriented model.

Industry has also found action learning an important training opportunity that could have some limited application in the Army. Action learning, as originally described, is when a team is assigned a real job – one that needs to be done – but they are provided the resources and time to learn in the process of doing the job. Thus, it is very much a learning by doing approach.

In our own work, we tried to capture the job relevance of training but do it in a experiential course structure. We build a learning management system and a suite of 60 courses for teacher professional development based on four design commitments: relevance to the learner, ease of access, sound pedagogy, and sustainability (Duffy, Kirkley, del Valle, et al, 2006). The specific design principles led to a course design that began with a curriculum problem and ended with the teacher developing a lesson plan she could take to the classroom. The learners are not told what to do, but rather are given subtasks (what they need to do, not what they need to learn) and provided a rich set of resources to support their learning. Thus, it is a guided problem solving approach. The courses are self-paced (start at any time) in order to meet the commitment to ease of access, but learners receive one on one mentoring throughout their work. This mentoring and evaluation process focuses on the understanding how principles related to inquiry based instruction are reflected in the lesson being designed. And, we find that what is learned does transfer to the classroom (see http://ltts.indiana.edu login:NECC pswd:guest)

And of course, case based learning can also fit this approach to instruction. The work Schank has done as well as Kolodner reflect some of the work of case based learning though I would also look to the business schools. Also, Kirkley et al's (2006) problem based embedded training approach has also been developed specifically to provide the Army with an approach to support problem solving with simulation-games.

In essence there are numerous ways of engaging the individual in the larger problem and in going from whole to part. However, I do like to reflect back on my high school and college biology experiences to remind myself how project based learning can go wrong through "scaffolding". Those classes, like so many today, had laboratory components that left nothing but following a procedure up to the students. The goal of the experiment, the method for doing it, and the method for analysis were all well defined and proceduralized. Little thinking was required and the only problem solving was in interpreting the instructions. Certainly I, and many of today's learners in similar contexts, was not engaged in the scientific problem/issue but rather in the problem of completing the class exercise.

Matching technology to training.

The first sub-question presented in our guiding document asks what training technologies (DE, games, immersive technologies, intelligent tutoring, etc) are best for what kind of training (memorization, declarative knowledge, problem solving, procedureal skills.) Let me begin by noting that in other work I have discussed five roles for technology in complex learning environments:

- Providing context: immersion and simulation environments
- Supporting visualization: the focus here is on making the abstract concrete and simplifying the comples
- Providing information access: the most powerful use of technology is the rich access people now have to information.
- Supporting communication: a close second in the powerful use category is the use of technology to communicate with others.
- Enhancing productivity: this is a tool use making mundane jobs easier to accomplish, e.g. word processors, spread sheets, data management

Since the work and in the context of thinking of Army training, I would add one additional use of technology:

- Supporting practice – this may be either support for developing automaticity or support for being able to repeat scenarios that are otherwise note easily repeated because of cost.

Within this context, I do not see intelligent tutoring or automated coaching as consistent with what we know about learning since they require a more controlled environment either in simplified, isolated environment or where the choices of learners becomes a guessing game. For academic learning – ability to pass a test – these may work just fine. However, I see them as being of limited use when the focus is on the learning functioning in the complex environment as a decision maker. However, in saying this, I acknowledge that I have been away from military training issues and complex training environments for a while – so I do look forward to being educated on these issues. My only concern is that we keep the whole-to-part and experiential learning framework in mind.

Within this context, distance learning can be used for almost all learning needs. All of the technological applications listed above can be realized in a distance learning environment. And virtually all of the tasks that one needs to do can be realized in an online environment using simulation or immersive technologies.

Finally let me comment on blended learning. The actual work of learning, I would submit, can always be done online. The onsite complement to blended learning serves particularly well in getting started (motivating the individual, establishing the initial problem and starting work on it as a team – even if individual) and in finishing up (assessment, after-action-review). Here I am assuming that synchronous audio as well as text communication are available in the distance environment as is asynchronous communication.

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PAPERS FROM DEVELOP LEADERS WORKING GROUP

Army Leader Characteristics for Full Range Operations
Comments on FM 6-22, *Army Leadership*

Jon J. Fallesen
Center for Army Leadership
21 July 2006

Background

Every day Army leaders continue to prove themselves around the globe in the contemporary operational environment. The reasons for their success are many, not the least of which is the Army's continuing dedication to robust leader development programs. The Army and the Nation cannot afford to let the quality of leaders erode. Identifying the characteristics of the Army leader is of the highest importance in order to align the Army's personnel management, leader training and development systems to the changing needs of the Nation.

To maintain effective leader development, the Army has continuously assessed the characteristics desired in the modern Army leader. While the vocabulary used for characteristics has varied some, the core characteristics have remained quite consistent over several decades.

An initiative in the early 90's, called Force XXI, looked at how the geo-political environment of the 21st Century would shape the required characteristics of future leaders. Force XXI emphasized the importance of adaptability and flexibility in what a leader would know and do. The Training, Leader Development and Soldier (TLS) Task Force that sprang from exploration with a Strike Force concept was a related opportunity to examine the requirements of the 21st Century leader.

In 2000 the Army's attention on leaders had increased even further and the Army Training and Leader Development Panel (ATLDP) identified requirements of current and future Army leaders. The officer phase of ATLDP highlighted the importance of adaptability and self-awareness in leaders. A Leader Development and Education (LDE) Task Force was initiated upon the shift of Army's efforts to Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) to ensure that ATLDP initiatives on leader requirements and leader training and development were still relevant. Simultaneous with the completion of ATLDP studies and the start of the LDE Task Force, Center for Army Leadership (CAL) initiated a focused study to develop a competency-based model of future leaders. They worked with the U.S. Army Research Institute (ARI) and professional competency modelers to develop a future-based model of leader requirements (Horey, et al., 2004[1]).

None of these efforts occurred in isolation, but all drew on multiple Army agencies to identify, understand, and address issues where required. In Force XXI, the Army War College (AWC) brought in experts from throughout the Army and ran future-based simulations to identify leader requirements. The Army Research Institute also conducted workshops to identify special leader requirements for Force XXI operations. CAL conducted TLS workshops to identify the future characteristics required of modular, quick reaction forces and also relied on assistance

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[1] Horey, Jeffrey, Jon J. Fallesen, Ray Morath, Brian Cronin, Robert Cassella, Will Franks, Jr., and Jason Smith. *Competency Based Future Leadership Requirements* (Technical Report 1148). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, July 2004.

throughout the Army, including the AWC, TRADOC, FORSCOM, AMC, and the Army research community.

ATLDP assembled experts from throughout the Army, academia, and the business sector to identify key characteristics and cost-effective leader development practices. Senior mentors were used to provide their historical knowledge and to guide the ATLDP way ahead. Strategic level leaders were brought together to validate ATLDP findings and provide guidance on suitable, feasible and affordable recommendations. A third group of experts was assembled for ATLDP as in process action team (IPAT) to transition empirically-validated recommendations to action plans. The Leader Development Council of Colonels took on oversight for tracking and guiding the recommended ATLDP actions. The LDE Task Force consisted of highly qualified experts that re-prioritized ATLDP efforts and refined the associated recommendations.

Determination of Leader Requirements

CAL sponsored a leader competency study performed by ARI with team members who had experience in previous competency efforts for military and civilian applications. The development team used a group of highly specialized experts in Army leader requirements to guide the development of the future-based competency model.

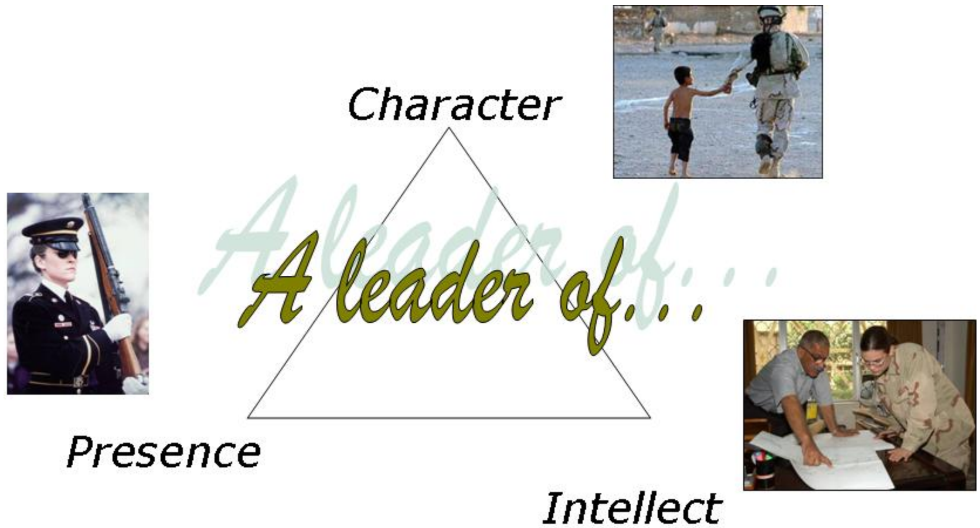
The leader competency study (Horey et al, 2004) took a comprehensive approach throughout its 15 month effort, beginning in 2003. It involved many steps to produce a set of future leader requirements. It analyzed projections of the future environment that would impact the Army's mission and force requirements. It reviewed the collection of leadership theories and what they said about the characteristics of effective leaders. It created a systems model of leaders and followers to identify the essential components and structures involved in leading. It reviewed hundreds of research reports and articles describing essential leader characteristics and identified over 120 unique leader characteristics. It reviewed fifty years of leadership doctrine and how the identification and description of the characteristics have changed over time. It analyzed sister service and civilian competency models to compare and contrast what each highlighted as important leader characteristics. It checked business sector and other nation's armed forces competency models to see how they put competencies together and how they labeled and described the competencies. The draft framework of eight competencies was reviewed by the group of Army leader requirement experts. Revisions were made which underwent further professional peer review, and the framework was turned over to the Combined Arms Center for implementation in the update to FM 22-100.

Attributes and Core Leader Competencies

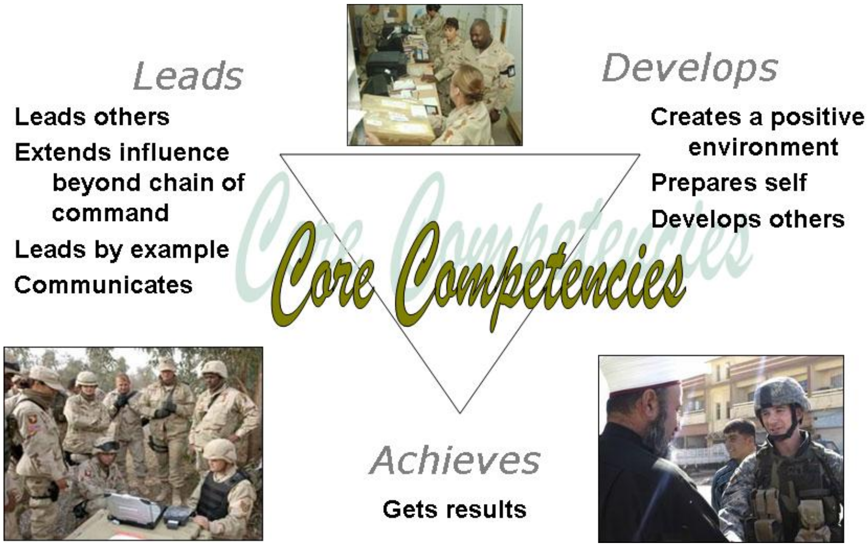
FM 22-100 (1999) was revised to better reflect the requirements of current and future leaders. The ATLDP and the LDE Task Force required that leader competencies be developed and promulgated in the revision to the Army's leadership doctrine along with increased emphasis or redefined constructs for leader development. Confidence in the description of the requirements of current leaders and leaders out to the year 2015 is supported by the feedback that has been received from the Leader Development Council of Colonels and the Training and Leader Development General Officer Steering Committee.

The attributes and core leader competencies are described in FM 6-22, *Army Leadership* (in publication). 21st Century leader requirements are embedded throughout FM 6-22. Most notably one can go to Chapter 2 to see the introduction to the model of Army leadership requirements (figure 2-2 and paras. 2-13 – 2-17, 2-22 – 2-25) and to Appendix A for a detail list of attributes and competencies.

This framework has a number of foundations, but most essential are (1) the Army's lasting emphasis on defining leadership as influence, and (2) the continuation of describing Army leaders as competent leaders of character. Both of these aspects are established in FM 1, *The Army*.



Leader attributes are described with three categories: a leader of character, a leader with presence, and a leader of intellect. Competencies represent what leaders do, drawn directly from three aspects of the Army's leadership definition: leading, developing, and achieving. Chapters 4, 5, and 6 describe the leader attributes in detail, and Chapters 7, 8, and 9 describe the core leader competencies. Appendix A provides lists of the attributes, competencies, supporting components, and example actions or behaviors. The other Chapters all contribute to a fuller description of the basis for these leader requirements, how they apply at the direct, organizational (Chapter 11), and strategic (Chapter 12) levels of leadership, and how they are moderated by outside influences (Chapter 10).

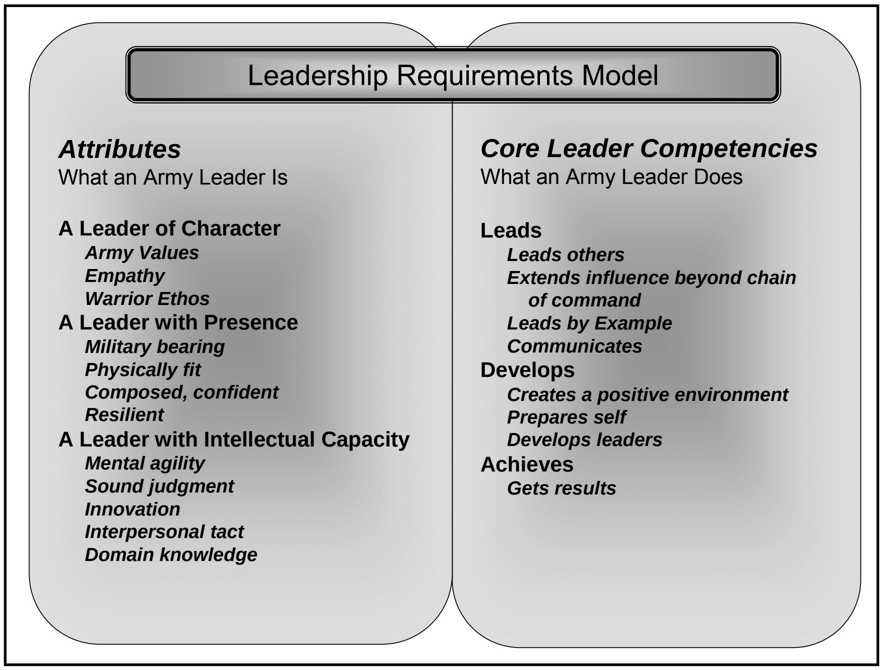


Competency Validation

Development, validation, and coordination on the leader competencies have used multiple approaches. Leader requirement documents and models have been compared to the core leader competencies developed for FM 6-22 to identify mutually supporting requirements and unique aspects. The comparisons included:

- AR 600-100 (1993)
- FM 22-100 (1999)
- Service competency models: Air Force, Navy, Marine Corps, Coast Guard
- OPM Executive Core Qualifications
- Ulmer's Leader Preference Behaviors
- USMA BS&L's performance feedback assessment tool
- USMA Cadet Performance Report
- Strategic leadership competencies (Wong, et al., 2003)
- CAL CTC multi-rater assessment and feedback domains
- TRADOC Common Core Tasks
- DA Officer Board MOI guidelines
- Pentathlete construct

The core leader competencies in FM 6-22 are sufficiently robust to compare favorably with all of these forms of leader requirements. In addition the FM 6-22 leader requirements model has an underlying theoretical and conceptual basis that unifies the characteristics and organizes them in a way that inclusion criteria have been made explicit. The essential characteristic of the Pentathlete metaphor is that leaders need to be multi-skilled for the 21st Century. This theme exists in the leader requirements model of FM 6-22.



The FM 6-22 leader requirements model is not a collection of random characteristics, generated from a narrow set of favorite traits and skills, but instead is based on a set of characteristics that have been validated in several ways:

- Based on analysis that identified effective leadership behaviors (Horey et al., 2004).
- Positive review by a group of specialized Army experts in leadership, leader development, and competency modeling.[2]
- Highly important and highly critical ratings for actions that leaders should perform; the ratings obtained from a sample of 259 Army officers and noncommissioned officers. Actions related to the competencies were rated significantly higher than actions unrelated to the competencies.[3]
- Importance and criticality ratings by Army civilians that had similar results.
- Professional review by experts that assisted in the development of the CTC multi-rater assessment and feedback instrument.
- Continuing application and evaluation of the CTC multi-rater assessment and feedback instrument (based on the competencies); where over 92% of the 2,200 assessed leaders believe the feedback on leader competencies is needed and is useful to them.
- Review of the literature that confirmed that the competencies represent constructs that have valid links to performance requirements.

[2] Included former commander of a combat center; former commandants of senior service school; brigade commanders; uniformed directors of military leadership and strategic study departments; a sergeant major; military and governments scientists; presidents and directors of commercial & academic leadership institutes; and university professors.

[3] *Leadership Competencies: Building a Foundation for Army Leader Development*, paper presented at the 20th Annual Conference of the Society for Industrial and Organizational Psychology, Los Angeles, CA. April 15-17, 2005.

- Criterion-referenced validation that determined performance on all eight competencies significantly relate to measures of overall leader performance (as rated by a total of 600 randomly selected superiors or subordinates)[4].

The core leader competencies continue to be examined to make sure that they are valid as indicators of leader performance and are acceptable to the Force.

The leader attributes and core competencies have also been coordinated with key agencies responsible for Army leader development. Besides the staffing of concept papers, circulation of drafts of FM 6-22, and objective data collected from active leaders in the Army, the leader requirements have been coordinated with a wide range of future- looking organizations and activities:

- Office of the Secretary of Army and Transition Team for the Pentathlete concept.
- Personnel Policy Branch, G1, HQDA for synchronization with DA PAM 350-58, AR 600-100, and for mentorship policy.
- Management Support Division, HRC, to address impact on Part IV of the draft OER form 67-9 and corresponding NCO form.
- Center for Army Lessons Learned (CALL) for collection of leadership observations.
- CAL for impact on common core task list; OES, NCOES, and WOES; ILE terminal learning objectives; and QAO evaluation criteria.
- Leader Development Forum.
- Leader Development Council of Colonels.
- Training and Leader Development General Officer Steering Committee.
- J7, JCS, for joint competency models for 06-level officers.
- Army Research Institute for research projects on accelerated leader development, career mapping, leader development models, and NCO competency assessment.

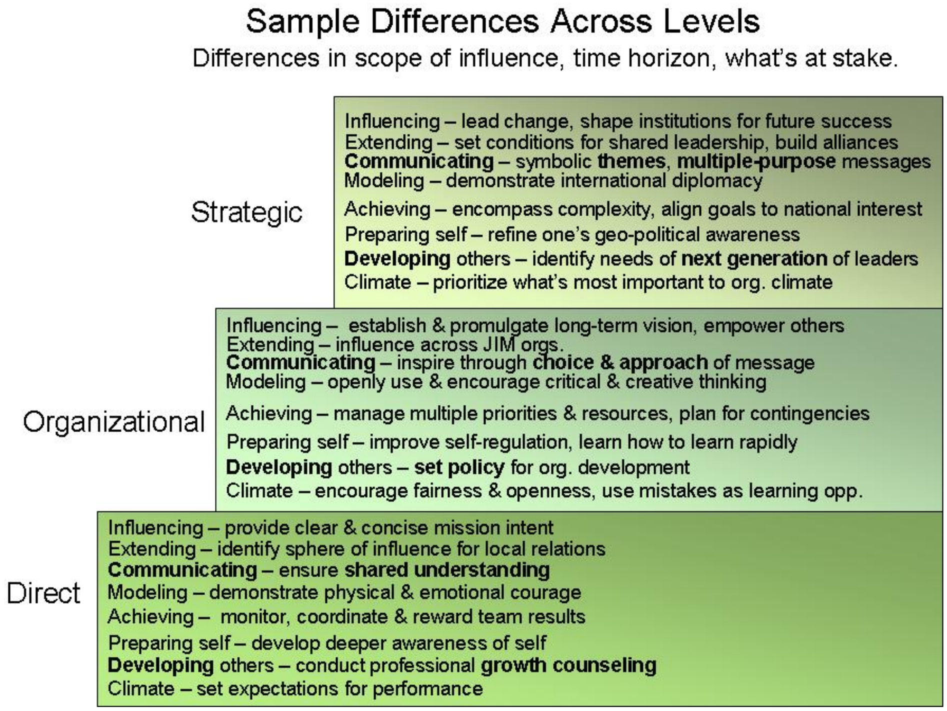
Application of Leader Characteristics

FM 6-22 provides a comprehensive basis and listing of Army leader characteristics. The model was intentionally designed to apply to the many anticipated environments and provide an indication of the breadth of characteristics required. The characteristics are described as a core set required at all levels with an understanding that conditions and behaviors can change slightly depending on the specific circumstances. The Army leader requirements model in the above Figure and the detail in FM 6-22, Appendix A provide a core set of competencies and attributes that apply to all levels of leadership (direct, organizational, and strategic).

Differences across levels require development in understanding the scope of influence, the time dynamics of influence, and differences of stakes and consequences. The relative amount of

[4] Horey, J., Harvey, J., Curtin, P., Keller-Glaze, H., & Fallesen, J. J. (in publication). A criterion-related validation study of the Army core leader competency model. Technical Report. Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

importance of competencies may change according to organizational level, but the nature of the situation and the goals and challenges at hand will probably be a bigger difference.



The leader attributes and core competencies can be used to generate a list of key questions that apply to leader characteristics regardless of level:

Does the leader exceed the minimal level on the following attributes?
- Demonstrate sound, moral character based on Army values, Warrior Ethos, and concern for the well-being of others?
- Have a commanding presence and appropriate level of physical fitness?

To what extent does the leader have the following attributes?
- Have a calming, reassuring influence under pressure.
- Maintain self-control & mission focus in the face of adversity and set-backs.
- Have an intellectual capacity to be adaptable, think critically, and demonstrate innovation.
- Relate and interact effectively with others.
- Have appropriate level of knowledge for his/her level and branch in technical, tactical, joint, cultural, and geo-political domains.

To what extent does the leader exhibit the following competencies?
- Leading others by providing purpose and motivation.
- Extending influence beyond the chain of command.
- Communicating to ensure mutual understanding, active listening, and clear statement of purpose.
- Leading by setting the example for others to follow.

- Creating a positive environment.
- Preparing self.
- Developing other leaders.
- Getting results.

Differences in various proposed models of leader characteristics relate to the underlying assumptions in the model, the intended applications, and the structure of what's highlighted and what's not. Frequently differences across models are not based on absolute disagreements of what's relevant and what's not, but the degree to which a characteristic is highlighted as important.

FM 6-22 places considerable emphasis on what leaders should do. Leader ethics and character are also emphasized, along with presence, thinking, and knowledge. These attributes are necessary, but not sufficient for what a leader does. An emphasis on leader behaviors is consistent with leadership theory and represents growth in the application of theory to leadership doctrine. Doctrine in the 1940's and 1950's emphasized leader traits, while more recent versions shifted to what leaders should do, rather than what traits leaders should have. This shift corresponds to the belief that leadership skill can be developed and improved, and that basic elements of character are needed for ethical and effective decision making.

8 Concepts for Learner-centered Development
and 6 Learning Behaviors for Adaptability

Jon J. Fallesen
Center for Army Leadership
21 July 2006

Learner-centered Development

1. Learner-centered (vs. instructor/organizational centered) – A learner-centered approach to education has the potential to create more effective and more efficient learning. Leader-centered education is consistent with the notion of lifelong learning and learning that is "pulled" by the individual. Instead of an instructor teaching what he or she knows well, student-centered learning is based on the learning needs of the student. Instead of offering courses that are scheduled for the convenience of the organization with an assumed match to needs of its students, a student-centered model would allow students more involvement in the timing and content of learning. Learning is highly dependent on student motivation and the greater responsibility that can be provided to students over their education the more authentic their motivation to learn will be. Distributed learning programs provide a means to support greater tailoring of a program of education to individuals. Learner-centered education is a common means of education in private business.

2. Learn to learn/perceive (vs. "content mastery") - Army leaders need to be good at learning how to learn and learning how to assess situations in different ways. Many approaches to instruction and training assume that the body of knowledge is concrete and stable. Such an assumption treats instruction/training as a process of transferring a given body of knowledge to the students/trainees and further implies that proficiency in the defined areas can be achieved through repetitious practice. The limitation of this approach is that there will always be significant new areas that education/training won't be able to anticipate in advance, prepare sufficient lesson materials for, or synchronize the instruction to match the schedule of those who need it. Individuals need to have good strategies for learning. (Von Glasserfield's theory of constructivism is consistent with the idea of learning to learn; also see "understanding constructed" below.)

Content mastery is important, but not sufficient for uncertain and ambiguous environments. The old adage applies: give a man a fish and he'll have food for a day, show a man how to fish and he'll have food for life. It's often been said that the goal of leader education is not focused on what to think, but how to think. Having knowledge of *how to think* may not always work, teaching people *how to learn* provides an even greater capability.

3. Pull/Learn (vs. push/teach) – Individuals should fully engaged in what and how they learn. A task-condition-standards approach to education and training is good for covering critical known functions, but is limited to material geared to the average person or the novice. Each individual's knowledge is different from someone else's. What a given individual will benefit from learning is dependent in part on what he or she already knows. This is consistent with Malcolm Knowles concepts for adult learning theory; adults want to learn what is relevant to them and not waste time being exposed to what they already know. Also David Kolb's theory

about learning style recognizes that individuals have preferred ways of learning that differ among people.

4. Understanding constructed (vs. structure imposed) – Understanding that is constructed by the individual will have greater meaning and utility to that individual. To be really good at something and to be able to adapt one's knowledge to the problem at hand, deep learning needs to occur. Deep learning describes the formation of knowledge that is well integrated into one's existing knowledge and that is readily applied to the performance of real, complex tasks. The theory of constructivism proposes that for learning to be robust and to last that the person have maximum engagement in the acquisition of the knowledge, and that he or she apply his or her own organization of the knowledge. The new knowledge of the individual is said to be "constructed." When people have actively constructed their own understanding of facts, principles or situations, that form of knowledge will be more accessible for future application and growth and modification.

5. Complexity maintained (vs. complexity removed) – Often instruction and training have the goal of covering topics very quickly and it has to be done by providing simple categories, principles, and examples. Simplicity is often used so everyone can understand. The problem with this is that everyone can understand the simplicity, but no one gets formal instruction or training on the complex cases. Maintaining complexity during instruction and replicating it during training have the benefits of conveying realism and more importantly provide a better foundation on which learning can be adapted in uncertain and ambiguous situations.

6. Sustained exploration (vs. disjointed examples) – Sustained exploration of subject material is an important element of learning things well and to be able to apply the information. Often examples are used in education based on their availability. Instructors often go from example to example or exercise to exercise with little connectivity among them. To develop deep learning and to understand the complexities of new subjects will require additional time for learning. Sustaining exploration of a subject will encourage time to promote the engagement to discover critical principles and relationships. Immersive environments are expected to encourage greater exploration of a knowledge space. Commercial game technology uses a number of techniques to sustain involvement by the individual.

7. Authentic tasks (vs. generic exercises) – Authentic tasks allow the possibility of realism and complexity to be contained in the task without excessive preparation on the part of instructors or trainers. Students can be exposed to many rich examples with real meaning and real outcomes. Instead of using exercises that are artificial in natural, real-life, day-to-day problems can serve as stimuli for practice and training. For example, in a class on strategic planning, the class could link with actual strategic planners who relay their current planning task for that day. The students can go about working on the task and later consider their experience with possible comparison to the actual planners. A class on critical thinking could use the latest edition of the Washington Times or information from www.globalsecurity.org as its "text-book" of source material to review and critique. News articles on policy debates can be reviewed to learn how to identify and assess arguments, or the logic of editorial positions can be studied.

8. Reflection on experience (vs. receive feedback on outcome) – To learn how to think and how to learn requires a greater emphasis on the process. The main interest of an education or training exercise usually is whether you successfully handle the enemy or some other indicator of results.

However, many real problems have no definite outcome, or at least no immediately known outcome. An emphasis on outcome is reinforcing what to think or know, instead of how to think or know. The training should focus on process not outcome to emphasize "*how.*" Many outcomes are the result of luck or, in the case of training simulations, they come from an incomplete model of selected battlefield variables. The individual's personal assessment of an experience will be richer and can have greater learning value than outcome feedback that may not be a real result of the individual's behavior or knowledge.

Learning Behaviors for Adaptability

Adaptability is an effective change in behavior in response to an altered situation. Six learning behaviors to support the development the development of adaptability follow.

1. Seek sources of knowledge.
   - By considering other people's construction of understanding one can short-cut one's own assemblage of knowledge; multiple perspectives of a subject can allow a broader and deeper understanding.
   - Explicit awareness about the sources of knowledge is important for learning (e.g., under what theory or assumptions is this knowledge true/applicable?)

2. Increase the development of conceptual skills and motivation to practice with them.
   - Conceptual skills give people the capability to think through unfamiliar and complex problems and are highly relevant for adaptation.

- People tend to avoid critical thinking because it is hard work to learn and develop the skills in the first place and hard work to apply them. Thus motivation is an important element of developing conceptual skills.

3. Practice with repetition under challenging and varied conditions, with time for feedback and reflection.
    - Repetition, challenge, and variety are important elements of training to address motivation and to build a robust understanding (i.e., learning that is both broad and deep).
    - Time for feedback and reflection are necessary elements to organize and assess new information, to explore various linkages among knowledge and to test the understanding in multiple situations.

4. Develop foundational knowledge.
    - Robust foundational knowledge is important to enable an individual to adapt, to go from what is well-known to something that is unfamiliar.
    - Experts know what they know well and have a sense of what they do not know.

5. Incorporate daily events as learning, practice and reflection.
    - On-the-job, work-centered learning occurs without our conscious awareness. The opportunities afforded in daily events are rich with context and realism. Reflection of what has occurred during work is a good object of reflection to identify what has been learned and what remains to be learned.

6. Maintain a supportive climate of innovation and autonomy.
    - An environment and climate conducive to learning is not reliant on place, time or instructor.
    - Transformation in learning is based on support that is emerging from technology. Technological advances allow learning to occur almost at any place, anytime, and through virtual learning communities. Technological innovations will continue to emerge and will offer new ways to reinforce the development of adaptability.

Building an Integrative, Adult Lifespan Theory of Army Leader Development

David V. Day and Michelle M. Harrison

Pennsylvania State University

Stanley M. Halpin

U.S. Army Research Institute

Paper presented at the 20th Annual Conference of the Society for Industrial and Organizational Psychology, Los Angeles, CA, 15-17 April, 2005

"Whatever its other causes, military incompetence implies a failure of leadership."

Norman Dixon, *On the psychology of military incompetence* (1976, p. 214)

"Leader development is arguably the most important single program of any army."

Lieutenant General Frederic J. Brown, U.S. Army (ret.), (2003, p. 68)

Leadership failure is identified most often through its outcomes. But as argued by many leadership scholars (Calder, 1977; Lord & Maher, 1991; Meindl & Ehrlich, 1987; Pfeffer, 1977; Staw, 1975), reasoning backward from performance outcomes to accurate inferences about the quality of leadership is risky and prone to bias. Although military incompetence (i.e., ineffective performance) may imply a failure of leadership as Dixon (1976) suggests, evidence of (in)effective leadership rests on more than individual, team, and organizational outcomes. Leadership involves applying appropriate competence and expertise in addressing complex challenges, defined as exceptionally novel or unique problems where proven solutions are of little help (Drath, 2001; Heifetz, 1994). Being an effective leader means drawing from a repertoire of skills and higher order competencies that can require nearly a lifetime of experience, intense practice, and learning to master. That is one big reason why ongoing leader development programs are especially critical to the Army and other military organizations. Competence is the backbone of leadership effectiveness and individual leader competence is a requisite condition for the enactment of effective leadership. It is hoped that expert leadership results in successful outcomes; however, it cannot be guaranteed because of unpredictable situational and environmental factors that also shape such outcomes.

What does it mean to develop as a leader or to be a highly developed leader? We seem to know very little about this process, despite the programs, interventions, and resources devoted to achieving that goal. Indeed, there has been quite a bit written about the kinds of programs to promote leadership development and general treatments of important supporting processes. The Center for Creative Leadership Handbook of Leadership Development (McCauley & Van Velsor, 2004) is a prime example of this kind of leader development resource[1]; however, what is missing is a strong theoretical foundation for understanding, predicting, and accelerating leader development. The need is critical in the Army because of increasing "task migration" to younger leaders (Brown, 2003, p. 75). Our purpose is to address this need by examining several theoretical areas that inform leader development processes. In doing so, we intend to develop and articulate an integrative, lifespan theory of leader development.

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[1] McCauley and Van Velsor acknowledge that most of what CCL has called leadership development is actually better described as leader development (Day, 2000). Our focus is on the development of individual leaders in the expectation of providing better leadership in the Army.

The theory offered in the present paper provides the beginnings of an integrative perspective on Army leader development that proposes a foundation for the emphasis on developing individual leader competencies. It is part of the Army's core mission that every day it trains soldiers and grows leaders. It is our intention to elaborate on earlier work addressing leader development in the Army (Day, Zaccaro, & Halpin, 2004) in building an integrative theory that informs the processes of leader development across the adult life span. It needs to be made clear, however, that this is not intended as a competency model that outlines the specific kinds of knowledge, skills, and abilities thought to be needed for effective leadership. There is other ongoing work directed at that goal (e.g., Horey & Fallesen, 2003, 2004). Instead, our approach focuses on underlying processes that support the life-long development of leadership competence. Thus, our theoretical focus is on process rather than content issues. In particular, we attempt to weave a coherent understanding of the leader development process by connecting the disciplines of skill acquisition and expert performance (cognitive psychology), self-regulation and identity development (social psychology), and adult development (developmental psychology). By connecting these fields around the overarching topic of leader development, it is expected that the resulting theoretical propositions will provide a unique and interesting perspective on the developmental processes of leaders. Furthermore, we hope that these theoretical propositions will help to guide research efforts in the Army as well as other military and non-military organizations.

Individual preparation for leadership goes beyond mastering the requisite technical competencies of a job to also gaining expertise in social and strategic competencies; furthermore, preparation for leadership involves developing more complex ways of thinking about and enacting leadership that are intertwined with key facets of adult development (e.g., identity and self-awareness). In order to understand how leaders develop with regard to competencies we believe that it is necessary to integrate this perspective with those involving skill acquisition and expert performance, as well as identity and adult development. Well-known previous work has addressed the issue of managerial competence (Boyatzis, 1982); however, the development of leadership competence is relatively uncharted territory (although see Lord & Hall, in press, for an information processing and identity perspective on the development of leadership skill).

The emphasis of this paper will be on the integrative aspects of these different perspectives, drawing from diverse fields such as expertise and skill acquisition, competency modeling, social identity and the self, and adult development and learning. The reason for this apparent eclecticism (we prefer integration) is that what is expected of leaders is multifaceted and complex. Any theoretical approach that is expected to illuminate the key developmental processes that affect leaders will likely need to be integrative and to draw from various literatures. This is what we have attempted, drawing largely from the social sciences and in particular psychology. Because we are trying to better understand those processes associated with leadership that are inherently relational, psychological theory is naturally at the core.

It should be noted that researchers in the area of wisdom have also posited a systems perspective of expertise. For instance, wisdom has been proposed as "expertise in the conduct and meaning of life" (Baltes & Staudinger, 2000), p. 124) and along with intelligence and creativity, wisdom is a form of developing expertise (Sternberg, 1998, 2003). There are some points of communality with regard to these views of wisdom and what we propose regarding leader development. There are also important differences, especially regarding the role of identity and self-regulation processes that we see are critical in bridging adult development with the development of the expert leader. Whereas it is sensible to think of developing an identity as a leader concomitant with the development of leadership expertise, it makes less sense to propose a wisdom component to social identity.

General Overview: Developing the Expert Leader

Our view of leader development may be visualized as "layers" of leader characteristics. There are the foundational level traits, motivational systems, and values. Related to these, and built upon these foundational elements, are common patterns of behavior, attitudes, and beliefs including attitude toward oneself and beliefs about oneself. Most visible to the external observer are the skills and specific behaviors that a leader brings to a particular leadership situation (in addition to outcomes). These observables can range along a continuum of developmental complexity from relatively simple and unsophisticated to relatively complex and perhaps even profound. The more highly developed leader brings a larger repertoire of available skills and behaviors to bear on a leadership challenge. Unseen are the more fundamental characteristics of the leader and the wide array of psychological processes that support development. These processes are articulated in a later section of this paper on adult development. The end-result of development is manifested in the observable behaviors (application of leadership competencies) in addition to performance outcomes.

> **Proposition 1:** Expert leadership can be differentiated from novice (less expert) leadership in terms of the complexity (sophistication) of the repertoire of a leader's thinking and behavior that is available to respond to complex challenges.

The observable or visible components of leader development are proposed as expressions of individual competencies. Although there is no universally agreed upon definition, competencies have been defined as those individual characteristics that summarize relatively enduring ways of behaving and thinking. According to work done in the area of competency modeling (Spencer & Spencer, 1993), there are five types of characteristics that support individual competencies. Knowledge and skills are visible to others and relatively easy to develop. Traits and motives are the deepest and most hidden and refer to dispositional characteristics that may be highly resistant to change, but support the development of particular competencies. The middle ground is made up of the attitudes, values, and self-images that compose a person's self-concept and identity. Processes that define adult development such as selection, optimization, and compensation (Baltes, 1997) are central to the developing self, which, in turn, are proposed to support the acquisition of leadership competencies and expert leader performance.

> **Proposition 2:** The development of expert leaders is supported by identity processes at a less visible level and by adult development processes at the deepest level.

No simple, coherent theoretical explanations for the development of leadership skills have been proposed. Leadership is such a complex phenomenon that it has proven more fruitful to develop explanations of particular behaviors, skills, and personal characteristics. The difficulty in characterizing, for example, value systems (much less measuring such aspects of a person) has led to a greater emphasis on the "upper" layers in our model. It is more feasible, for example, to conceptualize leader development in terms of skill acquisition. Highly developed leaders are said to possess sophisticated competencies (conceptualized as bundles of various skills) that support effective leader behavior across many and varied situations – from simple to complex. Indeed, there are theories of skill acquisition that might help provide a much needed foundation to understanding leadership skill acquisition. Perhaps best known is the work of Anderson (1982) that was later refined by Ackerman and associates (Ackerman, 1987; Ackerman, Kanfer, & Goff, 1995; Kanfer & Ackerman, 1989). From this theoretical perspective skill acquisition is posited mainly as a function of ***declarative knowledge*** (knowledge about "what" – i.e., facts and things) and ***procedural knowledge*** (knowledge about "how" – i.e., processes and procedures).

From skill acquisition to competency development. At the heart of Anderson's (1982) model is the notion that learning goals are structured in such a way as to support the progressive development of knowledge and skill competencies, building from relatively simple to complex forms. The development process follows the universal pathways associated with differentiation and integration. Declarative knowledge is typically involved at the more basic levels in knowing about the facts, concepts, and rules that define the competency domain (part of the differentiation process of understanding distinct concepts). Declarative knowledge becomes proceduralized through practice and experience. This knowledge about situations, responses, and outcomes is integrated in ways that provide context-specific rules for application. Procedural knowledge develops at more complex levels in that it represents an understanding of conditions and actions that guide the application of knowledge. Through the use of declarative and procedural knowledge in various situations and contexts, more complex "mental models" develop about a domain. These are more highly integrated and complex bundles of declarative and proceduralized knowledge that further allow for the development of ***strategic competencies***, which support the understanding of the contingencies that drive changes in priorities and the allocation of attention and effort (Bell & Kozlowski, 2002). At the most advanced or complex level is the development of ***adaptive competencies***. Adaptability involves extrapolating competencies to novel situations, understanding the situation as it unfolds, and generalizing one's knowledge and skill (i.e., competency) to cope with unexpected developments and complex challenges (Kozlowski et al., 2001). Thus, the ultimate goal of development can be construed as the formation of strategic or adaptive competencies to support effective leadership in coping with complex challenges.

Proposition 3: Over time and with relevant practice, more basic level skills combine to form complex and multifaceted leadership competencies (strategic and adaptive competence).

Although framing a competency-based approach to leader development in the context of a theory or theories of skill acquisition makes some sense, there are also distinct limitations. Leadership competencies are much more multifaceted and complex bundles of knowledge, skills, and abilities than what are typically considered in skill acquisition – even complex skill acquisition. Another limitation has to do with the timeframe involved. Whereas skill acquisition is usually studied in a relatively bounded period of time, leader development is ongoing across the adult lifespan. Leader development is therefore closer conceptually to what it takes to become an expert rather than acquiring a particular skill. Research suggests that important characteristics of experts' superior performance are acquired through extensive experience. Indeed, the effect of deliberate practice on expert performance is larger than earlier believed possible (Chi, Glaser, & Farr, 1988). Specifically, a minimum of ten years or 10,000 hours of concentrated practice is needed to attain elite performance levels associated with expert status in a given domain (Ericsson, 1996; Ericsson & Charness, 1994; Ericsson & Lehmann, 1996). Research also has elaborated on the acquired cognitive mechanisms that mediate the development of superior expert performance (Ericsson, 1996). In terms of developing expert leadership, the same amount of time – or more – might be required with similar supporting mediational processes. From this perspective, leader development is seen as a particular form of expert performance that is inherently a function of adult development given the extensive time commitment. Thus, it requires some grounding in research and theory in both fields.

Proposition 4: The development of expert leadership requires extensive practice over a relatively lengthy time period (perhaps ten years or more).

Developing leadership expertise: An analogy. An analogy might help draw the connection we see between the development of expert performance and leader development.

Instead of leadership, imagine the domain was music. Specifically, imagine someone (child, adolescent, or adult) who is starting out to learn how to play the piano. Well before any real music could be played the student needs to begin learning the layout of the keyboard, white keys/black keys, sharps and flats. In short, elemental **declarative knowledge** must be acquired. To reinforce the nascent declarative knowledge, assignments are usually given in the form of some very basic musical pieces as well as elementary scales to practice. This helps to integrate the declarative with **procedural knowledge** and skills. Once a certain level of mastery of the basics is attained, then the student might begin adding declarative and procedural knowledge/skills with regard to chords, and then chord progressions. Practice builds towards automaticity in which scales, chords, simple pieces of music can be played without a great deal of cognitive (attentional) resources devoted to the task. And so it goes over time and with extensive practice that greater complexity is incrementally added to the skills repertoire as more difficult pieces are practiced and learned. Of course, there are individual differences in how easily these skills are acquired and mastered.

As expertise is gradually acquired, bundles of differentiated knowledge and skills are integrated into more sophisticated competencies. Knowing the keyboard layout and distinguishing individual notes and chords, when combined with the skill of reading music, to form a **strategic competency** of "sight playing" (i.e., being able to play something without previously practicing it by reading and translating from the sheet music directly to playing – regardless of how haltingly). Recitals and other semi-public performances help to build strategic competencies that guide performance in front of an audience.

At some point during this process the student begins to take on the provisional identity (Ibarra, 1999) of a pianist (or at least a piano player) – or maybe not. There are legions of individuals who had lessons and built up certain skills and competencies related to the piano only to quit. Perhaps the task was not enjoyable or practice began to yield diminishing returns in terms of performance gains. Or that the piano student would rather be doing something else like playing baseball. At some point, however, there is the atrophy or outright rejection of this emerging or provisional identity as a pianist. Possibly the student quits piano but switches to the guitar and a different form of the superordinate musician identity begins to form. Those who continue with piano are likely to internalize this aspect of self as a subcomponent of individual identity. With continued practice and experience even more complex **adaptive competencies** develop that allow for impromptu performances with friends or possibly even professional or semi-professional engagements, solo or as part of a group. Still, there are very, very few who reach the level of expertise needed to make a living with one's music, and even fewer who reach of level of recognition and acclaim such as Vladimir Horowitz in classical music or Bill Evans in jazz.

Leader development is thought to occur in ways similar to the preceding example. There are relatively simple declarative and procedural knowledge and skills associated with first understanding what leadership is and then practicing certain leadership skills (e.g., setting the direction of a group; providing support and encouragement). At some point if the student is serious about leadership, an aspect of overall social identity becomes associated with "leader." But as in other domains, it may take at least 10 years of intensive practice and experience as a leader before expert performance levels are reached. Indeed, it may take more than 10 years because leadership is inherently an interpersonal and relational (i.e., more complex) phenomenon than mastering an instrument. It is also the case that very, very few individuals ever reach the elite status associated with being a world-class leader. But just as there are many perfectly serviceable pianists throughout the world, there are no doubt large numbers of good or even excellent leaders in all domains (business, education, military, or religion). Although there may be a large number of leaders who can organize a rally, there are very few who can lead a social movement and bring about large-scale societal change. Leadership is most often recognized and heralded when it is played out in a very large way (e.g., the Civil Rights movement, war, business fortunes and failures). But possibly even more important are the less acclaimed feats of leadership that occur daily. Whereas these leadership feats may not be accomplished by world-class leaders, they nonetheless have mastered some level of expertise in the domain. Furthermore, they are critically important to making businesses, militaries, and governments run effectively.

Practicing leadership. An important issue that deserves additional consideration is what it means to practice leadership. In most other expert domains it is clearly known when someone is or isn't practicing the skill in question. It is also clear what skills are being practiced; furthermore, standards often exist which provide a basis for relative, if not absolute, feedback to the practitioner. The pianist working to master a challenging chord progression will know when she has achieved her goal because she has heard others play at the desired skill level and/or she gets feedback from her instructor.

Practice is critically important to developing expert performance. Research has shown that the amount of deliberate (intentional) practice predicted the attained level of performance in musicians (Ericsson, Krampe, & Tesch-Römer, 1993). Based on records from detailed diaries of expert-level musicians who had studied music for over 10 years, it was found that the expert musicians with the highest levels of performance practiced for about 25 hours per week, which was three times more than the less accomplished expert musicians. Amateur musicians of the same age were found to practice less than two hours per week – less than 10% of the amount for the best group of expert musicians.

Clearly, deliberate practice matters in the development of expert musical performance. But unlike music, chess, or sports (typically studied domains of expertise), with leadership the practice opportunities are often more serendipitous. For example, someone (peer, subordinate) may ask for advice on a problem. Instead of providing a pat solution the practicing leader offers support and encouragement to help the other person construct a solution on his or her own. Is this leadership? Certainly under the transformational leadership heading of "individualized consideration" and "intellectual stimulation" it would be considered as leadership behavior. A significant question to consider is whether the leader is aware that he or she is practicing leadership. The question of whether expertise can develop outside of conscious awareness is debatable. What seems more certain is that being intentional about practice is likely to develop expertise more quickly and thoroughly than being ad hoc or unintentional about it. Thus, the role of **intentionality** in practice is proposed as a key process that supports the development of leadership expertise. It is noted that practice implies not merely repetitions of a behavior, but also involves implicit and explicit feedback that is obtained during and after the behavior.

Proposition 5: The extent that deliberate, intentional practice is engaged in is negatively related to the length of time needed to reach a level of expert leader performance.

The next section examines what are proposed to be key supporting processes in the development of the expert leader. Specifically, the development of a leader identity is seen as important to forming identity-development spirals. These spirals contribute to the level of perseverance needed to continue with ongoing development to more expert or even elite leader performance levels. Self-regulatory strength is also proposed as a critical resource that contributes to identity-development spirals and the perseverance to higher levels of development as a leader.

Identity Processes in Leader Development

The importance of self and identity development to healthy adjustment across the lifespan is supported by the theoretical as well as the empirical literature (Leary & Tangney, 2003). There is little reason to expect this state of affairs to be different for leader development. The development of a leader identity along with the development of leadership skills and competencies may be vitally important for persevering to become a master or expert leader (Lord & Hall, in press). Simply put, if someone does not identify as a leader it seems highly unlikely that there will be much attempt to acquire the kinds of skills or develop the competencies that are needed for highly effective leadership. But the process is thought to be a mutually reinforcing one. As leadership competencies develop, there is the likelihood of a leader identity crystallizing, which further supports the motivation to lead and to learn more about leading. Of course, with some leaders a sense of hubris may set in as they come to believe that they already are expert leaders and have nothing left to learn about leading. Other self concepts may also play important moderating roles, such as self-awareness. There may be a well-formed leader identity but little self-awareness regarding leadership strengths and (especially) weaknesses. In the case of leadership hubris associated with a lack of self-awareness, this is a mirage of leadership expertise. Although the identity piece is there, no further learning takes place; thus, no subsequent development occurs. There is always something more to be learned about leadership.

Control theory suggests that internally-focused attention, or self-awareness, can lead to a more accessible self-concept or self-schema and thereby influence the gathering and processing of self-relevant information (Carver, 2003, 2004; Carver & Scheier, 1981). Information that is self-relevant is attended to and processed to a greater degree. In this sense, heightened self-awareness will lead to greater processing of information that is self-relevant (Carver, 2003). If being a leader is part of an individual's self-concept, then leadership-relevant information may be given more attention and processed to a greater degree. The combination of having a salient leader identity and heightened self-awareness may facilitate the identification of situations in which leadership can be intentionally practiced, the depth of processing in the situation, and the intentionality of the practice.

A similar set of relationships has been conceptualized in terms of efficacy-performance spirals (Lindsley, Brass, & Thomas, 1995). As articulated by Lindsley et al., the relationship between efficacy and performance is cyclic in which performance influences self-efficacy, which affects performance, and so on. These spirals can be positive or negative in valence and can relate to groups and organizations as well as individuals (i.e., it is an isomorphic multilevel phenomenon). We believe that at a more observable level, such efficacy-performance spirals occur with regard to leadership. The more positive ones' self-conception is around being able to lead (self-efficacy for leadership), the better the leader performance (all things being equal). But at a less observable (i.e., more implicit) level we believe that identity-development spirals also occur in support of the efficacy-performance ones.

> **Proposition 6:** As leadership competencies develop, leader identity begins to emerge, which further supports learning and development around leadership (i.e., leader identity-development spirals).

At a more micro process level, the literature on identity development supports the important role that self-regulation processes play in shaping who we become. Self-regulatory processes guide our attention as well as our behavior. In short, these processes are instrumental components of human motivation. The executive function, which regulates important volitional and active capabilities of the self (Baumeister, 1998), fosters self-directed, intentional behavior including response inhibition, strategy generation and implementation, and flexible action (Denckla, 1996).

One type of executive functioning process associated with the self that appears to hold exceptional promise in advancing an understanding of leader development within the proposed framework is termed ***self-regulatory strength*** (Schmeichel & Baumeister, 2004) or its mirror opposite of ego depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Self-regulatory strength refers to "internal resources available to inhibit, override, or alter responses that may arise as a result of physiological processes, habit, learning, or the press of a situation" (Schmeichel & Baumeister, p. 86). It is closest in terms of a more general process that might be termed "will power" (or self control) that relies on a limited and exhaustible set of resources. When self-regulatory resources are exhausted, a state of ego depletion results and self-regulation failure is more likely. Thus, self-regulatory strength inherently pertains to self-control, which is an important attribute of an effective leader (Lord & Hall, in press).

Self-regulatory strength is an expansible capacity that can grow or develop with use – much like muscle mass. It also diminishes with exertion and is restored to initial levels only after some rest. In this way self-control comes at a cost in terms of resource depletion associated with the energy that is expended in executing essential control mechanisms. Research by Baumeister and his colleagues have shown that when ego depletion occurs (i.e., self-regulatory strength is low), individuals are less able and willing to regulate their behavior. This can result in the failure to control eating, drinking, or smoking behaviors (Baumeister et al., 1998) or enhance the likelihood of engaging in impulse buying (Baumeister, 2002) among other things. It may also have implications for the effective regulation and control of leadership behaviors. Without some degree of available ego resources that defines self-regulatory strength, leaders may fail to effectively regulate their emotions or social behavior. As a result, they may appear to be impulsive, inconsistent, or indulgent – any of which could likely undermine followers' perceptions. And as noted by Lord and Maher (1991), being perceived as a leader is critically important to gaining influence over others. Without a basis for social influence, leadership is unlikely to transpire.

Another reason for the theoretical importance of self-regulatory strength in leader development is in supporting the discipline needed to practice leader behaviors intentionally and to persevere with ongoing development as a leader. This is especially the case when events conspire to push other agendas instead of learning. Furthermore, ego depletion or low self-regulatory strength might be associated with falling back on well-learned behaviors rather than attempting more challenging approaches. As noted by one prominent approach to leadership development (McCauley & Van Velsor, 2004), experiences that are highly developmental in nature contain a large dose of challenge (in addition to assessment and support).

Proposition 7: Self-regulatory strength accelerates the ongoing learning and development of leaders.

As self-regulation is a key factor in developing skills, competencies, and expertise, a brief examination of individual differences that can influence self-regulatory processes might be helpful. In the present theoretical integration, three individual difference factors – goal orientation, generalized self-efficacy, and self-awareness – are thought to be particularly important as they relate to self-regulation in the leader development process.

Goal orientation. *Learning goal orientation refers to an individual orientation towards developing competence through acquiring and mastering new skills, while performance goal orientation refers to an individual orientation towards demonstrating competence either in terms of gaining a favorable judgment or avoiding an unfavorable judgment of others (VandeWalle, 1997). It has been suggested that one's goal orientation provides a cognitive framework to respond to achievement situations and influence performance through the use of self-regulation techniques (VandeWalle et al., 1999). Individuals with a learning goal orientation may expend more effort, as they believe that expending effort is viewed as a strategy for developing ability and is related task achievement. Similarly, they set more difficult goals, intended to put forth more effort, and intended to engage in more planning. Goal orientation may influence rate of skills acquisition such that those leaders with a high learning goal orientation should acquire skills more quickly because they may not view mistakes as threats, withdraw from obstacles, minimize effort, or focus attention on performance indicators rather than the task (Yeo & Neal, 2004). In addition, it has been proposed that those with a high learning goal orientation are proactive in seeking feedback (VandeWalle, 2003), which should augment practice in facilitating the development of expert performance.*

Proposition 8: High learning goal orientations facilitate development of leader expertise through the use of self-regulatory strategies.

Generalized self-efficacy. *Self-efficacy speaks to an individual's confidence in the ability to organize resources for goal attainment, and it relates to task choice, task effort, and persistence in task achievement (Gist & Mitchell, 1992). Self-efficacy often refers to an evaluation of one's task-specific ability, but can also be conceptualized as a more global characteristic. Generalized self-efficacy refers to a global trait-like characteristic of one's estimate of his or her overall ability to achieve required performance in a variety of situations (Bandura, 1997).*

Generalized self-efficacy has been included in higher order constructs addressing one's overall assessment of the self such as core self-evaluations (Judge, Locke, & Durham, 1997) and positive self-concept (Judge, Thorensen, Pucik, & Welbourne, 1999). Generalized self-efficacy was found to be a strong predictor of motivation through self-regulatory functions of goal-setting and goal commitment (Erez & Judge, 2001). Further, generalized self-efficacy, included in a positive self-concept positively related to a manager's ability to deal with change (Judge et al., 1999). Generalized self-efficacy is particularly useful in predicting how individuals approach novel or complex situations. For example, high generalized self-efficacy was found by Judge et al. to be a precursor for positive attitudes toward critical career-oriented events, specifically those involving major job and organizational changes. Individuals with low self-efficacy may avoid or become defensive in situations in which they believe they cannot perform well, whereas individuals with a high generalized self-efficacy respond more adaptively.

Proposition 9: A leader's generalized self-efficacy will positively relate to leader development and learning.

Self-awareness. The definition of self-awareness may vary across, but generally refers to "self-focused attention" and particularly to the consistency between aspects of self and actions (see Carver, 2003). In a leadership context, self-awareness pertains to a personal understanding of one's strengths and weaknesses. More specifically, it is an evaluation of the quality and accuracy of one's self-perceptions (Hall, 2004). Heightened self-awareness, or self-insight, facilitates attention to self-relevant information from the environment and thereby facilitates setting of development goals and provides feedback regarding progress towards goals (London, 2002).

In order to attain expert performance, an individual must monitor his or her performance and design intentional practice sessions around individual strengths and weaknesses. Individuals address specific performance problems through problem-solving and generating specific modifications that are fully integrated through extended deliberate practice (Ericsson, 2003). Often an individual must recognize areas needing development without substantial guidance from others. Self-awareness may help an individual to perceive particular areas that need attention as well as regulate progress towards goals within a practice session.

Proposition 10: Self-awareness will facilitate the development of leader learning and expertise.

The final section of the paper will address the role of adult development in the leader development process. As discussed, leader development occurs within the context of more fundamental developmental processes associated with maturation and aging. These processes are thought to occur at the least visible level, but are foundational. It makes little sense to expect much development as a leader to occur without some simultaneous development as an adult.

Adult Development

Leader development is thought to unfold over considerable time and can conceivably traverse the entire lifespan. At a minimum, the field of leader development has traditionally focused on the development of leadership knowledge, skills, abilities, and mental models in young adulthood and beyond. For this reason it is surprising how little integration there has been between the fields of leader development and adult development. Nothing much has changed over the last 15 years since it was noted that there are few direct applications of adult developmental theory to work settings (Cytrynbaum & Crites, 1989). Although there have been some efforts at applying social-constructivist development theory to the topic of leadership (Kegan & Lahey, 1984) as well as leader development (Torbert & Associates, 2004), these developmental approaches have been limited to how leaders think about and mentally construct their leadership world views. In addition, both approaches propose relatively rigid stage theories of adult leader development. We believe that leader development is more dynamic in nature and is exemplified by the open systems principle of equifinality (Katz & Kahn, 1978).

Perhaps leader development has always been integrated with adult development but the connections have been more implicit than explicit. Nonetheless, it has been recently re-stated that there remains a need for a cogent theory of executive (i.e., leader) development as adult development (Laske, 2003). In moving towards incorporating that goal in the present framework, we will explore explicitly the relevance of adult development theory and research for conceptualizing leader development and integrate key principles with previous domains of expertise and identity development.

One reason the adult development literature is of particular relevance to leader development is because it considers age-related changes as sources or outcomes of maturation. This is a critically important issue for an organization such as the Army in which individuals join in their late teens or early twenties and can continue to develop as leaders well into their forties and fifties. Leader development theory and research has largely ignored the well-documented findings that some components of intellectual development start to decline after a certain age (e.g., fluid intelligence, basic information processing) whereas other components continue to develop across the lifespan (e.g., crystallized intelligence, cultural knowledge; (Baltes, Staudinger, & Lindenberger, 1999). Others have proposed that there are different growth curve functions for the various components of intellectual functioning, including intelligence-as-process (i.e., fluid intelligence), crystallized intelligence, personality, interests, and knowledge (Ackerman, 1996). In short, there are naturally occurring maturational effects that are likely to interact with the experiences typically used as part of formal leader development initiatives. As far as we know, there has been virtually no attention given to these types of possible age-related interactions.

Proposition 11: Leader development is ongoing throughout the adult lifespan and is shaped by adult development and age-related maturation processes.

Adult development research and theory also is relevant to leader development because the former is intended to generate knowledge about three specific components of individual development: (a) interindividual commonalities in development, (b) interindividual differences in development, and (c) intraindividual plasticity (malleability) in development (Baltes et al., 1999). The last point, in particular, holds promise for better understanding the possibilities of accelerating leader development. Baltes reviewed the literature on cognitive interventions of development and concluded that the "evidence of the powerful role of experience and practice in the acquisition, refinement, and maintenance of the cognitive pragmatics is overwhelming" (p. 496). This evidence also includes neuropsychological evidence of changes in brain activity as a function of experiential interventions (Woodruf-Pak as cited in Baltes). Another interesting finding has been reported by Benes (as cited in Fischer & Pruyne, 2002), who noted that the process of myelination, which significantly improves the transmission of neural signals in the brain, not only continues through adulthood but shows a major growth spurt in the 40s and 50s, possibly due to the accumulation of experience. Overall, results appear conclusive that differences in levels of intellectual performance are influenced by variations in aspects of the physical or socio-cultural environment. By extension, there is evidence to suggest that leader development experiences can change the performance potential of individuals, at least within some age-related boundaries.

Perhaps the most compelling reason to consider leader development as adult development stems from the ultimate meaning of lifespan development. According to Baltes et al. (1999), lifespan development is essentially a process of selective adaptation and transformation. The orchestrating processes of development are conceptualized as *selection* (goals/ outcomes), *optimization* (means/resources), and *compensation* (response to loss of means). The outcomes are seen as the maximization of objective and subjective gains and the minimization of losses (Baltes, 1997). Successful development (i.e., growth) is couched in terms of the attainment of salient goals or states of functioning. The adaptation and transformation processes of lifespan development also can be considered to be fundamental to leader development.

In attempting to understand the extent to which age-related dynamics related to biology and external support (e.g., psychological, social, and material resources) predetermine the pathways of development is to consider the differences in three different goals of ontogenetic development: Growth, maintenance, and the regulation of loss (Baltes, 1997). The allocation of available developmental resources for growth (i.e., behaviors used for reaching higher levels of functioning or adaptive capacity) is thought to decline with age, whereas investments in the maintenance of functioning and the regulation of loss in adaptive capacity increase over the lifespan. Thus, there is a systematic lifespan shift in the relative allocation of resources to these three major developmental functions. An important developmental challenge, especially in later phases of adulthood, is appropriately and effectively allocating resources to these different developmental goals. As noted by Baltes et al. (1999), "the mastery of life often involves conflicts and competition among the three goals of human development" (p. 478). This becomes a particular challenge for growth because the older the adult the more time and practice it takes to attain the same learning gains. Furthermore, the older the adult the more they are in need of culture-based compensations to generate and maintain high levels of functioning. And as a point of integration, self-regulatory strength may play a key role in managing these competing goals.

Proposition 12: Individuals engage in selection, optimization, and compensation processes in maximizing developmental gains and minimizing losses associated with the acquisition of leadership competencies.

The notion that the developmental process involves an inherent dynamic of gains and losses (Baltes, 1987) is difficult to fathom if development is thought of as a ladder in which individuals progress upwards through identical stages. Rather than a ladder, development may be more like a web with different strands with varied developmental trajectories depending on specific contextual influences (Fischer & Kenny, 1986; Stevens-Long & Michaud, 2002). This potential "web of development" recognizes that more basic kinds of skills become intertwined in creating more macro and holistic competencies. Some of the basic skills may drop out of the developmental process (gain-loss dynamic) if they no longer serve an important role in functioning (e.g., a specific technical skill becomes less important to leaders at higher organizational levels).

Web of development. The traditional biological conceptions of growth or physical maturation tend to be based on linear, unidimensional, unidirectional, and unifunctional models (Baltes et al., 1999). A point that is often overlooked in the search for such simplicity is that development takes many forms and many components contribute to the development of a complex skill or activity (e.g., leader competencies). In contrast to the traditional biological conceptions of growth, the overall ontogenesis of mind and behavior is more accurately portrayed as dynamic, multidimensional, multifunctional, and nonlinear. Multifunctionality is especially important from an intervention perspective because it includes the systems concept of equifinality whereby the same developmental outcome can be reached by different means and combination of means (Gharajedaghi, 1999; Katz & Kahn, 1978).

The use of static metaphors have focused attention on what is stable in development rather than what changes and the conditions under which changes occur (Stevens-Long & Michaud, 2002). Development may be more like a web with different strands that have dissimilar development trajectories depending on specific contextual influences (Fischer & Bidell, 1998; Fischer & Pruyne, 2003); Stevens-Long & Michaud, 2002). These different strands may "represent potential skill domains…the connections between strands represent possible relationships among skill domains, and the differing directions of the strands indicate possible variations in the developmental pathways and outcomes as skills are constructed for participation in diverse contexts" (Fischer & Bidell, p. 474). This web of development also has been conceptualized as a more complex and multilayered system in three dimensions where the components mutually influence each other in dynamic ways (Thelin & Smith, 1998). Stevens-Long and Michaud (2002) elaborated on this more complex conceptualization by suggesting that "each of these strands is really a plane…[and] consider that for each component of development there may be several possible landscapes that develop over different contexts" (p. 8). The point of relevance is that more complex "web" conceptualizations of adult development are consistent with connectionist networks that Lord and Hall (in press) have argued are at the core of problem interpretation and observable leader responses.

There are several implications associated with conceptualizing leader development as a web of development. One such implication is that the various components of leader development (e.g., knowledge, skills, abilities, mental models) interact and influence each other. It also recognizes that any experience is multifaceted in terms of what kinds of skills domains are affected. From a systems perspective in which differentiation always precedes integration (Gharajedaghi, 1999), the development of different skills (differentiation) will result in processes that combine such skills into more holistic and higher-order bundles (integration) that could be labeled as competencies. Thus, the leader development process might be conceptualized as an ongoing system of differentiation and integration in which lower-order or more basic kinds of knowledge, skills, and abilities interact in developing more molar and holistic competencies (Day & Lance, 2004). Some of these basic skills may drop from the model over time if they no longer are important for leader functioning. A good example of this might be a specific technical skill that is necessary for functional leader behavior at early points in development but become less important and perhaps irrelevant at higher levels of functioning. This line of thinking acknowledges an important point made by Baltes (1987) that development inherently includes both the processes of growth and decline (i.e., development as a gain-loss dynamic).

Proposition 13: The development of complex, multifaceted leadership competencies is supported by a web of adult development that is dynamic and nonlinear in nature.

Implications of leader development as adult development. A primary message in this paper is that there has been a missed opportunity for advancing the notion of leader development as adult development. The importance and relevance of this message goes to some basic issues around adult development, including the robust findings of biologically based, age-related changes that affect functioning and developmental potential. The selection-optimization-compensation (SOC) theory advanced by Baltes and his colleagues argues that there is a systematic change across the lifespan in terms of how developmental resources are allocated among these three "orchestrating processes" of human development. This point of relevance notwithstanding, perhaps the most pressing reason to consider leader development as adult development is the perspective that lifelong development is essentially a process of selective adaptation and transformation (Baltes et al., 1999).

The central developmental process of adaptation and transformation can be seen in terms of how leaders change and grow as a function of environmental challenges. The transformation of leaders is one that transpires across the entire lifespan. Unfortunately, much of the research and theory on leader development has conceptualized and studied the development process as relatively short-term (even cross-sectional) and static, as opposed one that is longitudinal and dynamic. In addition, more traditional perspectives have conceptualized the developmental process as linear, unidirectional, unidimensional, and unifunctional. Rather than a developmental ladder in which change can only be up or down, conceptualizing it as a web of development opens up a number of rich possibilities in terms of how specific components (e.g., knowledge, skills, and abilities) develop and combine to from more holistic attributes (e.g., competencies).

Using the SOC theoretical lens to understand the leader development as adult development process might also provide leverage for accelerating leader development. The evidence from lifespan development psychology suggests the existence of interindividual differences in intraindividual plasticity (i.e., malleability) regarding potentialities of development. Thus, there may well be upper and lower boundary conditions for accelerating development. Concepts such as developmental readiness, triggers for development, as well as methodological procedures such as "testing-the-limits" (Kliegl, Smith, & Baltes, 1989; Lindenberger & Baltes, 1995) all have relevance for advancing a more sophisticated (and practically useful) perspective on leader development as adult development.

Summary and Conclusions

This paper opened with a quote on military incompetence and its implications for leadership. Our main focus, however, has been on military competence, especially the development of leadership competence as grounded in leader competencies. Theoretical arguments were made that the process of leader development is analogous to how expert performance develops in other domains such as music and sports. From the skill acquisition literature it was noted that basic kinds of knowledge and skills (e.g., declarative and procedural knowledge) develop with experience and practice into more complex and multifunctional strategic and adaptive competencies. This process is grounded in the expertise literature, but is also supported by the literature from the field of adult development. In particular, lifespan development is portrayed as dynamic, multifaceted, multifunctional, and nonlinear in which lower-order or more basic kinds of knowledge and skills interact as a function of experience in developing into more molar and holistic competencies (i.e., a web of development). The role of fundamental (invisible) adult development processes associated with selection, optimization, and compensation in guiding the development of molar competencies that support expert performance are proposed to be mediated by identity formation and self-regulation, especially self-regulatory strength. Identity-development spirals were proposed as self-reinforcing in nature in that taking on an identity (e.g., leader) would be associated with greater motivation to develop further as a leader. Self-regulatory strength offers an expansible resource that also contributes to development through its effects on motivation and self-control.

How does this emerging theory contribute to better understanding leader development? We believe that there are at least three important ways that the present theory contributes to this goal. First, it recognizes that leader development is ongoing across most if not all of the entire adult lifespan. We integrate some key principles and perspectives from the adult development and lifespan psychology literatures that help to highlight this inherently longitudinal process. Second, we approach leadership from an expert performance model that is grounded in the development of skills and competencies, rather than based solely on outcomes. This is the visible and observable component of leadership that is developed through experience and extensive, intentional practice. Third, development as a leader is facilitated through leader identity formation that is guided by self-regulation processes. Self-regulatory strength is a critical resource in this regard, with higher levels of self-regulatory strength being conceptually related to higher levels of self-discipline and self-control needed for effective leadership as well as long-term development.

In closing, there are potential limitations about the proposed theory that should be noted. The separate disciplines of expert performance, identity and self-regulation, and adult development are each voluminous (especially the latter two). We have only scratched the surface in terms of integrating all of the relevant research and theory from those fields. Further elaboration and syntheses are needed. Other questions might be raised about external generalizability. Given that this approach was conceptualized as a theory of Army leader development, there may be potential concerns about how relevant it would be in addressing issues of leader development in other non-military contexts. As noted at the beginning of the paper, we are relatively unconcerned at this time about the content of the competencies that support expert leader performance, focusing more on underlying process issues. We think the processes generalize outside the Army; however, we also acknowledge that the timeframe that the Army has to shape its top leaders is often considerably longer than in other types of organizations. Also, the Army does not select its officers from the outside. This is why it has been said that the lengthiest developmental trajectory in the Army is that of a senior officer (approximately 20+ years) – longer than it takes to development a personal weapon, a tank, or even a helicopter. We hope that the present theory can help to guide the considerable investments made in leader development by all types of organizations and to understand how that lifelong process might be accelerated. As noted by retired LTG Brown, “With such substantial task migration to younger leaders, the Army should rethink leader preparation, which should be continuous, as is characteristic of great learning and teaching organizations" (2003, p. 75). Basing such ongoing and continuous development efforts on sound theory is a very practical place to start

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Table 1: *Theoretical Propositions Organized by Discipline*

Expertise and Expert Performance

Proposition 1: Expert leadership can be differentiated from novice (less expert) leadership in terms of the complexity (sophistication) of the repertoire of a leader's thinking and behavior that is available to respond to complex challenges.
Proposition 2: The development of expert leaders is supported by identity processes at a less visible level and by adult development processes at the deepest (least visible) level.
Proposition 3: Over time and with relevant practice, more basic level skills combine to form complex and multifaceted leadership competencies (strategic and adaptive competence).
Proposition 4: The development of expert leadership requires extensive practice over a relatively lengthy time period (perhaps ten years or more).
Proposition 5: The extent that deliberate, intentional practice is engaged in is negatively related to the length of time needed to reach a level of expert leader performance.

Identity and Self-Regulation Processes
Proposition 6: As leadership competencies develop, leader identity begins to emerge, which further supports learning and development around leadership (i.e., leader identity-development spirals).
Proposition 7: Self-regulatory strength accelerates the ongoing learning and development of leaders.
Proposition 8: Learning goal orientations facilitate development of leader expertise through the use of self-regulatory strategies.

Proposition 9: A leader's generalized self-efficacy will positively relate to leader development and learning.
Table 1 (cont'd): *Theoretical Propositions Organized by Discipline*
Proposition 10: Self-awareness will facilitate the development of leader learning and expertise.

Adult Development
Proposition 11: Leader development is ongoing throughout the adult lifespan and is shaped by adult development and age-related maturation processes.
Proposition 12: Individuals engage in selection, optimization, and compensation processes in maximizing developmental gains and minimizing losses associated with the acquisition of leadership competencies.
Proposition 13: The development of complex, multifaceted leadership competencies is supported by a web of adult development that is dynamic and nonlinear in nature.

The Influence of Cognitive and Identity Factors on the Development of Leadership Skill

Robert G. Lord & Rosalie J. Hall,

The University of Akron

White paper for Science of Learning Workshop, Hampton, VA (August, 2006)

Address correspondences to:

Robert G. Lord

Department of Psychology

University of Akron

Akron, OH 44325-4301

phone: (330) 972-7018

e-mail: rlord@uakron.edu

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ABSTRACT

We propose that leadership skill development progresses from novice to intermediate to expert skill levels. At each skill level, qualitatively different knowledge and information processing capabilities are emphasized and required for successful leadership. In addition, because leadership skill development requires the leader to be proactive in his or her own development, the leader's identity, meta-cognitive processes, and emotional regulation are critical factors in developing the deeper cognitive structures associated with leadership expertise. Finally, we suggest that leaders who are experts may develop unique skills in grounding their identities and leadership activities in coherent, self-relevant values.

The Influence of Cognitive and Identity Factors on the Development of Leadership Skill

Leadership is often thought of in terms of a handful of inborn individual traits on the one hand, or learned behavioral styles on the other. However, it has recently been argued that leadership typically involves a more complex mix of behavioral, cognitive, and social skills, that may develop at different rates and require different learning experiences for different persons (Day, 2000; Day & Halpin, 2004; Lord & Hall, 2005; Zaccaro & Klimoski, 2001). Furthermore, we have become increasingly aware of the extent to which effective leadership skills are situated in a particular context -- although some leadership skills may transfer from one context to another, others may be much more context-specific and require very targeted types of experiences to mature.

It has also become clearer that opportunities to develop leadership skills may require proactive steps by a potential leader, making the leader's own motivation and interest in leadership a critical requirement for leadership development (Chan & Drasgow, 2001). Critically, this observation implies that experience alone will not guarantee the development of leadership. Further, to sustain interest for the months and years required to develop and practice complex leadership skills, it is also likely that the leadership role needs to become part of one's self-identity. Yet, at this point in time there is little leadership theory and scant empirical research regarding the development of core qualities related to interest in leadership and the assimilation of a leadership role into one's identity. Our understanding of the development of expertise suggests that such important developmental processes may occur over months or years, but practical expediencies often result in leadership training efforts that focus on behavioral skills which can be acquired more quickly. An interesting practical issue arising from this perspective is whether short-term training programs can maximize the extent to which they encourage the initiation of deeper, longer-term processes which will eventually create expertise.

The present paper briefly describes a model of leadership skill development that addresses change at this deeper level. (See Lord & Hall, 2005 for more details.) Our framework of leadership skill development generalizes ideas from the cognitive science literature on skill development and task expertise to the leadership domain. We argue that leadership skills develop from a cognitive bootstrapping process, in which micro level skills (productions) are first learned through problem-related experiences or observational learning, and then are organized into increasingly higher-level cognitive systems that guide behavior, knowledge, and social perceptions. These systems develop along with emerging personal identities in which leadership roles and skills become more central to an actor's sense of self, so that over time, leadership skills and knowledge become inextricably integrated with the development of one's self-concept as a leader. In addition, we posit that leaders' identities tend to shift from individual to more collective orientations as their expertise develops.

The next section of this paper addresses background literature that supports our basic argument and describes the information processing changes associated with the development of high skill levels. We then explain how the joint consideration of information processing and identity provides a framework for understanding leadership development. Finally, this framework is applied to the development of leadership skills in several domains including task, emotional, social and meta-cognitive skills as well as changes in values that underlie identities.

Overview of the Development of Expertise

Our discussion of the development of expertise and social identities is organized around three important points. First, we apply to leadership development the idea that skill acquisition depends both upon the ability to access problem-specific knowledge and upon processing skills. Then, we describe general patterns of qualitative changes in process and knowledge associated with the development of expertise. Finally, we explicate a rationale for expecting the progression from novice to intermediate to expert level leadership performance to be tied to social identities.

Skilled Performance Depends Upon both Processing Skills and Access to Relevant Knowledge

Cognitive science approaches to skill acquisition assume that skilled performance in many complex domains (including leadership) can be understood in terms of the underlying information processing involved. Thus, we conceptualize leadership skill both in terms of *how leaders access and use* information as well as the *content* of their underlying knowledge of the tasks and social issues related to leadership. (Here, knowledge is defined broadly to include task, emotional, social, and self-relevant knowledge.) *Skill development*, then, involves changes in both a leader's information processing activities (how information is accessed and used) as well as quantitative and qualitative changes in his or her knowledge base.

To understand how leadership expertise develops, one must recognize that knowledge is often generated or accessed in response to the momentary requirements of one's current task (Newell, 1990), so that the specific knowledge available to a leader may vary depending upon the current context. Things easily "known" to a leader in some situations may not be accessible in others (e.g., under stress, in unfamiliar settings, with a different team), making knowledge access a critical issue in explaining performance (Van Lehn, 1989). Because goals regulate access to knowledge (Johnson, Chang, & Lord, 2006), and identities, in turn, affect goal structures (Lord & Brown, 2004; Markus & Wurf, 1987), the ability to access knowledge across different situations (e.g., generalize leadership skills) may depend on whether the situations elicit similar identities and goals.

Self-knowledge, especially the leader's identity, may have a key function in leadership development. Furthering ones leadership skills requires a concomitant identification with the leadership role and sufficient self-confidence to attempt developmental leadership activities. These resulting activities must be met with both social acceptance and task success to increase skills and encourage one's self-view as a leader. We believe identities affect knowledge acquisition both indirectly through social processes, and also directly by influencing knowledge access. These ideas are summarized for skill development in general in Table 1, which is explained more fully in the next two sections. We then apply this framework to specific leadership skills. A key idea underlying the principles in Table 1 is that as skills are practiced working memory resources are freed so that more attention can be devoted to issues such as self-regulation, situational contingencies, and the potential needs and contributions of others.

Table 1. Differences in the Content, Access and Use of Knowledge by Leader Skill Level

SKILL LEVEL	KNOWLEDGE USE	KNOWLEDGE CONTENT	KNOWLEDGE CUES
Novice	Heavy reliance on working memory dependent processing to compose novel responses that integrate generic knowledge with situation	Implicit leadership theories and heuristics representing generic leadership and problem solving behavior	Surface level problem features Self-view as leader, with emphasis on individual level identities
Intermediate	Fewer uniquely created solutions, more use of connectionist networks Integration with meta-cognitive processes	Domain specific productions for leadership and problem solving behavior Greater knowledge of others	Same as Novice, plus … Match of social situation to patterns in connectionist networks
Expert	Greater dependence on understanding of situation More collaboration with others	Principle level knowledge	Same as Intermediate, plus … Principled understanding of situation and others, often in terms of values, emotions, and identities

Qualitative Changes Accompanying the Development of Expertise

Over three decades of research in cognitive science show that there are qualitative changes in both process and knowledge as skill develops from a novice to an intermediate to an expert level (e.g., Anderson, 1987; Ericsson & Charness, 1994; Glaser & Chi, 1988; Patel & Groen, 1991; VanLehn, 1989). One critical change is the development of a large repertoire of more targeted, domain-specific productions (aka "problem-specific" productions), rather than general heuristics which are applied to all superficially similar situations. (Productions are simply *if* –> *then* rules which specify operations to be performed when the conditions of the "if statement" are met.) If accessed efficiently, these domain-specific productions increase the likelihood that leaders will efficiently identify appropriate solutions for specific situations they face.

Further increasing efficiency, as novices develop their skills, productions are compiled into larger units, thus reducing the working memory demands of tasks (Anderson, 1987). As skill develops, previously acquired knowledge is increasingly substituted for search for a novel solution, thus reducing time and processing demands (Newell, 1990; Van Lehn, 1989). Skilled leaders already know what to do in most situations, rather than having to figure this out on the spot. Thus, at intermediate skill levels, we typically find an increase in efficiency due to knowledge compilation, as well as the development of more specialized rules or skills for dealing with specific situations. In addition, because processing demands are reduced, the intermediate skill level brings with it an increased capacity for meta-monitoring, that is, monitoring ones own performance and adjusting performance strategies based on feedback.

Expert level performance, which may take as much as 10,000 hours of experience and deliberate practice to obtain (Ericsson & Charness, 1994), is characterized by qualitative shifts in the nature of the knowledge that underlies skills. Especially important is the finding that experts see environments and problems differently than do novices or intermediates, defining them in terms of underlying principles rather than surface features. The deeper interpretive understanding of experts allows them to develop correspondingly deeper ways of organizing knowledge and more effective ways to cue productions, although there may also be costs to expertise such as increased rigidity (Sternberg, 1996). Experts also allocate time differently in addressing problems, spending more time on interpreting situations and planning actions (Isenberg, 1986), but then much less time searching for solutions (Ross, 2006).

Identity Applied to the Issue of Leadership Development

We noted earlier that because opportunities for developing leadership skills usually involve proactive behaviors in which individuals attempt leadership, at some risk to status and social acceptance, they are facilitated by seeing oneself as a potential leader and adopting a provisional leadership identity. As ones identity as a leader solidifies with increasing experience, a self-view as a leader should become a more central aspect of ones identity. This self-view may, in turn, be associated with many self-relevant goals and component skills related to leadership. Thus, when active, this self-view should have an increasingly important role as a meta-structure that guides knowledge access, goal formation, actions, and social reactions.

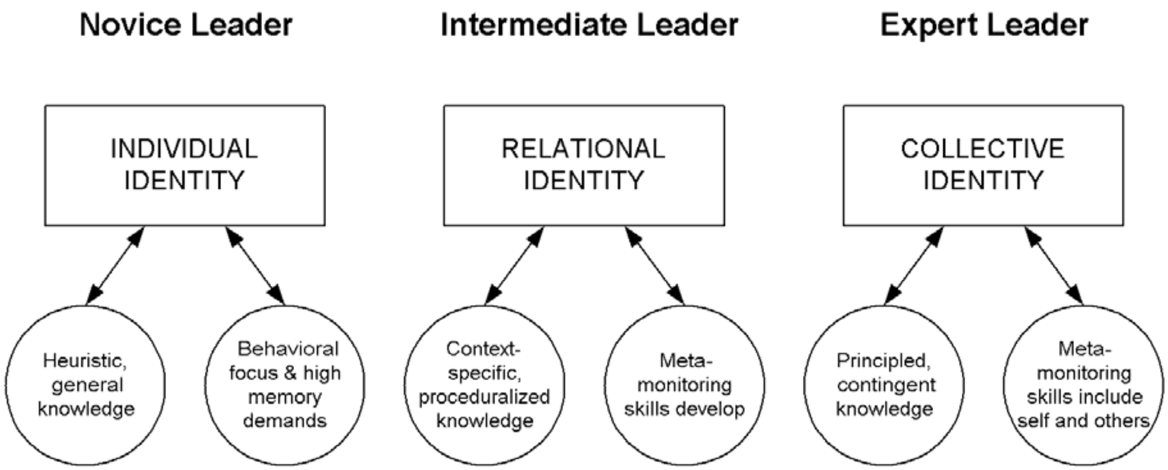
Ones currently active identity may vary from individual to relational to collective (Lord & Brown, 2004). *Individual level identities* emphasize ones uniqueness and differentiation of the self from others. *Relational identities*, in contrast, define the self in terms of specific roles or relations, often including others in the definition of ones own self-identity. Finally, *collective identities* define the self in terms of specific collectives such as groups or organizations, creating a desire to develop in oneself the qualities that are prototypical of these collectives (Brewer & Gardner, 1996). Each identity level provides an alternative basis for self-regulation, alternative ways to define leadership (Hogg, 2001; Hogg & van Knippenberg, 2003), and alternative goal structures and easily accessed leadership skills.

Novice leaders are likely to emphasize individual identities in themselves and their followers. Their key concern is with learning leadership behaviors and being seen as leaders by others. This involves demonstrating uniqueness and differentiating oneself from other potential leaders. From this viewpoint, social processes serve to validate the leader's self-view. If attempts at leadership are not accepted by others, then it may be much more difficult to establish a self-view as a leader. At intermediate skill levels, context-specific knowledge begins to develop, so that attentional demands associated with routine leadership tasks are lessened. This may allow a leader's orientation to begin shifting from the self to others, and leadership skills may begin to incorporate differences among others as a critical aspect of context.

This shift in orientation can involve one of two alternate forms of interdependent identities. If leaders are oriented toward relational identities, then specific others become included in the leader's self-identity (Andersen & Chen, 2002; Ritter, 2004). This form of leadership, which is differentiated across subordinates, has been investigated extensively in terms of qualitative differences in leader-member exchange (Graen & Scandura, 1987; Scandura, 1999). More effective leaders are those who develop many positive, but differentiated, exchange relationships on a subordinate by subordinate basis. Alternatively, a collective identity level may guide knowledge about leadership. In this case, group membership is very salient to both leaders and followers, and leadership may involve close adherence to group norms, or conformity to what has been called a group prototype (Hogg, 2001; van Knippenberg, van Knippenberg, De Cremer & Hogg, 2004). Consequently, a depersonalized leadership style which treats all group members similarly may be preferred to more differentiated style of leadership (Hogg, Martin & Weeden, 2003). The chronic nature of the leader's identity, plus aspects of the specific context, likely influence whether the leader develops more dyadic-level or group-level leadership skills.

With additional experience, the intermediate-level skill shifts to a more context dependent form of leadership in which the enactment of alternative identities is guided by explicit principles. This shift to a deeper structure is the hallmark of expert level knowledge. The leader's acquisition of a more abstract, general understanding of follower development likely underlies such changes. For example, as a leader gains experience working with followers over an extended period of time, he or she develops a more integrated sense of how those individuals develop and how specific elements of his or her leadership style may be more or less effective with them at different times. The values associated with alternative identity levels may also be incorporated into this more abstract, principle-based understanding of leadership. This general developmental sequence is shown in Figure 1.

Figure 1. Leadership Skill Development, Identity Level, Knowledge Type, and Knowledge Use



Leadership Capacity: Surface, Intermediate and Deep Structures

To help us apply this theory of how expert leadership skill develops, we borrow the cognitive science distinction between surface, intermediate, and deep knowledge structures and consider what they might include when applied to the domain of leadership.

Surface Structure and Behavioral Leadership Skills

Surface structures are the immediately observable components of leadership processes, such as the behavior of leaders *vis a vis* subordinates, feedback in the form of reactions of subordinates to such behaviors, and the task contexts in which leadership occurs. In other words, surface structures involve *what leaders do* when they lead. *This knowledge of what to do, and the productions related to generating the relevant behaviors are the central skills to be acquired at the novice level*. Developing surface level leadership skill involves learning normatively accepted definitions of what leaders should be and do. Novices likely develop implicit leadership theories consisting largely of an idealized representation of what leadership involves from observing the behavior of other leaders. Then, when given leadership opportunities, they attempt to behave in a manner consistent with their own implicit leadership theories (Lord, Foti & De Vader, 1984). Thus, for novices, self-directed leadership development often involves developing those particular behavioral skills which result in perceived leadership by others and which correspond to "common sense" ideas of leadership (Calder, 1977). Leadership theory relevant to this level of skill development has often focused on the type and amount of behavior exhibited by leaders (Yukl, 2002; Yukl & Van Fleet, 1992) and on the contextual or contingency factors that moderate the relation of various leadership behaviors to performance.

Implications for patterns of novice level skill development. From a surface feature perspective, leadership training incorporates a central behavioral component that attempts to teach leaders to exhibit more effective behavioral styles (e.g., Dvir et al., 2002). Such behavioral skills may be relatively quickly acquired, so that behavioral skill training programs often are of only a few days duration. However, one implication of thinking about leadership skills in terms of knowledge structures is the recognition that, in addition to the behaviors presented in training, novice leaders may be simultaneously attempting to conform to their own, vicariously-learned implicit theories of leadership, which likely to vary from leader to leader (Engle & Lord, 1997), and may not be consistent with the leader behaviors desired by the organization. Consequently, behavioral training might be effectively supplemented with efforts to modify implicit leadership theories to be consistent with organizational norms.

Ibarra's (1999) work illustrates how social, cognitive and motivational factors may combine in a process of identity development and skill learning. She suggests that individuals exploring new roles often adopt "provisional identities" which allow them to try out and modify new behaviors based on effectiveness. Applying this idea to leadership, we expect the transition from follower to leader involves the adoption of a *provisional leader identity* and development of associated skills. For novice leaders, these provisional identities and associated skills may be refined through task and social feedback, solidifying self-views as skilled leaders when feedback is positive, and causing one to discard this potential self or type of behavior when feedback is unfavorable. The nature of this process suggests that over extended periods of time, we may see greater leader development in individuals who are more open, exploratory, and flexible about adopting provisional identities and learning from them. Furthermore, organizations which more effectively provide accurate feedback in a manner that increases its likelihood of acceptance should expedite the process of trying out provisional identities.

Intermediate Structure and Cognitive, Emotional, and Identity-Related Regulation

Cognitive and identity related changes. Intermediate knowledge structures involve proceduralized skills in task and social domains which free resources for more complex processing. With experience, intermediate level leaders have developed skill which is "knowledge rich" rather than "knowledge lean" as they substitute the cognitively faster and more efficient *recognition* of appropriate responses in familiar environments for a more thoughtful *construction* of appropriate responses as unfamiliar situations are encountered (VanLehn, 1989). These cognitive changes are assimilated with an emergent identity as a leader. They involve a shift from normative definitions of leadership, which are heuristically applied to all situations, to contextually dependent definitions of appropriate leadership. One critical aspect of the sense making in which intermediate level leaders engage involves assessing appropriate social roles, and conceptualizing the social situation as requiring specific leadership activities that one can and should perform.

For intermediate level leaders, cognitive demands should be reduced as social interaction skills become more automatic, allowing the capacity for the development and application of meta-monitoring skills in social and task domains. At this level, meta-cognitive processes likely become integrated with self-relevant goals and schema. Leaders with this degree of skill and experience may increasingly be able to focus on characteristics of their followers, building knowledge structures of specific followers' needs, identities, and reactions to leader behavior. Cognitive structures, in turn, may increasingly include other individuals (when dyadic identities predominate) or groups (when collective identities predominate).

Implications for patterns of intermediate-level skill development. At intermediate skill levels, the development of cognitive and emotional structures that guide the interpretation and understanding of situational information is key. Leaders with intermediate level skills not only have more refined behavioral skills that are easier to use, they should be better at matching these skills to situational demands. The critical situational information may be task-oriented, social, team-based, or organizational; but in each of these domains, we expect intermediate leadership skills to be oriented towards developing a richer and more organized understanding of the situational factors determining when and how those behaviors should be applied. Kozlowski, Gully, Nason and Smith (1999) describe just such changes in the development of adaptive teams, and we also expect them to characterize the development of leadership skills. This line of thinking has been characterized by research on the development of complex cognitive structures involving perceptual categories, cognitive maps, mental models, schemas and scripts.

Increasing importance of identity and motivational factors in skill development. The critical factor in developing intermediate level knowledge is *personal experience in relevant task environments*, which broadly means experience with specific tasks, individuals, teams, or cultures. Normative implicit theories can be developed from observing others, but intermediate level knowledge integrates with self-views as a leader, which in turn, develop from attempted leadership and favorable social reactions and tasks outcomes associated with these attempts. Consequently, to develop intermediate level skills, potential leaders must proactively attempt leadership in varied environments and receive accurate feedback to help them tune their skills to an understanding of context. Motivational factors such as interest in leadership, which determine the extent to which leaders assume some responsibility for initiating and sustaining actions or creating the situations in which leadership is attempted and reinforced, are thus important in predicting the development of intermediate level leadership skills (Chan & Drasgow, 2001).

Identity development is also likely to be quite important in the intermediate stage of skill development for cognitive, motivational, and emotional reasons. Whereas novices may focus on developing a specific provisional identity as a leader, intermediate level leaders have the experience to develop many provisional leader identities which incorporate more specialized styles of leadership. Specific skills, goals, and self-regulatory structures may become associated with different identities. As suggested by Lord and Brown (2004), different working leadership self-concepts can emerge in different situations and cue different self-regulatory structures. Because of their self-relevance, such structures have emotional, motivational and cognitive significance. Formal efforts to development skills must effectively address these motivational and emotional aspects of meta-cognitive processes as well as the more cognitive components.

As leadership identities develop, it is also likely that individuals will become increasingly motivated to attempt new leadership activities, creating the potential for learning new leadership skills and further identity development. For example, Hall, Lord, Ritter, Swee and DuBois (2005) found in a longitudinal study at West Point that cadets who had more social and leadership experience in high school had higher initial leadership performance at West Point, and plateaued less rapidly, perhaps indicating a greater readiness to master complex leadership skills. Similarly, Day, Sin and Chen (2005), who studied team leaders in the National Hockey League, found that assuming leadership positions had facilitative, rather than detrimental, effects on other aspects of performance, again illustrating that leadership identities affect skill development.

Deep Structure: Principled Leadership Skill

For experts, added to the changes discussed for intermediate level leaders, we also expect to find the development of deeper, more principled definitions of problems. These may involve a greater understanding of factors defining the situational contingencies that influence *both* leaders and subordinates. *Deep structures* that might be associated with such expertise include principle-level task and social expertise or emotional regulation skills. Other deep structures include the personal articulation of self-identity and core values, an important source of flexibility in leadership skills, in part, because different values may prime different identities (Lord & Brown, 2001). These deep structures allow leaders to construct sophisticated understandings of situations (including detailed cognitive representations of tasks, relevant cultures, subordinate qualities, etc.) that can be used to guide their thoughts and behaviors. Expert leaders may also increase their effectiveness by building relevant knowledge and self-regulatory capacities in others, expediting the delegation of some leadership tasks to others.

Principled knowledge. In general, experts' more extensive knowledge, organized around general principles, leads them to different understandings than those derived from the less extensive knowledge of novices, which tends to be organized around surface features (Chi, Feltovich & Glaser, 1981; Glaser & Chi, 1988). For example, Day and Lord (1992) compared the knowledge structures of CEOs in the tool and dye industry to those of MBA students. Experts used a combination of deeper principles (e.g., quality control) and surface features (e.g., machinery problems) to classify organizational problems, whereas novices primarily used explicit surface features.

Applied to leadership, these findings from the expertise literature suggest that leaders will develop *domain-specific and principled* task and social expertise. For example, expert military leaders would have extensive and principled knowledge of military tactics and strategies for specific types of battle conditions, as well as knowledge structures for how to interact with other soldiers under those conditions. Principle-level knowledge might be grounded in basic military doctrine and knowledge of command and control systems. In keeping with the typical findings in the expertise literature that skills are domain specific, one would not expect this knowledge to generalize to domains that do not rely on the same principles. For example, battlefield skills may not generalize to the demands of peacekeeping situations and interactions with civilians or politicians, to the extent that underlying principles used in these two situations differ. However, some principles will hold across situations, such as understanding the implications of individual, relational, or collective identity activation for eliciting cooperative behavior, and leadership skills related to those principles should generalize across domains. Deeper leadership structures may also involve an increased focus on *changing others and changing systems* rather than on changes within leaders. Leaders likely must have already developed proceduralized behavioral and self-regulatory skills, as well as strong social and emotional skills, in order to develop this type of other- or system-focused, principled leadership knowledge.

Implications for patterns of expert skill development. Expert leaders can build on the domain-specific knowledge cued by identities to develop flexible leadership skills. Because these skills tend to be grounded in a more abstract, principled understanding, the development of expert leadership will vary substantially from person to person as the understanding of specific principles develops. We suspect that there is not a general set of principles, but rather that different skill domains have different underlying principles. For example, skill in emotional aspects of leadership may be guided by different constructs than skill in task accomplishment. The cognitive literature on the acquisition of expertise emphasizes that experts spend considerable time learning and deliberately practicing skills (Ericksson & Charness, 1994). Thus, principles associated with many aspects of expert level leadership may benefit from formal instruction and extensive deliberate practice by leaders. Training methods with greater capacity for tailoring to individuals and their specific situations are likely to be most beneficial to leaders developing expert-level skills.

Theory in a Nutshell

To summarize, we view the development of leadership skills as occurring over an extended period of time, with multiple loosely-connected skills at first effortfully (although not necessarily completely consciously) attempted. These early attempts at leadership are guided by leaders' desires to match their surface features (e.g., behaviors) to implicit theories of effective leadership. Those skills become increasingly proceduralized and contextualized, and finally their application becomes more driven by the internally-held values and proclivities of the leader. A critical aspect of this process is the integration of leadership skills with leadership identities. Ones self-view as a leader not only influences proactive attempts to gain leadership experience, it may also be an important cue to access knowledge related to leadership. With sufficient development, the integration of leadership skills with identity can result in an expert and unique manner of leading that can incorporate the development of followers as well as the leader. Skill development is also domain specific. Table 2 applies this framework to skill domains associated with tasks, emotions, social processes, meta-monitoring and values. A more detailed description of skill development in each domain can be found in Appendix A.

Our theoretical approach to leadership has superficial similarities to other theories that posit that leader's develop more complex frameworks for understanding themselves or others as they develop (Draft, 2001; Kagan, 1994). However, it is unique in grounding this development in cognitive theory and social reactions to attempted leadership. We see leaders developing from appropriate experience in task and social contexts as well as from formal instruction. Further, although there are qualitative changes in knowledge content and processes that vary as one moves from novice to intermediate to expert levels, identity development is not constrained to follow a rigid developmental sequence. Indeed, in other cultures, relational or collective identities may be associated with initial stages of leadership development, and implicit theories may be based on collective rather than individual level prototypes of effective leaders (Hogg, 2001). It is also worth noting that changes in leadership practices in organizations may require changes in both the leader and others (Wagner, et al., 2006). This may require leaders to focus on both individual and collective identities, a capacity that may require expert level skills.

Table 2. Knowledge Content Emphasis of Different Leadership Skill Levels

Skill Domains	Novice	Intermediate	Expert
Task	Technical and task skills Generic Decision Making and Problem Solving Skills	Domain specific task skills; Meta-monitoring capacity	Principled understanding of task and self-regulation
Emotional	Expression	Empathy and understanding of others Domain specific emotional regulation techniques	Formal principles of emotional regulation Principles specifying the effects of situational labeling, change, and social justice on emotions Understanding the synthesis of cognitions and emotions
Social	Fit with Implicit Leadership Theories Understanding agentic behaviors & social influence tactics	Integration with dyad or group Communal Behaviors Self-monitoring skill	Capacity to develop others Authentic, principle-based leadership
Identity Level	Individual identity as leader differentiates self from others	Relational or collective identity includes others or group	Value-based identity grounded in abstract principles
Meta-Monitoring	Largely based on social reactions and task progress; Focused within one's own emotional and motivational orientation	Integrated with Identities; greater adjustment to others; Flexibility in emotional and motivational orientations	Based on formal principles relating identities to value structures Principled understanding of positive and negative emotions/motivation
Value orientation	Value orientation learned and applied implicitly	Integration of identities and values	Principled understanding of value structures and their relation to authentic leadership

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Appendix A: Specific Skills Associated with Leadership Development

Task Skills

At lower levels of the organizational authority hierarchy, leadership skills are often thought to involve technical mastery or basic social and decision making skills (Vroom & Jago, 1988). However, leadership at higher levels of the organizational hierarchy is generally thought to involve a wider and more flexible set of skills. For example, Zaccaro and Klimoski (2001) organize such skills into seven imperatives for executive-level leaders: cognitive, social, political, personal, financial, technological, and staffing. Skill development at higher levels is also thought to involve more complex and diffuse processes which often depend on other individuals or groups and which take much longer to produce observable results (Jaques, 1989). Team-building skills are but one example of such skills.

This complexity and extension over longer time periods introduces greater difficulties in monitoring the development and effectiveness of more advanced leadership skills. However, although we would expect the development of the skills needed for higher-level leadership to occur more slowly, there is nothing fundamentally different about the process of developing such skills. Because such skills are often tied to particular groups or individuals, particular organizational contexts, or the particular identities they evoke in leaders, they would have the same domain-specific quality associated with expertise. Transfer of these skills to new contexts such as different organizations might take considerable time as leaders must adjust to a new set of contextual contingencies. It is also worth noting that many of the cognitive structures supporting such higher-level leadership skills could be conceptualized and measured in terms of mental models (Johnson, Daniels, & Huff, 2001) and furthermore, a comparison of the similarity of one's mental model to those of experts or trainers could be made (Day, Arthur, & Gettman, 2001). The identity-related structures that facilitate the use of such knowledge can be measured in terms of leadership self-schema (Smith, Brown, Lord, & Engle, 1999). Considerable "hands-on" experience as well as formal instruction and deliberate practice are required to attain expert levels of task performance.

Emotional Skills

Particularly during times of crisis, effective leaders must regulate their own emotions, and they must also communicate appropriate emotions to others. However, because human emotional reactions have been honed through evolution to address important human survival issues (Cosmides & Tooby, 2000), some aspects of emotional processing and behavior have a strong hereditary component that may be relatively inflexible (Deckers, 2001). Emotions involve very fast-acting processes that may have effects that are unconscious, making them difficult to identify and adjust. Emotional processing also may function as a leading system that can structure subsequent cognition and motivation (Cosmides & Tooby, 2000; Gray, 2004). Also, emotional regulation, when it occurs, may require considerable attentional resources (Wenzlaff & Bates, 2000) which can be difficult to marshal in the very conditions that make emotional regulation critical. For these reasons, we would expect that learning to regulate emotions would be a challenging leadership requirement that would take considerable time and perhaps would require a reorientation of attention toward emotions in learning contexts which have traditionally emphasized the role of cognitions. Finally, learning to regulate emotions may require implicit as well as explicit processes.

Two other factors complicate the development of emotional skills. One is that emotions and emotional reactions tend to be focused in time, occurring with respect to particular events (see Lord & Brown, 2004, Chapter 6). This suggests a strong domain- and event-specific quality to emotions and emotional regulation skills, where the domains are very narrowly defined in terms of types of events. This topic has not been carefully examined by leadership researchers, and we know little about the potential dynamics of emotional reactions and regulation. The second complication is that emotions often occur in a social context. Thus, a critical quality in leaders may be their sensitivity to the emotions of others. Indeed, the capacity to perceive and respond to the emotions in others, *emotional empathy*, has recently been shown to be a strong predictor of leadership emergence (Kellett, Humphrey, & Sleeth, 2002). Because of the complexity and implicit nature of emotional skills, we would expect that it would be hard to learn to regulate them.

Skill in handling emotions will likely interact with individual difference variables such as emotional orientation or working memory capacity, such that emotional regulation strategies that work well for one leader may not be optimal for another. In other words, as skill in this domain develops, the novice strategy of patterning one's behavior on what appear to be effective examples from others should be replaced by a more sophisticated and personalized strategy that incorporates self-knowledge about the best regulatory strategy for oneself. Thus, we would expect the abilities to communicate felt emotions, self-manage emotions, and respond appropriately to the emotions of others may also be quite distinct skills that develop at different times and in response to different contingencies. That is, the different facets of emotional intelligence (Law, Wong, & Song, 2004) likely develop at different rates.

Based on other theories of skill development (Anderson, 1987; Sternberg & Ben-Zeev, 2001), we would expect emotional regulation skills to also become more efficient with practice and to eventually become proceduralized, reducing the cognitive demands in their use (Moon & Lord, 2004). Some support for this argument comes from Kanfer and Kantrowitz (2002), who found that emotional regulation skills are higher in older adults. One particularly challenging issue for leaders is developing strategies to help others to regulate their own emotions.

Social Skills

Although many proceduralized social skills are implemented with little conscious thought, they are not necessarily knowledge-lean. Rather, these skills may be highly dependent on implicit knowledge learned through extensive experience in a particular domain. This topic has been investigated extensively with respect to leadership perception processes, with the typical finding that recognition of leadership in others depends on a match of their traits and behaviors to the perceivers' implicit leadership theories (Lord & Maher, 1991). The production of leadership behaviors may similarly be guided by implicit theories that are held by leaders themselves (Engle & Lord, 1997) as well as by the identities they have developed (Platow, Haslam, Foddy & Grace, 2003)

Implicit theories are thought to be acquired by lower-level learning processes associated with neural networks (Lord, Brown, Harvey, & Hall, 2001); however, the nature of such learning may also be guided by self-monitoring processes. Self-monitoring refers to the tendency to monitor and regulate the public appearance of the self that is displayed in social settings and interpersonal relationships. It is associated with leadership emergence in part because high self-monitors are able to construct and maintain more effective social relations (Day, Schleicher, Unckless & Hiller., 2002), and likely richer implicit theories. Because social cues are often communicated through emotional reactions, emotional intelligence may also facilitate the development of social skills. Formal training and deliberate practice may also facilitate the development of leadership skill in the social domain.

Meta-Monitoring Skills

Meta-monitoring skills are used to regulate task performance, identity development, and emotions. Increases in meta-monitoring capacities occur, in part, because the cognitive resources for meta-monitoring activities become available when lower-level skills become proceduralized and working memory demands are reduced. Although provisional leadership identities initially may be closely monitored, requiring both cognitive and emotional resources, over time they become established as more central aspects of ones identity, and thus can be evaluated more efficiently. Thus, skilled leaders may adjust the identities they enact and communicate them to others based on a variety of situational factors such as the need for cooperation or competition. Increased self-knowledge and more clearly defined identities also organize and appropriately activate the goals and standards that allow self-regulation in task domains. Meta-monitoring may also require a deliberative shift towards focusing on others and their reactions to leadership rather than on one's own skill in behaving as a leader.

Meta-monitoring activities of leaders may also differ on a key emotional/motivational dimension. Some individuals are more sensitive to positive emotions and approach motivation, whereas others are more attuned to negative emotions and potential losses (Carver, 2001, 2004; Shah & Higgins, 2001). Thus, it is likely that the monitoring procedures that develop are oriented towards these different domains. We would expect meta-monitoring skill for intermediate level leaders to be focused on their preferred domain, but expert leaders should develop a more principled and flexible understanding of this process. Effective leaders may also match their behavior to the emotional/motivational orientation of followers. For example, Benjamin and Flynn (2006) found that transformational leadership was most effective when followers had a regulatory focus that emphasized locomotion toward desired goals, and transactional leadership was most effective when subordinates were geared toward avoiding a poor fit with standards.

Values

Schwartz (1992) defines values as "desirable states, objects, goals, or behaviors, transcending specific situations and applied as normative standards to judge and to choose among alternative modes of behavior (p. 2)." According to Schwartz, values provide a framework for the development of socially sanctioned purposes and coherence in behavior across situations. Thus, values are often an important aspect of culture, and they are transmitted by many formal and informal means. In addition, conformity to appropriate values is often an important component of self-evaluation. Thus, we would expect there to be a strong linkage between values and identities. For example, Lord and Brown (2001) maintain that the values that leaders espouse and symbolize through their actions prime specific identities in their followers, eliciting specific self-evaluation processes in followers. Values inherent in a situation may also influence a leader's own salient identity, and thereby indirectly structure the development of other leadership skills and the principles on which they rest.

Values have an underlying structure that is relevant to both identities and self-regulatory orientation (Lord & Brown, 2001; Schwartz, 1992). However, their multifaceted nature may make it difficult to for leaders to appreciate the full impact of values or to learn that there are alternative constellations of values that may make sense in different societies. Consequently, we would expect that the development of expert knowledge of values would require formal training, and the skilled use of values in connection with leadership would require deliberate practice and extensive experience. We expect that development of a deep level understanding of values and their relation to identity levels is the mark of sophisticated, expert level international leaders. Lord and Brown (2004) provide a more detailed description of how such value systems can be integrated with leadership theory. It is important to note that training leaders to adopt and communicate a specific value pattern may not be appropriate when leaders manage organizations that operate in many cultures. An expert level, principled understanding of value structures, and how they relate to identities and self-regulation, is a more appropriate basis for leadership development.

Adaptability and Adaptive Performance

Current Findings and Future Directions for Building Adaptive Forces

David Dorsey
Rose Mueller-Hanson
Elaine Pulakos

Personnel Decisions Research Institutes, Inc

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1. Foundations

A critical incident:

A platoon-type raid was planned to snatch a prisoner. The plan called for a large force to hit the objective and grab the prisoner under cover of darkness. The enemy force size was unknown, but was thought to be squad plus. The reconnaissance team leader set up his surveillance team at the objective and saw that the prisoner had been brought out with only two guards far from the camp. This team leader decided to rescue the prisoner there and then. The prisoner was rescued; this mission would probably have failed if it had been executed as planned.

- White, Mueller-Hanson, Dorsey, Pulakos, Wisecarver, Deagle, & Mendini (2005), p. A-4.

Adaptability and related concepts such as flexibility and versatility are elusive concepts that have not been clearly defined nor adequately understood in psychological and human performance research. However, the practical impact of these characteristics is readily observable in many real-world performance domains. This is particularly true for military operations, as demonstrated in critical incidents such as the one described above. The focus on adaptability as a critical capability has become even sharper in the last decade. Specifically, the asymmetric and uncertain nature of the threats facing the United States has resulted in a number of reports, panels, and sources of expert guidance calling for an increased focus on adaptability in selection, training, and even force structure considerations (Department of the Army, 2001; Tillson, Freeman, Burns, Michel, LeCuyer, Scales, & Worley, August, 2005). Similarly, within academic and professional literature, adaptability has become a core construct of interest (see Burke, Pierce, & Salas, 2006).

Consistent with this interest, PDRI has been conducting a program of applied research on adaptability and adaptive performance, in partnership with sponsors such as the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). In this paper, we offer a brief précis on some of the key findings from this and related research programs. In addition, we take a brief look at the broader body of research on adaptability in order to highlight potential high-value directions for future research.
We begin by offering a working definition of adaptability. Adaptability has been broadly defined as *an effective change in response to an altered situation* (White et al., 2005). Consequently, adaptability entails the capability to:

- Maintain situational awareness and recognize when an adjustment in behavior is needed— either in response to a change in the environment (reactive) or as an attempt to shape the environment (proactive),

- Change behavior in a manner that leads to more effective functioning, and

- Evaluate the outcome of this change, and make further adjustments, as needed, to achieve the desired result (Mueller-Hanson, Wisecarver, Miller, Mendini, & Bagget, in preparation).

In our view, performing adaptively, in a manner consistent with this definition, is meaningful at levels of analysis beyond individual performers. As suggested in Table 1, the capacity to perform adaptively is a multilevel organizational process or phenomenon, which is enabled or facilitated by a host of organizational interventions. We explore elements of this framework in subsequent sections of the current paper.

Table 1. Adaptability from a Multilevel Perspective

Level of Analysis	Type of Intervention				
		Attracting, Selecting, and Retaining Adaptive Personnel	Training and Developing Adaptability Skills	Creating and Sustaining Adaptive Organizational Systems (e.g., rewards, structures)	Developing Adaptable Leaders
	Individual	√	√		√
	Team	√	√		
	Organization			√	

2. What We Know

Dimensions of Adaptive Performance

One fruitful approach to adaptability research is to "start with the end" and address what adaptability or adaptive performance looks like in terms of actual job performance. This approach makes sense in light of the ubiquitous "criterion problem" (Austin & Villanova, 1992) that plagues much of applied research. That is, if you do not understand the criterion or performance domain that you are trying to train or to predict, it is difficult, if not impossible, to adequately develop and calibrate effective organizational interventions.

In response, a group of PDRI researchers and academic partners developed a taxonomy of adaptive job performance that expands upon previous models of the performance domain (e.g., Campbell, McCloy, Oppler, & Sager, 1993). Two studies were conducted to develop and refine this taxonomy. First, more than 1,000 critical incidents from 21 different jobs (both military and non-military) were content analyzed, yielding an eight-dimension taxonomy of adaptive performance. Second, this taxonomy was investigated empirically via the development and administration of a Job Adaptability Inventory (JAI)—an instrument designed to describe the adaptability requirements of jobs. Exploratory factor analyses of JAI data from 1,619 respondents across 24 jobs yielded an eight-factor solution that mirrored the hypothesized eight-dimension taxonomy. Subsequent confirmatory factor analysis (using a separate sub-sample) indicated a good fit for the eight-factor model. The eight dimensions of adaptive performance are as follows (this research is further highlighted in Pulakos, Arad, Donovan, & Plamondon, 2000):

1) Handling emergencies or crisis situations;
2) Learning work tasks, technologies, and procedures;
3) Handling work stress;
4) Demonstrating interpersonal adaptability;
5) Displaying cultural adaptability;
6) Solving problems creatively;
7) Dealing effectively with unpredictable or changing work situations; and
8) Demonstrating physically oriented adaptability.

This initial research highlighted two particularly important points, namely that 1) adaptive performance is a multidimensional construct, and 2) individual jobs or organizational roles have unique profiles of adaptability requirements, which vary predictably along the eight adaptability dimensions. Both of these findings hold implications for organizational interventions (e.g., training, personnel selection).

Individual Differences that Predict Adaptive Performance

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change."

- Charles Darwin

Having an initial understanding of the criterion space is only a beginning in understanding adaptability. Within the various dimensions of adaptive performance (physical, cultural, interpersonal, etc.), individuals likely vary on both innate and acquired individual characteristics that enable adaptive functioning. Research on these individual differences is now starting to emerge. For example, Pulakos, Schmitt, Dorsey, Hedge, & Borman (2002) further developed a model of adaptive performance, based on the eight-dimension taxonomy described above, and sought to directly address the issue of individual differences.

In this research, criterion measures of adaptive performance and a battery of individual difference measures were developed and tested. These measures were evaluated in a concurrent criterion-related validation study, involving 739 U.S. Army personnel from a wide array of occupational specialties. The specific measures used included:

- <u>Criteria:</u> Behaviorally-oriented rating scales used by supervisors to rate subordinates on each of the eight adaptive performance dimensions.
- <u>New Adaptability Predictor Measures:</u> Instruments designed to assess the extent of respondents' past experiences in situations requiring the eight different types of adaptability (experience), their interest levels in handling situations requiring the different types of adaptability (interests), and their levels of self-efficacy for handling situations linked to the eight dimensions of adaptive performance (self-efficacy).

- Cognitive Ability and Personality Measures: Measures of cognitive ability and personality (including measures of achievement motivation, openness, emotional stability, and a number of other constructs).

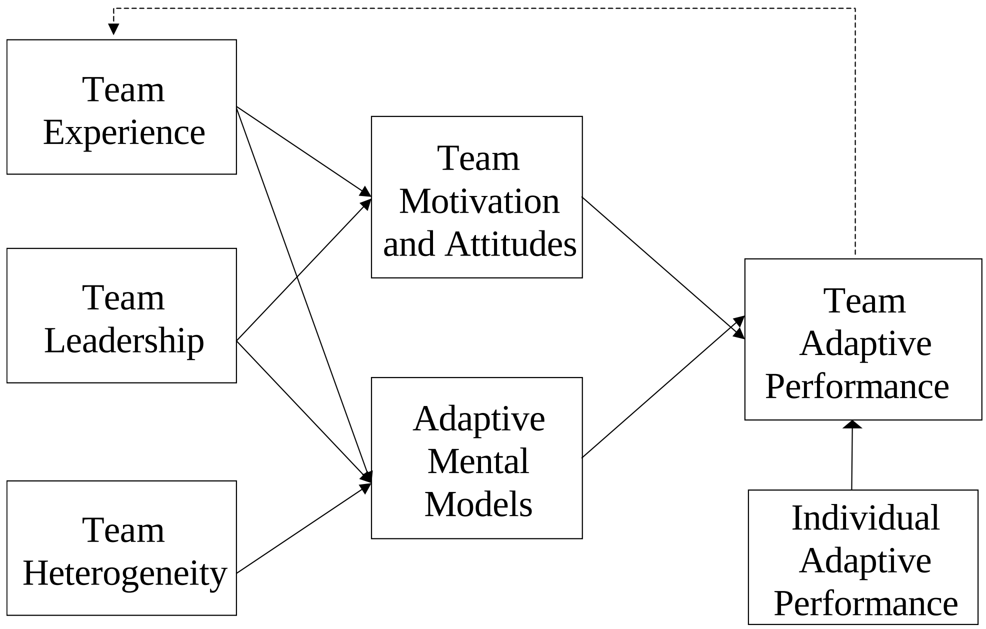
The results from this research yielded a number of interesting findings. First, confirmatory factor analyses of the predictor measures showed support for the eight-dimension model of adaptability. Second, the new adaptability predictors, along with cognitive ability and personality (particularly achievement motivation), were shown to predict adaptive performance. Moreover, the individual difference measure of adaptability *experience* demonstrated incremental validity in predicting adaptive performance, beyond the more traditional cognitive ability and personality measures. This research is described in detail in Pulakos, Schmitt, Dorsey, Hedge, and Borman (2002). While this initial study suggested that it is possible to predict adaptive performance, the picture of the specific individual differences that drive adaptive performance remains unclear. For example, as discussed by Stewart and Nandkeolyar (2006), studies to date have yielded conflicting findings regarding the role of personality attributes such as conscientiousness in understanding adaptive performance.

Understanding the contributions of individual differences to adaptive performance may be complex, given possible variance in relationships across the different dimensions described by Pulakos et al., 2000. For example, culture has been described as a complex "mosaic" (Chao & Moon, 2006)—are the individual differences that predict cultural adaptability also a complex constellation of traits and acquired knowledge, skills, and experiences? Pulakos, Dorsey, and White (2006) present a series of hypothesized linkages between individual attributes and the various adaptive performance dimensions. Such linkages have yet to be fully tested via empirical research. Moreover, Ployhart and Bliese (2006) offer a theory of adaptability, where adaptability is viewed as a higher-order compound trait, determined by more distal knowledge, skills, abilities, and other characteristics. Research is needed on these various individual difference issues and models.

Models of Team Adaptability

As discussed, we conceive of adaptability as a multilevel organizational phenomenon and process. Correspondingly, adaptive performance must be considered in light of how individuals form and perform to create adaptable groups or teams. In recent years, increasing attention has been paid to adaptability at the team level, and many models of team performance include some capability to adapt or adjust to novel circumstances (e.g., Kozlowski, Gully, Nason, & Smith, 1999; Marks, Zaccaro, & Mathieu, 2000). Figure 1 below shows one model of team adaptive performance intended to explicitly define influences on effective team adaptive performance (from Pulakos et al., 2006). Other models and frameworks for understanding team adaptability have been proposed as well (e.g., Stagl, Burke, Salas, & Pierce, 2006).

Figure 1. Model of Team Adaptive Performance



Beyond just proposing such models, empirical research is needed to solidify our understanding of antecedents, consequences, and core processes related to adaptive team functioning. Over the last decade, such research has begun to emerge. For example, Koslowski, Deshon, and colleagues (e.g., DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004) have undertaken an impressive program of research, developing both theoretical models of team development and adaptation and conducting empirical research. This work focuses on several theoretical pillars, including 1) the role of self-regulatory processes and variables, 2) instructional strategies and designs that potentially influence core psychological constructs and processes, and 3) multilevel models that reinforce a joint focus on both individual and team variables, including the temporal aspects of team development. Other bodies of work have produced insights into the role of team structural adaptation and composition (e.g., LePine, 2003; Moon, Hollenbeck, Humphrey, Ilgen, West, Ellis, & Porter, 2004) and the critical role of team leadership (e.g., Marks, Zaccaro, & Mathieu, 2000).

Models of Leader Adaptability

Dimensions of Leader Adaptability

Much of what we have described related to adaptability in individuals is applicable to leader adaptability. That is, the same dimensions and predictors of adaptability likely fit for both leaders and followers. However, it is not enough for leaders to be individually adaptable. Leaders must also develop adaptability in others by encouraging and rewarding adaptive behavior and by ensuring cooperation and coordination. The role of the leader in encouraging adaptability suggests at least two broad performance dimensions of leader adaptability: *developing the adaptive* ***capabilities of others*** **and** ***creating a climate that fosters adaptability.***

Developing adaptive capabilities in others requires that the leader set expectations for adaptive performance, provide opportunities to perform, and deliver feedback to reinforce effective behaviors and correct ineffective behaviors. Setting expectations and providing opportunities entails knowing the characteristics of adaptability and of the individuals and the structure of the work team. Zaccaro (2001) recommends that a team leader should understand "... team and subordinate resources, team role structure and assignments, team cohesion and morale, the communication and social influence patterns within the team, the tenure and size of the team, and specific performance protocols and norms (cf. Fleishman and Zaccaro, 1992)" (p. 145). Providing reinforcement and feedback is also critical to developing adaptive capabilities in others. A team will be able to improve its performance only if team members recognize and are prepared to correct mistakes. Tannenbaum, Smith-Jentsch, and Behson (1998) recommend that leaders hold regular briefings, both before and after the team performs, to improve the team's adaptive capabilities. Specifically, they suggest that the leader should provide specific constructive suggestions for improving performance, discuss teamwork as well as task work processes, and give positive feedback for improvements and successful performance. Holding such briefings also helps the team leader to establish shared mental models for adaptation across the team (e.g., Zaccaro, Burke, Marks, & Mathieu, 1999), as does delivering feedback on a less formal basis.

To enable adaptive behavior, leaders must create a climate that fosters adaptability. As such, leaders have an even greater responsibility than non-leaders to maintain situational awareness, scanning the environment for leading indicators that change is necessary. When facing change, leaders must articulate a clear vision and rationale for change and help subordinates translate the vision into a workable plan (Zacarro & Banks, 2004). In addition, creating the right climate involves setting flexible goals, establishing rules and norms that allow for and even encourage creative thinking, developing reward systems to reinforce adaptive performance, and allowing for participation and "a voice" in team activities.

Although all team members contribute to this climate, the leader is critical to setting the tone. For example, participative leadership styles tend to encourage open and effective creative problem solving (e.g., Axtell, Holman, Unsworth, Wall, & Waterson, 2000; Edmondson, 1999; Tannenbaum, et al., 1998; West & Wallace, 1991). In a study of surgical teams, Edmondson and her colleagues found that teams whose leaders encouraged people to voice opinions, admitted their own mistakes, and asked for advice when it was necessary were more successful in learning a new procedure (Edmondson, Bohmer, & Pisano, 2001). Further, in reference to planning within Special Forces teams, Morrison, Smith, Sticha, and Brooks (1995) asserted that planning must be a team activity; even though there is a commander with ultimate responsibility for the plan, team members have their own areas of responsibility and are expected to provide input (especially if they are more experienced than the commander).

<u>Predictors of Leader Adaptability</u>

Most, if not all, of the factors that have been shown to predict adaptive performance in individuals would likely apply to leaders. However, it may be that the importance of these factors varies according to the unique adaptive requirements of the leadership role. For example, decision-making and problem-solving skills are especially important for leaders who bear significant decision making authority. Communication skills are central to a leader's role and are critical for executing the behaviors described above. In addition, self-awareness is inextricably linked to adaptability (Day & Lance, 2004) and is important to leaders who need an accurate understanding of follower perceptions in order to effectively motivate and influence them.

In addition to these general adaptability predictors, several researchers have identified other adaptability-related characteristics that are especially important to leaders. For example, leaders may differ significantly from non-leaders in the extent to which they exhibit social perceptiveness and behavioral flexibility (Zaccaro, Gilbert, Thor, & Mumford, 1991). Social perceptiveness is one's capacity to perceive and accommodate the needs and goals of others and the implicit and explicit relationships within an organization; behavioral flexibility is the ability and willingness to change one's response as appropriate to the environment (Zaccaro, et al., 1991). These attributes are enabled by the more complex knowledge structures and the larger behavioral repertoire of leaders in comparison to non-leaders. In essence, these experiences enable leaders to develop more fine-grained scripts for a wide variety of situations, which can be applied readily to novel settings and problems.

According to Day and Lance's (2004) Leadership Complexity Model, self-aware and adaptable leaders stem from increased behavioral, cognitive, and social complexity. Developing increased complexity happens through the growth process. Growth is defined by increasing levels of differentiation, the ability to specialize and make fine-grained distinctions, and integration—making connections across distinct concepts.

Developing Adaptive Leaders

There are two overriding principles for developing adaptable leaders that apply to any type of training method. The first is based on the finding that experience is an important predictor of adaptive behavior. As described previously, domain specific knowledge and experience are malleable individual characteristics that are likely to be important for adaptable behavior. From the pioneering work of the Nobel laureate Herb Simon and from subsequent work on naturalistic decision making (Klein, 1997), there is ample evidence that individuals can develop a "catalog" of experiences and implicitly draw upon the catalog in order to handle new situations effectively. Therefore, training interventions should expose leaders to a wide variety of situations requiring adaptability. Whether simulated or real, this exposure will allow the individual to build a catalog of experiences, possibly accelerating the acquisition of expertise (Mueller-Hanson, White, Dorsey, & Pulakos, 2005).

One of the best ways to acquire this experience is through challenge assignments (Barrett & Beeson, 2002; Ohlott, 2004). Challenge assignments should give the leader an opportunity to stretch (in an appropriate way) and include an intentional learning component. "Thus, a developmental stretch assignment can be any challenging job, task, or role that requires thinking and acting in more complex ways. Underlying the choice of such an assignment should be the purposeful transformation of the individual to a more complex level of leadership functioning." (Day & Lance, 2004, p. 50). In a related vein, placing a leader in a challenge assignment with very little preparation may further encourage them to behave and think in a way that is more complex (Day & Halpin, 2001).

Experiential Learning Theory (ELT) provides a framework for how experienced based learning contributes to increased knowledge (Kolb, Boyatzis, & Mainemelis, 2000). According to this theory, learning occurs by the transfer of experience into knowledge via a four-stage cycle where concrete experiences are the basis for reflective observations, which in turn lead to abstract conceptualizations that imply some form of action. Once action is taken, active experimentation serves as a guide to creating new experiences. Research has shown that ELT provides a useful framework for instructional design, curriculum development, and educational innovation (Kolb et al, 2000). Therefore, to maximize the value from challenge assignments, leaders should be encouraged to reflect on their experiences, draw lessons learned, and abstract key principles that can be applied to future assignments.

The second overarching principle for developing adaptive leaders is that an iterative process of practice, feedback, and practice is a necessary part of development. Individuals should have the opportunity to practice new skills, obtain feedback on their results, and apply lessons learned in subsequent sessions (Mueller-Hanson, et al., 2005). For example, Day and Lance (2004) suggest that written feedback may be more relevant for enhancing cognitive complexity, verbal feedback may be more helpful to promote behavioral complexity, and coaching/mentoring may be most useful for enhancing social complexity. In addition, feedback promotes self-awareness by allowing the leader to compare self-perceptions with those of others.

One Specific Model for Training and Developing Adaptive Skills

Given the breadth of individual differences that may impact adaptive performance, in both leaders and individual performers, the design of training interventions targeting adaptability skills has become an important endeavor. The design for such programs should follow sound instructional design principles and decompose a training strategy into specific learning objectives and targeted knowledge and skills. But, what knowledge and skills should be acquired? It is our belief that the design of adaptability training should be driven by several practices, including:

1) Discerning “trainable” abilities and skills from less malleable individual differences (see Figure 2),
2) Conducting specific work and job analyses to determine what adaptability means in a given performance domain,
3) Using effective instructional strategies, such as scaffolding adaptability development via careful sequencing of interventions, using discovery learning and a mastery orientation, providing experiential learning (across a wide array of situations requiring adaptability), and facilitating deliberate practice with feedback.

Following these principles, we highlight here one model for developing adaptability training. Specifically, PDRI in collaboration with ARI and the U.S. Army Special Forces developed an Adaptive Thinking and Leadership (ATL) training program. The initial version of this program was developed for U.S. Army Special Forces (SF) team leaders—a job which involves numerous types and high levels of adaptability.

Figure 2. Hypothesized Trainability Continuum

Stable Attributes (Selection factors)			Malleable Attributes (Training Factors)
• Cognitive Ability/ Intelligence • Openness • Resiliency • Tolerance for Ambiguity • Achievement Motivation	• Problem Solving/ Decision Making Skills • Metacognitive Skills • General Self-Efficacy	• Communication Skills (Negotiation and conflict resolution, persuasion, collaboration) • Awareness (self, others, situation)	• Domain-specific Knowledge • Varied Adaptive Experience

Note: adapted from Mueller-Hanson, White, Dorsey, & Pulakos (2005).

The design for this program called for a classroom-based training program for new SF team leaders that would better prepare them for a variety of on-the-job challenges. As viewed by one senior SF officer, the ATL is "a unique experience for 18A candidates that helps them to better evaluate new situations and focus on how they can change to more effectively handle problems or unfamiliar situations" (Mueller-Hanson et. al, in preparation).

The primary goal for the course was to provide the soldiers with a comprehensive framework for interpreting adaptive situations and to facilitate related knowledge and skill acquisition. For example, although the soldiers typically realize that they must be adaptable in operational planning, they often do not give adequate weight to understanding and mastering situations requiring interpersonal, cultural, or leadership adaptability. Thus, the course provides an "advance organizer" for approaching a variety of situations. In addition, the course emphasizes a variety of strategies for effectively handling these situations (e.g., strategies for solving problems and making decisions under extreme pressure, negotiation strategies for conducting interactions with foreign units).

The course involves a minimum of lecture and places a heavy emphasis on scenario-based training. This aspect of the course design conforms to the role that experience likely plays in predicting adaptive performance (Pulakos et. al, 2002). In addition, the course leverages the view of adaptability as a multidimensional construct and involves techniques derived from current thinking and literature surrounding the topic of adaptability. Table 2 presents an overview of the initial ATL program of instruction, by conceptual adaptability domain. While the course leverages some general best practices, the course was tailored to SF team leader jobs and mission environments. After completing the ATL, lessons-learned are reinforced in scenario-based field training that incorporates role-players in real-time events. Thus, adaptability skills are built in a "crawl, walk, run" manner, across a series of increasingly high-fidelity training exercises and interventions. The course has been applied to SF warrant officers, Civil Affairs officers, and Psychological Operations (PSYOPS) officers.

Table 2. ATL General Program of Instruction

Adaptability Area	*Example Instructional Content/Activities*
General Overview	Basic adaptability concepts; Overview of adaptability in the SF environment; Guided self-development
Mental Adaptability	Switching mindsets; Tools and strategies for critical thinking; Naturalistic versus deliberate decision making
Interpersonal Adaptability	Understanding social environments (self, others, systems); Negotiation
Leading an Adaptable Team	Communication/leadership styles; Effective feedback

Models for Designing and Developing Adaptive Organizations
At the broadest level, understanding adaptability and adaptive performance can only be accomplished by understanding aspects of organizations (and organizational units) themselves. The military has reached similar conclusions; for example, *Joint Vision 2020* from the U.S. Joint Chiefs of Staff emphasizes, *"Decision superiority does not automatically result from information superiority.*
Organizational and doctrinal adaptation, relevant training and experience, and the proper command and control mechanisms and tools are equally necessary."

In line with this emphasis, research and experimentation on the characteristics of adaptive organizations has taken place. For example, Hess and colleagues (2000) report the results of experiments designed to evaluate the relative effectiveness of various command and control (C2) systems. Moreover, programs such as the Office of Naval Research's A2C2 (Adaptive Architectures for Command and Control) program have generated a number of interesting findings suggesting that organizational structures generated through modeling and experimentation outperform structures designed using traditional methods, such as subject matter expertise (Levchuk, Serfaty, & Pattipati, 2006). The types of organizational design facets that have emerged from this research as being important for adaptability include methods of resource allocation, type of communication networks, and command structures (Levchuk, Serfaty, & Pattipati, 2006). Similarly, researchers and practitioners in the business world have sought to define characteristics of the "adaptive enterprise" (Haeckel, 1999). More work along these lines is certainly needed and is likely to emerge.

3. What We Don't Know

In order to foster further consideration, debate, and research, we end our discussion of adaptability by presenting a number of unresolved research questions. In our view, the answers to such questions hold promise for extending our collective capabilities at improving force adaptability, via the application of research-based interventions.

1. *Is the eight-dimension taxonomy of adaptive performance sufficient or necessary for developing models of performance?*

    - As suggested above, adaptive leadership may involve additional facets of performance, such as developing the adaptive capabilities of others and creating a climate that fosters adaptability.

    - Some authors have argued that most of the dimensions in the Pulakos et al. (2000) eight-dimension model are, in essence, dimensions of technical and contextual performance (Johnson, 2003), thus begging the question: how specifically is adaptive performance different? While some aspects of adaptability may look similar to routine technical performance, adaptation may involve doing the same activity to a greater degree, with greater intensity, or in a substantially different way. Thus, distinctions regarding adaptive and technical performance may center on definitions of typical versus maximal performance (DuBois, Sackett, Zedeck, & Fogli, 1993; Ployhart and Bliese, 2006). In addition, Ployhart and Bliese (2006) suggest that adaptability is a characteristic of the environment, not of the criterion construct domain, and that any task can have an adaptive component. More research is needed to disentangle these issues.

2. *Is there a definitive individual differences model (or set of models) for predicting adaptive performance?*

    - While the role of some predictors is likely to emerge quickly (e.g., cognitive ability predicts adaptive performance), other predictors may present less clear and convincing evidence. For example, as discussed above, findings regarding some personality attributes remain mixed. To resolve these issues, careful experimentation and research should be conducted, assessing linkages between individual difference constructs and the different facets of adaptive performance.

3. *Is it possible to build a "grand model" of adaptability that integrates knowledge of individual differences, mediating processes, and different adaptability criterion dimensions? Alternatively, does each type of adaptability (e.g., cognitive, physical, cultural, interpersonal, leadership) require a unique model for prediction and understanding?*

    - We need models for how individuals interact with (and shape) the environment; adaptability may be as much about shaping the environment as reacting to it. In additional, regulatory processes (e.g., self-regulation, self-awareness) and other mediating processes (e.g., strategy selection) may be critical to adaptability (Ployhart & Bliese, 2006).

    - As stated previously, we currently have little research on the similarities and differences among different facets of adaptive performance (interpersonal, cognitive, physical, cultural, etc.). Research on these issues should be paramount.

4. *What are the best models and instructional strategies for training adaptability skills, and to what degree can adaptability be developed?*

- Different training models may be needed for different types of adaptability (e.g., cognitive, physical, cultural, interpersonal, leadership). Moreover, it is likely that certain individual differences (e.g., cognitive ability) place boundary conditions on the extent to which individuals can be trained to adapt.

5. *How do leaders influence individual, team, and organizational adaptability?*

   - We need a better understanding of the processes and mechanisms that leaders use to foster adaptability in individuals, teams, and organizations.

6. *What types of organizational structures and systems enable adaptive performance?*

   - Models (and modeling tools) for understanding the characteristics of adaptive organizations are now starting to emerge. This nascent area of research will be an important part of understanding adaptability from a multilevel and strategic perspective.

7. *Are there facets of adaptability that can only be studied adequately in field versus laboratory settings?*

   - Some facets of adaptability (e.g., handling work stress or crisis situations) may be difficult to study in laboratory settings.

8. *Are there ways in which adapting can be maladaptive—is there such a thing as too much adaptability?*

   - In some performance environments, the study of excessive, unpredictable, and/or ineffective change in response to perceptions of altered situations may prove useful. For example, in military settings, it may be important to research the nature of shifts between following standard operating procedures and engaging in non-routine acts of adaptive performance.

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Organizational Socialization: Leaders and Developmental Networks for Work Adjustment

Georgia T. Chao
Eli Broad Graduate School of Management
Michigan State University
East Lansing, MI 48824-1122

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Georgia T. Chao
Eli Broad Graduate School of Management
Michigan State University

"...One who knows how to unite upper and lower ranks in purpose will be victorious..."-Sun-tzu.

More than 2,000 years ago, Sun-tzu's *The Art of War* identified united ranks within an army as one of five factors that would predict victory (the other four factors are knowing when to fight or not fight, being able to effectively use large and small forces, being prepared, and having able generals not interfered by rulers). The concept of united upper and lower ranks has been viewed in several ways, including group cohesion, *esprit de corps*, teamwork, organizational culture, and commander's intent. Within military life, these concepts have been found to positively affect motivation and performance (Siebold, 2006a). However, "united upper and lower ranks" is often easier said than done. The ties that connect ranks involve more than power and authority; they embody a socialization component that requires people to learn and adjust to each other and to an organization's purpose. This white paper describes the socialization process and how leaders are key socialization agents for building unified ranks.

Organizational Socialization: A Primer

Overview

Organizational socialization describes an interaction of individuals and an organization as these individuals adapt to a new organization or to a new organizational role. This adaptation process is most noticeable for organizational newcomers where, for example, surprise, shock, and sense-making are experienced by civilians who join military service. For some officers, early socialization experiences often start at the military academy. Crackel (2002) described how new cadets at West Point were socialized during their first year. New cadets or plebes, were indoctrinated into the West Point culture through formal training, classes, and expectations from officers and faculty. In addition, they were informally harassed by upper classes, especially during the first two months of training (e.g., Beast Barracks). Some forms of hazing were physically and/or psychologically harmful, despite administrative efforts to curb them. Many plebes made sense of these experiences by viewing the training, education, and harassment as rites of passage or tests of their "manhood". Others failed to cope and left the academy or were discharged.

The socialization period generally covers the first few months of organizational life. The length of time required to adjust to an organization is dependent on a number of factors: the organization itself, type of job, leader, current organizational members, as well as the individual's background, personality, and motivation to be an organizational member. Successful person-organization fit occurs when the individual and organization accept each other as appropriate and view each other as highly desirable. Unsuccessful socialization often results in early termination/turnover or marginal status in the organization. Between these two extremes, lie infinite grades of fit, with some people successfully adapting to their job, but not their work group; others only find moderate levels of adaptation; and still others who were late bloomers, not fitting in well at first, but later finding their niche.

> From the individual's perspective, the socialization period can profoundly affect that person's commitment and subsequent performance in the military (Grojean & Thomas, 2006). Early experiences are interpreted within the individual's prior experience base, current values, and future aspirations. Atkinson (1989) reported that General George Patton had a childhood desire to be a warrior and perhaps this ambition helped him persevere over low grades during his first year at West Point, and to repeat his plebe year. In a similar vein, the 2006 recipient of the title Best Ranger, aspired to be a Ranger when he was a child. An immigrant from Kazakhstan, and the son of a former Soviet special forces soldier, Spec. Mikhail Venikov credits military and old-world values associated with hard work and discipline as critical guides to be Best Ranger (Army News Service, 2006).

From the organization's perspective, the socialization period is often referred to as military indoctrination, where exercises, disciplinary actions, and performance expectations are intentionally designed to strip away old self-concepts and foster a new military identity for the recruit (McGurk, Cotting, Britt, & Adler, 2006). Recruits are told to leave their former lives and to adopt a military life. They operate in a total organization that controls all their time, activities, and restricts recruit access to outsiders. The stages of indoctrination include softening-up recruits with a variety of stressors to help them let go of old self-concepts; compliance with new behaviors and job expectations, internalization of military values, and finally consolidation of all experiences into an accepted new military identity. This "break-down and build-up" process occurs through formally designed interventions as well as informal and perhaps unintentional experiences that may reinforce or contradict formal socialization goals.

Building a competent workforce, one where people believe they fit in well with their organizations, is often viewed as a competitive advantage in the business world. For organizations, a competent and committed workforce minimizes costly turnover and selection expenses. Moreover, individual employee attributes associated with successful organizational socialization can accumulate across the organization to positively effect organizational performance and effectiveness. Organizational socialization is a primary process to facilitate work adjustment for new employees or for employees taking on new roles. The extent to which both organizational and individual socialization processes support a good person-organization fit will define the extent to which that individual has been successfully socialized.

Typically, organizational socialization concerns how new hires adjust to a new job and organization, and these people are generally described as organizational newcomers or recruits; however, the socialization process applies to anyone who faces a new job. Thus, every new assignment or transfer that substantially changes an individual's location, duties, and/or surrounding personnel will require a new round of socialization as a new role is learned.

Furthermore, every promotion will require an adjustment period as the individual assumes the new rank. Thus, chains of socialization experiences are linked with each new experience interpreted within a context of prior socialization episodes. Organizational newcomers generally have more to learn than job changers because they need to adjust to both a specific job and an organizational culture, so most of the research on organizational socialization focuses on organizational newcomers.

Organizational Socialization: Process and Content

Most models of organizational socialization describe three basic stages beginning with anticipatory socialization, entry-encounter experiences, and ending with change and mutual acceptance. The anticipatory socialization stage occurs before organizational entry and describes how early job/organization expectations are shaped as a person selects and prepares for a particular career. Young adults' career choices are often based on rough ideas or expectations of what that career will be like. These initial expectations may be inaccurate, with military life perceived as in motion picture films like *Full Metal Jacket* and *Behind Enemy Lines*. Unrealistic expectations are linked to greater perceptions of shock when the newcomer enters the organization and reality.

The second stage of socialization typically includes early learning and adjustments after organizational entry. The newcomer learns how to do the job and how to fit into the organization's culture. This learning stage includes the sense making process that helps the newcomer reconcile unmet expectations and surprises. Within an organization, there are six general areas of learning: performance proficiency, language, people, politics, organizational goals and values, and history (Chao, O'Leary-Kelly, Wolf, Klein, & Gardner, 1994). First, *performance proficiency* involves learning the knowledge, skills, and abilities to perform a job successfully. Siebold (2006b) described his life as an airman during the Vietnam war, and noted that job competence was a fundamental value in a unit. If you couldn't pull your weight consistently, someone else had to pick up the slack or the risk. Thus, being proficient on the job was a primary condition for "fitting in" with a unit. Second, *language* involves learning special acronyms and terminology used by the organization. Ricks (1997) describes how the Marine Corps boot camp teaches recruits a new language to accompany their new world. Floors are decks, doors are hatches, writing pens are inksticks and sneakers are go-fasters. The particular words and acronyms used by organizational members distinguish themselves from organizational outsiders. Thus, the Army understands TRADOC, FCS, and TASS whereas the American Psychological Association understands CIRP, BAPPI, and COGDOP. Third, the *people* dimension includes learning to get along with other organizational members. At West Point, cadets often followed the dictum "cooperate and graduate", in order to survive and thrive (Atkinson, 1989). Newcomers who fail to get along with others are most likely to be marginalized and relegated to an "out-group" of misfits.

The fourth socialization content dimension, *politics*, involves learning formal and informal power structures. Understanding who could do what, regardless of rank, is valuable knowledge for someone trying to fit in. It helps the newcomer understand who to go to for help and who to avoid. Formal power is readily understood, but informal power is less transparent, albeit potentially more effective. Seibold (2006b) recounted how a person who was widely despised by the finance office could have his pay records misplaced or lost. Although a tame example, this type of informal power was wielded on those who did not fit in. The fifth dimension, *organizational goals and values* involve understanding the organization's culture. Research has shown that individuals who do not accept the organization's goals and values as their own, are likely to leave that organization. Finally, *history* involves learning about the organization's past as well as the specific history associated with the newcomer's group. Elite units like the Rangers, Airborne or Special Forces, instill a strong sense of history and culture to their newest members who are duty-bound to uphold these traditions. The need to identify with these elite units may be so great that officers who did not complete their training may risk wearing unauthorized insignia rather than face humiliation (Atkinson, 1989).

The final stage of socialization generally recognizes successful adjustment as an organizational newcomer is transformed into an organizational insider. Insiders have "learned the ropes" to fit in and can serve as valuable resources of information for future newcomers. Organizations may hold graduation ceremonies to signify that a newcomer is no longer a recruit, but a full-fledge member of the organization. Although most of the research on organizational socialization centers on newcomers, some studies recognize that insiders can learn more about their own roles as they socialize newcomers or as newcomers precipitate shifts in role expectations for insiders.

Research in the private sector found that organizational newcomers generally scored lower than organizational insiders on the six socialization content dimensions. Thus, newcomers faced significant learning needs in multiple areas. Furthermore, people who were better socialized, tend to be more satisfied with their jobs, more involved in their careers, and earned more income than people who were less well socialized. Perhaps most interesting is the finding that people who don't perceive themselves to fit with the organization's goals and values are most likely to quit their jobs and change organizations. Regardless of *how* people learn in these content areas, mastery was associated with greater socialization and greater socialization was associated with positive job and career outcomes.

Leadership, Developmental Networks, and Organizational Socialization

During the organizational socialization process, there are many organizational members who can help or hinder a newcomer's adjustment. Organizational superiors, peers, and subordinates can all serve as socialization agents, providing different perspectives, lessons, and sense-makings to a newcomer. Within this context, a leader's influence is likely to carry the most weight, due to the leader's power and influence. However, the amount of contact a newcomer has with other personnel and the quality of those relationships, can moderate the effectiveness of a leader's socialization efforts.

Leaders often serve as mentors to their subordinates. As a mentor, a leader provides two broad types of support to the protégé: career-related and psychosocial support. Both functions involve the mentor teaching a protégé to be successful; hence they involve socialization content and processes. The career-related function is focused on how the protégé learns to perform his or her job well. The mentor can serve as a role model, directly train the protégé or provide stretch assignments that challenge and develop the protégé's skills. The psychosocial function is focused on how the protégé learns to fit in and be accepted by others. Here, the mentor counsels the protégé, affirms the protégé's value to the organization, and may protect the protégé from others if necessary. Good mentors do not micro-manage their protégés, but rather let them develop within the organization with an insider's guide to what works and what doesn't work. Aspects of all six socialization content dimensions (performance proficiency, language, people, politics, organizational goals/values, and history) may be seen in career-related and psychosocial functions.

Leaders are prime agents to communicate and model an organization's goals and values. Although goals and values can be explicitly taught, the real lessons come from actions, not words. Brigadier General Floyd W. Radike (2003) described an incident during WWII when he served as a lieutenant in Guadalcanal. His regiment completed a week of field exercises and was ordered to return to camp. The battalion mortar section loaded its equipment into a truck and marched back with the rest of the regiment since no one was to ride back. Upon arrival at camp, a colonel noticed that the mortars were not being carried and ordered the battalion CO to have the mortar weapons sent back to the exercise area to be carried back by men. The CO was livid and thought he and the other officers should perform this task. They agreed and during the last half mile of their march, they were greeted by the entire regiment who lined the road to cheer the officers on. Beer and spirits were handed to the marchers and they returned to the battalion area as triumphal heroes. Radike noted that "Nothing else we ever did so impressed the men".

Leaders have power to affect others' job assignments and visibility. They may also be in position to protect others from early mistakes or to shield them from negative organizational members. Radike's story illustrates how a colonel's order can be evaluated negatively, resulting in little respect for the officer or for what that officer represents. We can only speculate the goals or values represented by that order. Despite the lower rank, the CO demonstrated leadership by personally carrying out the colonel's order instead of passing it down. This action conveyed respect to the soldier; a true value the Army espouses. Leaders who convey the organization's goals and values through their actions serve as powerful role models for others to follow.

Socialization Space: New Information Coming In All the Time

Good leaders can create a 360-degree socialization space for newcomers. Just as battle space recognizes potential targets from all possible locations in land, sea and air; a 360-degree socialization space recognizes potential socialization agents from a newcomer's total environment. A soldier's officers, peers, and unrelated personnel can provide profound experiences to shape that soldier's values, expectations, and commitment. Most importantly, the lessons that come from these experiences are often not planned lessons, but unintended lessons that are implicitly absorbed into a person's knowledge base.

Implicit learning is generally viewed as a default mode of learning because it occurs at a nonconscious level. Since the term *unconscious* includes popular conceptions associated with sleep or trauma (e.g., a blow to the head knocked him unconscious) as well as wakeful states of conscious unawareness, the term *nonconscious* is used here to describe a physical state of consciousness but a lack of conscious awareness. Thus, with implicit learning, we learn things when we are not aware that we are learning. A common marketing example of implicit learning involves commercial jingles and slogans. Although the typical TV viewer is not consciously trying to learn a commercial jingle, indeed the viewer may not even be paying attention to the TV during the commercials, most people have learned "the few, the proud… the Marines" and in the Army, you can "be all that you can be".

Implicit learning occurs all the time, making it the primary learning process. By removing the requirement that the individual be attentive or motivated to learn, implicit learning is faster and processes more information than consciously controlled cognition. Not only is the individual unaware that learning has occurred, he or she is unaware that such knowledge would influence attitudes or behaviors and is generally unable to consciously retrieve or articulate this knowledge. When asked the question, "What is your favorite color?" most people have a quick answer, but they often cannot explain why their answer is their favorite color. Cognitive psychologists believe that chance pairings or covariations of stimuli can lead to the development of specific attitudes or values. Thus, a toddler's beloved blue blanket may shape that child to identify blue as his favorite color. However, that same child may not be consciously aware of the tie between the blanket and his preference for blue.

The knowledge derived from implicit learning is often described as tacit knowledge that fuels a sense of intuition or gut feeling. This inexplicable sense of what is right or wrong helps an individual make decisions or engage in a particular course of action. Research on implicit learning and tacit knowledge has found that reaction times to specific situations are faster when people don't have to think about it. Furthermore, implicit learning is characterized by robustness to time, psychological disorders, and secondary tasks (Berry & Dienes, 1993). Subjects in psychological experiments were found to use implicitly learned knowledge long after explicit knowledge was lost. In addition, people who suffered from amnesia, clinical depression, brain damage and other serious psychological and/or neurological disorders were able to implicitly learn information they were unable to explicitly master. Finally, subjects who were distracted on secondary tasks showed little interference in their ability to implicitly learn.

Within an organizational socialization context, newcomers pool all their experiences together to make sense out of them and to determine if they fit with this derived sense of the organization. Much of this socialization occurs in informal ways through incidental learning conditions that were not planned nor intended to teach specific lessons (Chao, 1997). Thus, leaders are cautioned that any and all newcomer experiences may be critical for successful socialization. Important military values have to permeate through most of these critical experiences for their relevance to sink into a newcomer's tacit knowledge base. Leaders have to "walk the talk" in order to expect their charges to do so. They do this at the personal level and at the interpersonal level as they influence other socialization agents of the newcomer.

Developmental Networks: Shaping the Socialization Space

Although traditional mentoring describes a close, one-on-one relationship between a senior mentor and a junior protégé, current research has expanded the general concept of mentoring into developmental networks. Instead of one intense mentorship, individuals are likely to have multiple role models who help them adjust to the organization and job. Chao (in press) describes how a developmental network can facilitate the organizational socialization process. Within an individual's network, developers are socialization agents who provide career-related and psychosocial support as he or she adjusts to a new organization or role. These developers are generally described by two category schemes: 1) their hierarchical relationship with the newcomer and 2) the key feature(s) that attract the developer and newcomer to engage in a professional relationship. From a hierarchical perspective, the developer may be the newcomer's direct or indirect superior, peer, or subordinate. Direct relationships are closely tied to the newcomer's formal lines of authority, current job assignment, and performance expectations; thus these relationships are better positioned to help the newcomer adjust to the job. Indirect relationships generally cross one or more lines of authority or units; thus these relationships are better positioned to help the newcomer adjust to the general organization and culture.

Developers who are peers or subordinates of a newcomer are less likely to have organizational power, but the newcomer may be more comfortable seeking help from these kinds of developers. Peer developers often support each other in the socialization process and share lessons learned. Their similar positions in the organization and shared need to adjust efficiently provide a common ground for developmental relationships. Subordinate developers can be rich sources of information about people and procedures. Newcomers may be more comfortable asking a subordinate for help because the subordinate is less threatening and their evaluations of the newcomer are generally not as important as superior and peer evaluations. For example, a newly promoted officer may be more likely to ask a subordinate or former peer about a particular procedure than to ask peers or superior officers.

In addition to categorizing developmental relationships by places in the organization's hierarchy, these relationships can be distinguished by key criteria that link a newcomer with a developer. These criteria may include shared demographic characteristics like race, gender, and religion or they may be more complex with people networking with others based on shared values, interests, or skills. Leaders can help newcomers build their developmental networks by forging links with others who positively promote the organization's goals and values. Social learning, whether it be implicit or explicit, is more likely to occur when the newcomer identifies with a developer through one or more key criteria.

The developmental network approach recognizes that people are the primary socialization agents. In addition to interpersonal interventions, organizations can help newcomers adjust to their jobs by providing adequate resources to help them maximize their job performance. Manuals can help newcomers learn important acronyms and jargon that distinguish organizational members. Handbooks can shape newcomer expectations and identify behaviors and customs of members that the organization would like to promote. Finally, performance feedback can give newcomers a sense of how the organization perceives the person-organization fit and provide guidance to improve the fit, if warranted.

Within developmental networks, leaders can serve as central nodes or connectors in the network. Good leaders exemplify military values and clearly articulate organizational goals that are relevant to a subordinate's performance. Good leaders identify and reward positive role models for newcomers. Good leaders recognize that subordinates are always learning from them. Values take time to establish, but only a second to destroy. Thus, good leaders monitor the newcomer's environment to make sure the lessons learned are consistent with the organization's goals and values. Finally, good leaders help newcomers interpret their experiences and correct any misinterpretations or negative experiences. The socialization process involves cumulative learning, with new experiences interpreted within the context of old ones. Thus, early socialization of young adults into the military will establish the critical foundation for basing subsequent behaviors, attitudes, and decisions.

New Challenges with New Recruits

Current research in psychology and sociology describe a new generation of young adults who are qualitatively different from previous generations. Arnett (2004) describes these young adults as emerging adults – people generally between the ages of 18-25 who have not assumed full adult roles. Traditionally, adulthood is defined by three states: financial independence, marriage, and starting a family. In contrast, emerging adults are delaying marriage and parenthood, and often still live with their parents. Popular motion picture films like *Failure to Launch*, attest to the growing trend of young adults who postpone traditional adulthood. This generation has developed attitudes and values that impel organizations to change their socialization strategies if they want to effectively and efficiently indoctrinate new members.

What makes this generation of young adults different from previous ones? Economic, cultural, medical, and historical trends have enabled today's young adults to put off financial and familial responsibilities. Unlike previous generations, most of today's emerging adults are likely to have parents who can still afford to support them well after high school and college graduations. Although some parents would rather see their adult children on their own, many encourage these young adults to stay home in order to avoid an empty nest. Cultural attitudes are more tolerant of premarital sex with television programs like *Sex in the City* supporting lifestyles that don't encourage marriage. Furthermore, medical advances in birth control and fertility, have made it possible for more women to postpone childbirth until they are in their 30's or even 40's. Finally, recent scandals in government, business, and religion have eroded emerging adults' trust in traditional institutions and leaders from these establishments. Presidential impeachment, corporate implosions in financial scandals, and large-scale lawsuits convicting religious leaders of sexual misconduct have helped produce a generation of emerging adults who are less likely to follow advice from their elders and more likely to take their time to make life-changing decisions.

Descriptions of emerging adults reveal positive and negative pictures. On the positive side, delaying marriage until the late 20's may help reduce teenage pregnancies and early divorces. Delaying career choices may also give emerging adults more time to carefully consider alternatives and develop a realistic preview of a chosen career. On the negative side, many emerging adults choose to live with their parents and drift in a series of low paying, disconnected jobs, saving their money to buy cars, HDTVs, cell phones, etc. They have a sense of entitlement to special attention, extra favors, and rewards; but don't feel obligated to put in the work that might merit these considerations.

A veteran with over 20 years in the Air Force complained to me that new recruits were getting harder and harder to train. Many emerging adults were not committed to military values and job expectations. They were more likely to challenge an order and less likely to be conscientious in their work. This problem is observed also in the private sector where early turnover is a growing concern. Many organizations are discovering that salary alone is not enough to attract young adults. These people want exciting work that challenges them, although many may not have the requisite skills or experience to perform those jobs. Furthermore, plum assignments and high-impact jobs are typically awarded to established employees who have already demonstrated their qualifications and motivations to do the job.

So what can an organization do? We need to develop leaders who can provide the proper context for successful socialization. Such training can include an understanding of the socialization process, what needs to be learned, how newcomers typically learn it, and what can be done to make this learning more efficient. The training and development of these leaders cannot be bound by formal training programs, but must be integrated into everyday life. It is a reflection of the organization's culture and a living example of its values.

Conclusions and Future Research

Like Sun-tzu's maxim at the beginning of this paper, the goal of organizational socialization is to unite upper and lower ranks in purpose. This process is complex because it involves interactions between the newcomer, current organizational members, and the organization. Lessons learned may be intentional or unintentional; conscious or nonconscious. The mix of formal organizational interventions (e.g., basic training) and informal interventions (e.g., a mentor) may not provide compatible lessons, thus complicating the sense making process. It must be noted that no amount of organizational intervention can socialize newcomers to be radically different from current members unless factors supporting new organizational roles and values are promoted for all. Not all experiences can be carefully orchestrated, but initial directions, via leadership and training for all personnel, can chart a course for successful organizational socialization.

What We Know Now

Key research findings on organizational socialization include:

- Regardless of what an organization may do or not do, newcomers and members in new roles will go through a socialization process; thus good leadership would prescribe some planning to guide this adjustment.
- Early successful organizational socialization leads to later career success.
- Newcomers who rely more on their leaders for socialization information are better adjusted over time.
- A leader's relationships with subordinates help define a shared climate and understanding of that leader's unit.
- A leader can help newcomers overcome reality shock from unrealistic expectations of the job or organization.
- A leader can help minimize newcomers' dissatisfaction and intentions to leave the organization.
- Current theory asserts that leaders can shape socialization and team development processes to build adaptive teams.

- A leader has long lasting effects on an individual's organizational socialization.

What We Still Need to Know

Future research in organizational socialization will be challenging. Ideally, longitudinal research should examine how organizational interventions and individual actions and reactions interact to determine the person-organization fit. New interventions need to be designed to accommodate emerging adults with different career aspirations and values. Corrective measures taken by one or both parties who perceive a misfit should be explored. Actions taken to correct misperceptions could save a valued soldier from leaving the army. Conversely, if a true misfit is identified, an early separation would benefit both parties and minimize negative consequences. Well-designed longitudinal studies can track the socialization process as it unfolds and effects a new generation of people entering and building military careers.

Future research can take many directions. A few are listed below to close this white paper and to stimulate new research on organizational socialization, leadership, and developmental networks.

- Network theory can be applied to future organizational socialization research. Within a developmental network, what kinds of network links aid or hinder work adjustment?
- The leader's roles within a developmental network need to be better understood in order to maximize their effectiveness. These roles may include serving as a role model, mentor, information resource, sense maker, and linking pin to other socialization agents.
- Within a dynamic framework, a leader's roles within a newcomer's socialization space should be researched to understand how leaders can best establish and maintain positive socialization experiences.
- Research is needed to understand differences between the initial socialization process for organizational newcomers and resocialization processes of established organizational members. A particularly strong or powerful new officer has the potential to resocialize members of an existing unit to a new way of work and conduct. How can a leader efficiently break down previously learned, negative socialization lessons and indoctrinate proper goals, values, and behavior?
- How does organizational socialization tie in with other organizational processes such as organizational learning, team development, and complex adaptive systems? What kinds of socialization changes are needed to accommodate future systems and future generations of organizational members? Is organizational socialization the bedrock for building an agile organization?

To maximize an organization's competitive advantage, it must be effective and efficient in uniting upper and lower ranks. It starts with leaders in the upper ranks, who are equipped with the knowledge and skills to direct socialization experiences of others. It should end with a cohesive organization, united in goals and values.

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INTRODUCTION

OUR VIEW OF LEADERSHIP DEVELOPMENT

Ellen Van Velsor
Cynthia D. McCauley

As in any discipline, the field of leadership development advances its understanding and practice by examining and reexamining fundamental questions.
In leadership development, these central questions include the following:

- What does it take to be an effective leader?
- What aspects of a leader's talents are hard-wired, and what aspects are developable?
- How do people learn important leadership skills and perspectives?
- Do some people learn more than others from their leadership experiences?
- What are the necessary ingredients for stimulating development in leaders?
- What are the best strategies for enhancing leadership development?

Exploring these types of questions with our clients and colleagues has been the basis of the Center for Creative Leadership's efforts to advance the understanding, practice, and development of leadership. In the 1970s, CCL began experimenting with feedback-intensive leadership development programs—programs that provide participants with a heavy dose of feedback in a supportive environment. Over the years, we have refined these programs and added new components, developed more sophisticated feedback tools and methods, and studied the impact of our programs on the participants. We have also tried to understand how managers learn, grow, and change throughout their careers—not just from formal programs but also from the challenges in their working and nonworking lives, the relationships they cultivate, and the hardships they encounter.

We continue to invest energy and resources in efforts to understand and improve the leadership development process. For most of CCL's history, the essential question that has provided direction for both our research and educational activities has been, How can people develop the skills and perspectives necessary to be effective in leadership roles? Much of what we have learned from examining this question is contained in this handbook. More recently, we have broadened our research and practice beyond developing individuals to developing organizational capacity for leadership. What we are learning from this broader perspective on leadership development is also shared in the handbook.

In this introductory chapter, we present a framework for understanding what is to follow. We distill what we have learned into a model of leader development, and this model serves as scaffolding on which to place the concepts that are discussed in detail in the chapters that follow. We also discuss how and why our understanding of leadership development is expanding to include issues in addition to the development of the individual leader.

Assumptions and Model of Leader Development

We define *leader development* as the expansion of a person's capacity to be effective in leadership roles and processes. Leadership roles and processes are those that facilitate setting direction, creating alignment, and maintaining commitment in groups of people who share common work.

You should note three things about this definition. First, it is a definition of *leader development,* not of the more commonly used phrase *leadership development.* Most of our research and educational programs are directed toward developing the individual, so developing *leaders* is where we begin in describing our model. We will return to the broader concept of *leadership* development later in the chapter.

Second, we try to look at what makes any person effective in a variety of leadership roles and processes (rather than looking at the traits or characteristics of formal leaders). The assumption here is that in the course of their lives, most people must take on leadership roles and participate in leadership processes in order to carry out their commitments to larger social entities—the organizations in which they work, the social or volunteer groups of which they are a part, the neighborhoods in which they live, and the professional groups with which they identify.

These leadership roles may be formal positions infused with authority to take action and make decisions (for example, a manager, an elected official, or a group's representative at a meeting), or they may be informal roles with little official authority (the team member who helps the group develop a better sense of its capabilities, the person who organizes the neighborhood to fight rezoning efforts, the whistle-blower who reveals things gone wrong). Leaders may actively participate in recognized processes for creating change (such as serving on task forces or project teams, identifying and focusing attention on problems or issues, or getting resources to implement changes) or more subtle processes for shaping culture (telling stories that define organizational values, celebrating accomplishments).

Rather than classifying people as "leaders" or "nonleaders" and focusing our work on developing "leaders," we believe that all people can learn and grow in ways that make them more effective in the various leadership roles and processes they take on. This process of personal development that improves leader effectiveness is what we understand leader development to be about.

Finally, although it may go without saying, we should note that we do believe that individuals can expand their leadership capacities and that this effort to develop is worthwhile. A key underlying assumption in all of our work is that people can learn, grow, and change and that this learning and personal growth does enhance individual effectiveness. We do not debate the extent to which effective leaders are born or are developed. No doubt, leadership capacity has its roots partly

FIGURE I.1. LEADER DEVELOPMENT MODEL.

(**a**) Developmental Experiences

(**b**) The Development Process

in genetics, partly in early childhood development, and partly in adult experience. What we focus on here is what our experience has amply demonstrated: adults can develop the important capacities that facilitate their effectiveness in leadership roles and processes. People can use their existing strengths and talents to grow in their weaker areas and can significantly enhance their overall effectiveness through leader development work.

The core question, of course, is how to go about it. How do people acquire or improve their capacity for leadership? How do organizations help them in this process? A two-part model, illustrated in Figure I.1, reflects our attempt to summarize what we have learned thus far about the ingredients that go into leader development. The three factors in part (a) of the model—assessment, challenge, and support—are the elements that combine to make developmental experiences more powerful. That is, whatever the experience, it has more impact if it contains these three elements.

We know that although leaders learn primarily through their experiences, not all experiences are equally developmental. For example, the first year in a new job is usually more developmental than the fifth or sixth year. Working with a boss who gives constructive feedback is usually more developmental than working with one who does not. A training program that encourages lots of practice and helps participants examine mistakes is usually more developmental than one that provides information but no practice. Situations that stretch an individual and provide

both feedback and a sense of support are more likely to stimulate leader development than situations that leave out any of these elements. You can make any experience—a training program, an assignment, a relationship—richer and more developmental by making sure that the elements of assessment, challenge, and support are present.

Part (b) of the model shows that leader development is a process that requires both a variety of developmental experiences and the ability to learn from experience. The latter is an element that the individual brings to the development process. In the course of much of our work, we have noticed that people learn from similar experiences to differing degrees and in different ways. Although such variation is explained in part by the level of challenge that different people perceive in any experience, another factor is the individual's ability to learn from an experience. The ability to learn is a complex combination of motivational factors, personality factors, and learning tactics.

Part (b) of the model also shows that developmental experiences and the ability to learn have a direct impact on each other. Being engaged in a developmental experience can enhance a person's ability to learn, and being more readily able to learn can lead one to draw more development from any set of experiences. Thus although we conceptually separate the developmental experience and the learner in our model (the better to discuss them), they are in actuality closely interconnected: developmental experiences can enhance a person's ability to learn, and individuals with high ability to learn seek out and may benefit more from a variety of developmental experiences. This dynamic is examined in much greater detail in Chapter Seven.

Finally, part (b) indicates that any leader development process is embedded in a particular organizational context: the organization's business strategy, its culture, and the various systems and processes within the organization. This context shapes the leader development process—how it is focused, how well-integrated and systemic it is, and who is responsible for it.

Elements of an Effective Developmental Experience

Through CCL's research and educational programs, we have begun to gain a better understanding of the elements that are key drivers of leader development (assessment, challenge, and support). When we look at any type of developmental experience, from training programs to job assignments, we find that they are most effective when all three elements are present.

These elements serve dual purposes in the development process. First, they motivate people to focus their attention and efforts on learning, growth, and change. Second, they provide the raw material for learning: the information, observations, and reactions that lead to a more complex and sometimes quite different understanding of the world. To enhance the development of leaders, we need to help them find, create, and shape a wide range of learning experiences, each of which provides assessment, challenge, and support. Table I.1 summarizes the motivational role played by each element, as well as the kind of learning resource each provides. In the next three sections of this chapter, we look at each of these elements in more depth.

TABLE I.1. ELEMENTS OF A DEVELOPMENTAL EXPERIENCE.

Element	Role in Motivation	Role as a Resource
Assessment	Desire to close gap between current self and ideal self	Clarity about needed changes; clues about how gap can be closed
Challenge	Need to master the challenge	Opportunity for experimentation and practice; exposure to different perspectives
Support	Confidence in ability to learn and grow; positive value placed on change	Confirmation and clarification of lessons learned

Assessment

The best developmental experiences are rich in assessment data. Assessment data can come from oneself or from other people. The sources are almost limitless: peers in the workplace, bosses, employees, spouses, children, parents, friends, customers, counselors, and organizational consultants. The processes for collecting and interpreting the data can be either formal or informal, with many shades of variation in between.

Formal assessment from others includes such processes as performance appraisals, customer evaluations, 360-degree feedback, organizational surveys that measure employee satisfaction with managers, and evaluations and recommendations from consultants. Informal assessment data from others are available more regularly through less structured processes: asking a colleague for feedback, observing others' reactions to one's ideas or actions, being repeatedly sought out to help with certain kinds of problems, or receiving unsolicited feedback from a boss. Self-assessment can also occur through formal and structured means, as with psychological inventories or journaling, or through informal and often in-the-moment processes, such as monitoring of internal states, reflecting on decision processes, or analyzing mistakes.

Assessment is important because it gives people an understanding of where they are now: their current strengths, the level of their current performance or leader effectiveness, and what are seen as their primary development needs. So one important function of assessment data is that they provide a benchmark for future development. Another is that they stimulate people to evaluate themselves: What am I doing well? Where do I need to improve? How do others see me? In what ways do my behaviors affect others? How am I doing relative to my goals? What's important to me? Still another is that assessment data provide information that helps people answer these questions. In the context of their everyday work, people may not be aware of the degree to which their usual behaviors or actions are effective. In the face of a new challenge, they may not know what to continue doing and what to change. Even if they realize that what they are doing is ineffective, people may believe that the answer is merely to work harder; it may not occur to them to try a new strategy. But when an experience provides feedback on how one is doing and how one might improve or provides other means for critical self-reflection, the result can be an unfreezing of one's current understanding of oneself to facilitate movement toward a broader and more complex understanding.

Assessment information also points out the gaps between a person's current capacities and performance and some desired or ideal state. The desired level might be based on what the job requires, what someone's career goals demand, what other people expect, or what people expect of themselves. This gap is one of the keys to why developmental experiences motivate learning, growth, and change. If the area is something that is important to them and if they believe in the accuracy of the assessment data, people work to close the gap by improving their current capacities. If the assessment data indicate that there is no gap—that in fact someone is quite effective in a particular area—then the outcome of the assessment can be increased self-confidence. As a result, the person may seek out more opportunities to use and refine the strength.

Good assessment data also help people clarify what they need to learn, improve, or change. Having data not only motivates a person to close the gaps but also provides clues as to how those gaps might be closed. For example, if a leader learns that part of the reason for low morale in his work group is his pattern of not delegating important work to others (which, he comes to understand, is grounded in perfectionism), then improving morale involves learning how to let go of work, including how to be more in touch with his perfectionist tendencies so that they can be better managed. If a person's frustration at work is diagnosed as being partially caused by low tolerance for ambiguity, she can focus on ways to increase her tolerance or to shape situations so that they are less ambiguous.

Assessment enhances the power of leader development because assessment processes, whether formal or informal, help people fully understand their situation and become motivated to capitalize on the learning opportunities available to them.

Challenge

Developmentally, the experiences that can be most potent are the ones that stretch or challenge people. People tend to go about their work using comfortable and habitual ways of thinking and acting. As long as conditions do not change, people usually feel no need to move beyond their comfort zone to develop new ways of thinking and acting. In a comfortable assignment, people base their actions on well-worn assumptions and existing strengths, but they may not learn much from these opportunities. The same is true for a comfortable relationship, feedback that confirms, or training in skills that have already been mastered. In all such cases, comfort is the enemy of growth and continued effectiveness.

Challenging experiences force people out of their comfort zone. They create disequilibrium, causing people to question the adequacy of their skills, frameworks, and approaches. These experiences require that people develop new capacities or evolve their ways of understanding if they are going to be successful.

For example, a task force assignment can be developmental when the task is critical to the business, success or failure will be known, and task force members must present a recommendation for action to the senior executives of the organization, because challenge is embedded in the assignment. However, it is particularly developmental for people who have not faced such challenges before.

People feel challenged when they encounter situations that demand skills and abilities beyond their current capabilities or when the situation is very confusing or ambiguous and current ways of making sense of the world no longer seem to work. For some people, challenge might mean being caught in the middle of a conflict where others are making demands that seem to call for resolution in opposite ways. For others, challenge might mean struggling to empower subordinates who do not take initiative and seem to resist taking a personal stake in their work. And for others, challenge might come in the form of work in a corporate environment, where it becomes less clear what “results” mean or how to achieve them.

So what are the elements of situations that can stretch people and motivate development? In other words, what are the sources of challenge? One common source is novelty. Experiences that require new skills and new ways of understanding oneself in relation to others can be the most challenging. These situations are often quite ambiguous, requiring much discovery and sense making by the newcomer. The power of new experiences is illustrated in Linda Hill’s in-depth study (1992) of men and women during their first managerial assignment. Hill found that becoming a manager required more than learning new skills and building relationships. Rather, it was a profound transformation, one that caused them to think and feel in new ways—to actually develop a new identity.

Difficult goals, whether set by oneself or by others, are another source of challenge. People often respond to difficult goals by working harder. But they may also discover that extra effort is not enough, that they have to work differently in order to reach the goal. Executives report that some of the toughest assignments in their careers are starting-from-scratch assignments in which they have the difficult goal of building something from nothing—and usually have to do it quickly, with little To succeed, they have to let go of normal operating procedures and learn as they go, using whoever and whatever is available to solve problems. Leaders who go through formal leadership development programs are often faced with the difficult goal of changing their own behavior or risking endangerment of their groups' performance or their own career goals. Again, this difficult goal is a source of challenge and thus is a potential stimulus for learning and growth.

Situations characterized by conflict, either with someone else or within oneself, can also be a source of challenge. Effectively dealing with conflict with a person or group requires people to develop an understanding of other perspectives, to become better able to differentiate others' points of view from their own, and perhaps to reshape their own points of view. People face similar challenges when they experience incompatible demands that cause conflict within themselves—for example, meeting work and family responsibilities, working satisfactorily for both the boss and subordinates, or meeting customer needs in ways that do not overstress the organization. Ron Heifetz (1994), director of the Leadership Education Project at the Kennedy School of Government, Harvard University, sees the surfacing and orchestration of conflict as one of the hardest but most valuable tasks of leadership. In his view, conflict is the stimulus for mobilizing people to learn new ways. He gives the example of an industrial plant that was a major source of jobs for a community but was creating levels of pollution unacceptable to federal agencies. As community leaders were forced to deal with the conflict between jobs and health, they developed new ways of understanding the problem (namely, as an issue of diversifying the local economy), which implied new courses of action for them to take.

Dealing with losses, failures, and disappointments can also stretch people. Job loss, business mistakes, damaging relationships, and similar events can cause a great deal of confusion, often stimulating a search for new meaning and understanding. In CCL's work, we have found that these kinds of experiences, which we call *hardships*, startle people into facing themselves and coming to terms with their own fallibilities. Hardships also teach people how to persevere and cope with difficult situations. This is sometimes referred to as the "inoculation effect": undergoing stressful experiences may render similar experiences in the future less distressing, primarily because the person has developed better coping strategies.

The element of challenge serves the dual purpose of motivating development and providing the opportunity to develop. Challenging situations motivate by causing disequilibrium and then capitalizing on people's need for mastery. When the outcomes of the situation matter to people, they are motivated to work toward meeting the challenge. This means becoming competent in new areas, achieving difficult goals, managing conflicts, and easing the pain of loss and failure. Mastering challenges requires putting energy into developing skills and abilities, understanding complex situations, and reshaping how one thinks.

Challenging experiences also provide opportunities to learn. People learn how to negotiate without having places to practice negotiation, test out different strategies, and see how people react. They do not gain broader perspectives without coming face-to-face with people who have different perspectives or with situations that do not fit neatly into how they think about the world. People do not learn to cope with stress without feeling stress and figuring out how to decrease it. By engaging the challenge, people interact with the environment in a way that produces the information, observations, and reactions needed to learn.

Simply stated, people do not develop the capacity for leadership without being in the throes of the challenge of leadership work. Participating in leadership roles and processes is often the very source of the challenge needed for leadership development. Leadership roles and processes are full of novelty, difficulty, conflict, and disappointments. In other words, leadership itself is a developmental challenge. Leading is, in and of itself, learning by doing.

Finally, we also want to emphasize the importance of variety of challenge for developing the wide range of capacities that leaders need. We emphasize this because we have found that people learn different lessons from different kinds of experiences. From a “fix-it” job, leaders can learn toughness, the ability to stand on their own two feet, and decisiveness. From leaving a line job for a staff position, leaders have the opportunity to learn how to influence individuals over whom they have no direct control. From a formal leadership program, participants learn how to step back from the day-to-day routine and develop a deeper understanding of their preferences, strengths, and blind spots. From an effective boss, leaders learn important values such as fairness and sensitivity to the concerns of others. From a hardship situation, people can recognize their limits and learn how to deal with stress. All are important leadership lessons; each is learned from a different type of experience. Thus a variety of challenging experiences throughout their careers is an important ingredient for developing versatile leaders.

Support

Although developmental experiences stretch people and point out their strengths and weaknesses, such experiences are most powerful when they include an element of support. Whereas the element of challenge provides the disequilibrium needed to motivate people to change, the support elements of an experience send the message that people will find safety and a new equilibrium on the other side of change. Support helps people handle the struggle and pain of developing. It helps them bear the weight of the experience and maintain a positive view of themselves as capable, worthy, valuable people who can learn and grow.

Support means different things to different people. For some, seeing that others place a positive value on their efforts to change and grow is a key factor in staying on course with development goals. For others, having the resources and freedom to move forward on self-initiated goals is the needed support.

Perhaps the largest source of support is other people: bosses, coworkers, family, friends, professional colleagues, coaches, and mentors—people who can listen to stories of struggle, identify with challenges, suggest strategies for coping, provide needed resources, reassure in times of doubt, inspire renewed effort, celebrate even the smallest accomplishments, and cheer from the sidelines.

Different people may provide different kinds of support. For example, the new managers in the Hill study cited earlier relied heavily on peers to release their pent-up frustrations and find emotional support. Those who had developed close relationships with former bosses often turned to those individuals when struggling with difficult questions.We have also found that the support of one's current boss is particularly important when trying to change behaviors or learn new skills. Bosses can be a strong source of reinforcement for the desirability of the targeted development, and they can provide the needed resources for successful learning and change.

Support can also come from organizational cultures and systems, taking the form of norms and procedures. Organizations that are more supportive of development have a closely held belief that continuous learning and development of the staff are key factors in maintaining organizational success, and they tend to have systems in place that support and reinforce learning. They have systems for helping people identify development needs and work out plans for addressing them. They use a variety of development strategies, make resources available for learning, and recognize and reward efforts to learn and grow. Feedback, crossgroup sharing of knowledge and information, and learning from mistakes are part of their organizational culture.

Support is a key factor in maintaining leaders' motivation to learn and grow. It helps engender a sense of self-efficacy about learning, a belief that one can learn, grow, and change. The higher their self-efficacy, the more effort people exert to master challenges, and the more they persevere in difficult situations (Bandura, 1986). Support also serves as a social cue that puts a positive valence on where people are currently and on the direction in which they are moving. They sense, "If other people support me in doing this, it must be something valuable to do."

Support mechanisms also provide learning resources. By talking to others about current struggles, openly examining mistakes, and seeing to it that the organization reacts positively to the changes they make, people have the opportunity to confirm and clarify the lessons they are learning. They get the sense that they are on the right track, that the feedback they are receiving is legitimate, and that the new ways in which they are making sense of their situations are shared by others or will work toward making them more effective.

If people do not receive support for development—that is, if their environments, coworkers, bosses, friends, and family do not allow and encourage them to change—the challenge inherent in a developmental experience may overwhelm them rather than foster learning. For a sales manager on a key cross-functional task force, beginning to understand and value the dilemmas of the manufacturing engineer on the task force may be the initial step in developing a broader perspective—but what if she is thwarted by a boss who constantly reminds her not to give in to "the unrealistic demands of those bozos in engineering"? Or, as another example, an organization that wants to develop more effective teamwork is unlikely to make progress if it continues primarily to reward individual contributions.

In summary, the key elements that make any experience more developmental are assessment, challenge, and support. Whether you are designing a training program, providing 360-degree feedback, putting someone in a developmental job assignment, or matching an individual with a mentor, you need to ensure that all three elements are part of the experience.

What Develops in Leader Development

Over the years, we have asked effective managers to identify what they have learned that has made a difference or a lasting change in how they manage. We asked them to think about experiences on the job, outside of work, and in formal leadership development programs and to isolate the critical lessons. The results are clear: development comes from many kinds of experiences. These managers learned from challenging assignments, from significant people, from hardships, from training and coursework, and from a miscellany of other events (Douglas, 2003; McCall, Lombardo, and Morrison, 1988; Morrison, White, and Van Velsor, 1987, 1992). The lessons they learned involved new skills, values, abilities, and knowledge. Over time, people who failed to learn became stuck—whether in their personal lives or in their jobs.

We also know, however, that some traits such as IQ and certain personality characteristics are more or less innate and appear to remain stable over time. Development work with adults cannot significantly improve IQ or provide a personality transplant, despite what some people hope and others fear.

Over time, we have begun to identify some of the individual capabilities that enable leadership and can be developed. We believe that when these capabilities are enhanced, individuals are better able to carry out the leadership tasks of setting direction, gaining commitment, and creating alignment. Some capabilities reflect how individuals manage their own thoughts, feelings, and actions. Other capabilities reflect how individuals work with others in a social system. A final set reflects how individuals facilitate the accomplishment of organizational work.

Self-Management Capabilities

People develop more effective ways to manage themselves—their thoughts, emotions, attitudes, and actions—over time. The capacity for self-management enables leaders to develop positive and trusting relationships and to take initiative—important aspects of roles that help people work together in productive and meaningful ways. Self-management capabilities include self-awareness, the ability to balance conflicting demands, the ability to learn, and leadership values.

Self-Awareness. A key aspect of understanding oneself is having awareness of personal strengths and weaknesses: what one does well and not so well, what one is comfortable with and uncomfortable with, which situations bring out one's personal best and which are difficult to handle, when one has a wealth of expertise to draw on and when one had better look for expertise elsewhere. But selfawareness also means that people must understand *why* they are the way they are: what traits, learned preferences, experiences, or situational factors have shaped their profile of strengths and weaknesses. Self-awareness means understanding the impact their strengths and weaknesses have on others, on their effectiveness in various life roles, and on reaching their goals.

Ability to Balance Conflicting Demands. In organizational life, people encounter conflicting demands. For example, boss and subordinates may have different priorities, internal systems may not match external client needs, and the joint demands of personal and work life may cause stress. People must learn to not let the conflicts paralyze or overwhelm them, to understand the natural roots of the conflicts, and to develop strategies for balancing or integrating them.

Ability to Learn. When we say someone has the ability to learn, we mean that the person recognizes when new behaviors, skills, or attitudes are called for, accepts responsibility for his or her own development, understands and acknowledges current personal strengths and weaknesses, engages in activities that provide the opportunity to learn or test new skills and behaviors, reflects on his or her own learning process, and works to develop a variety of learning tactics in order to acquire needed skills or behaviors. A person with the ability to learn does not deny or ignore the need for new approaches, does not get stuck using habitual behaviors or outmoded skills, and is not seduced by past success into believing that no change or development is necessary.

Leadership Values. We have found that people who project certain personal values are particularly effective in leadership roles. Foremost among these values are honesty and integrity, which engender trust and credibility in others. Strong personal initiative and drive are needed to persevere in the face of difficult organizational goals. A positive, optimistic attitude supports both individual and group efficacy.

Social Capabilities

People develop many interpersonal and social skills over the course of their lives. Because leadership roles and processes are by their very nature social (meaning that they require making meaningful connections to others), the ability to work effectively with others in social systems is a fundamental capacity of leaders. Social capabilities include the ability to build and maintain relationships, the ability to build effective work groups, communication skills, and the ability to develop others.

Ability to Build and Maintain Relationships. At the heart of social capabilities is the ability to develop cooperative relationships. In leadership roles, the ability to develop positive relationships with many different types of people is particularly important. The foundation of this ability is the capacity to respect people from varying backgrounds and to understand the perspectives that they bring.

Ability to Build Effective Work Groups. People in leadership roles need not only to develop their own relationships with others but also to facilitate the development of positive relationships among others who work together. Effective leaders help create synergy, motivation, and a sense of empowerment in work groups.

Communication Skills. Communication skills operate in two directions. In addition to being able to communicate information, thoughts, and ideas clearly in different media, individuals with effective communication skills are able to listen carefully and understand what others are saying, thinking, and feeling.

Ability to Develop Others. Leadership roles often call for the ability to develop others in ways that allow people to work together in increasingly productive and meaningful ways. This includes the ability to help others diagnose their development needs, to provide appropriate feedback and other learning opportunities, to coach and encourage changes in their behavior, and to recognize and reward improvements.

Work Facilitation Capabilities

People develop skills and perspectives that enable them to facilitate the accomplishment of work in organizational systems. Organizations consist of many individuals, groups, and subsystems that need to work interdependently to accomplish collective goals and outcomes. Individuals in leadership roles facilitate the implementation, coordination, and integration of this work. Work facilitation capabilities include management skills, the ability to think and act strategically, the ability to think creatively, and the ability to initiate and implement change.

Management Skills. Management skills encompass a broad range of competencies related to the facilitation and coordination of the day-to-day work in organizations, including setting goals and devising plans for achieving those goals, monitoring progress, developing systems for accomplishing work, solving problems, and making decisions.

Ability to Think and Act Strategically. Day-to-day work is accomplished in the context of broad organizational objectives that support the long-term vision and mission of the organization. People who can think and act strategically have a clear sense of the desirable collective future. They make decisions, set priorities, and support initiatives that will bring the current reality more in line with the desired future.

Ability to Think Creatively. Creativity involves seeing new possibilities, finding connections between disparate ideas, and reframing the way one thinks about an issue. Creativity yields innovation when novel ideas or perspectives are used to solve difficult problems. Implementing innovations also requires an element of risk taking, of going into uncharted territory and leaving the familiar behind.

Ability to Initiate and Implement Change. Leadership roles often require the ability to make major changes in organizational systems and practices. This includes establishing the need for change (for example, by demonstrating that current ways of working are no longer adequate), influencing others to participate in the change, and institutionalizing the new ways of working.

Although by no means exhaustive, our description of individual capabilities illustrates the breadth of capabilities needed to provide leadership in organizations.
To develop any of these capabilities, people first have to realize that their current skills or perspectives are inadequate or are not being fully utilized. This alone can be a major step, sometimes triggered by a mistake or failure, a personal crisis, or a piece of feedback from an assessment experience. Next, people have to identify the skill or perspective that they want to more fully develop and begin to try it on for size. Finally, after an extended period of practice, they can begin to feel comfortable with the new skill or perspective and start to use it effectively. This cycle is repeated many times as people expand their self-management, social, and work facilitation capabilities. This is why we say that leader development takes time.

Enhancing Leader Development

We believe that leader development can be enhanced by intervening in the learning, growth, and change processes of individuals. This is a key assumption underlying our work. If leaders do learn, grow, and change over time, and if we understand the factors that contribute to that growth process, development can be enhanced by influencing these processes.
The leader development model suggests three main strategies for enhancing this process:

1. Create a variety of rich developmental experiences that provide assessment, challenge, and support.
2. Enhance people's ability to learn from experience.
3. Use an approach that integrates the various developmental experiences.

Creating Rich Developmental Experiences

There are many types of experience that develop a person's leadership abilities. Significant among them are the formally designed developmental experiences of 360-degree feedback, feedback-intensive programs, and coaching relationships, as well as the more naturally occurring experiences of job assignments, developmental relationships, and hardships. (Each is explored at length in its own chapter in Part One of this handbook.) The developmental potency of any one of these experiences depends on whether it contains a good mix of assessment, challenge, and support.

For example, although a feedback-intensive program focuses on assessment, it must also challenge the participants and at the same time support them. The element of challenge comes from exercises and simulations used in these programs, which are deliberately designed to take people out of their comfort zone, and from interactions with other participants, who often challenge participants' points of view. At the same time, these programs take great care to create a supportive environment in which people can be candid and hear negative information about themselves, while the positive information they get shores up their self-confidence.

Job assignments are another example. They can be particularly rich sources of challenge, but if people are to learn from assignments, they must have opportunities to receive ongoing feedback while struggling with the challenge. People in challenging assignments also need others they can turn to for support, as well as a feeling of being supported by the organization in general.

Enhancing the Ability to Learn

To repeat, learning from experience involves recognizing when new behaviors, skills, or attitudes are called for, accepting the responsibility for development, understanding and acknowledging current strengths and weaknesses, engaging in activities that provide the opportunity to learn or test new skills and behaviors, reflecting on one's own learning process, and working to develop a variety of learning tactics in order to acquire the needed skills or behaviors. The person does not deny or ignore the need for new approaches, does not get stuck using habitual behaviors or outmoded skills, and is not seduced by past success into believing that no change or development is necessary.

It is usually not easy to recognize when new skills or approaches are needed. Sometimes mistakes or failures serve to get people's attention. But often, even in new situations, people tend to stick with the skills and approaches that have worked for them in the past. The temptation to rely on existing strengths can be especially powerful when new situations demand a quick response or when one has had a long history of success with a particular approach.

Assessment and feedback are crucial if people are to recognize that current skills are insufficient and comfortable approaches are inadequate. Getting reliable information continuously about how they are doing is an important way for people to know that change is necessary; it is therefore an important component of enhancing the ability to learn. Assessment that includes feedback on strengths, as well as development needs, can work to build self-efficacy and help individuals face the difficult challenge of learning new behaviors.

Relying on comfortable approaches in new situations almost always limits effectiveness and learning. Yet it is possible to develop new learning tactics. When people are given a variety of challenging experiences, the novelty they face demands that they develop new learning tactics. Assessment of how they currently learn, understanding of other ways to learn (perhaps through reading or skillbased training), developing the practice of reflecting on their experience, and getting the opportunity to experiment with new behaviors and learning tactics (in the classroom or on the job) can help people develop the flexibility inherent in a strong ability to learn from experience. Chapter Seven looks in depth at what is involved in enhancing this critical ability.

Linking Developmental Experiences

Creating rich developmental experiences and equipping people to learn are two strategies for enhancing leader development. A third strategy is to design and implement developmental experiences so that they are more integrated and connected to one another.

For example, a training program can be preceded by open conversations about expectations of learning goals and can be timed so that it helps a leader rise to the challenge of a tough new assignment. The assignment is in turn supplemented by ongoing feedback and coaching, as well as opportunities to reflect—alone and with others facing similar challenges—on what and how the leader is learning.

Our major criticism of the approach of many organizations to leader development is that it is not systemic but rather events-based. How, they ask, should we develop a bright young engineer—clearly gifted, with high potential—who needs improvement in interpersonal skills? Too often the answer is to send the engineer to a training program, and the shorter it is the better. There is no question of determining readiness, no feedback prior to training, no planned support or reinforcement upon return. The hope is that this kind of training "fixes" people. As you will discover, we have found that training is a powerful intervention and an important part of a developmental system—but it is only one part.

The story is the same with multirater (or, as some call it, 360-degree) feedback. Again the frequent tendency is to use the feedback as an isolated event rather than as part of a process. Multirater feedback is an effective assessment activity, an experience that helps unfreeze people and prepares them to learn from other developmental experiences. But if you just give someone feedback from an instrument and stop there, little real development takes place.

From Leader Development to Leadership Development

In the first edition of this handbook, we focused almost exclusively on leader development. The hint of a broader framework was beginning to emerge, but we could not yet clearly see where we were headed. Five years later, we are much more on the "other side" of this shift in our perspective.

As we said earlier, we have begun to understand leader development as one aspect of a broader concept of leadership development. We define *leadership development* as the expansion of the organization's capacity to enact the basic leadership tasks needed for collective work: setting direction, creating alignment, and maintaining commitment. Traditionally, these leadership tasks have been carried out through a management hierarchy, that is, primarily by individuals in positions of authority in organizations. Yet it is getting harder and harder for formal leaders to enact leadership effectively on their own. The challenges that organizations are facing today, both internally and externally, are challenges that often overwhelm existing resources and defy known solutions. These complex challenges require new assumptions and methods yet to be developed. They require organizational and individual learning and change. Perhaps most important, today's challenges are often too complex for individual leaders to fully understand alone. To face these complex challenges, shared meaning must be created in the midst of seeming chaos and uncertainty. Individuals, groups, and organizations must work collaboratively to explore, set and reset direction, create alignment, and maintain commitment.

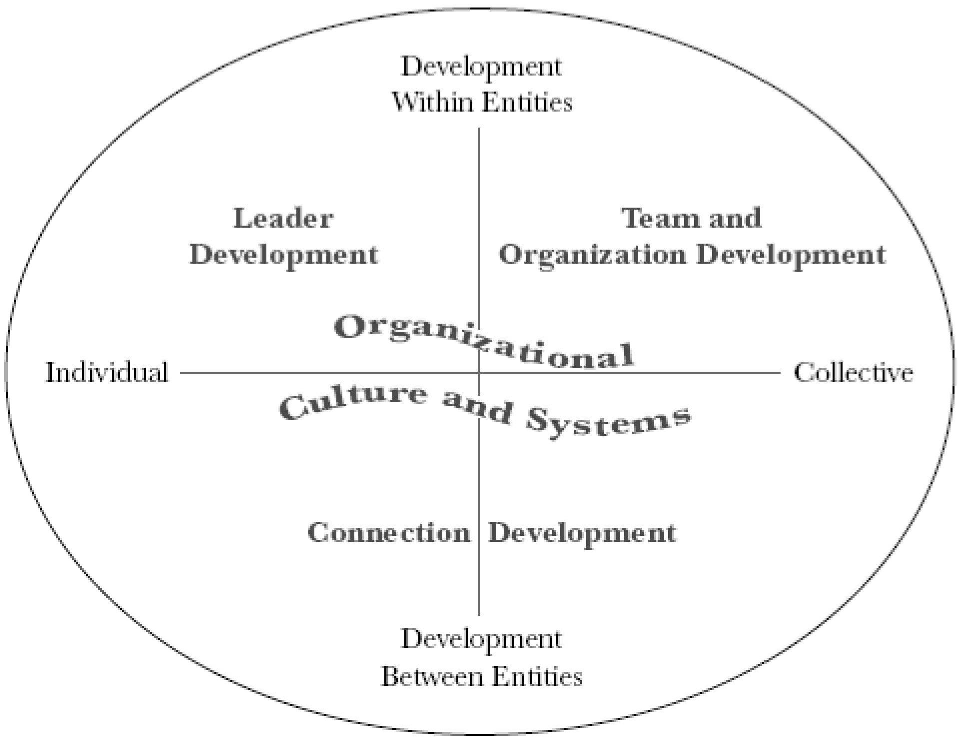
So to expand leadership capacity, organizations must not only develop individuals but also develop the leadership capacities of collectives (for example, work groups, teams, and communities). They must develop the connections between individuals, between collectives within the organization, and between the organization and key constituents and stakeholders in its environment. Developing connections means enhancing understanding and recognition of the interdependencies that exist between individuals and between groups within an organization, as well as between organizations in a supply chain, an industry group, or any other kind of network. It also means developing the individual and collective capacities to create shared meaning, to effectively engage in interdependent work across boundaries, and to enact the tasks of leadership (setting direction, creating alignment, and maintaining commitment) in a way that is more inclusive. For example, organizational leadership capacity is enhanced when the executive team is able to enact leadership effectively as a unit; when interdependent groups can identify an emerging organizational problem and pull together to effectively deal with it; when leaders and group members in various parts of the organization readily connect with each other about interdependent work, shared challenges, or shared expertise; and when individuals and groups engage in dialogue with one another rather than act in isolation.

Figure I.2 illustrates both the relationship between leader development and leadership development and the shifts this movement implies for practice. The figure is made up of two intersecting axes, the horizontal axis representing development that targets individuals, on the left, and development aimed at a collective (group or organization) on the right. The vertical axis differentiates between development that is focused on capabilities seen as existing *within* an entity (individual or group), at the top, and development that is focused on the interdependencies *between* entities (individuals or groups), at the bottom.

Traditional leader development practices, including much of the work done with participants in feedback-intensive programs, 360-degree feedback instruments, and formal coaching, focus on capabilities (skills, perspectives, and preferences) that are seen as within the individual. These leader development practices can be thought of as populating the upper left quadrant of Figure I.2. The work CCL has done on how managers learn, grow, and change from their experience can also be seen as captured here, because for the most part it has focused on how developmental events are understood by individuals and incorporated within a person's developing capability as a leader. This work has been a key influence on

CCL research and practice and is discussed in several chapters of this handbook. In fact, the leader development model, discussed earlier, also fits in this upper left quadrant, as we have understood and used it thus far.

FIGURE I.2. LEADERSHIP DEVELOPMENT FRAMEWORK



Team development and organization development comprise the upper right quadrant of the figure. While both of these categories of practice move from focus on the individual to focus on the collective, the activities tend to remain focused within the entity, developing capabilities of the team, or focusing on intraorganizational processes, such as culture or systems change.

The lower two quadrants of the figure represent leadership development practices that focus on the interdependencies between individuals (lower left), between groups or teams, and between whole organizations (lower right). The practices we would imagine in these quadrants would be those that worked to develop the connections between individuals, between groups or teams, and between whole organizations so that the shared work of the organization could be carried out in a way that is most effective.

The figure also illustrates that the development of individuals, collectives, and connections is embedded in the organization's culture and systems and therefore shaped by them. Both culture and systems often reflect the assumptions being made by organizational members about interdependence, learning, and shared work, as well as the understood processes for enacting the leadership tasks. Thus culture and systems can support or be an obstacle to moving beyond the limitations of current ways of enacting leadership in the face of new challenges.

We believe that this kind of comprehensive approach to leadership development—engaging in developmental work that spans all four quadrants—is the surest route to sustainable leadership capacity for organizations. As we go forward with our research and practice, we will continue to use practices developed for work on capabilities within individuals and teams while expanding our work to focus on helping individuals, teams, and organizations develop enhanced connectivity between entities at all levels.

What stimulated this shift in our thinking? As we worked more with the same organizations over time and with multiple leaders in the same unit or organization, we became attuned to the limitations of an exclusive focus on individual development. Individual leaders can no longer accomplish leadership tasks by virtue of their authority or their own leadership capacity. Instead, individuals and groups need to carry out the leadership tasks together in a way that integrates differing perspectives and recognizes areas of interdependence and shared work. For organizations or other collectives to experience sustained leadership over time—to have a sense of direction and alignment, to maintain commitment to the collective work, particularly when dealing with difficult problems that require organizational change—they need more than well-developed individuals. They need well-developed connections between individuals and deeper and more meaningful relationships around shared work. They need to form and deepen relationships within communities and across the boundaries between groups and collectives. They need to develop the capacities of collectives for shared sense making and for learning from shared work and shared experiments in the face of challenge and change. They need to get better at integrating the learnings into a unified sense of purpose and direction, new systems, and coherent shifts in culture—that is, to enact leadership together through the connections between individuals, groups, and organizations. Certainly, individual development is still a vital aspect of leadership development. It is, in fact, a basis for enabling the other aspects of leadership development and will remain a key focus of our work. However, we believe that broadening our knowledge and practice of leadership development provides more avenues for improving leadership in organizations and more potential impact for the work we do.

We have been able to sustain this shift in perspective because we are part of a larger community of leadership scholars and leadership development practitioners who are experiencing and articulating the same shift. For example, David Day (2000) points out that developing social capital (that is, the networked relationships that enhance cooperation and resource exchange among individuals in an organization) is an important aspect of leadership development. Recent approaches to organizational sustainability have taken a more integrative approach to individual, team, and organizational development (Beer, 2001). And in *Relational Wealth* (2000), Leana and Rousseau focus on the idea that relationships are a key competitive advantage for a firm, rather than simply an outcome of its activities.We see our new work going forward as connected to the work of these others—that is, toward understanding how the unique properties of relationships, networks, and communities of practice can be seen and developed in any organization, public or private.

Conclusion

To sum up, let us return to the leadership development model and the assumptions behind it. First, we define *leader development* as the expansion of a person's capacity to be effective in leadership roles and processes. Second, we believe that developing the individual capacities needed for effective leadership—such as selfmanagement, social skills, and work facilitation capabilities—is synonymous with what is often labeled "personal development." This development unfolds over time. It is maximized by a variety of experiences that challenge people, support them, and provide them with understanding of how they are doing. It also depends on their having an ability and willingness to learn from experience. Leader development processes that integrate various experiences and embed them in the organizational context are the most likely to be effective at developing leaders' abilities. But we realize that leader development and leadership development are not synonymous. We see leadership development as the expansion of the organization's capacity to enact the basic leadership tasks needed for collective work: setting direction, creating alignment, and maintaining commitment. And we are just beginning to develop knowledge and expertise in the aspects of leadership development that go beyond individual development.

Finally, if there is one key idea to our view of leadership development—an overarching theme that runs throughout our work—it is that leadership development is an ongoing process. It is grounded in personal development, which is never complete. It is embedded in experience: leaders learn as they expand their experiences over time. It is facilitated by interventions that are woven into those experiences in meaningful ways. And it includes, but goes well beyond, individual leader development. It includes the development of the connections between individuals, the development of the capacities of collectives, the development of the connections between collectives in an organization, and the development of the culture and systems in which individuals and collectives are embedded.

PAPERS FROM FUTURE CAPABILITIES WORKING GROUP

Enabling the Adaptive Warrior

Science of Learning Workshop, Future Capabilities Group, Facilitator's Guidance: "The primary objective of the workshop is to identify learning science findings and technologies to help the Army train Soldiers and grow leaders for today and tomorrow. Our group represents a sizable chunk of the 'tomorrow' part i.e., 2016-2025 timeframe. We want to try to project ourselves out into that timeframe in order to do some 'back planning.' If we can articulate a vision of what could or should be possible in that timeframe … what are the S&T issues that will need to be addressed between now and then to get us to our vision?"

The future can seem like science fiction to those outside the Future Capabilities group. Decision makers are often more apt to endorse recommendations when they see a path from the present to the future so it is sometimes useful to be a little pragmatic when influencing potential outcomes.

One recurring theme is how we enable the agile, adaptive warrior, comfortable with uncertainty, who functions in an expeditionary environment. We can frame this theme by limited resources to train, shaping expectations of decision makers who are "digital immigrants", and other factors. For example, our doctrine says we deploy a brigade in 72 hours. By definition, this means to deploy without organic assets and necessitates a reach back capability. While we train reach with some digital brigades and some schoolhouse training scenarios, these seem to be an exception. The point is training reach ought to be commonplace across institutional training, such as synchronized portions of a Captains Career Course among branches.

To take a step further, our senior leadership states how we do not prepare deploying forces for the mission they face when they arrive in country. We train force on force in simulation for pre-deployment while the mission is phase four stability operations. Since the mission and locations are both dynamic and unknown, the requirement is for a rapid simulation development, expressed in terms of minutes or hours. This training capability should be close to the operational capability in terms of mission rehearsal yet the training capability should be affordable compared to full deployment of operational capability in a training environment. While it may be ideal to have actual BOS for training, much of the operational equipment is actually deployed and sometimes scarce for advanced training environments. Even if BOS were plentiful, it is unlikely we could issue BOS for learners to use in their homes where at least some training will take place. We can improve quality, increase users, and reduce cost to train compared to existing methods. For success, we would have to couch in such a way as to compliment the current simulation community as compared to replacing existing capabilities.

Beyond this, one ought to ask at least two other questions. One is why we should have conventional classrooms in the first place. If we follow the bent of guided experiential learning (similar to the CTC experience), then use the model for resident training where learners are immersed in the learning experience compared to a lecture from an instructor. This type of approach is at least foreseeable with some of the work sponsored by RDECOM with ICT in California. The other point gets to the notion of the "pentathlete" and the meta-data about a person that tells us their art/knowledge/skill set(s) in the context of terabits of information converted to knowledge in perhaps seconds. One logical conclusion is a personal "avatar" that attends to and filters stimuli. The avatar also represents a person in terms of interaction with potential stimuli looking for the right skill set for a particular mission. Folks might take these two ideas as science fiction.

Some believe we can implement a proof of concept to show a unified collaborative training environment that gets to synchronized portions of Captains Career Course across branches. We believe it is possible to stimulate a constructive simulation in a web-based multi-user environment in such a way that when users build a COA in a common operating picture (COP), the unit symbols in the COA/COP de-aggregate and auto-parse into the constructive simulation. This allows the simulation to play out and change on the fly when one must modify a COA. Other features such as GUI/Skins that replicate each branch BOS, high fidelity with synchronized 3-D tied to geo-tracking with 2-D map and rapid COE scene generation are possible. Much of the capability exists in tactical BOS today and JFCOM has at least explored such a capability for first responders.

This type of proof of concept can show the path from the present to the future.

Hindsight Night
(or Win's WAND)

Author's Note

This is a living draft White Paper intended to stimulate thought about the training of military forces in the future, and the research and development needed to make that training happen. It attempts to get beyond general terms like "adaptive" and "multifunctional" into what such terms really mean from the perspective of two combat veterans having a father-and-son conversation. It includes explication of ideas in boxes, and some thinking outside the boxes. The primary author is Dr. Bill Burnside from the US Army Research Institute (ARI) at Fort Knox, KY. The original version of this paper was completed in 2001, with the assistance of MAJ Bill Rademacher, US Army. This revision was completed in mid-July 2006, with the assistance of Dr. May Throne and others. Ideas expressed, such as elimination of institutional training centers and the Army as we know it, are those of the primary author and not official Department of the Army or ARI positions. Please provide any comments or thoughts to Billy.Burnside@knox.army.mil, aka Bill.Burnside@us.army.mil, DSN 464-2613, Commercial (502) 624-2613.

It's a warm fall evening in 2025 as Defense CPT Winthrop Hindsight rides through the rolling hills of Tennessee in the Electric Individual Transport (EIT) he just linked up with at the heliport. It seems most evenings are warm these days. The only sound is the latest Rolling Stones sample recreation playing in Winthrop's EarPal. Winthrop watches the scenery roll by as the EIT takes him to the new home of his father, Chad Hindsight, out here in what remains of the farm country. Winthrop has just returned from a challenging mission in Generica, and he's looking forward to a long weekend with Dad. Dad is a retired Army COL who was a tank platoon leader way back in the First Gulf War of the early 1990s. Winthrop loves talking to his Dad about the Defense Force of today and comparing it to Dad's old Army. This is definitely not your father's Army.

The Defense Force of 2025 is completely joint. The old Army, Air Force, Navy, and Marines have merged, and the new components are the Coalition Defense Force (CDF) and the Homeland Defense Force (HDF). The CDF deploys around the world with allies. The HDF has replaced the National Guard.

The EIT pulls into a side road and up to a rambling natural wood house sitting among some small trees. "It looks like Dad is doing ok with that money he got for helping revive the Russian military," Winthrop thinks to himself. "I wonder if Dad ever thought he'd retire on rubles?" Winthrop thinks his EarPal off, removes his Smart Card from the EIT, grabs his bag and his Wireless Adaptive Notebook Device (WAND), and steps out. He walks up on the front porch and the front door dissolves as he approaches. There stands Dad! Winthrop puts down his bag and WAND and embraces his father

warmly.

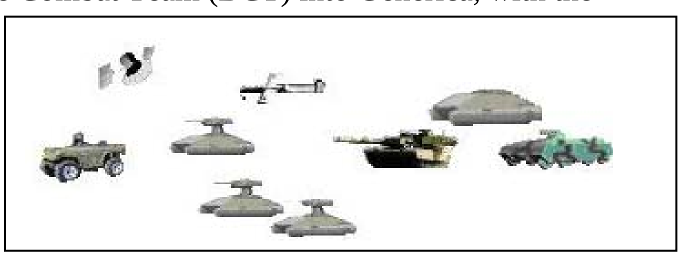
"Man it's good to see you Win," Chad exclaims. "Those stills and audio notes you sent me from Generica had me a bit worried. Some mission huh?" "Yeah, things kind of went to hell there for a while," Winthrop answers as he drops his bag and begins to stretch. "What started out as a regular peace keeping mission turned into my first real combat experience. Then we ended up taking care of the very people who had been trying to kill us. What a world! But my Team did fine and I loved it, except for a few hectic moments here and there. Let me put away my stuff and we'll talk about it. Where's my room? Do you still drink beer Dad? It's so good to see you."

Winthrop returns in a few minutes to find his father sitting in a brand new Virtual Room. "Wow Dad, this looks like the latest VR stuff!" Winthrop exclaims while looking around the blank blue walls. "Yeah Win, it's a bit hot outside, so I thought we'd sit here, drink a few cold ones, and maybe bring up scenes from Rockaway Beach. We had some pretty good times there eh?" Winthrop replies, "Yep Dad, some of my favorite childhood memories are from that place. Bring it up." Chad smiles, "Okay Win, and maybe we'll bring up some scenes from Generica on the west wall there and you can fill me in. You know, I archived a lot of the news stream while you were there."

A panoramic beach scene fills the walls and the sound of a gentle surf flows through the room. Chad leans back in his Adaptive Seat and says, "Well Win, I can't wait to hear first-hand how peace keeping turned into bullet dodging." Winthrop laughs and replies, "Yeah Dad, that's about what it was, kind of like the Iraq and Afghan Wars back early in the century. I assume between what you got from Continuous Nodal Network News (CNN2) and the stuff I sent you, you pretty well know the big picture. Based on the UN request, I took one of six pretty much

> A Component is the smallest deployable Defense Force unit, something like a late 20^{th} century cavalry troop, only combined arms and usually multi-national. It can be configured for virtually any mission, and normally deploys as a primary element of a Brigade Combat Team. It can sustain itself almost anywhere for up to five days. Common configurations are:
>
> - Human support
> - Terrorist/criminal pursuit
> - Peacekeeping
> - Interdiction
> - Combat support (supporting elements of the remaining Corps (-) of heavy ground forces)

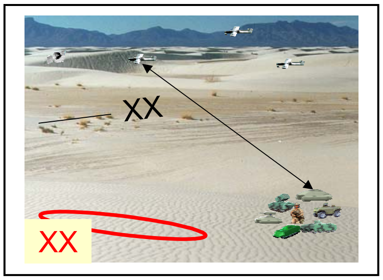
standard Defense Components in the Brigade Combat Team (BCT) into Generica, with the peacekeeping configuration. I had three Warfighter Carriers, three Recon Platforms with their Ground Bots, two boxes of Non-Line-of-Sight Rockets just in case we needed them (which we did), one Command and Control (C2) Platform, ten sets of Ground Sensors and three Air



Bots, the new Class II miniature ones. I also had the standard Engineer, Medical, and Repair/Recovery Platforms and some miscellaneous human relief stuff. So I had about 120 Soldiers and 20 Bots, along with a bunch of unmanned sensors and stuff. Most of our assets were American; I had a few Arab and Brazilian soldiers and the Air Bots were British"

"The mission looked to be pretty much standard peace keeping," Winthrop continued. "We were to keep the peace between the elected Generican government and a mid-sized opposition group, supported mostly by drug credits. Then you know the story. It turns out the government was supported by drug credits too, and we got caught in a government attack on the opposition headquarters. The bad thing about that is I lost two Soldiers before we could extract ourselves and the Interdiction Components could get in. I still wonder if I could have done something different. I think that'll haunt me the rest of my life."

Winthrop takes a drink, then goes on, "So then the Interdiction Components get control of the situation quickly, and we end up going back in and supporting the Generican government while



it reforms. After the rush of combat, humanitarian relief was a bit slow. But I guess you know that from the First Gulf War Dad. Anyway, I thought we'd be there about two months and we ended up being there five. I had my first combat. And I lost my first Soldiers, and hopefully my last. We handled the situation pretty well I think, but no mission is completely successful when you lose Soldiers. I also had to command three sets of Ground Sensors to self-destruct before they got captured, but they're replaceable. I guess when I think back on it, it was pretty wild"

Chad senses his son's tenseness. "Don't be so hard on yourself, son," he replies. "I heard that the problems were mostly with conflicting intelligence from on high and temporary interference with your information flow. Nothing you could really control. You know, you guys look at combat differently than we did 30 years ago. The loss of life is unfortunate, but we accepted a certain amount of risk in that area. We expected to lose some people, and we tried to minimize that through things like really big heavy vehicles. You guys don't expect to lose anyone."

"That's true Dad," Winthrop responds. "I have good, nearly perfect, information on the situation at all times and I try to use Bots where there's real risk. I don't expect to lose anyone." Chad perks up and says, "Win, that's just one of many differences between the Defense Force of today and the heavy Army forces I led 30-some years ago. You all today are dealing with a complex world and some unbelievably sophisticated equipment. And you respond to all kinds of situations quickly with little or no loss of life. You can get a complete Component on the ground and functioning within

Principles of Training (FM 25-101; 1990):

- Train as combined arms and services team
- Train as you fight
- Use appropriate doctrine
- Use performance-oriented training
- Train to challenge
- Train to sustain proficiency
- Train using multiechelon techniques
- Train to maintain
- Make commanders (leaders) the primary trainers

about 48 hours. Sometimes I'm amazed at how you do it."

"Well Dad," Chad replies slowly, "I think there are a couple of important points here that relate to your days in the Army. For one thing, we have basic principles or tenets that we go by that apply to most any situation. You had some of those in your day, like 'train as you fight.' And we have great equipment and Soldiers, but I think our success can be tied to the training we do. Frankly I think the Army of your day got away from rigorous training and short-changed it a bit to save time and money. We do a lot of training. That allows us to be flexible quickly One good thing that came out of the Iraq and Afghan Wars 20 years ago is military forces designed and trained to respond quickly to most any situation."

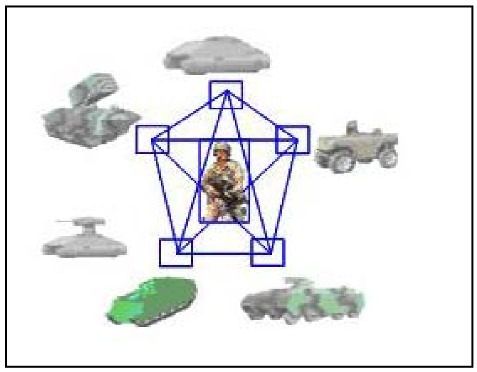
"Okay Mr. Chief of Defense," Chad responds chuckling. "Tell me about your basic tenets and your hot-shot training. How'd you get from my poor old Army to being so good today?"

"All right Dad, you asked for it. Give me another beer and let's go," Winthrop fires back.

TENET: Network all operations and training

- No system operates alone
- Redundancy provided
- Information shared completely, all on the Net

"For one thing, everything today is netted, or netcentric as some of your generation put it for a while. I don't think your old cronies all understood the full impact of that Dad. No one Soldier or platform in my Component does the whole job or operates alone. Take the direct fire configuration for example. Each of our Line-of-Sight Platforms has three Firing Bots with three weapons each, and is linked to multiple unmanned sensors, both ground and air if possible. So the two sergeants in each Line-of-Sight Platform have a lot of information for controlling at least nine distributed guns, and they keep their platform back out of risk as much as possible. And I overwatch and command all these platforms from my C2 Platform. We aren't performing gunnery like your Soldiers did, so we don't need to train that. We're performing more like what you called distributing and coordinating fires. We handle other weapons systems in the same way."



TENET: Use robots as much as possible (30% or more of force)

- Robots in high-risk positions
- Primary sensors and shooters

Winthrop goes on, "Another meaning of netted that I'll probably come back to later is that my Soldiers and Bots are always connected to each other and to all the information there is, during training as well as operations. We always know the status of each other and what each other is doing. Everybody knows what everybody else knows. We input information into the Net and draw it out in the same way,

TENET: Use standard Net protocols for communications

- Voice or digital
- Vary only as necessary
- Same for humans and robots

whether we're human or Bot. I give my Bots orders in the same way I do human Soldiers, orally or through preset menus. And I know everybody's training or programming status all the time through the Net; more on that later."

"Wait a minute Win," Chad interrupts. "It seems to me that you're awfully dependent on the Net. What if the Net is down? We had lots of commo problems back in my day." "Well Dad," Winthrop replies, "since we have multiple redundant channels commo is seldom a concern. Once in a while there's a slight slow down, but it's rare when we can't get into the Net. Our automated systems can just about always find a secure open channel."

TENET: Train anytime anywhere, using delivery system(s) available

- WAND
- Simulation
- Actual Equipment

"Now let's talk about training Dad," Winthrop plunges on. "We train anytime anywhere, on whatever delivery device we have available. As a matter of fact, I may do some training on my WAND tonight if you don't get me too drunk. All the information there is about my Component, its equipment, and its potential missions is available to me through my WAND. I can call up and review information by talking, typing, or touching. I can take tests or practice tasks by gaming with intelligent agents through my WAND. Or I can link up with members of my team or other teams and game with them. I can reach anyone on my team anytime through my WAND. Let me check on my 2IC. Hmmmm, she hasn't been on since this morning. I think she's snuck away on a bike trip up in Indiana, I'll leave her be for now."

The Wondrous WAND

- Wireless, secure personal portal into the Net
- About 5 x 8 inches, unfolds to 4 times that size for large displays (e.g., maps)
- Input by voice and on-screen typing or touching
- Transfers information between people and equipment

"So you get all the training you need through that magic WAND?" Chad asks skeptically. "No no, Dad," Winthrop replies. "The WAND isn't the answer to everything; it's just a window (catch that reference to ancient history Dad?) into information and limited ways to practice. There are some things we can't do on the WAND. For some things we go into simulation sites, but as you know there aren't many fixed simulation facilities left since those tend not to be cost-effective. We do most of our training on our actual platforms, what you used to call embedded training but it's really more like what you used to call electronic performance support systems. Let me try to talk you through how it works."

TENET: Be prepared to deploy anywhere anytime on any mission

- Receive/transmit orders through WAND
- Configure Component(s) for mission(s)
- Call up and adjust training package(s)

"When I got orders through my WAND to be prepared to deploy to Generica in 48 hours, we were pretty much trained up for that type of mission already," Winthrop explains. "The first thing I did was forward the warning order to my people, who were scattered primarily in about three locations. I guess you know Dad that I don't really have a standing Component that's together in one location. I have primary people located in several places, and we organize and augment as needed with people from other locations, maybe other countries, as the mission dictates. That way we can adapt to about any mission. In this case I didn't question the order from higher that this mission required our standard peacekeeping configuration, but I suggested a couple of additions. For example, I requested a couple of human translators since we don't have good automated ones yet for Generican."

Winthrop continues, "So after concurring with the Component configuration, the next thing I did was check the training status of my people for the expected mission, again through the WAND. I looked at all my peoples' ratings and experiences. One thing I was reminded of right away was that I had three pretty new inexperienced people, so I messaged them to speed up their individual WAND training, mostly reading and basic knowledge applications. The WAND suggested we all review some cultural background and intelligence on Generica, along with a set of refresher training routines for my primary people, so I went along with that. I felt we needed some practice in two or three high-risk areas, and I noticed a fixed simulation facility near our debarkation point. So I scheduled some hours there through the WAND. I also looked at the outlines of the simulation exercises the WAND recommended, and I made some tweaks and forwarded the exercise files to the facility."

Primary applications of training delivery systems

- WAND – individual information acquisition, low-level gaming
- Simulation Sites – high-risk tasks, extensive synchronization practice
- Actual Equipment – embedded individual skill sustainment and collective exercises, final mission rehearsals

"Now in this case we were deploying pretty much with our own equipment," Winthrop notes. "So through the WAND I tailored some quick embedded refresher routines for equipment operations, and some network collaborative exercises for us all to fine-tune synchronization. Luckily we had time to include a little 'what if' exercise on transition to and withdrawal from combat. We ran these exercises on our platforms while we were deploying, as final rehearsals."

"Slow down a bit now Win," Chad implores. "I'm not sure I follow how you knew what tasks to train in what environment and how your training strategy all fit together. That was a tough nut in my day." "Well," Win responds slowly, "we don't look at it as what tasks to train where, as you maybe did. We have a primary system for meeting each training requirement, but we sort of train everything everywhere, in different degrees or in different ways. We try to train all the time, making the best of everything. We train and communicate on everything through our WANDs, but we can only practice to a certain level on those, kind of like the classrooms and those primitive old sand tables and things you had back when there was an Armor School, Dad. Then we use stand-alone simulations of actual equipment sometimes, but only when they're cost-effective. We may use them to practice high-risk tasks, or when our actual equipment is just not available. Then we always pull everything together with collaborative rehearsals on our platforms. And we

TENET: Commanders/leaders are the primary trainers

- Check/adjust recommended training approaches
- Check/adjust available training packages
- Monitor training results; adjust training as needed

adjust our operational plans based on simulation runs on our operational network. You all called this process crawl-walk-run, right Dad?"

"Yeah Win." Chad replies. "Son, I caught your reference to the old Armor School. Now that there's no Armor Center and School anymore, do you ever get back to or work at Fort Knox much? I spent a lot of time up there myself. Or do you deal mainly with the Defense Ground Forces Hub down at Fort Benning?" "Well Dad, in the physical sense I seldom get back anywhere," Winthrop answers. "Most everything I do is at a distance, and we don't spend much time in classrooms in laptop defilade like you all did in your day Dad. Ha Ha. But seriously, my initial officer orientation training of five weeks included one week at Fort Knox, mainly to get to know my fellow officers face-to-face and to review some history. Now that Knox is a Homeland Defense Hub I don't get back there much. And I've visited Benning but I haven't done any training there. I get what I need from there through the Net. And I mentor five lieutenants through the Net so that punches the old instructor ticket. Training institutions went away with gasoline-powered personal vehicles Dad."

> By 2025 all military training centers or institutions have been consolidated into a few Defense Hubs. These primarily accomplish training distribution and quality control functions, and the Hubs are in fact largely distributed. Hubs are said to be located at the sites of former training centers so these sites can be maintained for historic purposes.

> **TENET**: Train/prepare at a distance
> - No training institutions; only initial training at common sites
> - Collective Team training through the Net
> - Computer-generated entities fill in for Team members as required
> - Leaders serve as instructors or mentors through the Net

Winthrop leans forward. "One more point I want to emphasize Dad, is that my people, bots, platforms, and other equipment make up a real team. Like I said earlier, I communicate with my bots in the same ways I do with my people. And every weapon system has everything we need built into it or at least accessible through the Net. For example, my C2 Platform has all the performance support I need built into it, always up to date. If I should forget how to do something, I can call up the information I need right away, with an example if I need it, sort of like the old help screens only a lot more helpful. If something should come up that hasn't come up or been thought of before, I can quickly to get to my commander or one of my mentors for help. Again, this works mostly through my WAND."

> **TENET**: All systems include embedded training and performance support
> - Individual performance support
> - Access to collective exercises
> - Access to experts/mentors

"When I get into my C2 Platform," Win continues, "I just plug in my WAND and I have a complete read-out on the status of the Platform and it has a complete read-out on me. It tailors its displays and controls the way I like them, so I actually can configure with any Platform in a matter of seconds. One of the things that comes up as soon as I ask for it is my training prescription, based on my Component, Platform, and mission. The system tells me what individual training I may need, and I can test to verify that if I want. It also tells me what collective exercises I and my key team members should participate in, and who is on Net to train with. The Net will generate other people or bots or nodes if necessary to support my training. So training is sort of normal day-to-day stuff with me, and my WAND, Platform, and I are one compatible system."

"One thing Win," Chad interrupts. "It strikes me that there's a lot of information about you and your people in those big databases in the sky. Don't you ever worry that the enemy might tap into your databases? Or that someone higher might somehow misuse information on you? Those were real concerns back in my day." "Well Dad," Win responds. "For one thing I'm really not worried about anyone breaking into our databases, given the personal security techniques we have. We don't use those primitive password systems any more, you know? My WAND checks my thumbprint and voice pattern each time I use it. It will self-destruct if anything isn't right. And I can cause it to self-destruct by uttering one sequence of words."

"But I think there's a bigger picture with your concern Dad," Win goes on. "People used to be sort of paranoid about information being kept on them, but we've gotten past that. I mean, how can you function without complete information in the Net about yourself? And another point Dad. I don't mind being tested; I want to be tested, that's the way I learn. All I ask is that the test be valid and that I be given complete feedback so I can improve. Training is still just practice, practice, practice with feedback Dad. We have the tools to make that happen."

TENET: All training is assessed

- Performance-oriented, learn by doing
- Specific feedback provided rapidly
- Standards adjusted regularly, based on performance databases

Chad responds slowly, "Okay Win, so you train at every opportunity and you get tested often in various ways. This sounds kind of like drill and practice, regimented stuff. I wonder whatever happened to what we called commander's initiative or freedom?" "Man Dad," Winthrop laughs, "I can't believe that someone from your Army days is worried about being over-regimented. Yes I have training routines and exercises given to me. But I have software tools allowing me to tailor those as I see fit or to find versions someone else already tailored close enough to what I need on the Net, within boundaries from higher. And by being tested we get to higher levels where we can train with the really fun stuff. Once we're certified we can get into interactive exercises or games with our mentors, where we can experiment with stuff that maybe nobody has tried before. So we can still get into the old video game or free-play level of adventure training. We just have to earn our way there by working through exercises structured for our needs."

Chad leans forward with a furrowed brow, "You know something, Win? This conversation reminds me of something. Or maybe it's the beer. Back when I was a senior instructor at Fort Knox, during about '01 I think, some civilian came by one Friday afternoon and talked to us about the future, what we called Objective Force or Future Force back then. You're there or beyond that today. Anyway, she wanted to know the research requirements for getting to the Future Force. She wanted to specify the research that should be started then to form the basis for training way out in the future. I really didn't know exactly what to say to her. What do you think I should have said, Win?"

Winthrop thinks a few moments. “Well Dad, I can think of lots of research and development in the training database that got me and my Component where we are today,” he begins. “Of course, one key is the tools and techniques for identifying and keeping up-to-date the missions we have to be prepared for, and the underlying environments and tasks.” “Do you mean task analysis?” Chad interjects.

“No Dad,” Winthrop replies. “Old-fashioned task analysis is way too slow. Identifying the specific tasks to train, and maintaining an accessible database of how to perform and train them in various environments are important. Identifying and stressing main principles or tenets that apply in all situations or at least certain categories of situations is key. That way my Component has start points we can recognize and adapt from. Then we can generalize from a recognized pattern and quickly know which procedures to execute or at least start with, sort of like old chess players. This is similar to how we have common or highly similar interfaces on all of our equipment, designed using basic display principles. We quickly know how to operate almost any equipment, given some configuration help from our WANDs. In the same way we quickly know how to respond tactically. All the work that goes into identifying and updating missions, tasks, principles, and patterns really helps. I spend quite a bit of time inputting into the Net and communicating to my mentors what I learn from each mission. But it’s well worth it for what I get in return.”

What are adaptive, multifunctional soldiers and leaders?

- Highly practiced and proficient in basic operations
- Quick to recognize established principles and patterns
- Simulation-based experience in adjusting training and tactics
- Automatic, tailored but consistent interfaces with equipment

“”But wait, it all still comes down to performing tasks to standard, Son,” Chad protests loudly. “And someone had to identify and analyze those tasks based on system and mission requirements in order for you to train on them.” “Yeah Dad, I’ll grant you that one,” Win responds. “But the basic tasks are pretty much common given the commonality of our weapons systems. And we practice those tasks to such a high level in different conditions that we perform them pretty much automatically, without really thinking. This lets us move to a higher level of performance where we think more about patterns and principles than individual tasks. Let me try to explain that more.”

Research Axis: Develop a system for identifying and updating missions and tasks, and for deriving general performance principles and patterns

- Knowledge management tools for controlling and accessing large distributed databases
- Methods for inferring general performance principles and patterns from varied cases
- Adaptable training techniques and exercises for practicing (and generalizing) the recognition of patterns and tailoring the application of principles
- Methods for efficiently collecting and organizing (“mining”) mission performance data and lessons learned from participants (human and robotic)

“As I talked about earlier,” Winthrop continues, “another key thing is the ability we have to train just about everything everywhere on-demand at any time, using what we have available. Someone figured out for us how to train with our WANDs, simulations, and equipment, and how to make the best of each of them. Not only that, but they also figured out how to make training fun, using games and Net connections. The ability to link up with and train with my team

Research Axis: Develop a system to support training anywhere anytime, exploiting available media

- Tools for semi-automatic tailoring of training for delivery on each primary medium (WAND, simulation, actual networks and equipment)
- Methods for networking collective training of team members, at distant locations with participants being live or Net-generated
- Techniques for incorporating gaming into training, providing appropriate levels of competition and entertainment, making training fun where appropriate
- Methods for managing distributed training of individuals and teams, based on automated tracking of performance results
- Approach for integrating management of training, leader development, and self development into a career management system

members wherever we are around the world amazes even me sometimes. And we can take on other teams. And we can train against Net-generated teams or with Net-generated people or bots within our Component. Hell I train whenever I get a spare moment. It’s what I do. I’ve got to have it”

Winthrop rushes on, “All that work on integrating performance support within our Platforms was great too, Dad. Whenever I need help, it’s right there on my WAND and my C2 Platform. But frankly I practice so much I don’t need much help. It’s good to know it’s there if I need it, or if I get new team members. And the ability to contact my commander or mentors any time is great, too. Whoever set up the continuous mentor line did some really good work.”

Research Axis: Integrate complete training and performance support within each platform or system

- Techniques for providing embedded support or assistance when requested or when performance is detected out of range
- Methods for providing embedded support across teams as well as to individuals
- Methods for automatically updating embedded support based on doctrinal and software changes, as well as based on performance data from repositories for teams and individuals
- Tools for providing direct access to commanders and mentors for additional assistance during training and operations

After pausing for a breath, Win goes on. “Something I can’t believe I almost forgot to mention is the digital communications tools and the ability we have to command and control mixed human and robotic forces. Dad, your Army may have tried to move too quickly at digitizing back in the early years of the century, but we’ve got it together now. The message formats are short, sweet, direct, and the same for humans and robots. Sometimes I swear I don’t know if I'm dealing with a human or a robot; the interaction is basically the same. Information coming to me from whatever source is filtered and consolidated like I want it, and I know how to get more if I need it. The decision support built into my C2 Platform allows me to see the choices open to me and the likely outcomes of each. By working with this, I can in most cases make the best decision very quickly. And all the training I have allows me to give commands like those old-time quarterbacks, adjusting on the fly as I need to."

Research Axis: Develop efficient methods for commanding and controlling human and robotic forces

- Common message formats for a wide range of situations
- Adaptive methods for integrating and prioritizing information from various sensors and other sources
- Methods for navigating rapidly through large databases to find specific additional information needed
- Automated decision support aids with instantaneous wargaming of alternative courses of action

"And I guess one more thing I'd have to mention is the ability to adapt or modify my Component's training on the fly," Win continues. "We have some great software tools that must have some fantastic research and development behind them. I can get immediate access to a training package for just about any requirement. I can tailor it quickly or re-use one somebody else tailored and send it to the WANDs, simulation sites, or Platforms where it is needed. And that includes the collaborative games and exercises for my Component. The ability to work collaboratively at distant locations with real or Net-generated team members is essential."

Research Axis: Develop tools for rapidly adapting or modifying training exercises and support packages

- Techniques for distributed storing of and access to training support packages with numerous variations
- Methods for managing and maintaining quality control of large amounts of adaptive training materials
- Tools for modifying training support packages collaboratively at a distance (e.g., by team leader and a mentor)
- Techniques for training support materials to adapt automatically based on individual or collective performance results

"Okay, one more point and I'll shut up," Win says as he slows down. "As I said earlier I like being tested as long as the test is valid and gives me useful results. Automated performance measurement and feedback is built into all my training as well as in my C2 Platform. If I do something wrong or out of range I immediately get cued on it. Then I can adjust, or continue on as is, or consult my commander or a mentor. Figuring out the right measures and how to display them so I can understand them quickly must have been a monumental research and development effort. Having the same measures and displays during training and operations makes things a lot simpler. I salute the people who did that, and are still doing that."

Research Axis: Develop tools for automated performance measurement and feedback

- Automated measures and readily understandable displays of them for all key tasks and skills, including command and control
- Methods for automatically importing performance data into individual and collective performance databases
- Techniques for adjusting or evolving individual and collective performance standards or acceptable ranges based on archived performance results
- Methods for cuing and adjusting performance when it moves out of acceptable range

Winthrop notices Chad slumping in the Adaptive Chair. “Hey Dad, INCOMING,” he yells. Chad jumps, “Sorry Win, too much good beer and chat I guess. This was one great talk. And I had the logger on so we can maybe review it and go on with it some time. It reminds me of a great paper I read back early in the century that predicted a lot of what we’ve covered tonight. It came out of some learning conference back when the Army had a Training and Doctrine Command. Man those people were right on. They should have been paid a lot of money.” “Or maybe we could find them and give them some good old-fashioned cold beer,” Winthrop responds. “Here’s to ya.”

Future Army Training, Leadership and Education (TLE) Shortfalls—Focus Areas for the Contributions of Learning Science

Dr. Diana Tierney, TRADOC, DCSOPS&T

Learning science continues to have broad applicability to all of the future capabilities required by Army TLE (e.g. training realism and accessibility). However, at this point in time, there is one future TLE capability most in need of additional attention by learning science, and that is "efficiency". The press for more efficiency in the training system predates OIF but has been highlighted by it, and is certain to build in the future along with competition for resources. The Army needs the ability to train, educate and develop soldiers in the shortest amount of time and using the fewest resources possible, while ensuring that effective, transferable learning has occurred. This means using innovative instructional approaches and technologies to streamline learning, doing assessment and evaluation to ensure we maintain or improve effectiveness, understanding soldier variables that can slow or disrupt learning, and taking advantage of all sources of knowledge and experience in the soldier's environment as opportunities for learning. Seven focus areas for learning science, all related in one way or another to potential efficiency gains, are described briefly below, and are followed by initial lists of possible research questions in each focus area. The focus areas and questions are intended to be representative of efficiency-related issues rather than exhaustive.

Learning Science Focus Areas

1) Defining "Knowledge" and "Learning" for the Future Force

An incomplete understanding of what "knowledge" and "learning" will mean for future soldiers and leaders hinders our ability to develop truly comprehensive and effective TLE programs. We are in the midst of a growing "information explosion" that may require a new model of learning—one that interrelates information from different knowledge domains and that truly reflects the "changing nature of knowing" (e.g. not merely the mastery of facts, but the ability to access and integrate new information).

In addition, we now recognize that "learning" is a life long process—one that is not confined to the schoolhouse or based solely on "schoolhouse" products. For example, on-the job/operational experiences are powerful forces for soldier learning. Learning science research is needed to help us understand the relative contribution of these types of less structured learning to the overall development of soldiers and leaders, and to reframe the learning model accordingly.

2) Individual Soldier Issues

There are several unknowns about current and future soldiers that limit our ability to develop TLE programs that completely support their learning. Obviously, new soldiers do not arrive with "clean slates", rather, each soldier has unique prior knowledge and experience, beliefs, attitudes and interests that motivate him or her, as well as competing demands on their time and attention. To some extent, our future ability to produce more effective and efficient "accelerated" learning is dependant on our understanding of these sorts of basic soldier issues.

3) Developing and Applying Improved Instructional Methods

Today, because of operational contingencies and resource constraints, there is pressure to ensure that we retain soldiers and leaders in the training base for only the minimum time needed for learning to occur. It is likely that the push toward maximum efficiency in learning will continue and strengthen in the future. However, there are several "foundational issues" in instructional methodology (e.g. transference) that are only partially resolved and hinder our progress. An added problem is that some of what is known about effective and efficient instructional methods for adult learners has not been effectively transferred to use in Army TLE. Progress is needed in both areas in order for the Army to refine and implement an improved learning model in the future.

4) Team Training

As demonstrated by OIF, high performing, independent and well led teams have been the key to successful Army operations. In networked future Army, where teams and small units are likely to function even more autonomously, knowledge interdependencies between and among team members will create greater demand for team training. The Army is a team organization; however, current Army learning models and instructional methods focus largely on individual soldier learning, or the role of the individual soldier in a larger collective of soldiers. The Army needs to know how to make team learning more effective and efficient.

5) Individualized Instruction

Ultimately, one of the most promising approaches to improving efficiency of Army TLE may be individualized instruction. However, there is still much to be determined about how individualized instruction would "work" in the Army and the specific advantages and disadvantages of this approach for unique Army needs. Another roadblock to progress in this arena is the lack of understanding of how to do the diagnosis and assessment of individual (or collective) performance levels that is needed to individualize instruction.

6) Enabling Technologies for Efficient Learning Methods.

Once we have identified instructional methods that cause efficient learning we can determine how technology can be used to serve that purpose. Of the seven focus areas, this area probably receives most attention in current Army research. However, more research is needed to determine, which specific technological advances are most essential to the adoption of efficient learning practices, as well as to actually make those technological advances realities.

7) Measures and Research Methods

Improved approaches are needed to do field research and program evaluation to answer questions about the effectiveness and outcomes of "efficient" teaching strategies in classroom settings and real world settings (as opposed to laboratory research). Additionally, new measures/indicators of success/effectiveness must be developed (i.e. not just number of graduates, but what are graduates able to do and know on the job?).

Example Questions in Each Focus Area

1) Defining "Knowledge" and "Learning" for the Future Force

-How should we define "knowledge" and what will "being knowledgeable" mean in the future? Is accessing and using knowledge the same thing as learning?

- What is the relationship between memory and critical thinking? Must information be memorized and readily accessible from memory before it can be used in the service of thinking?

-What should be the relationship between TLE and the other "knowledge" sources that will be available to soldiers? For example, what are the knowledge management issues of importance for TLE? How should TLE interrelate with communities of practice and knowledge repositories? How do we integrate these "knowledge" elements into a complete "knowledge system"?

-How can we be sure we are preparing soldiers and leaders to take maximum advantage of the knowledge available to them? How can we empower soldier and leaders to be good information managers?

-What is the role of knowledge transfer in our learning model/strategy?

-Much of what soldier and leaders learn is learned in informal and unstructured ways, on the job. How do we facilitate and take advantage of that experiential learning? How do we intensify soldier development during operational assignments? How do we expand the boundaries of the TLE "system" to incorporate these sources of learning?

- How can we demonstrate that both formal and informal learning interactions are critical to performance and to our learning strategies?

- How can we capture and facilitate knowledge that is shared or created in informal exchanges?

-How do we define teaching and training within the context of the new definitions of "knowledge" and "learning"? What kinds of skills will future instructors/facilitators/knowledge managers need?

2) **Individual Soldier Issues**

-Do soldiers have beliefs and/or misconceptions about learning that hinder or facilitate their learning? (e. g. if soldiers believe that learning is quick and problem solving is immediate this may be an obstacle to learning; similarly, the belief that knowledge comes only from an authority figure can impede deeper learning). How can we challenge these beliefs?

-How do we motivate soldiers to learn in general, and more specifically, in the area of dL? DL is a rapidly
growing area yet we don't have sufficient information about the variables that will help keep soldiers motivated to continue a dL course to completion.

-What are the psychological processes and characteristics of being an active learner? Can soldiers be trained to be active learners?

-How can we help our Soldiers/leaders embrace learning as part of their daily work experience?

-To what extent are "motivation" problems actually problems of student self-management and time management??

-Are programs needed to support soldiers who are "at risk learners", and if so, what should they include?

-How much of soldiers' personal time should be devoted to learning? What is a reasonable expectation in this area and should a limit be established?

3. **Developing and Applying Improved Instructional Methods**

- How can we package knowledge most effectively to develop soldier/leader competencies? I/O psychologists tend to work backwards by asking what is needed for a particular job and then creating the bundles of knowledge and competencies required. Could Army TLE benefit from a similar approach to understanding how to bundle and cluster knowledge to most effectively support competency development?

- What performance competencies (skill/knowledge/attributes) are we attempting to grow/improve/sustain and what should our learning model look like to achieve that improvement? Are there **core** common competencies that enable transfer of learning from one system or scenario to another without formal retraining?

-What tools and resources must we provide learners when there is more to learn that we can fit into traditional institutional courses?

- How should we sequence and interrelate courses/material to improve retention of knowledge**?** How do we build on and connect the knowledge soldiers gain over time to reduce forgetting?

- What strategies can be used to overcome some of the problems of mentoring at a distance?

- How do we ensure our learning model/strategy enables individual growth across intellectual (cognitive), physical and character (affective) responses to the environment?

- How can we do a better job of evoking learning transference?? In other words**,** what instructional methods would best ensure soldiers can spontaneously use the skills and knowledge they have learned in the classroom in other situations?

-How do we get a much tighter integration of instruction and assessment? Should the Army adopt a feedback based learning model in which there is considerable trainee practice with provision of feedback?
throughout learning rather than one in which there is post-hoc assessment of learning (i.e. the test).

-Is "shallow knowledge" a problem for Army learners? A problem identified in education at large is the over reliance on superficial understanding. Students are given key concepts and definitions but do not achieve deeper levels of understanding and the ability to reason and problem solve. The knowledge students have is inert—not active. What strategies can be applied in Army education and training that facilitate soldiers achieving a higher level of thinking more quickly?

-Rather then having compartmentalized expertise, how do we combine effort across MOS/functional areas/branches to create learning based on new operational needs and fields? What is the salience of interdisciplinary learning for application in the real (operational) world?

-How do we convey the knowledge gained by learning science to trainers/educators? What are the leverage points for achieving transfer and wide scale acceptance of more effective approaches? Could demonstration projects exploit these leverage points and evaluate/illustrate their effectiveness?

- Can our understanding of metacognition be applied to improving the effectiveness or efficiency of Army training and education, and if so, how?

- What are the best strategies for linking domains of knowledge, and for linking knowledge from context to context, to facilitate soldiers' learning and transfer of that learning to the job?

4) **Team Training**

- How does distributed reasoning/cognition work in teams/small groups? Army teams/units must not only have common goals but also common/shared understanding and knowledge. How do we evoke that?

-How can we structure a reward system for team or group work?

-How can we teach soldiers to be cooperative learners and enable them to apply that ability to learn cooperatively in an operational setting?

-What are the skills and knowledge about high performing teams that soldiers most need to participate effectively in teams?

5) **Individualized instruction**

-How can technology be used to assess competence in order to tailor instruction to the needs of individual soldiers?

-How much time savings (and resource savings) are associated with individualized instruction enabled by transparent, automated and integrated assessment systems?

-What is the role of simulated environments in assessment and individualization of instruction? What is the role of networked simulation in the assessment of team/unit performance?

-How do we develop a “learner centric” model of education in which individual knowledge, skills and other developmental needs are used to tailor timing, delivery and duration? How do we advance and support individuals at their point of need?

-What areas of soldier/leader training, education and development best lend them selves to the individualized instruction approach? Are there TLE categories where individualization does not make sense?

6) Enabling Technologies for Efficient Learning Methods.

-What is the potential for soldiers to use PDAs as tools for time management while in school or learning on-line?

-Can technology in some way(s) help us ensure that soldiers focus their attention on a learning task?

-How should we mix the sizzle of “edutainment” with pedagogy? There is insufficient longitudinal research on how people process new modes of presentation such as animation or multimedia sources of information.

-Can technology assist us in increasing student comprehension and at the same time reducing time spent in learning (e.g. offsetting discussion sessions with interactive, computer based learning)?

-How is technology a mediator of knowledge and understanding? What are the risks and benefits of a heavy reliance on technology to evoke learning?

-What is the status of intelligent agent, coach and mentor technologies needed to guide trainees through on-line, embedded and other training? What is the range of applications for intelligent agents within the TLE domain?

7) **Measures and Research Methods**

-How do we evaluate life long learning? What are the measures of effectiveness? When, where and how should they be applied?

-How do we measure team learning and performance, and reward team learning?

-How do we measure intrinsic motivation to learn?

-We have some notions about how to measure training effectiveness but how do we approach measurement of the effectiveness of the totality of a soldiers learning (e.g. from community of practice; on-the job learning)?

Other related issues:

- What are likely areas of resistance or challenge for future learning models?
- What is the model for training trainers of future learners?
- Will new "institutions" be necessary? (Note not necessarily brick and mortar institutions.)
- How will new learning models drive the financing/costing training?

*   Note-Information for this paper has been accumulated from several sources including TRADOC PAM 525-66, Force Operating Capabilities, TRADOC DCSOPS&T's analysis of shortfalls in future TLE capabilities, and various internet sources on learning science. The Claremont McKenna College website for their 2001 conference, "Applying the Science of Learning to the University and Beyond: Cognitive, Motivational, and Social Factors", which listed the learning science research topics suggested by participants, was especially useful.

ARI Science of Learning Workshop

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Futures Panel

Alice F. Healy

Center for Research on Training

University of Colorado

What We Know and What We Need to Know in Learning Science to Achieve Greater Efficiency and Effectiveness in Training

I will be discussing what we know and what we need to know in learning science to achieve greater efficiency and effectiveness in military training (SEE SLIDE 1). To discuss this issue, we first need to make clear what we mean by effective training. There are three aspects of training that we should consider (SEE SLIDE 2). First is the efficiency or speed of training. Because of the high costs of training, we certainly want to be sure that effective training be accomplished as quickly as possible. However, optimizing training speed should not be the only, or even the most important, goal. If individuals have successfully learned how to perform a task during training but then forget how to perform it sometime later, the training has clearly been ineffective. Passing a test at the end of training does not guarantee later success in the field. Training needs to be durable as well as efficient. Long-term retention of the trained knowledge and skills is essential. But even durable training will not be sufficient if the learned knowledge and skills cannot be applied to situations different from those encountered during training. Training can rarely capture the full set of circumstances under which tasks are subsequently encountered. Another important goal for training then is transferability or flexibility. Thus, effective training should be efficient, durable, and transferable.

In our research program at the University of Colorado, which has been supported by the ARI for the past 20 years (SEE SLIDE 3), we have been able to develop a set of training principles for optimal training efficiency, durability, and transferability. What we know about optimizing training can be summarized in terms of these principles. I will describe three sample principles to give you a feeling for their range and for the type of scientific support we have for them.

The first principle is perhaps the most unintuitive because trainers often try to make training as easy as possible for learners. However, according to the *training difficulty principle* (SEE SLIDE 4), any condition that causes difficulty during learning may facilitate later retention and transfer. Our initial support for this principle came from a study of foreign vocabulary learning. In this study, non-French-speaking college students learned the association between 25 French words and their English equivalents. Subjects learned these pairs in one session, using a study-test procedure in which all 25 word-pairs were presented and tested three times. At the end of that study-test procedure, subjects were given an immediate retention test. After a week delay, subjects returned and took the retention test again. Vocabulary learning is fundamentally bidirectional and requires two complementary sets of translation processes, one from the foreign language to English, and the other in the opposite direction. We examined both sets of processes as well as transfer from one set to the other. Specifically (SEE SLIDE 5), half of the subjects were trained and given an immediate retention test with French words as cues and English words as responses, and the remaining subjects were trained and given an immediate retention test instead with English words as cues and French words as responses. In the second session 1 week after training, subjects were given a delayed retention test, with the same set of cues and responses as in the first session for half of the subjects and with the opposite set for the remaining subjects.

We found that the manipulation of translation direction created opposite effects on immediate and delayed testing (SEE SLIDE 6). Subjects given the more difficult task during training with English cues (which required responding with unfamiliar French words) showed lower accuracy on the immediate retention test but higher accuracy on the delayed retention test than did subjects given the easier task during learning with French cues (which required responding with familiar English words). This result makes it clear that optimizing efficiency of training is not sufficient because training conditions that lead to optimal performance at an immediate test are not always the same as those that lead to optimal performance after a delay.

The second sample training principle is the *specificity of training principle* (SEE SLIDE 7), according to which retention and transfer are depressed when conditions of learning differ from those during subsequent testing. This principle is more intuitive, but the degree of specificity is often quite surprising.

A recent study illustrates clearly the striking specificity of training. This study involved a speeded response task, in which subjects saw on a computer screen a clock face display with a central start position surrounded by a circle of digits (SEE SLIDE 8). A target digit was displayed above the start position, and subjects used a computer mouse to move a cursor from the start position to the location of the digit along the clock face circumference. The task was made more difficult by reprogramming the computer mouse to introduce stimulus-response incompatibilities. Three reprogrammed mouse conditions were used (SEE SLIDE 9): Either only horizontal movements were reversed, only vertical movements were reversed, or both horizontal and vertical movements were reversed. Subjects were trained in one condition and then returned 1 week later for testing in the same or another condition. Comparisons of performance at the start and end of training (SEE SLIDE 10) showed a large decrease in movement time (the time to move from the start position to the target location), demonstrating learning of this skill. Comparisons of performance at the end of training and the beginning of testing 1 week later also showed a small but significant decrease in movement time for those subjects who were in the same condition in both weeks, reflecting perfect retention and dissipation of fatigue across the delay. However, for those subjects who were in different conditions in training and testing, movement time at the start of testing actually tended to increase relative to that at the start of training. Although subjects learned much during training, they could not transfer the skill they learned to testing on a new condition 1 week later.

The high degree of specificity of transfer implied by this principle may be discouraging to trainers because it is often impossible to anticipate the testing conditions during training. However, the last sample principle provides a more optimistic outlook. According to this *strategic-use-of-knowledge principle* (SEE SLIDE 11), learning and memory are facilitated whenever pre-existing knowledge can be employed as a mediator in the process of acquisition. A recent study has shown just how powerful transfer can be for such a task. In this study (SEE SLIDE 12), subjects learned 144 facts, 12 facts each about 12 unfamiliar people or 12 unfamiliar countries. Subjects in the mediated knowledge condition were given prior training to associate each unfamiliar item with a familiar individual, such as a friend or relative; subjects in the low knowledge condition were given no prior association training. All subjects were given three rounds of fact learning followed by a test. The proportion of correct responses on the test for mediated knowledge subjects, who had been trained to associate the unfamiliar items with familiar individuals, was overall more than twice as high as that for low knowledge subjects, who had not received such association training (SEE SLIDE 13), and this advantage for mediated learning was just about as large for learning facts about countries (which are conceptually unrelated to the familiar individuals) as for learning facts about other people. Also, prior knowledge about familiar individuals aided learning facts about unfamiliar individuals even though the facts were unlikely to be true about the familiar individuals with whom they were associated.

The work developing these training principles has led to a large new research project begun last year and funded by a MURI award from the Army Research Office (SEE SLIDE 14).

The aim of this project is to predict the effects of various types of training on performance of various types of military tasks. The MURI includes three major parts (SEE SLIDE 15): experimental tests of training principles, taxonomic analysis, and predictive computational models.

The first part extends our earlier experimental work testing training principles in three ways (SEE SLIDE 16): First, we provide tests of the generality across tasks of individual principles, most of which were established for a single simple laboratory task. Second, we provide tests of multiple principles in a single task. Such tests are especially important when two principles lead to opposite predictions. Third, we provide tests of principles in complex, dynamic environments.

The second part is a taxonomic analysis of training along four dimensions (SEE SLIDE 17): The first dimension involves training methods; the second involves task types; the third involves training principles; and the fourth involves performance measures.

We added this last dimension because we found that not all measures of performance yielded the same pattern of results, so that conclusions based on one measure might not be appropriate if another measure were examined instead. For example (SEE SLIDE 18), we have found evidence for both speed-accuracy tradeoffs and different patterns of results for component measures of speed and accuracy.

The third part of our MURI project (SEE SLIDE 19) is devoted to predictive computational models. These models are being formulated from experimental data, of the type I've already described. They are designed to be applicable to military tasks; they incorporate the four-dimensional taxonomic analysis; and they are constructed using two computational platforms already used for modeling in the military, ACT-R and IMPRINT. The MURI research, if fully successful, should thus enable us to predict performance using computational models sensitive to variation in training methods, tasks, principles, and measures.

Being able to predict performance is what the Army needs in order to move closer to the ultimate goal of improving efficiency and effectiveness of training. But that goal cannot be reached solely on the basis of the MURI research, which provides only a relatively small step in that direction. We will need to accomplish much more beyond the MURI research (SEE SLIDE 20). First, we will need to continue basic empirical research into training principles. At this point, we have outlined 30 tentative principles. Even though the MURI should make a strong headway towards identifying new principles, there will undoubtedly be others to uncover. Also, the ones that have already been discovered will need to be refined and their boundary conditions will need to be specified in further basic empirical research. Second, the predictive computational models will need to be extended to complex military tasks. Most of the tasks examined in the MURI research are quite simple. Even the more complex tasks are very far from the elaborate activities required of troops on the networked battlefield. Also, the tasks studied in the MURI are necessarily laboratory tasks rather than realistic military tasks. The computational models will need to be extended to the full range of actual tasks used on the networked battlefield. The third need is related to the second one. The MURI effort involves basic research exclusively. Applied research with soldiers in real military contexts will also need to be conducted to test the applicability of MURI conclusions to the field.

We have recently proposed one stepping-stone to take us beyond the MURI and provide a link from the MURI research to the study of more complex military tasks and applied research with such tasks. This stepping-stone is built on the assumption that no matter how elaborate the behavior of individuals might appear to be, it is basically understood in terms of its simpler component facts and skills. To study behavior under battlefield conditions, then, we have proposed a new approach that will attempt to identify the components of successful behaviors and will then test these components both in isolation and in the context of a simulated battlefield scenario.

Specifically, we have constructed a battlefield scenario involving the need to direct friendly fire toward a threatening enemy position. This scenario contains within it many of the critical behavioral elements of coordinated command, control, and reaction. In particular (SEE SLIDE 21), responding to enemy threats with fire typically requires: (1) identifying and locating enemy positions, (2) receiving information about squad location and enemy targets, (3) following commands involving location and route information from dispatchers, (4) estimating time intervals and distances, (5) decision making and responding logically to danger signals, (6) entering data into digital computers or communication devices, (7) retrieving facts from both human and computer memory when needed, (8) making both mental and computer calculations, (9) coordinating hand and eye movements, and (10) keeping track of the state of several concurrent variables. In our proposed methodology, subjects will assume the role of battlefield squad members and be required to perform a variety of tasks, both at the direction of a dispatcher and in response to the unfolding series of events that occur over the course of performance assessments within the scenario. This paradigm will allow us not only to test established training principles but also to identify new principles for their application in the battlefield scenario.

This effort would lead us to move one step closer to the ultimate goal of achieving efficiency and effectiveness of training in the future. That goal can only be reached gradually and must be attained through a concerted effort involving basic empirical and theoretical research along with applied research in the field. As the manner in which the Army conducts war changes, the training of soldiers will undoubtedly need to be changed to accommodate these developments in ways that are difficult if not impossible to anticipate at this point. But with a solid foundation of research, such accommodations should be made with relative ease.

Out of Many, One: Assessing Future Army Leadership

Anna T. Cianciolo
Command Performance Research, Inc.

"Although advanced technical capabilities are indispensable to force transformation, leaders and Soldiers will remain the centerpiece of Future Force formations. Exploiting the full potential of tomorrow's technical capabilities will require an unprecedented breadth and depth of technical and tactical skill, individual and organizational adaptability, and personal initiative and creativity... The significance of knowledge - the most human aspect of future operations - can hardly be overemphasized. All joint and service concepts postulate higher levels of knowledge as a fundamental condition of effective future operations."

-- *The Army's Future Force Capstone Concept 2015-2024* (Version 2.0, p. 4)

The above quotation simultaneously illustrates the continued importance of the human dimension to mission success and indicates that the future operational environment will place unique demands on leader capability and knowledge. According to Army Field Manual 22-100, *Army Leadership* (U.S. Department of the Army, 1999), leadership is an interpersonal influence process by which leaders provide the purpose, direction, and motivation to accomplish missions and improve organizational effectiveness. The successful execution of the leadership process has been a critical determinant of military victories throughout history. However, future leaders must conduct this process in the context of much greater complexity than previously has been known. From a leadership perspective, complexity may be defined as the number of non-overlapping, or partially overlapping, contributors to the leader's battlefield visualization and decision making process and the number interconnections among these contributors. Complexity also includes the number of interconnected outcomes of leader actions, a condition especially prevalent in operations other than war. In order to "see first, understand first, act first, and finish decisively" in full spectrum operations, future leaders must (a) rely on a greater number of sensors, both human and non-human, to gather intelligence (Association of the U.S. Army, 2004; Steele, 2005); (b) integrate information from a larger body of specialists to comprehend the battlefield (U.S. Army Training and Doctrine Command, 1999); (c) mobilize and synchronize a greater diversity of assets (organic units plus reserve components, joint, interagency, and coalition forces, and unmanned tactical equipment) to act on the operational environment (e.g., U.S. Army Training & Doctrine Command, 2005; Steele, 2005); and (d) simultaneously coordinate multiple lines of operation to achieve lasting effect (Chiarelli & Michaelis, 2005; U.S. Department of the Army, 2006).

In addition to increased complexity, the future leader also must deal with increased task difficulty due to the rapid rate of change in threat tactics characteristic of asymmetric warfare and in unit structures, tactics, and operational terminology brought about by Army transformation and digitization. The future leader, in other words, must devise planning and execution strategies that leverage the greater diversity in available assets, including human minds, at a time when the knowledge of these assets and their use must constantly be updated. This challenge is the hallmark of future leadership. The purpose of this paper is to identify the unique implications of the future operating environment for conceptualizing leadership during full-spectrum operations and, in turn, for assessing future leader tactical performance in training and educational settings.

Tactical Leadership in Complex and Difficult Operating Environments

The substantial increase in complexity and difficulty imposed by the future operating environment requires that the functions of tactical leadership be re-conceptualized in terms of collective action rather than individual behavior. Although the unit commander bears ultimate responsibility for mission success, his ability to envision operations and make effective decisions is inextricably linked to the knowledge, expertise and collaborative behavior of others. If the amount of information and knowledge that one person must have to visualize and execute successful missions is not already prohibitive, the future operating environment certainly will prevent such cognitive self-sufficiency. Unit effectiveness, even at the platoon and company level, will become as much a function of access to information and knowledge as of its personal possession.

One might alternatively define tactical leadership, then, as a collective process, enacted by humans and technology, by which operations are visualized and orchestrated to enable mission accomplishment. This definition of tactical leadership is consistent with the intent of Department of Defense net-centric initiatives such as Horizontal Fusion (Stenbit, 2004), but adds the critical human dimension to achieving the tactical advantage of networked technologies. Understanding leadership in this way requires the development of a model that represents the information processing among the multiple members of the collective, including technology, to produce unified visualization and decision making. This model would serve as the basis for leader training and education that develops the group, or unit, mind.

Using the collective, rather than the individual, as the level of analysis for understanding collaborative activity is not new. For example, the theory of distributed cognition (Hutchins, 1995) posits that the performance of collaborative tasks, such as ship navigation, can be described in terms of the propagation of information among the members of the team, much as electrochemical activity is propagated among neurons in the brain. In the case of an aircrew (see Hutchins & Klausen, 1996), the “neurons” include team members’ individual memories, the forms of communication among the crew (e.g., speech, gestures, actions), and the information displays in the task environment. The “electrochemical activity” would include the aircraft’s altitude, heading, flight plan, and so on. To the extent that task information is available throughout the system and knowledge about how the system operates is shared among the team members, coordinated action is enabled through common expectations for behavior.

Distributed cognition has somewhat limited application to understanding Army tactical leadership in a complex operating environment, however. That is, the theory of distributed cognition is meant to apply to relatively small teams with highly overlapping knowledge and functions executing narrowly bounded tasks having well-understood and established structures. This may characterize teams or squads conducting mission tasks, but it is a far cry from the company and higher echelons, whose structures have themselves become more complex. Tasks, such as command and control, for which team members contribute specialized knowledge and perform largely non-overlapping functions, are not adequately addressed by the theory because all team members do not possess (cannot feasibly possess) all of the information and knowledge possessed by all of the other team members.

What is needed is a model of the collective, distributed information processing of complex teams characteristic of the future operating environment, where the possession and sharing of information and knowledge must be bounded and purpose driven.

Wegner's (1986) theory of transactive memory provides such a model by conceptualizing the group mind of teams whose members have only partially overlapping knowledge and functions. The theoretical transactive memory system is a property of the group that enables the collective to have far greater knowledge than any one of its individual members. Collective activity is enabled by the connection of differentiated individual memories through communication. Similar to Hutchins, Wegner theorizes that memories may be internal (i.e., mentally stored) or externally situated in the physical structure of the environment (e.g., stored in information displays or databases). In contrast to Hutchins, Wegner focuses on collaborative tasks, such as organizational management, in which all of the relevant knowledge cannot be personally possessed by everyone involved and task structure often must be defined in each new situation.

According to Wegner (1986), the success of collaborative activity depends on the shared awareness of where knowledge is stored within the collective memory system. A well-defined and widely used system for storing knowledge and encoding the location of stored knowledge is a critical determinant of this shared awareness. Examined from a slightly different angle, collaborative activity in complex teams is determined by the quality of the knowledge management practices performed by the team.

Broadly defined, knowledge management is the process by which an organization transforms the knowledge of its members into value (Levinson, 2005). Value is derived by achieving organizational goals. In the case of Army tactical leadership, these goals include forming an accurate, integrated, and shared visualization of the operational environment and making effective decisions during mission execution. Conceptualizing leader goal attainment in terms of the collective practice of knowledge management has clear implications for identifying what must be developed to enhance the effectiveness of the future leader.

Note that the theoretical transactive memory system is a generalized model for describing the performance of complex teams. In order to develop a model of Army tactical leadership that represents the collective activity involved in producing visualization and decision making, the transactive memory system model must be significantly enhanced through detailed analysis of future command and control tasks. This analysis should focus on the knowledge required to form integrated visualizations of particular operational environments, the knowledge possessed by the individual members of command and control teams (including the information present in technological displays), sources of knowledge outside of the team that can be brought to bear, and the required flow of knowledge among team members to enable knowledge integration.

Implications for Future Leader Education and Training

The implication of a transactive memory model of Army tactical leadership is that future leader tactical training must be collective, involving the team members and representative command and control technologies that would be involved in the actual operational environment. Future leaders must be taught to think of tactical leadership in terms of collective activity through the practice of developing and exercising unit knowledge management practices. The Army has well-established collective exercise formats, including staff exercises and map exercises, for facilitating command and staff integration during planning and execution. These exercises can be conducted effectively in a variety of environments with varying levels of fidelity, but of critical importance to training effectiveness will be the level of fidelity with which the knowledge and information flow in the simulated tactical operations center is represented. Practice developing, disseminating, and automatizing standing operating procedures for information and knowledge management (as opposed to mission execution, *per se*) must be the central training objective of these exercises.

The preparation of individual command and control team members, including leaders, for these collective training exercises will enhance their effectiveness. Individual training should include coursework in the officer education system that focuses on knowledge management. The design of this coursework should be derived from best practice in adult learning and education and be consistent with the principles of collective thinking. That is, the coursework should (a) combine instruction in knowledge management theory with practical application using fielded command and control systems; (b) should be conducted in a seminar-type setting with small student groups; and (c) should involve a group project involving scenario-based development of information sharing tactics, techniques, and procedures. To fully support collective training, schoolhouses should leverage existing constructive simulation technologies to conduct networked capstone command and control exercises such that officers from different warfighting functions can practice true combined arms information processing. Individual leaders should be encouraged to self-develop through participation in online professional forums and continuous learning through independent research.

Future Leader Assessment

The implication of conceptualizing tactical leader functions as collective action is that leadership performance cannot be assessed independently of the performance of the command and control team as a whole. A second implication is that assessment of the collective must have as its focus information and knowledge sharing. This section presents an overarching approach to accomplishing diagnostic assessment of collective information processing, lists candidate methods for capturing collective performance, and describes the challenges to conducting collective assessment.

What to Assess

Collective assessment, regardless of the type of performance assessed, should be conducted on multiple levels, capturing the determinants, processes, and outcomes of collective performance (see Cianciolo & Sanders, 2006; Noble & Kirzl, 2003). Multi-level assessment enables the diagnosis of shortfalls in the outcomes and processes of collective performance and the provision of targeted feedback at both the individual and group level.

In the case of Army tactical leadership, the outcomes of collective performance should reflect the goals of leadership functions. Recall that these goals are accurate, shared, and integrated visualization of the operation and effective decision making. Therefore, outcome measures should include planning products, especially the decision support matrix, which reflects shared visualization and the robustness of the plan to mission events. Outcome measures also should include the quality of the leader's decision-making process as reflected in the leader's search and consideration of the available information. Mission accomplishment should not be used as an outcome measure because mission accomplishment is determined by numerous factors beyond the direct control of the command and control team (e.g., the actions of subordinate units). Multiple determination is an important limitation of outcome measures, however careful selection of such measures based on an understanding of the performance being assessed can produce useful assessment data.

The collective processes of critical importance to tactical leadership are those that comprise team knowledge management practices and information sharing, i.e., collective information processing. The assumption behind this level of assessment is that collective information processing is a critical determinant of the quality of planning outcomes and command decision making. To capture collective information processing, several knowledge management variables should be included, such as adherence to standing operating procedures or tactics, techniques, and procedures for information management, involvement of the commander and staff officers in the command and control process, timeliness of information sharing, robustness to technological failure, and so on.

The determinants of collective information processing include individual knowledge and technological and situational factors. Assessment of determinants should inform the diagnosis of deficits in collective information processing. When diagnosing deficits in knowledge and information management, assessment of individual knowledge should include awareness of own and others' information needs (Cianciolo & Sanders, 2006), as well as digital skills (Leibrecht, Lockaby, Perrault, & Meliza, 2004a), and awareness of the unit's tactics, techniques, and procedures or standing operating procedures for information management (Noble, 2004). Technological and situational factors that should be assessed include turnover in the unit, personnel absences, and technical problems with the digital command and control systems, among other things.

Techniques for Collective Assessment

A battery of collective assessment techniques should be used to capture the determinants, information processes, and outcomes of future Army tactical leadership. Traditional techniques such as knowledge tests, surveys, and archival data analysis (e.g., system data indicating outages or training records indicating absent personnel) all could be employed to capture the individual, technological, and situational determinants of performance. Ideally, data collected on performance determinants related to individual knowledge are collected prior to the training exercise. The relation between knowledge determinants and performance can be much more clearly depicted if the determinant data are not contaminated by the experience of the training exercise itself (e.g., practice effects). Some situational determinants, such as personnel absences or system outages may be captured during the exercise through observation or system data collection. One advantage of system data collection is that it can occur after the exercise has been completed.

The most commonly used assessment of collective processes or team collaboration is observation-based rating, typically applied to assessing team coordination and communication behaviors in response to specific target events (Fowlkes, Dwyer, Oser, & Salas, 1998). This method has been demonstrated to have acceptable inter-rater reliability and can be used to assess team performance in response to both regularly occurring and low-base rate events (Cianciolo & Sanders, 2006; Fowlkes, et al., 1998). This method also can be used to evaluate information flow relative to a recognized standard, such as can be determined from doctrine (Cianciolo & Sanders, 2006). The disadvantage to observation-based rating is that it is subjective and difficult to apply to geographically distributed teams unless multiple raters are used. Even for co-located command and control teams, tactical operations centers are characterized by a great deal of activity happening at one time, which can overwhelm a single rater. In addition, rater checklists require a working level of knowledge in the domain area to be used effectively. It is best to use observation-based rating in combination with other techniques, such as automated data collection, in order to form a complete picture of collective information processing.

Because simulations, particularly embedded training systems, will play a significant role in the training of the future force, it will be advantageous and common practice to use automated measures of future Army tactical leadership (e.g., Throne, Holden, & Lickteig, 2000). The assumption behind the use of automated measures is that most, if not all, command and control activity is mediated by digital technology, a safe assumption for the future force. The advantage to automated measures is that they are unobtrusive, reliable, objective, and easy to administer. The challenge posed by automated measures is that they require a great deal of inference in order to link the relatively simplistic activity data that can be collected by digital command and control technologies (e.g., number of messages sent, number of users on the system at any one time, etc.) to complex team information processing. A detailed collective task analysis would support such inference, although observation-based assessments should be used to augment automated ones.

Collective information processing also can be assessed using other objective and quantitative means based on multiple-regression analysis. Adelman, Yeo, and Miller (2006) assessed team performance on a simulated air defense task using multi-level Brunswik lens modeling. In this study, Adelman et al. conceptualized a leader's decision-making process as a combination of (1) the leader's utilization of environmental cues; (2) the leader's reliance on the recommendations of his staff members who in turn used environmental cues; and (3) the degree sharing of non-overlapping cue information among all members of the command and control team, including the leader.

Leaders' decision accuracy was represented in this study by the correlation between the leader's judgments of threat level and "ground truth" (i.e., known simulation parameters). The accuracy of staff recommendations regarding threat level was represented in an analogous fashion (i.e., correlation with ground truth). Information sharing was represented by the average amount of cue information shared among team members. The leader's adaptive reliance on staff members was conceptualized as the relative weight he placed on the recommendations of staff members with varying accuracy. Finally, leader knowledge was represented by the relative cue utilization of the leader compared to the optimal cue utilization for reaching an accurate decision.

This technique could be used to judge the quality of the commander's decision making in terms of the efficacy of information sharing between the commander and staff and the accuracy of the commander's decision making based on the information available in the environment (i.e., the knowledge of the collective). The independence of this technique from decision outcomes makes it ideal for studying decision-making in a way that is strongly determined by the collective activity of the leader and staff. The disadvantage to this technique is that it is most feasibly applied to single decisions that can be analyzed ahead of time and cannot easily be adapted in real time as an operation unfolds. An additional challenge posed by this technique is that it requires trainees to go through several training exercises to in order to produce stable data.

Other leadership outcomes, such as the decision support matrix, integrated overlays or other planning products, can be relatively straightforwardly assessed using expert-derived scoring keys based on doctrine (e.g., see Cianciolo & Sanders, 2006). The keys should be designed to reflect accurate, shared, and integrated visualization. Such keys are time-consuming to create but can be modified relatively easily for use in different training exercises.

Challenges to Assessing Collective Performance

The greatest challenge to collective assessment is the difficulty in specifying exactly what is to be measured. As described previously, the theoretical transactive memory system is not described in sufficient detail to support assessment directly. The constructs in this model must be articulated in terms of knowledge management practices within the context of specific task performance. A detailed collective task analysis, where the task is command and control knowledge management, is required to reach an adequate level of detail. This is a difficult endeavor for multiple reasons.

First, the task analysis must involve the observation of command and control teams during the conduct of operations. Even when combat training center exercises are used as a safer alternative to actual combat operations, collaborative activity often is geographically distributed (e.g., with the commander in a vehicle several kilometers away from the rear tactical operations center) and difficult to observe by one person. Geographical distribution multiplies the number of people required because military subject matter experts are necessary to assist in making sense the highly technical ongoing activity. Second, the task analysis should be conducted using command and control teams accomplishing a range of operational success in order to identify effective and ineffective knowledge management practices. However, units generally do not arrive at combat training centers having conducted the recommended prerequisite collective training. They instead use the combat training experience to identify and resolve difficulties experienced during collective task execution.

To increase the effectiveness of observation, assessment designers must thoughtfully prepare by studying doctrine, identifying capable and interested subject matter experts to assist in conducting the observation, and learning about the units rotating through the combat training centers to discern which ones to observe to maximize the likelihood of identifying group differences. Where doctrine is used to support the task analysis, joint review with subject matter experts prior to observation is necessary to understand where actual performance can be expected to differ acceptably from doctrinal standards. Interviews with subject matter experts alone will not be sufficient.

Some reports have demonstrated that collective task analysis is doable and can produce observation-based measures containing a significant amount of detail (e.g., Cianciolo & Sanders, 2006; Leibrecht et al., 2004b; Mullen, Kemper, Harrison, & Bartkoski, 1997). Each of these reports are focused on particular collective activities, however, and considering the rapid rate of change in unit structure and organization, those reports that are not already outdated will be soon. Moreover, none of these reports explicitly focuses on knowledge management or accounts for command and control activity in operations other than war. The first critical step in assessing the future leader is to specify the transactive memory system in particular command and control teams as they are envisioned in future force units conducting a range of likely future missions.

A second challenge to collective performance assessment is that all collective assessment techniques are time- and resource-consuming to develop, administer, and/or analyze. First, assessments must be integrated into exercise scenarios designed to elicit collective performance. These scenarios must be carefully developed with assessment in mind (and vice versa) as well as properly resourced. Situational constraints, such as personnel availability and resource limitations, already bound the feasibility of collective exercises, let alone rigorous assessment. Second, because purposeful assessments are tools for diagnosis, feedback, and development, they must be closely tied to the performance they are designed to capture and they must be administered during multiple phases of task performance (before, during, and after). Assessments therefore must be detailed and should carefully designed so that they are easy to use and as unobtrusive as possible, especially where raters are involved. Finally, to the extent that the technologies and team structures used for command and control change, assessment techniques and criteria must be redefined and measures re-developed. This is especially true for automated measures that are tied to particular digital systems.

A third and final challenge to collective performance assessment is external validation of the assessments against other performance criteria or group characteristics (e.g., rate of turnover, level of digitization, etc.) and internal validation of the causal model of determinants information processing outcomes on which the assessments are based. Validation is critical for determining whether high payoff collective activity is being captured by the assessments and whether the assessments effectively discriminate between more and less successful command and control teams. Put another way, validation is necessary for answering the questions “Are we assessing the factors we should be assessing?” and “Are our assessments sensitive to real differences in the effectiveness of tactical leadership?” The main threat to validation is the limited access to data. Many more command and control teams must be observed than can be feasibly observed in order to produce reliable validation data.

Conclusions

Networked command and control technologies are believed to be critical enablers of future tactical advantage in both conventional and irregular warfare (e.g., Stenbit, 2004). The promise of these tools is that they will unify intelligence efforts, enhance situational understanding, and accelerate decision making. In order for these tools to have the intended impact, the human dimension of network effectiveness must be understood and developed. Hierarchical conceptualizations of tactical leadership limit this understanding and development because they fail to account for the collective information processing that comprises command visualization and decision making. Collective models of tactical leadership address the collaborative activity of humans and technology that comprises effective command. These models provide a means for developing net-centric tactical leadership through collective assessment and feedback.

Although collective assessment is fraught with many challenges, long-term efforts must be made to overcome them as much as is feasible in order to enable optimal training design and execution. Meanwhile, attention in the shorter term should be focused on devising workable (and ideally somewhat generalizable) solutions that provide targeted tactical leadership assessment for high-payoff or frequently occurring mission tasks. These assessments could be used to capture samples of collective performance most important to overall organizational effectiveness. Such assessments likely would have a short "shelf-life," but their generation should inform the development of a larger scale assessment solution and the creation of a process for rapid short-term assessment construction.

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Intelligent Tutoring Systems: Prospects for Guided Practice and Efficient Learning

H. Chad Lane
Research Scientist
Institute for Creative Technologies
University of Southern California
http://www.ict.usc.edu
lane @ ict.usc.edu
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Rapid technological advances and compounding complexities of the modern world have profound implications for all levels of education and training in the United States and around the world. Intelligent tutoring systems (ITS) represent an important class of educational technology poised to play particularly critical role helping learners acquire the skills needed to succeed. This paper argues why this is the case, describes existing ITS technologies and functionalities, summarizes current research streams, and highlights underrepresented areas of research that (in the author's opinion) will be essential to the training and education of the Soldiers and leaders of tomorrow.

The new science of learning

Researchers in the learning sciences seek to uncover fundamental principles of human learning. About 30 year's worth of such findings are summarized in the National Research Council's report *How People Learn* (HPL) (Bransford, Brown, & Cocking, 2000). In this section, we briefly highlight two (of many) consensus points highlighted by this team that have a particular relevance to ITS research.

HPL stresses the importance of helping learners develop a *deeper conceptual understanding* when they are learning a new domain. This means going beyond facts and procedures to thinking about applicability conditions and dynamic modification of such knowledge to fit new situations. "When students gain a deeper conceptual understanding, they learn facts and procedures in a much more useful and profound way that transfers to real world settings" (p.2, Sawyer, 2006). Allowing learners to actively participate in their own learning is essential to this aim. This guideline is broadly supported by many theories of learning (most prominently those of pioneers such as Piaget and Vygostky).

Another finding highlighted in HPL is the *importance of reflection*, or metacognition, in learning. In addition to acquiring factual and procedural knowledge (with deep conceptual understanding, of course), learners should also be improving their ability to learn. Reflective skills, such as planning, questioning, explaining, and criticizing, are generally highly developed in experts but not novices. To accelerate the maturation to expertise, then, it is essential to create learning environments that encourage and support these kinds of activities. Clearly, active learning and reflection go hand-in-hand and should be high priority considerations in the development of computer-based learning environments.

Human and intelligent tutoring

There are no known forms of education as effective as a professional human tutor. Students working one-on-one with expert human tutors often score 2.0 standard deviations – roughly two grade levels – higher than students in a conventional classroom (Bloom, 1984). In contrast, the very best intelligent tutoring systems achieve learning gains of about 1.0 standard deviations (Anderson et. al., 1995; VanLehn et. al., 2005). The best computer-aided instructional systems – computer tutors that do *not* use techniques of artificial intelligence (AI) – produce learning gains of about .4 standard deviations (Niemiec & Walberg, 1987).

Why is tutoring effective?

Although a precise answer to the question of why tutoring is more effective than other forms of instruction has remained elusive, most explanations focus on the fact that the best tutors balance the need for active participation of the student with the provision of guidance. This means the student does as much of the work as possible while the tutor provides just enough feedback to minimize frustration and confusion (e.g., Merrill et. al., 1992). Also, effective tutoring has less to do with improved didactic explanations on the part of the tutor and more to do with the interaction between the tutor and student. Chi et. al. (2001) conclude that "students' substantive construction from interaction is important for learning, suggesting that an ITS ought to implement ways to elicit students' constructive responses" (p. 518). It is a common pattern in ITS research to first identify effective learning events and patterns in human tutoring, then attempt to emulate them in an ITS.

Classification of ITS technologies

One way to organize tutoring systems is around what role they are intended to play. At one end of the spectrum, some systems are intended to replace a textbook or classroom instruction to deliver domain content for the first time to a student (e.g., intelligent hypermedia systems). At the other end are systems designed to directly support *practice* (sometimes described as "homework helpers"). These usually complement an existing instructional component such as lectures. Although very few systems sit on the edge of this spectrum, ITS research tends to lean to the practice end. Indeed, practice is when "the rubber hits the road" in learning: it represents a volatile time when knowledge gaps are revealed and skills are automatized. Modern theories of learning stress the critical role of practice and most highlight the importance of feedback because of the risks of unguided learning (Kirschner et. al., 2006; Clark, 2004).

Tutoring systems typically support practice in one of two ways. *Product* tutors evaluate final outcomes, such as an essay or a mission plan. Typically, a student works on a solution until it is deemed complete, then submits it for feedback. The ITS analyzes the solution by looking for flaws, omissions, or sub-optimal elements. Some advanced product tutors are able to reverse engineer solutions using techniques such as *plan recognition* to identify the reasoning that likely underlies the solution. An inherent weakness of product tutors is that students might become stuck before they are able generate a solution. More interactive and pro-active systems that provide support while the student is working towards a solution are best described as *process* tutors. This is perhaps the most familiar category because most human tutors operate in this mode – the student is observed step-by-step, feedback and hints are given, questions are asked and answered, and so on.

Recurring ITS research areas

A core collection of “good old fashioned” ITS research areas has managed to stay in favor throughout the years. Broad surveys of the field conducted roughly 10 years ago (Youngblut, 1994; Shute & Psotka, 1996) and more recently (Loftin, 2004) highlight several recurring themes, many that date back to the earliest years of ITS research:

- *Learner or student modeling:* General problems in this area include diagnosis of misconceptions, tracking of learning over time, representation of faulty (i.e., “buggy”) reasoning, “open” learner modeling, and affective/emotional modeling. Learner models can provide assessments to instructors, used to generate appropriate problems, and be the basis for individualized, adaptive instruction (although this remains an unrealized goal).
- *Natural language dialogue:* Some of the earliest tutoring systems attempted to use techniques of natural language processing to simulate human-human tutorial dialogues. Even with intermittent periods of low activity, this stream of research has not gone away. Recent support from ONR and NSF helped produce some modernized systems shown to enhance learning as a direct result of improved dialogue quality.
- *Cognitive modeling:* Research in this area generally involves creation of plausible symbolic representations of the rules and strategic thinking needed to solve problems in a domain. Resulting models are used to evaluate student actions, generate feedback, and provide a basis for learner modeling (Anderson et. al, 1995). Tutoring itself can be treated as a task, and so researchers have also built cognitive models of expert tutoring.
- *Complete systems and evaluations:* ITS research overlaps significantly with the learning sciences, and so thousands of systems have been built and many hundreds evaluated to answer research questions. This trend should snowball in the coming years resulting in more effective tutors and continued contributions to the science of learning.
- *Authoring tools, knowledge acquisition, and development tools:* The burden of creating an ITS was quickly realized, and thus approaches to reducing ITS development time (e.g., encoding expertise, teaching strategies, and domain models) began to surface in the early 80’s. This continues to be a focus area and is discussed in the next section.

This list encompasses many subcategories, but is certainly not complete. Loftin et. al. (2004) include (in addition) learning strategies, system design, and collaborative learning environments on their list of recurrent ITS research topics. These problems are recurring because, in part, they have resisted truly general solutions. Interweaving complexities such as broad ranging domains of interest, varying learning goals and contexts, and learner differences all contribute to this resistance and have led some to question the efficacy of seeking truly general solutions. A better approach may be to seek to build specialized components that address certain classes of educational problems – this is also one of the conclusions reached by Loftin et. al. (2004).

The first 20-30 years of ITS research produced a large body of AI-based approaches to building educational software. Tutoring systems proved their ability to be involved in learning in ways that other educational software could not. For example, detailed cognitive models proved that students could get help with "mental" steps involved in problem solving. The clear stumbling block was the lack of adoption and large scale transition of ITS technology into schools (see Koedinger et. al. (1997) for a rare counterexample). This was in part due to the massive effort and special skills required to build an ITS, which motivates more attention to authoring tools.

Recent trends and developments in ITS research

The last section summarized several traditional areas of ITS research that continue to receive attention from the community. In this section, we unpack the most prominently represented of these research themes and describe several other areas of interest that have emerged recently.

<u>Learner modeling.</u> In the last five years, a great deal of attention has been given to the modeling of the *affective state* of learners. Most of this effort has targeted *motivation* since there is evidence form the learning sciences that (1) expert human tutors *do* manage the motivational and emotional states of learners, and (2) instruction can be adjusted according to motivation in ways that improve learning. Often using the highly detailed measurements a computer environment can provide (e.g., time between keystrokes), researchers have built algorithms that translate these patterns into evidence about affective states. In some cases, motivation has been tied to ability and help-seeking tendencies while in others feedback frequency has been adjusted based on the system's motivational state estimate of the student.

O*pen learner modeling* is an extension of traditional learner modeling that makes the model a visible and interactive part of the learning environment. In other words, the display includes a representation of the system's internal belief of the student's knowledge state. A common visualization used is the progress bar. As a student solves problems in a domain, each action is tracked and treated as positive or negative evidence towards a belief domain elements are understood (or not). The progress bars move in one direction or the other, all for the student to see. It is often argued that this inherently motivating because students are usually given the chance to "challenge" the model, essentially telling the ITS "I want a problem to solve to prove I possess skill X." Open learner models are often argued to support reflection and active learning because in order to challenge the model, students must assess their own understanding and decide how to work through the curriculum.

<u>Authoring systems.</u> As discussed previously, if ITS technology is to make its way out of the lab on a large scale, authoring tools will need to be available for end users who want to build new tutors or tweak the system's behaviors based on what they find in the field. A recent book on state of the art authoring tools (Murray, Blessing, & Ainsworth, 2003) makes it clear that although the many existing systems have been successful, all remain research prototypes. This is not true for authoring systems that focus solely on creating

and modifying domain *content*, but rather in the case of authoring tutorial and expert *knowledge*, significant hurdles remain.

A particularly promising approach to authoring is based on the idea of *authoring by example*. The basic idea is that rather than encoding domain expertise and tutoring knowledge in an AI programming language, the author instead *demonstrates* ideal solutions. To create feedback messages, the user specifies what the system should say to a student at various points of the demonstration. To handle mistakes, the author simply labels parts of the demonstration as errors, then again authors appropriate feedback messages. This is the approach taken by the Cognitive Tutoring Authoring Tools (CTAT) project. Preliminary testing has shown an authoring speedup of between 1.4 and 2 times over a "reduced" version of the tool lacking the demonstration capability (Aleven et. al., 2006). Because the demonstrated models tend to be overly rigid, researchers are also exploring the use of machine learning techniques in attempts to infer cognitive models from series of demonstrations.

<u>Group, collaborative, and online learning.</u> The advent of the internet and relative ease of networking computers together has radically advanced the state of the art in collaborative learning. ITS work in this area, including intelligent support for team training, has historically been quite limited (Loftin et. al., 2004), but has seen dramatic increases in the last few years thanks in part to the successes of the Computer Supported Collaborative Learning (CSCL) community. Jermann, Soller, & Muehlenbrock (2001) point out that early CSCL systems were essentially networked work environments that performed "mirroring" of actions so all participants could be aware of actions taken in some community workspace.

Advanced CSCL systems go beyond mirroring to provide deeper supports, such as *rate* data (showing how fast collaborators are at completing tasks), social networking tools (to reveal level of communication between participants, for example), and problem solving monitoring with feedback (to offer guidance to individual team members). Because robust free-form natural language understanding is an unsolved problem, advice-giving CSCL systems tend to use other techniques to monitor communicative activities. One approach is to require the use of *sentence openers* (such as "I agree, but…" or "Do you know…") which can provide a deep enough level of intentional information to track collaboration patterns.

Evaluations of CSCL systems have shown that many of the expected benefits, such as increased motivation and participation, have not been realized. Studies repeatedly reveal problems such as low participation and communication rates, satisfaction, and limited learning. To deal with some of these problems, ITS researchers have recently focused on a variety of approaches, such as improving team visualization, support for peer and reciprocal tutoring, and intelligent "matching" of group members. In general, automatic assessment of individual performance in a team environment is limited because of the complex nature of doing plan recognition on groups of human participants. However, in some cases it is feasible to provide one-on-one style tutoring to individuals in a team environment. One example appears in Livak (2004) in the form of a cognitive tutor that supports tactical operations in a 3D first-person "shooter" game.

<u>Natural language dialogue.</u> In face-to-face situations, human tutors use a variety of communicative techniques such as body language, gesture, hesitation, intonation, and, of

course, dialogue. Because many intelligent tutoring systems avoid the use of natural language (often called "2nd generation systems"), researchers have suggested that improved natural language dialogue may help "close the gap" between human and computer tutors. This is also motivation for research into *pedagogical agents* that attempt to also leverage non-verbal modes of communication such as facial expressions, body language, and so on.

The pedagogical power of dialogue lies in the increased opportunity for interaction it affords for tutoring systems. Dialogue-capable tutoring systems are now showing learning gains over read-only control groups in support of an *interactivity* hypothesis for learning with tutoring systems (VanLehn et. al., in press). Improved natural language understanding techniques and authoring tools are making it possible to understand student utterances well enough to allow systems to respond in productive and realistic ways. Beginners, who have yet to refine their domain vocabularies but are surprisingly consistent in their language patterns, are ideal targets for modern dialogue-based tutoring technology (Lane & VanLehn, 2005).

ITS as a catalyst in the development of a science of learning. An often overlooked benefit of automated tutors is that their behavior can be "dialed" to test specific hypotheses about learning and tutoring effectiveness. This is difficult to do consistently with human tutors. An area where this strength is quite evident is in the study of feedback. Given a "good" ITS, it is usually a straightforward matter to experimentally adjust the frequency, form, and content of feedback messages and test for difference in learning. For example, McKendree (1990) conducted a study comparing feedback types in a geometry proof tutor. The study showed that goal-directed feedback (i.e., forward-looking hints) led to better performance than backward-looking feedback that flagged errors or explained why steps were incorrect. Studies like this one play an important role in the search for methods of effective instruction and guided learning. At the Pittsburgh Science of Learning Center (PSLC), intelligent tutoring technology is being leveraged (alongside a host of traditional learning science approaches) to address a broad range learning issues and develop a robust theory of learning.[1]

Moving forward: Underrepresented areas of ITS research

To address the future training and educational needs of the Army, it is likely that certain areas of research will need heightened focus from the ITS, AI, and learning science research communities. In this section, we begin with a summary of Loftin et. al.'s (2004) recommendations, then move into brief discussion of areas that appear to be gaps in the ITS community's overall research outlook.

Summary of recommendations of Loftin et. el. (2004)

Loftin et. al. (2004) conducted a large-scale review of ITS research including analysis of the current U. S. Army training requirements, review of non-DoD funded ITS research programs, and interviews with ITS experts and TRADOC personnel. Their recommendations target useful results in eighteen months to three years. The recommendations are broad, including basic and applied research, and a call for large scale transition into some existing Army training program. A few of the specific highlights are:

- creation of an ITS *ontology* to organize ITS concepts and facilitate consensus building
- development of a mapping between classes of ITS architectures and application domains
- increased research into pedagogical agents and virtual humans
- further research and prototype tutors for *team training*
- continued development of ITS development and authoring tools

Two domains are highlighted as potential targets for transition of ITS technology into current Army training: *military history* and *battle analysis*. These are domains of importance in Army training and consist of primarily well-defined components that are within the scope of modern ITS technology. A visible and large-scale integration would be an important proof of concept and example for accomplishing ITS transition efforts in the future. If this goal is adopted, it will be important to apply the lessons learned and basic formula from successful instances of transition (e.g., Koedinger et. al., 1997).

Tutoring and assessment in ill-defined domains

Significant progress has been made in the ITS field for well-defined domains such as algebra, physics, and computer programming. In these domains, the boundaries between right and wrong are crisp – given a model of expertise, it is usually straightforward to immediately assess an action as correct or incorrect. Generating appropriate tutor feedback messages also benefits from this clarity. A good number of domains, including many with particular relevance to Army training, resist such clean models of expertise. These are often described as *ill-defined domains* and have received less attention. If a domain is clearly not well-defined and seems to involve choices that are not obviously right or wrong, there are two possibilities regarding its true nature:

1. The domain *appears* to be ill-defined, but is in reality well-defined – it simply requires further "unpacking" through cognitive task analysis or other forms of analysis.
2. The domain is in fact ill-defined, consisting of instances of subject matter expert disagreement and elements of subjectivity in evaluation criteria.

Successful intelligent tutors have been built for domains like legal reasoning, art interpretation, cultural awareness, and database design. Even with prototype systems like these, the extent to which modern ITS technologies are applicable to ill-defined domains

[1] More information about the PSLC can be found at www.learnlab.org. It is one of four science of learning centers funded by NSF that all share the common goal of advancing learning research (www.scienceoflearning.org).

remains an open question. Some technologies are generally robust enough to handle the lack of domain clarity – for example, Bayesian modeling is agnostic to what nodes represent and robust with regard to how updates are made. Others tend to be less of a fit.

For example, model tracing algorithms often rely on the ability to evaluate actions as correct or incorrect. In general, as research on ill-defined continues, the fit of existing capabilities to the unique demands of ill-defined domains will become more clear.

Two basic areas of related research appear to need immediate attention. The first is development of detailed accounts of expert behavior in ill-defined domains through cognitive task analyses and other knowledge acquisition tasks. An exemplar of this kind of research Sternberg et. al.'s (2004) influential research on leadership, practical intelligence, and tacit knowledge. The second area is to understand how human experts perform *assessment* in ill-defined domains. We require detailed accounts of the decision-making processes instructors use to understand, classify, and give feedback to students in ill-defined domains. Game environments provide an ideal context in which to collect assessment data and begin to answer these questions. Raybourn et. al. (2005) has adopted this approach by developing a multi-player game for negotiation training that allows human instructors to observe events, log assessments, and provide guidance.

Serious games and narrative learning environments

Sternberg et. al. (2004) found that leadership expertise is bound to experience. In order to accelerate the development of leadership skills, then, it is argued that *experiential* and *narrative-based learning* (i.e., the use of story) should play a role to begin to build a foundation of experiences in learners. This suggests interactive story-telling environments could play an important role in the next generation of leadership training tools. A particularly appropriate context for participating in narrative and practicing skills is provided by modern gaming environments. A relatively new area of research and commercial application, known as *serious games*, attempts to combine realistic simulations of real-world phenomena with the motivational and goal-based features of games.

Frequently, serious games are built with education and training goals in mind from the beginning (e.g., Raybourn, 2004). Unfortunately, there is a conspicuous absence of rigorous evaluations for learning in serious games, so it is not clear yet if expected learning gains are simply not being realized or if more research needs to be done. It is possible that serious games are suffering from the same problems that plagued discovery learning environments (Kirschner, et. al., 2006), and so the role of intelligent tutoring represents an important area of future research to provide the necessary guidance for learners. Several systems represent early attempts to merge these two technologies. Murray (2006) has integrated intelligent tutoring with tactical planning and mission execution, Core et. al. (2006) have built a tutor to support acquisition of interpersonal skills and cultural awareness, and finally, Johnson et. al. (2006) provide a coach for players of a 3d game that teaches conversational Arabic and cultural awareness.

A final area of research that has received very little attention from the ITS community lies in the intelligent manipulation of the simulation itself to achieve pedagogical goals. For example, difficulty changes have been an important component of commercial games for years to enhance entertainment value. An interesting research challenge is presented by exploring the space of difficulty and game behavior adjustments to see how they might be "dialed" to promote learning. Because the best tutors "know when not to" (they intervene only when necessary), this kind of "stealth" tutoring is a particularly appealing path for future research.

Metacognitive tutoring

Domain experts tend to have highly developed metacognitive skills that evolve over time and accumulate with experience. These skills include planning, reflection, and reasoning about hypothetical situations. Although a number of recent tutoring systems have targeted metacognitive skills, more work needs to be done, specifically for ill-defined domains. Metacognitive skills seem to play *more* of a critical role for skills such as critical thinking and decision making. Other areas of AI research play significant roles in tutoring systems that target metacognitive skills, such as natural language processing, dialogue systems, and commonsense reasoning. Continuing fundamental research into ill-defined domains should include detailed analyses of how human tutors operate in them. This will be an important step into understanding the role of reflection and how to scaffold productive introspective skills for improvement and growth.

Automatic detection of unproductive behaviors

Because learners often lack necessary background knowledge and metacognitive skills, it is common to see them display behaviors that are unproductive. It is important to provide guidance at these times so that productive learning can resume as soon as possible. Given the incredibly limited windows of time available for training in many contexts, it is critical to minimize unproductive time. Two categories of unproductive behaviors have been pursued. The first is *gaming behavior*, defined as ways learners will misuse a learning environment to make progress and achieve apparent goals (Baker et. al., 2006). The most common form of gaming tutoring systems is when learners overuse demand help facilities. If students learn that if they ask for help 5 times in a row then get an answer, for example, then they will often rapidly cycle through the less helpful hints to get to the "give-away." A second form of unproductive behavior that has almost no significant research effort is *floundering*. When students are stuck in a learning environment they will often start "trying things" in the hopes they will do something that helps.

This often involves pulling down menus, clicking on buttons, and so on. It is dangerous when they are successful because on the surface, they will succeed. However, since no domain knowledge is involved in using the strategy, it is has no hope of producing desirable learning outcomes.

Conclusions and outlook for intelligent tutoring

Much like the AI community in general, ITS research has resulted in a large body of algorithms and techniques that can be applied to educational problems. The specific advantage of AI-based educational software is its ability to represent domain knowledge and scaffold learning in interactive and deep ways that are not possible in other kinds of learning environments. Learning science research has shown the importance of guidance for effective and efficient learning. For situations when human guidance is unavailable (e.g., while at home) or of limited availability, ITS techniques can help fill this void by giving automated feedback to learners. As the Army revises training practices to reflect science of learning findings (Clark, 2004), it will be essential to include the provision of timely and relevant feedback in computer-based simulations and games for training. Intelligent tutoring systems have made significant strides in the last few decades in well-defined domains. This paper has suggested an increase in focus on the problems posed by tutoring in ill-defined domains, like leadership and interpersonal skills, will be necessary if the educational and training demands of the Army are to see similar benefits from ITS technology. Specifically, ill-defined domains present research challenges in knowledge representation, learner modeling, capturing expertise, and in authoring. Many believe that serious games provide a motivating and interesting context for learning. The role of tutoring in serious games, both in individual and team contexts, needs to be explored and better understood. Research in dialogue systems have begun to show promise in the context of intelligent tutoring, so this momentum should also continue. If needs such as these are fueled now, there is little reason to believe that early successes of ITS will not be repeated for the new classes of emerging educational and training challenges facing the U. S. Army.

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The Future of Semantics – The Meaning of Information

Adam Pease
@

July, 2006

Introduction

The future of computing is in capturing meaning rather than just the structure and naming of information. Computers handle enormous amounts of information but have little understanding of the meaning of the information they process. A computer can tell you what documents or phrases match and which are most popular, but they can't tell what those documents or phrases mean. They can't tell you what common sense information follows from the statements in a document. A document search system might return some text of a speech by the Secretary of State, but it won't know common sense information that follows from the text, such as that the secretary is an adult US citizen, or specialized information such as that the secretary has studied foreign policy, or is subordinate to the US President. Computers can handle massive amounts of financial transactions, but won't know that the birth date of a buyer must be before the date of the transaction unless the applications processing the data have been specifically programmed to check that. Computers can be better tools and partners for the soldier if they have some real understanding of the soldier's world.

Background

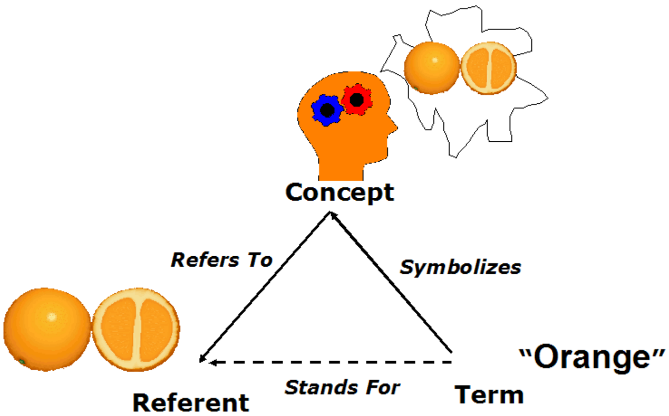
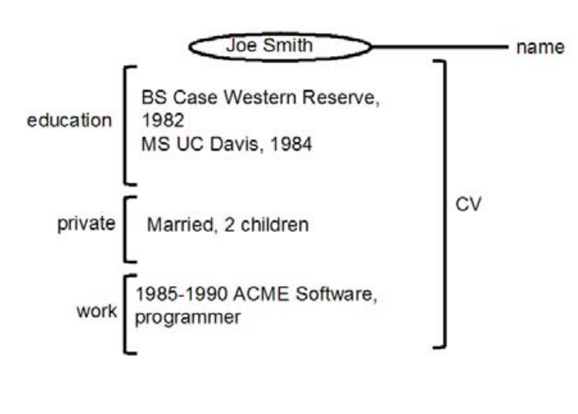
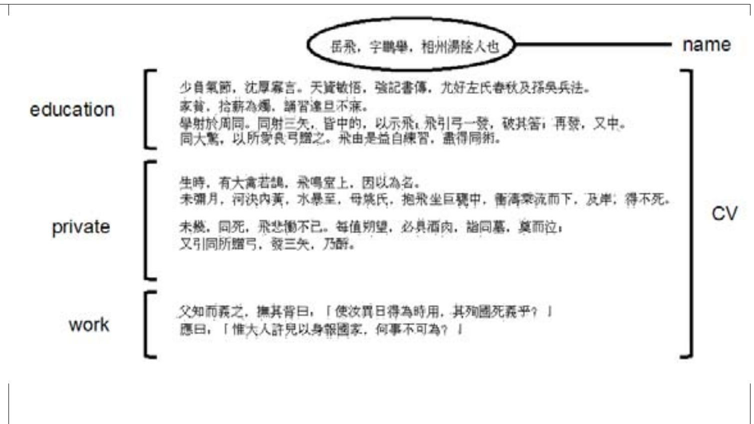


Illustration 1: The meaning "triangle" (courtesy of [1])

In order to frame a discussion about meaning, we can start by distinguishing three concepts: (1) an object in the real world, called a "*referent*" (2) a name for an object, called a "*term*" (3) a "*concept*" that is an understanding of the object, held in the brain.





What you see ***What the computer sees*** **(courtesy of [2])**

When you read a document, your knowledge allows you to understand the context and meaning implied by the text. Reading a resume, you know which portion is the name, which portion lists education and experience and so on. Computers must currently be told what portion of the text has what label. This is commonly known as *metadata*. The computer does not have any understanding of the text however, even after it is labeled. The words are as unintelligible as Chinese characters would be to someone who does not read Chinese.

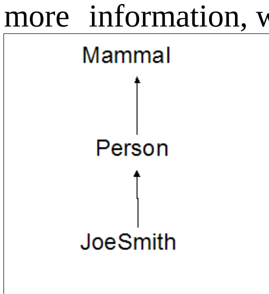
The current wave of encoding information in eXtensible Markup Language (XML) does not solve this problem. While having data in a standard format with labels agreed upon by pairs of applications is a start at interoperability, it does not address *semantics*, or the meaning of information. Data formatted in XML has tags that label the data with intelligible names, such as the following example fragment of code which might describe an employee.

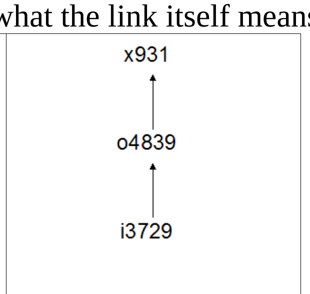
```
<job name="Joe Smith" title="Programmer">
```

What the computer sees however, is still just a largely meaningless collection of characters

```
<x83 m92="|||||||||" z55="..............">
```

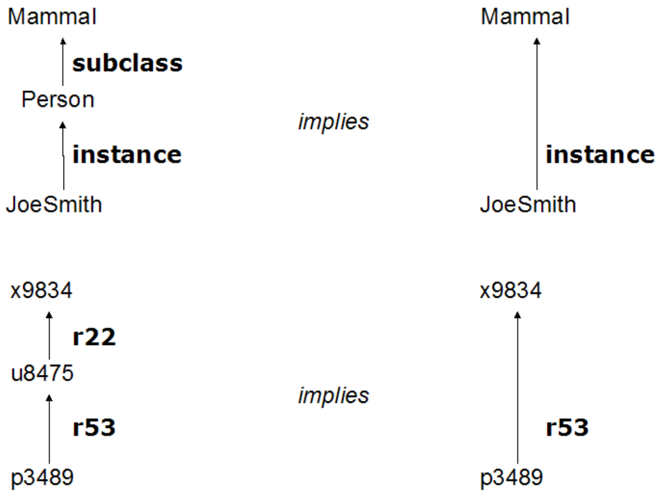
There is some effort in industry to create *taxonomies*, which are terms arranged in a hierarchy from more general to more specific. This will be familiar to those who have taken a high school biology course. While knowing that o4839 is a more specific kind of x931 may be useful, there is a great deal more to meaning than such a basic relation. Also, it is not clear, without much more information, what the link itself means, and what new conclusions it might enable.





What you see *What the computer sees*

The semantic web is an idea and a set of associated technologies which hold some promise. They go a step further than mere taxonomies by providing a formal definition of the more-specific/more-general relationship, as well as a number of other relationships. The formal definitions allow for a prescribed set of new conclusions to be drawn from a set of facts. The semantic web standards enforce these meanings, creating a measure of compatibility among conforming applications.



The formal definition of relationships like “subclass” and “instance” licenses a conforming application to make logically sound inferences, such as that “JoeSmith” is a particular “Mammal” as well as being a particular “Person”. Despite the fact that the computer will not understand the full meaning of those words, it will be able to make this same simple inference that a person would be able to. The challenge and promise of this approach is to gather enough facts about each concept that the computer will be able to make a useful set of inferences that parallel those of a human thinker.

While the semantic web effort has created a useful start by defining a logical language and a very small set of formally defined relations, it has not to date placed much effort behind agreeing on a large set of common and general terms. Lacking agreement on common terms computer applications with have to translate between their individual naming schemes. For common sense notions, without commonly agreed-upon mathematical properties, it is unlikely that concepts in the different systems will have identical definitions. Even in the simplest case, a human will need to compare the two systems and create a mapping between them. This is precisely the situation that a formal semantic system is intended to avoid. Agreement on common terms is therefore a necessity and several efforts do offer such a corpus of concepts (see references [3],[4],[5]).

Future Capabilities

Systems of the future will have several key advances over current computational systems.

1. Some general knowledge about the world. This will prevent a certain percent of the “idiot savant” answers that we expect from computers that currently have the unintended power to do incredible things that make no sense for the goals of the user
2. Ability to synthesize information rather than just calculate and regurgitate. Databases currently have limited ability to combine information from different sources and to generate answers rather than just perform retrieval. English interfaces, larger repositories of more complex and sophisticated information that can be understood, rather than just

stored, will enable non-technical users to collaborate with machines much as with a junior human assistant.

3. Ability to hold simple dialogs in English. Some computerized tools will still have conventional menu-and-button interfaces. There's not much need for a sophisticated English interface to a toaster. But complex interfaces will be able to respond to English commands and ask the user for clarification when commands aren't clear. New users will be able to make use of many more complex systems without training. Far more sophisticated applications will be possible for a wider range of users. Simulations for training and entertainment will have realistic characters that can carry on believable dialog with a human participant.
4. Computers will have better ability to translate between different human languages because they will have some real understanding of the meaning of what is being said. While emotional content, metaphor and many idioms may remain unprocessed, factual dialogs will have precise and correct translations.

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[1] Diagram adapted from (c) Key-Sun Choi for Pan Localization 2005, from the slide of [Bargmeyer, Bruce, Open Metadata Forum, Berlin, 2005], and ultimately from C.K. Ogden/I.A. Richards, The Meaning of Meaning: A Study in the Influence of Language upon Thought and The Science of Symbolism London 1923, 10th edition 1969

[2] Thanks to Frank von Harmelen

[3] Niles, I., and Pease, A. 2001. Towards a Standard Upper Ontology. In Proceedings of the 2nd International Conference on Formal Ontology in Information Systems (FOIS-2001), Chris Welty and Barry Smith, eds, Ogunquit, Maine, October 17-19, 2001. See http://www.ontologyportal.org

[4] Oltramari A., Gangemi A., Guarino N., Masolo C.: Sweeting ontologies with DOLCE. Ontologies and the Semantic Web, 13th International Conference, EKAW 2002, Siguenza, Spain, October 2002. See http://www.loa-cnr.it/DOLCE.html

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APPENDIX F

WORKING GROUP BRIEFS

BRIEFING SLIDES FROM LEARNING MODELS WORKING GROUP

Learning Model

Panel 1

Richard Clark
Institute for Creative Technology
University of Southern California

Science of Learning Workshop
Army Research Institute and Institute for Defense Analysis
Hampton VA 1- 3 August 2006

Topics

- From learning theories to training design
- 3 factors: Trainees, Tasks, Training Methods
- Critical features of new training design systems
  - Merrill's 5 Star analysis
  - Guided Experiential Learning (GEL)
  - Two studies comparing SME to GEL training
- Effectiveness and Efficiency Estimates

From Theories to Training Design

- Learning theories not translatable to training.
  - Examples: Constructivism, PBL.
- "Best practice" is unreliable.
  - 50+ training models exist – few are tested.
  - NRC - from best practice to "processes".
  - Best example is John Anderson's ACT-R.
- Complex learning requires new design models.
  - Selection must be "evidence based".

Learning Models to Training

- Research suggests 3 main factors influence learning and performance in training.

  1. Trainees; 2. Tasks 3. Training Methods

- We need prescriptions such as:

  For X types of <u>Trainees</u> and Y kinds of learning <u>Tasks</u> we need Z types of <u>Training Methods</u> to produce maximum performance.

Three Factors: Trainees, Tasks, Methods

What <u>trainee characteristics</u> influence learning?

1. General Ability (intelligence).
2. Prior Experience (expertise).
3. Motivation (self efficacy).

What characteristics DO NOT influence learning?

1. Learning styles. (Stahl, 1999; Cassidy, 2004)
2. Generation differences.

Three Factors: Trainees, Tasks, Methods

What <u>task</u> characteristics influence learning?

1. Declarative tasks - learned differently than -
2. Procedural tasks

What task factors DO NOT influence learning?

1. Media / multimedia (influence efficiency)
2. Games (<u>might</u> influence motivation)

Three Factors: Trainees, Tasks, Methods

What task characteristics influence learning?

1. Declarative tasks - learned differently than -
2. Procedural tasks

What task factors DO NOT influence learning?

1. Media / multimedia (influence efficiency)
2. Games (might influence motivation)

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Three Factors: Trainees, Tasks, Methods

What task characteristics influence learning?

1. Declarative tasks - learned differently than -
2. Procedural tasks

What task factors DO NOT influence learning?

1. Media / multimedia (influence efficiency)
2. Games (might influence motivation)

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Three Factors: Trainees, Tasks, Methods

Task Analysis is flawed and must be adjusted:

Task information must be accurate/complete – BUT expert knowledge highly automated.

- Evidence that SME's only provide 30%.
- Leads to errors – need to continue training.

Need to implement Cognitive Task Analysis.

- Increases accuracy to +/- 70%.
- Focus on decisions.
- Decreases training time and errors.

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Three Factors: Trainees, Tasks, Methods

For X types of <u>Trainees</u> and Y kinds of training <u>Tasks</u> we need Z types of <u>Training Methods</u> to produce maximum performance.

IF - Ability, expertise and motivation are high -

- Very little training is required.

IF - Ability and/or expertise is low to moderate -

- Strong guidance training methods required.

IF - Motivation is low, no learning.

- Provide motivation.

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Three Factors: Trainees, Tasks, Methods

What types of Training Methods provide effective guidance for low to moderate expertise trainees?

Merrill's Five Star Model provides insights.

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Merrill's 5 Star Model

Reviewed evidence-based design systems and identified five critical training components.

1. Solve real problems from field.
2. Activate relevant prior knowledge.
3. Demonstrate how to perform /solve problems.
4. Apply what is learned "hands on" w/ feedback.
5. Integrate learning (part/whole task practice).

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Guided Experiential Learning Compared to Unguided Immersion and Features Training

Comparing GEL to Unguided learning.

Three training groups (50 adults in each group) developing an Excel Spreadsheet:

1. Unguided Experiential learning lesson.
2. Standard "features" training from Excel.
3. Guided Experience – Model I will discuss.

Merrill's study of unguided, guided and standard training to use excel spreadsheets

	Learning	Time
Unguided	34%	60 min+
Standard	68%	49 min
Guided	89%	29 min

Velmahos study of SME guided and GEL training of Medical Students on CV Catheter

	Pretest	Learning: Memory	Learning: Perform	Time
SME based	8.0	8.64	7.5	15.4 min
CTA w/ GEL	7.33	11.0	12.6	9.6 min
% gain/loss		20%	65%	30%

Guided Experiential Learning: Training Methods:

1. Objectives (actions, conditions, standards).
2. Reasons (benefits/risks).
3. Overview (outline, training strategy).
4. Declarative knowledge (memory level).
5. Procedural knowledge.
   - ("How to" taught with CTA-based demonstrations).
6. Problem solving and feedback.
   - (Part and whole task practice of increasingly novel. problems to promote VUCA transfer).

Training Design System

Select Goals & SME's → Identify Many Job and Mission Problems → Cognitive Task Analysis

Information
- How to act and decide
- New concepts, processes
- Equipment and materials
- Performance standards

Design Blueprint
- Sequence Lessons
- Design each lesson with
  - Goals and Reasons
  - Background
  - Demonstration, practice & feedback of declarative and procedural knowledge
- Design Job Aids for transfer

Select delivery media →

Evaluation
- Four level evaluation
- Test of prior knowledge
- Transfer letters

Benefits of a GEL Design System

1. Flexibility – works on any delivery platform.
2. Effectiveness –
   - Procedural learning increases ~ 20 to 60%.
   - Declarative learning increases ~ 20%.
   - Decision errors decrease ~ 40 to 70%.
3. Efficiency –
   - Time to learn decreases by ~ 20 to 30%.
   - But design time increases by ~ 20%.

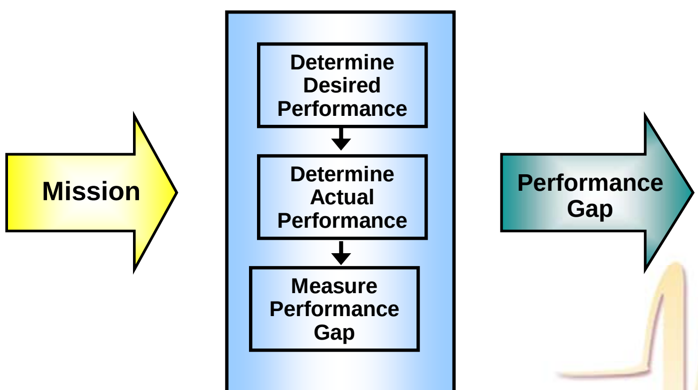
Training Needs Analysis?

Five Phases of API (Army Performance Improvement):

1. Performance Analysis.
2. Cause Analysis.
3. Intervention selection and creation.
4. Implementation.
5. Evaluation.

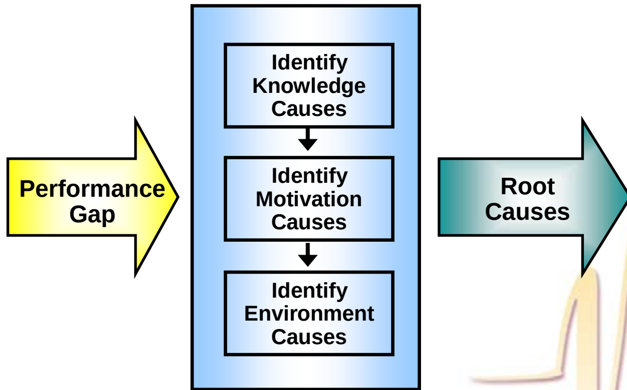
9/18/2006 USC

1 Performance Analysis



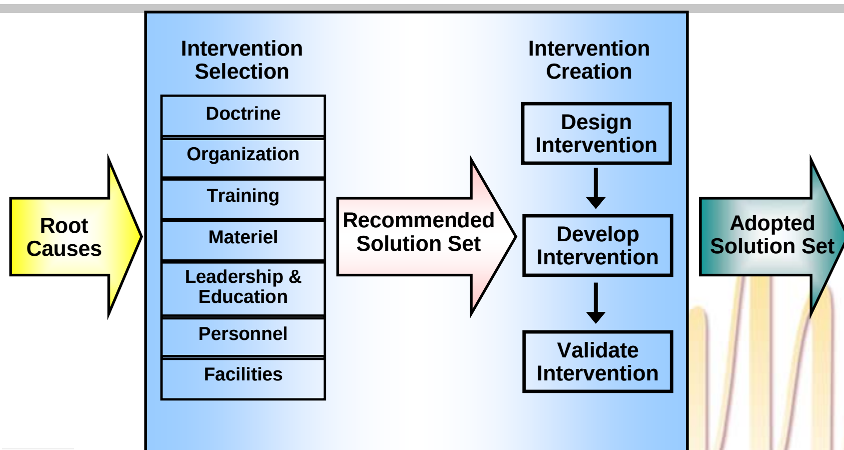
9/18/2006 USC

2 Cause Analysis



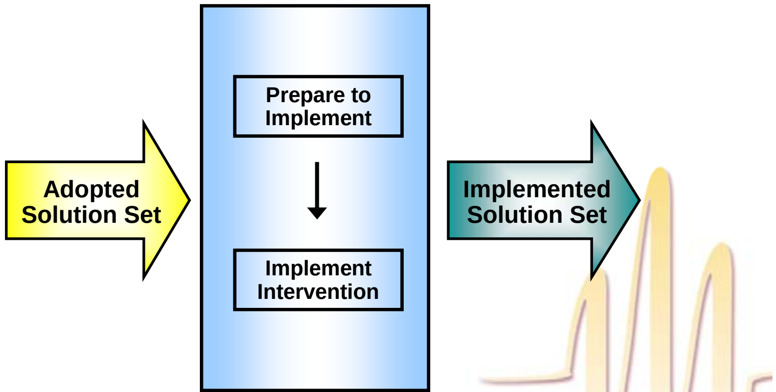
9/18/2006 USC

3 Intervention Selection & Creation

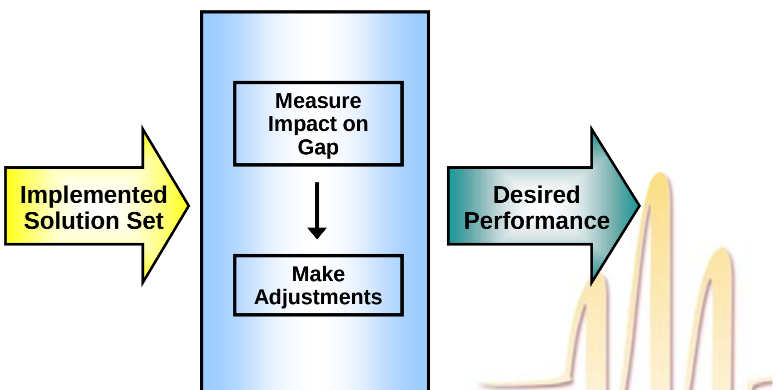


9/18/2006 USC

4 Implementation



5 Evaluation



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On Developing an Army Learning Model

Janis A. Cannon-Bowers, Ph.D.

August 2006

University of Central Florida

OVERVIEW

- Background
- Types of Learning Models
- The Navy's Experience
- The Navy's Learning Model
- Recommendations

2

Background

- Why do we need a model at all?
  - To organize and streamline information
  - To guide a process
  - To communicate with constituents
- Different types of models serve different purposes
  - Maybe the Army needs several different types of models to serve different purposes

3

Types of Models

- Conceptual (scientific) model
  - Point of departure is how people learn
- Implementation model
  - Describes a process by which training can be designed
  - Prescriptive in nature
- Descriptive model
  - Delineates the types of training (methods and strategies) that a soldier needs
  - May take a career-based perspective--what do soldiers need at various points in their career

4

The Navy's Experience

- Executive Review of Navy Training (ERNT)
- Task Force EXCEL
- Human Performance Center
- What we came up with…

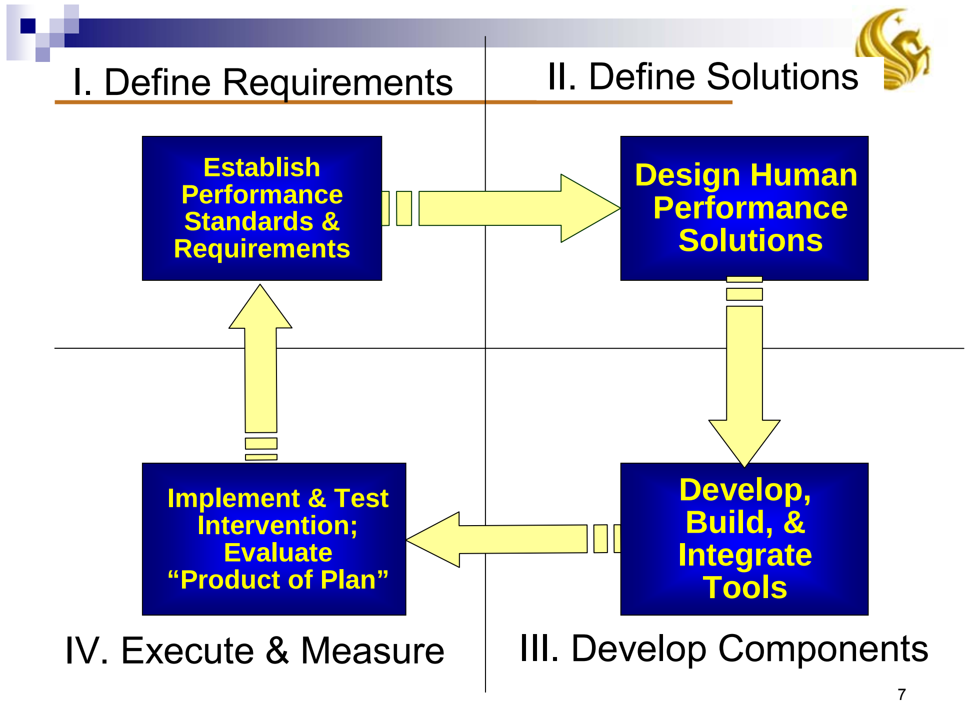
5

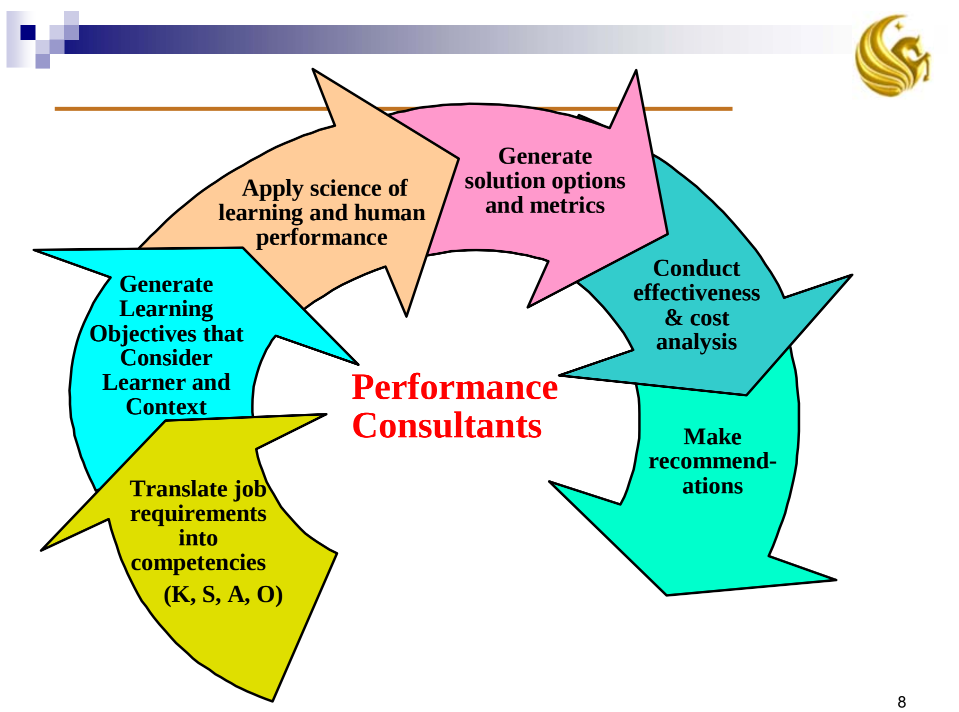
What we learned

- Keep me up to date/current
- Invest in me
- Care about me career/future
- Don't waste my time!

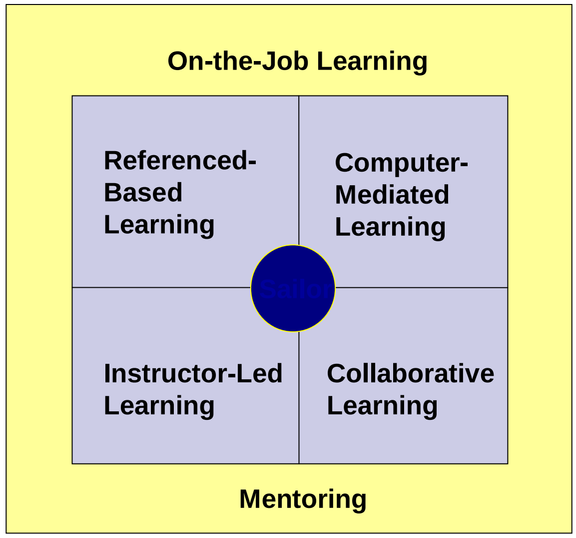
- Message mismatch
- Use case
- Buy in the Chief's mess

6


I. Define Requirements
II. Define Solutions
Establish Performance Standards & Requirements
Design Human Performance Solutions
Develop, Build, & Integrate Tools
Implement & Test Intervention; Evaluate "Product of Plan"
IV. Execute & Measure
III. Develop Components
7


Apply science of learning and human performance
Generate solution options and metrics
Conduct effectiveness & cost analysis
Make recommend-ations
Generate Learning Objectives that Consider Learner and Context
Translate job requirements into competencies (K, S, A, O)
Performance Consultants
8

Navy Learning Model



9

Elements of a Good Learning

- Interactive
- Experiential
- Authentic/relevant
- Guided
- Motivational/Engaging
- Appropriate to the Learner
- Collaborative (sometimes)

- Also
  - Practical
  - Acceptable (QOL)

10

The Way Ahead

- Determine the role or purpose of a Learning Model
  - Multiple views are probably needed
- Consider developing an Implementation (Process) Model
- Keep it simple!
- Broaden beyond training
- Specify inputs/outputs rather than particular strategies
- Think through the possible uses of a descriptive model and develop one (several?) to meet these

Complex Learning, 4C/ID-model, and Cognitive Load Theory

Source:
Jeroen van Merriënboer

Presented by:

Aubteen Darabi
At ARI Science of Learning Workshop
August 1-3, 2006

Source: Jeroen van Merrionboer (1997)

Complex Learning

- Diagnosing X-ray pictures
- Designing software
- Aircraft maintenance
- Policy analysis based on simulation models
- Troubleshooting chemical plants
- Designing electronic circuits
- Air traffic control
- Conducting surgical techniques
- Statistical analysis
- Examination of patent applications

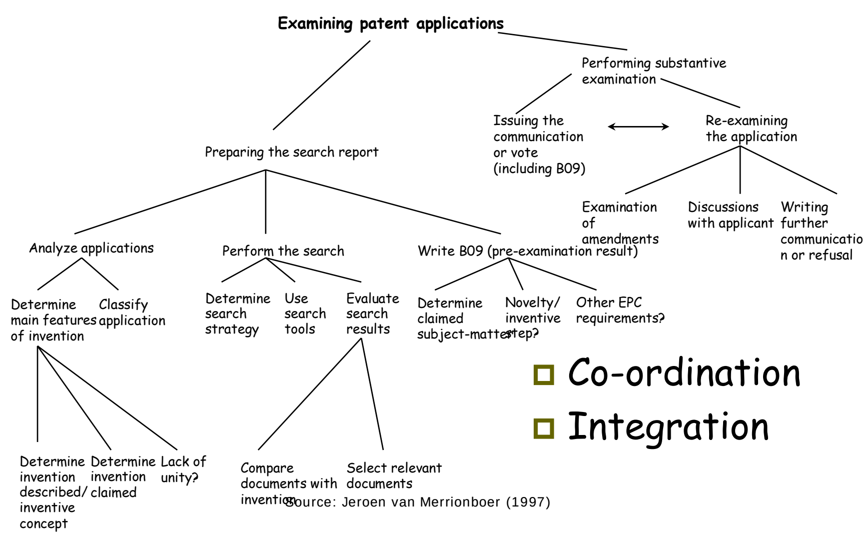
Source: Jeroen van Merrionboer (1997)

Characteristics

- Constituent skills
- Goal-directed
- Simultaneous learning processes
- Lengthy and effortful process

Source: Jeroen van Merrionboer (1997)

Constituent Skills



- Co-ordination
- Integration

Source: Jeroen van Merrionboer (1997)

Goal Directedness

- Knowledge based (Novices)
  - Rudimentary form of problem solving
  - Working backward
- Schema based (experienced, Mastery)
  - Knowledge of sub-goals guides behavior
  - Finding means to reach sub-goals
- Skill based (Experts)
  - Routines
  - Working forward

Source: Jeroen van Merrionboer (1997)

Simultaneous Learning Processes

- Schema construction
  - Leads to schema based behavior
  - Non-recurrent constituent skills
- Schema automation
  - Leads to skill based behavior
  - recurrent constituent skills

From Novice to Experienced (Mastery) to Expert

Source: Jeroen van Merrionboer (1997)

Lengthy and Effortful Process

- At least 100 hours of practice to reach "mastery"
- May take thousands of hours to become a real expert
- Learners have to invest (a lot of) effort in acquiring the skill
- Cognitive capacity constraints

Source: Jeroen van Merrionboer (1997)

Outline of the 4C/ID Model

Working on authentic learning tasks in a simulated or real task environment

Learning tasks → complex learning outcomes; competencies

- cases
- projects
- problems
- ......

Simultaneous, integrated process of

- schema construction
- schema automation
- attitude formation

- transfer

Source: Jeroen van Merrionboer (1997)

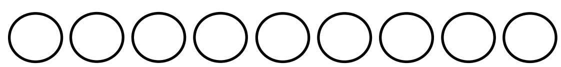
Four components

- Learning tasks
  - Backbone of the training program
- Supportive information
- Just-in-time information
- Part-task practice

Source: Jeroen van Merrionboer (1997)

component 1:

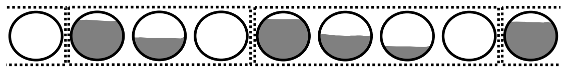
learning tasks (whole-task practice)



- Schema construction
  - cognitive strategies
  - mental models
- Schema-automation (to a certain degree.....)

Source: Jeroen van Merrionboer (1997)

Task classes and support

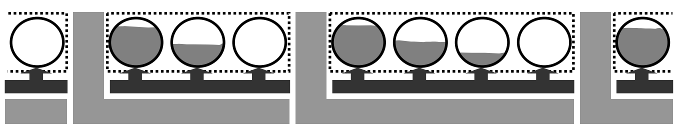


- Higher complexity for each subsequent task class
- Diminishing support within the same task class ("scaffolding")

Source: Jeroen van Merrionboer (1997)

component 3:

JIT Information



- For "recurrent" aspects of learning tasks
- Present precisely when necessary

Source: Jeroen van Merrionboer (1997)

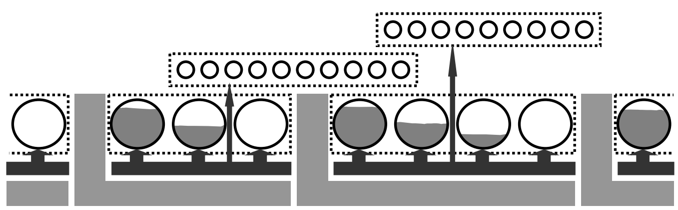
Research

- Inductive vs. deductive strategies
- Task-analytical models for analyzing supportive and JIT information
- Timing of information presentation in courses of short duration

Source: Jeroen van Merrionboer (1997)

component 4:

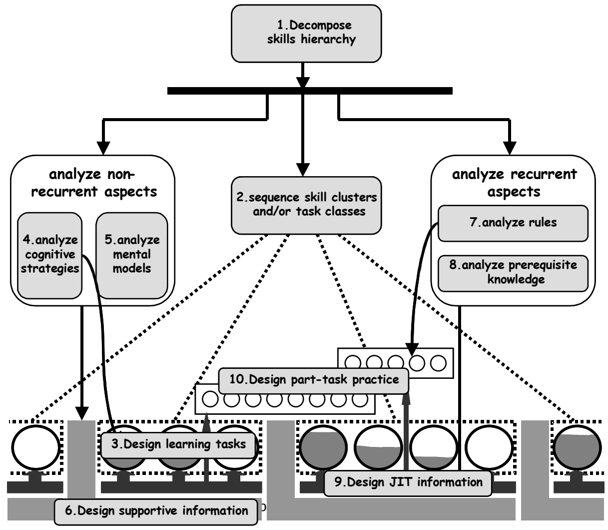
Part-task Practice



- Repetition
- JIT-info
- Cognitive context

Source: Jeroen van Merrionboer (1997)

10 steps to complex learning



3. Instructional Systems Design

- A systematic and (cost-) effective approach for developing instructional systems
  - Analysis
  - Design
  - Development
  - Implementation
  - Evaluation

Source: Jeroen van Merrionboer (1997)

Cognitive Load Theory

- Intrinsic cognitive load
  - Necessary to perform the task
  - High if many interacting elements, low if few interacting elements
- Extraneous cognitive load
  - For processes irrelevant to learning
  - searching information, integrating information sources, weak-method problem solving
- Germane cognitive load
  - For learning processes
  - Schema construction, mindful abstraction

Source: Jeroen van Merrionboer (1997)

Basic guideline

- Decrease extraneous load and optimize germane cognitive load, within the thresholds of total available cognitive resources
  - Mainly a matter of (re-)directing attention to those processes that are directly relevant to learning

Source: Jeroen van Merrionboer (1997)

CLT and 4C/ID

See first 2003 issue of Educational Psychologist, 38(1), 5-13.

- 1. Learning tasks
  - Decrease *intrinsic* cognitive load through sequencing simple-to-complex task classes
  - Decrease *extraneous* cognitive load through product- and process oriented support
  - Increase *germane* cognitive load through variability, asking questions, provoking self explanation etc.

Source: Jeroen van Merrionboer (1997)

CLT and 4C/ID (cont.)

- 2. Supportive information
  - High element interactivity – present before tasks, elaborate, easily accessible in LTM during practice
- 3. JIT information
  - Low element interactivity – present during learning tasks, directly available in WM during practice
- 4. Part-task Practice
  - Helps to free up cognitive resources that may be devoted to learning (germane cognitive load)

Source: Jeroen van Merrionboer (1997)

Main Differences with Conventional ISD Models

- Dedicated to complex learning
- Strong focus on whole task practice
- Add presentation (information) to practice (learning tasks), instead of practice to presentation
- Distinction between supportive and JIT information
- Research based

Source: Jeroen van Merrionboer (1997)

U.S. Army
Research & Social Sciences (ARI)

Science of Learning Workshop
"Corporate Learning Models"

Mr. Matthew Peters
Defense Intelligence Agency
August 1-3, 2006

1

HCL Directorate for Human Capital, Office of Learning

Human Capital…Top strategic resource of 21st Century!

- The Corporate environment is changing …
  - Work has changed
  - Workforce has changed
  - Workplace has changed
- The training architecture needs to change….
  - Chief Learning Officers (CLOs)
  - Training, Learning & Performance
  - Supply vs. Demand model

2

Strategic and Cultural Shifts

20th Century
- Training divisions
- Fragmented and misaligned
- Supply model
- Sporadic funding
- Synchronous focus
- Instructor led
- Classroom-centric
- Knowledge and skill content
- Individual courses
- Learning as a cost
- Overhead status
- Static
- Training requirement
- Adhoc process initiatives
- Office/Department model
- Fixed course lengths

K-12 Mentality

21st Century
- Learning enterprise
- Cohesive and aligned
- Corporate learning model
- Demand model
- Dedicated funding
- Employee led
- Practice and experiential
- Learning in variety of environments
- Competency-based content
- Learning as an investment
- Business Line linkages
- Performance requirement
- Learning in chunks
- Innovative, experimental, risk-taking

Lifelong Learning

3

Evolution of the Corporate Training Function

Training
- *"I want a course"*
- ISD / ADDIE
- Factory Metrics (TTT, Classroom Utilization, Student/Instr ratios, etc)

Learning
- *"Blended Learning"*
- Adult Learning
- Technology (eLearning, mLearning, games, M&S, etc)

Performance
- Specific Job/performance requirements
- Business Partnerships - Internal Consultants
- Change Management

4

Keys to success…..

- Requirements
- Metrics
- Performance Improvement
- Workforce development
- Learning Models
- Innovation / R&D
- Enterprise-wide Learning System
- Quality Control
- Change Management

5

Insights from the Defense Acquisition University

"Enterprise Learning Model"

Dr. Bob Ainsley
Director, eLearning and Technology Center

1-3 August 2006
ARI/TRADOC Science of Learning Workshop
Hampton, Virginia

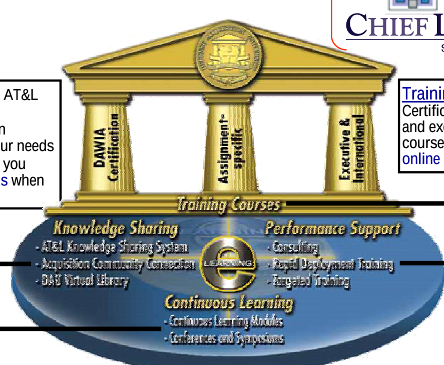
AT&L Performance Learning Model

24/7 Learning Assets for the Classroom and the Workplace

Award-winning Best Practice!

- AKSS - Online gateway to AT&L information & tools
- ACC - Online collaboration communities tailored to your needs
- Virtual Library - Keeping you connected to research tools when you are not on campus

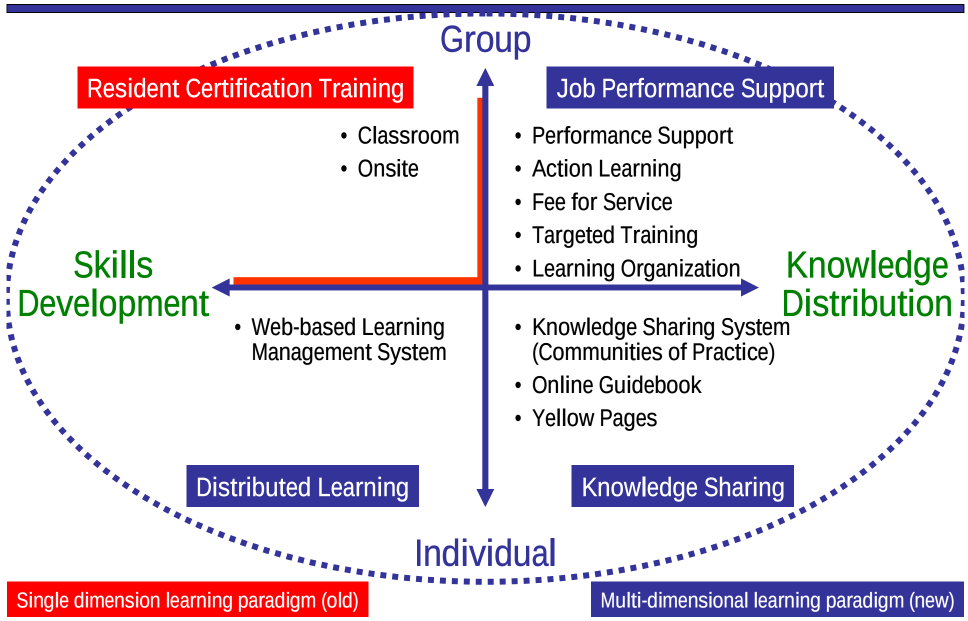
Training Courses - DAWIA Certification, assignment-specific, and executive & international courses – in the classroom and online



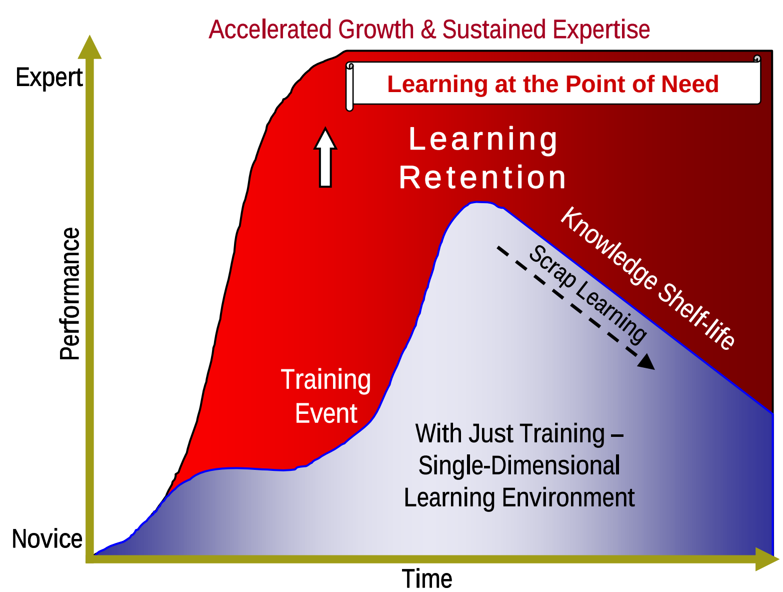
- CL Modules - Online modules to help you earn continuous learning points
- Conferences
  - PEO / SYSCOM
  - Business Manager
  - DAU Alumni Association

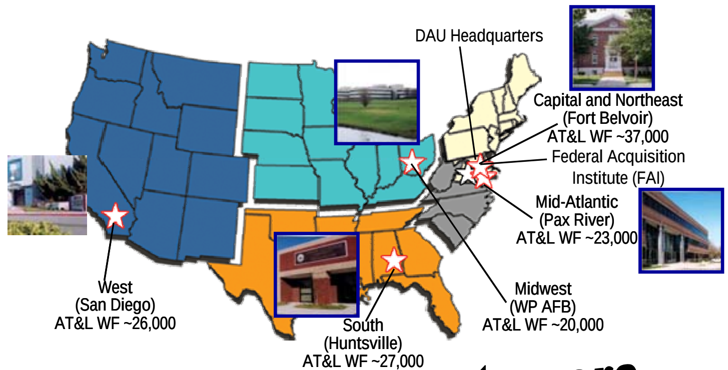
- Consulting - We come to your workplace to assist you
- Targeted Training - Tailored learning for your organization
- RDT - On-site and online training on the latest AT&L policies

A Learning Architecture for an Agile Learning Environment

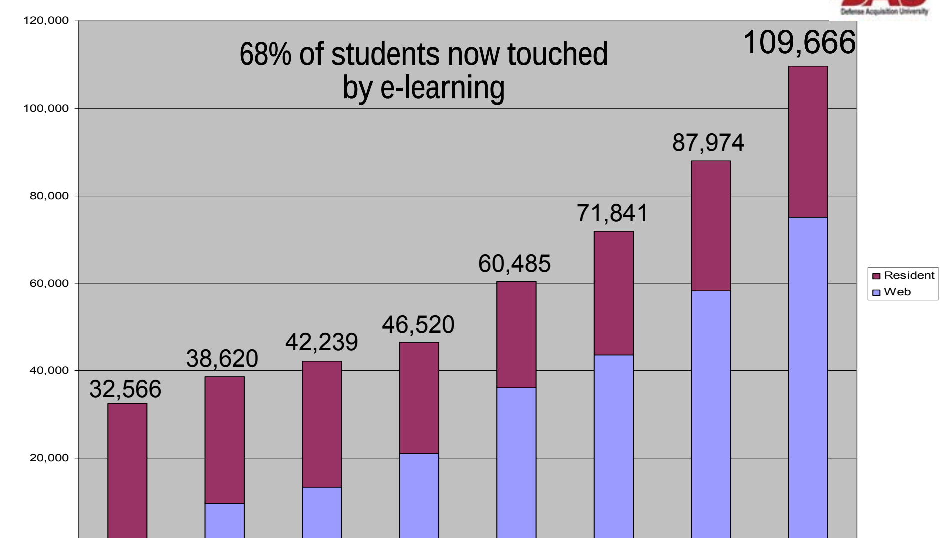


Benefits of AT&L Performance Learning Model



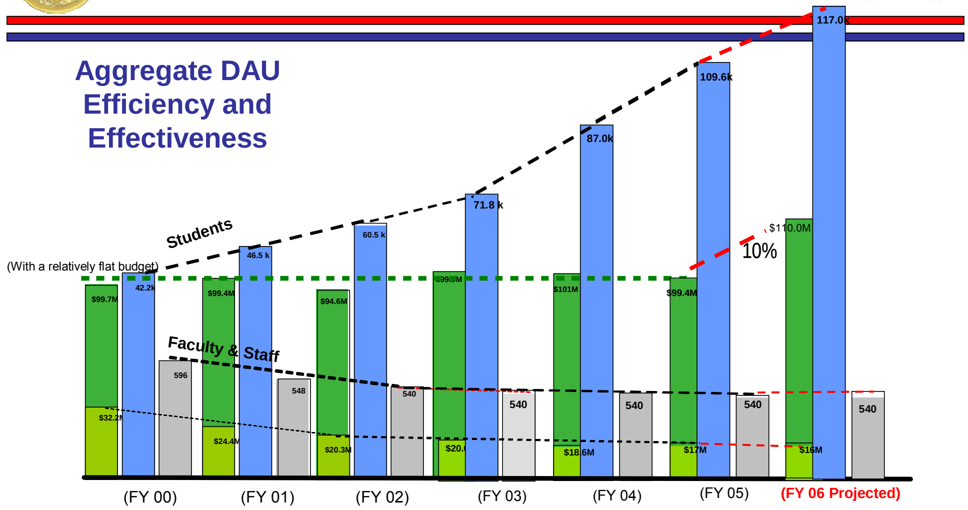


Located with our Customers



	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY05
Resident	31,939	29,031	28,859	25,489	24,368	28,192	29,684	34,587
Web	627	9,589	13,380	21,031	36,117	43,649	58,290	75,079

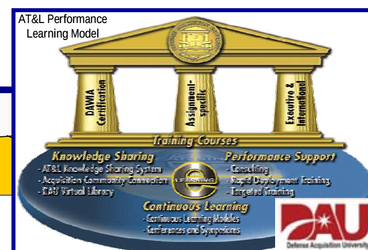
Strategic Long-term Value...



Legend	FY00	FY01	FY02	FY03	FY04	FY05	FY06
Student Travel	32.2	24.4	20.3	20.0	18.6	17.0	16.0
Total Budget	99.7	99.4	94.6	99.9	101.0	99.4	110.0
Faculty and Staff	596.1	548	540	540	540	540	540
Students	42,239	46,520	60,485	71,841	87,0974	109,666	117,000

- ✓ *Student Travel Costs Down 45%*
- ✓ *Faculty & Staff Down 10%*
- ✓ *Student Throughput Up 178%*

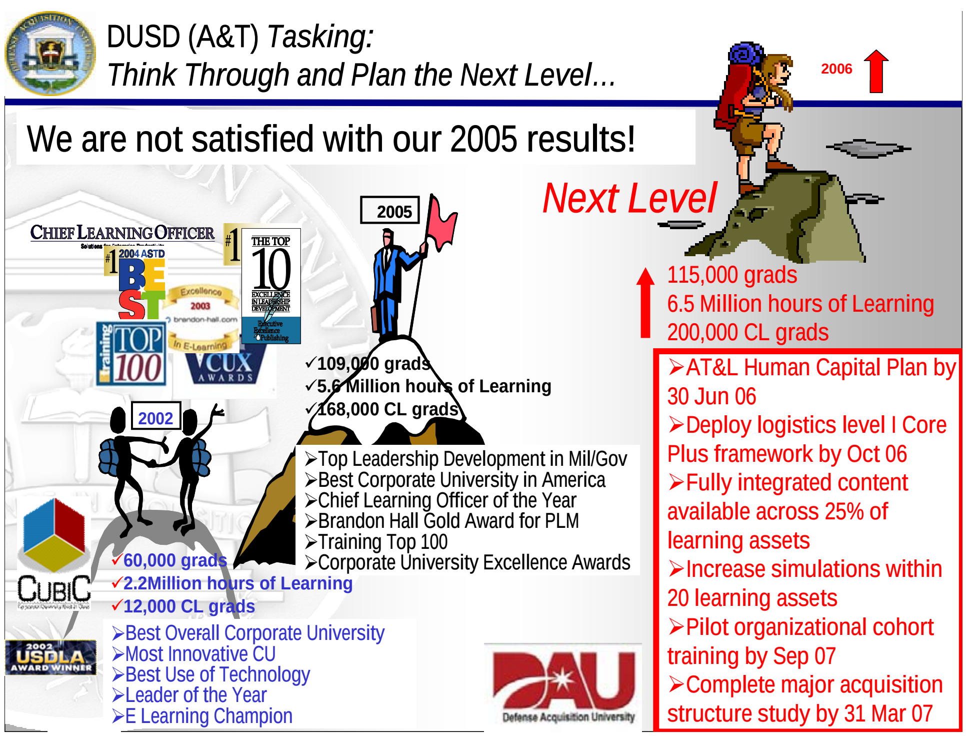
FY 05 Knowledge Sharing

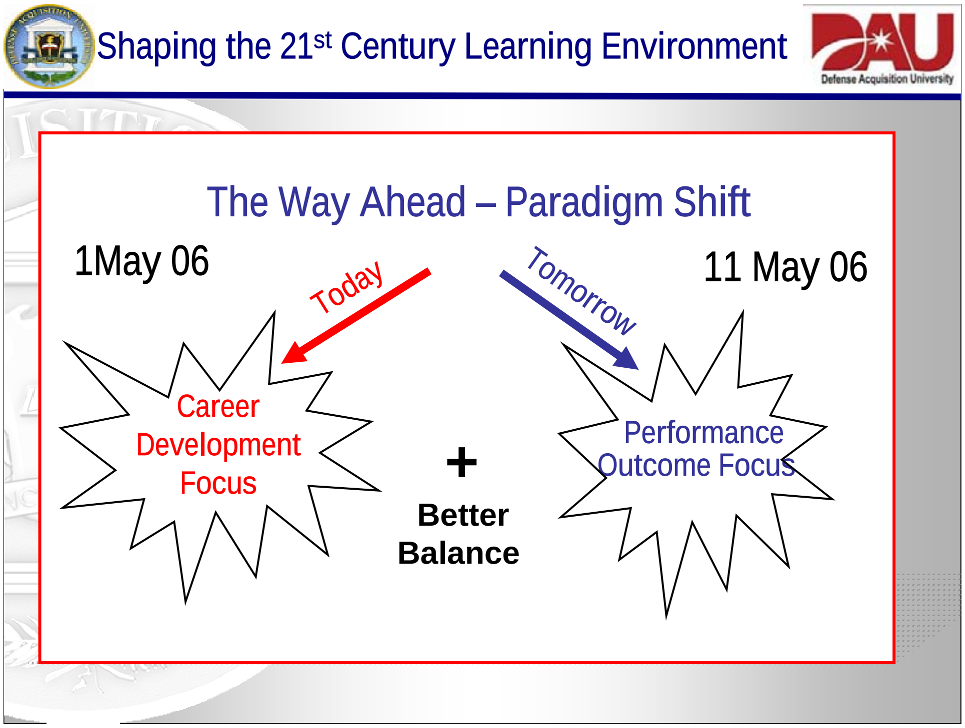


Knowledge Sharing System:
- **19,700 people per week visited online AKSS**
- **Over 420,000 contact hours on AKSS**
- **2,350,800 page views per month AKSS**
- **AAP Answer Rate 86%**
- **Defense Acquisition Guidebook 450,000 visitors in first year**

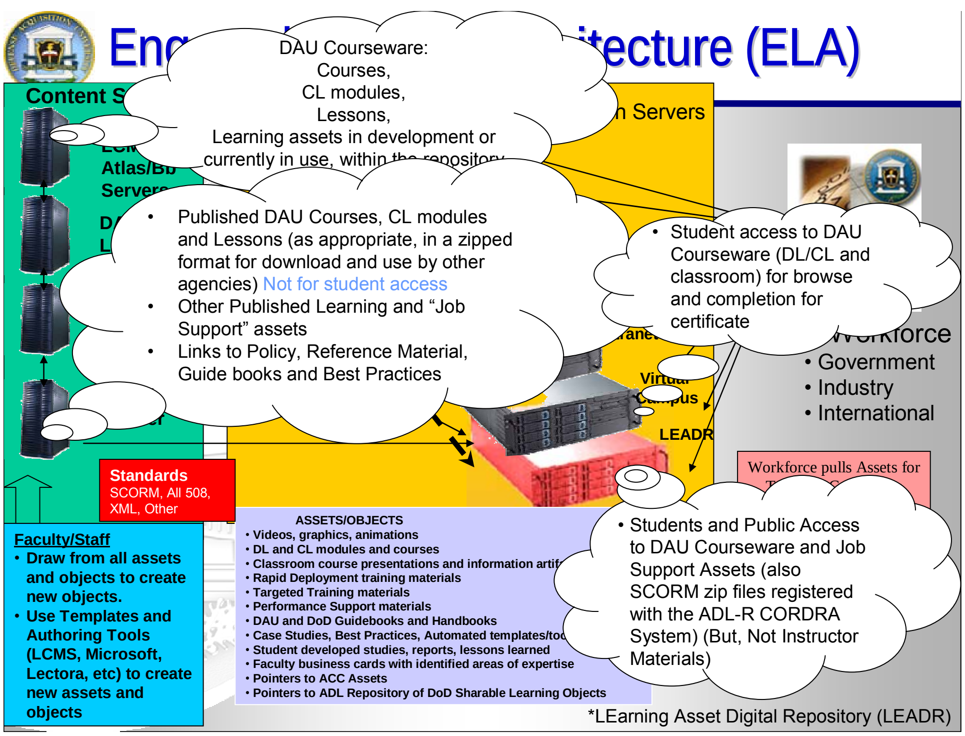
Communities of Practice:
- **13,935 registered members of the ACC**
- **Over 355,654 contact hours on ACC**
- **Over 46,130 knowledge contributions to ACC**
- **Over 377 collaborative workspaces**
- **Restructured 3 major communities, added 8 new Special Interest Areas, advanced EVM to CoP status**
- **New FY 05 Workspaces (Unique Sample Only)**
  - **Competitive Sourcing, Contingency Contracting, Contractors Accompanying the Force, Competitive Sourcing, Hurricane Katrina, Joint Rapid Acq., Naval Enterprise Open Architecture, Strategic Sourcing**
- **Over 10 Million page views on ACC for FY05**


Real-time Performance Support and
Access at the Point of Need
Defense Acquisition University
Performance support expands
concept of le
the course…
Speci
"Federal agencies still were doing Hurricane
Katrina damage assessment when the
Hurricane Katrina Resources Viewed 10581 times
Hurricane Katrina Community of Practice
Katrina
Hurricane Katrina Resources
Emergency Procurement Flexibilities Viewed 5523 times
Contracting Related Websites Viewed 3033 times
Emergency Acquisition Resources Viewed 2289 times
Policy and Guidance Viewed 1978 times
Katrina Relief Websites Viewed 1532 times
techniques"
Government Executive Magazine Oct 05


DUSD (A&T) Tasking:
Think Through and Plan the Next Level…
2006
We are not satisfied with our 2005 results!
Next Level
2005
CHIEF LEARNING OFFICER
#1
2004 ASTD
BEST
Excellence
2003
brandon-hall.com
In E-Learning
THE TOP 10
Training TOP 100
VCUX AWARDS
✓109,000 grads
✓5.6 Million hours of Learning
✓168,000 CL grads
115,000 grads
6.5 Million hours of Learning
200,000 CL grads
➢AT&L Human Capital Plan by 30 Jun 06
➢Deploy logistics level I Core Plus framework by Oct 06
➢Fully integrated content available across 25% of learning assets
➢Increase simulations within 20 learning assets
➢Pilot organizational cohort training by Sep 07
➢Complete major acquisition structure study by 31 Mar 07
2002
➢Top Leadership Development in Mil/Gov
➢Best Corporate University in America
➢Chief Learning Officer of the Year
➢Brandon Hall Gold Award for PLM
➢Training Top 100
➢Corporate University Excellence Awards
CUBIC
✓60,000 grads
✓2.2Million hours of Learning
✓12,000 CL grads
2002 USDLA AWARD WINNER
➢Best Overall Corporate University
➢Most Innovative CU
➢Best Use of Technology
➢Leader of the Year
➢E Learning Champion
Defense Acquisition University



Shaping the 21st Century Learning Environment
DAU
Defense Acquisition University
The Way Ahead – Paradigm Shift
1May 06
11 May 06
Today
Tomorrow
Career Development Focus
+
Better Balance
Performance Outcome Focus



Enterprise Learning Architecture (ELA)
DAU Courseware: Courses, CL modules, Lessons, Learning assets in development or currently in use, within the repository
Content S
Atlas/Bb Servers
n Servers
• Published DAU Courses, CL modules and Lessons (as appropriate, in a zipped format for download and use by other agencies) Not for student access
• Other Published Learning and "Job Support" assets
• Links to Policy, Reference Material, Guide books and Best Practices
• Student access to DAU Courseware (DL/CL and classroom) for browse and completion for certificate
Workforce
• Government
• Industry
• International
Virtual Campus
LEADR
Workforce pulls Assets for
Standards
SCORM, All 508, XML, Other
Faculty/Staff
• Draw from all assets and objects to create new objects.
• Use Templates and Authoring Tools (LCMS, Microsoft, Lectora, etc) to create new assets and objects
ASSETS/OBJECTS
• Videos, graphics, animations
• DL and CL modules and courses
• Classroom course presentations and information artif
• Rapid Deployment training materials
• Targeted Training materials
• Performance Support materials
• DAU and DoD Guidebooks and Handbooks
• Case Studies, Best Practices, Automated templates/to
• Student developed studies, reports, lessons learned
• Faculty business cards with identified areas of expertise
• Pointers to ACC Assets
• Pointers to ADL Repository of DoD Sharable Learning Objects
• Students and Public Access to DAU Courseware and Job Support Assets (also SCORM zip files registered with the ADL-R CORDRA System) (But, Not Instructor Materials)
*LEarning Asset Digital Repository (LEADR)

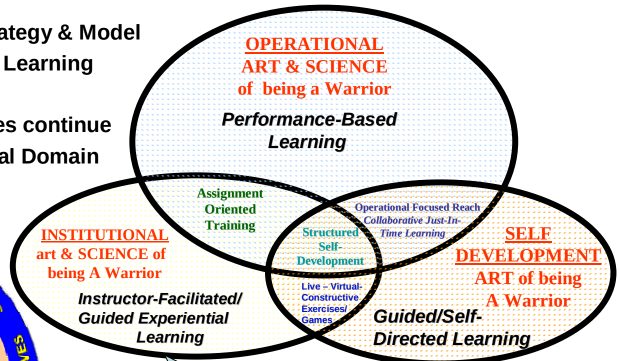

"New performance plans clearly linked to organization's mission and strategic goals"
DAU
Defense Acquisition University
"The United States will…transform American's national security institutions to meet the challenges and opportunities of the twenty-first century."
President George W. Bush
September 2002
"Another priority element of the Department's corporate transformation strategy is the reform of the acquisition process. The Department is reducing cycle time and aligning acquisitions with a new capabilities-based resource allocation process built around joint operating concepts."
Secretary of Defense Donald Rumsfeld
April 2003
AT&L Goals
1. High Performing, Agile, and Ethical Workforce
2. Strategic and Tactical Acquisition Excellence
3. Focused Technology to Meet Warfighting Needs
4. Cost-effective Joint-Logistics Support for the Warfighter
5. Reliable and Cost-effective Industrial Capabilities Sufficient to Meet Strategic Objectives
6. Improved Governance and Decision Processes
Hon. Ken Krieg
USD (AT&L)
Linked to Performance
Hon. James I. Finley
DUSD (A&T)
Hon. Jack Bell
DUSD (L&MR)
Hon. John J. Young, Jr.
Director, Defense Research & Engineering

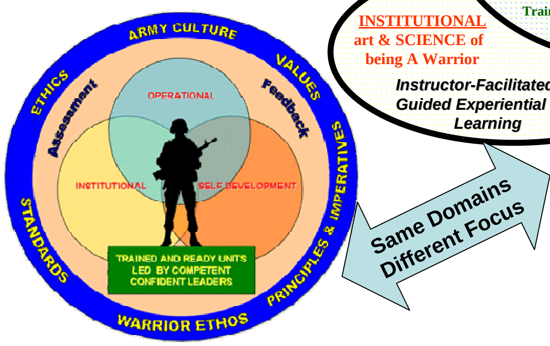
Notional Learning Model

(Visualizing a Learning Strategy)

(Expanding the Training and Leader Development Model to a Learning Model)

- **We have a Army Training Strategy & Model**
- **We need a comparable Army Learning Strategy & Model**
- **ARFORGEN & Other Initiatives continue to limit time in the Institutional Domain**

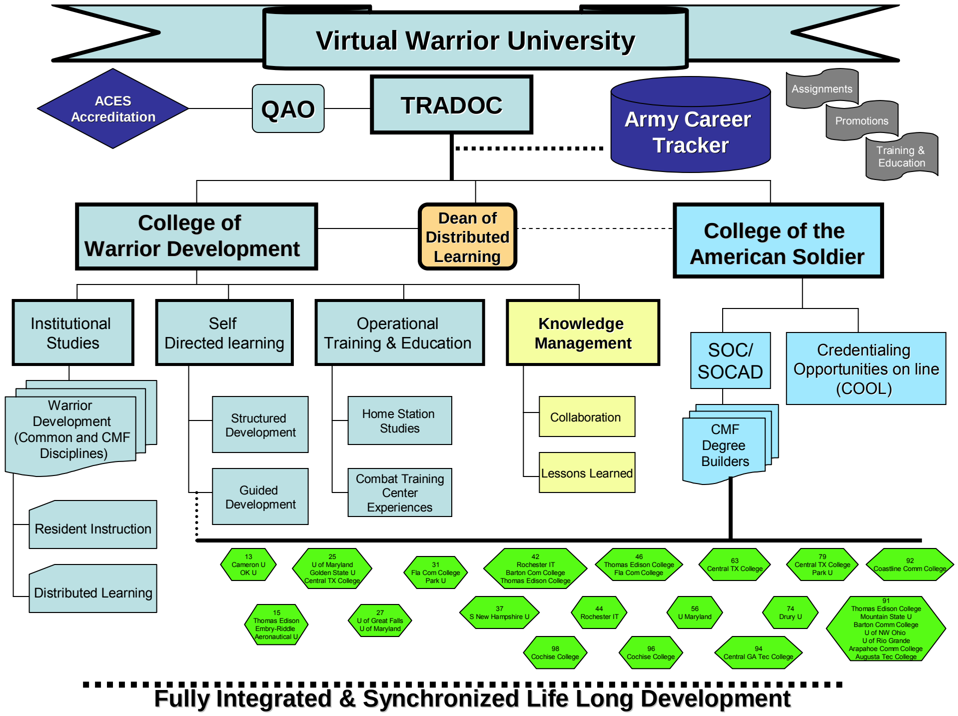




- **The Self-Development Domain lacks structure and purpose**
- **SD should be viewed from two core perspectives**
  - **Structured: Required content spread across the career**
  - **Guided/self-directed**

Key Aspects of a Learning Strategy/Model

- Learner-Centered as much as possible
  - knowledge needs of the Soldier
  - time, place, and resource limits of the Army
- Enable/balance push and pull aspects of learning
- Encourage individual understanding and assimilation of new knowledge
  - deep learning within our constraints
  - encourage individual exploration of our profession
  - leverage consistently relevant-authentic examples/ exercises
- Focus on ability to apply processes to a multitude of problems - process not the school solution outcome



Assessment and Feedback

- Requires a central Portal to manage enrollment, delivery, assessment, feedback and tracking - Warrior U fills this gap
- Requires linkage to individuals Proponent Career Map and first line leader's involvement
- Should combine self-assessment with performance feedback and first line leader's help in developing and maintaining an individual Leader Development Action Plan
- Should incorporate current Competency Assessment initiative
- Must be flexible and enable continuous adjustment based on performance and the Soldier's attainment of individual goals

Army Learning Model for Professional Military Education (PME) Overview

1

<u>Problem</u>

How do we modify our current learning model to: (1) take advantage of the most recent research in adult learning, and (2) leverage instructional technology?

2

Design Considerations

Operational

- Learning model supports the Army Force Generation model
- Resources constrained for the foreseeable future
- Model applies to Professional Military Training, not Initial Military Training
- Vast majority of students have access to instructional technology
- Supervisors have a say in the learning location
- Soldiers not allowed time to complete instruction at home station
- Instructor contact reduced through use of technology & instructional design
- Supervisor feedback improves instruction

3

Design Considerations

Pedagogical

- Distributed Learning (dL) is 30% more efficient than traditional instruction, with equal effectiveness
- Formal classroom instruction won't exceed eight hours per day
- Cohesion & improved performance through structured collaboration
- Learning decay & attrition are minimized
- Self-pacing and testing out of content already mastered
- Homogeneous groups entering resident classroom
- Learning to learn (self-regulate)

4

Foundation of a Good Learning Model

TRADOC determines …	By using …
• When to use: (1) face-to-face (f2f) ↕ (2) dL (Efficiency)	Three Criteria: 1. What senses are needed? 2. Or, are environmental conditions complex? 3. Or, is on-the-spot observation & feedback of complex performance required?
• How to design instruction (Effectiveness)	Guided Experiential Learning (GEL) • Job-relevant problem • Activate prior knowledge • Demonstrate • Practice • Transfer

5

Proposed Army Learning Model for Professional Military Education

-Guided Self-Development
-Just-in-Time Learning
-Live/Virtual/Constructive Exercises

MTT, OJT, AOT

Individual Learning Preparation

Phase I: dL at TRADOC Schools

Option to complete at home station. Most will complete Phase I at TRADOC.

Knows: Common terms, facts, basic concepts, basic principles (entrance requirement)

Diagnostic Testing: Writing, reading, tactics, etc. (entrance requirement)

Common content: Common core & mandatory training (graduation requirement)

Collective Learning Synergy

Phase II: Classroom Instruction
Blend of dL & face-to-face

- dL for nights, weekends, & planned weekday periods
- f2f maximizes integrated performance-based instruction (e.g. hands-on, CPX, FTX, capstone events)

-Shared challenging exercises build cohesion.

AOT AS REQUIRED

Reinforcement

Phase III: Learning at Unit

Graduation Requirement: Student responsibility to complete common content

Provide for Transfer

- Sustainment *via* dL (e.g. reach-back multi-media)
- Job aids

Supervisor provides feedback for course improvement

Guided Experiential Learning
(How to Instruct)

6

CG's 12 Apr 06 Guidance

Provide more detail in Phase 2:

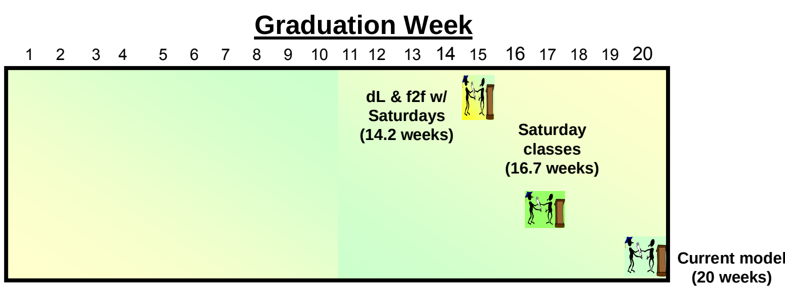
- dL/f2f blend
- Fast track for accelerated learners
- More dL at end of course
- Saturday classes

7

7

Course Length Comparisons: Efficiency for a 20 Week Course

If we use…	Then we save…	Reducing course to …
Saturday Classes	3.33 weeks	16.67 weeks
dL for ~ 50% of the remaining 16.67 weeks @ ~ 30% efficiency	~2.5 weeks (8.34 wks x .3)	~ 14.2 weeks



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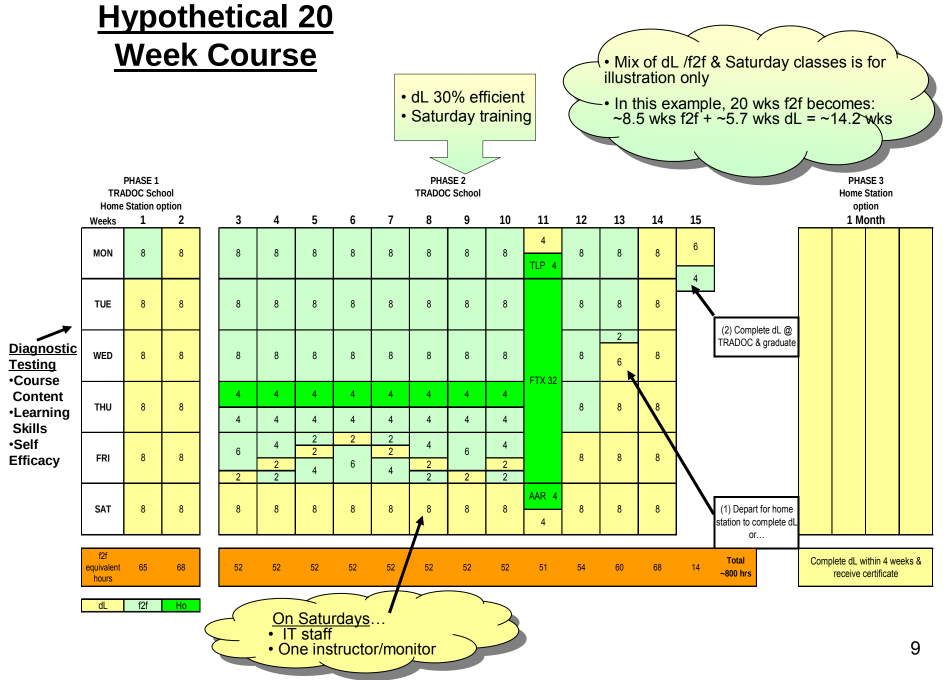
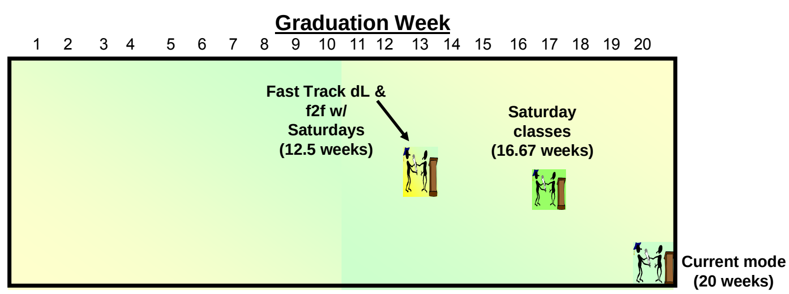
Hypothetical 20 Week Course



9

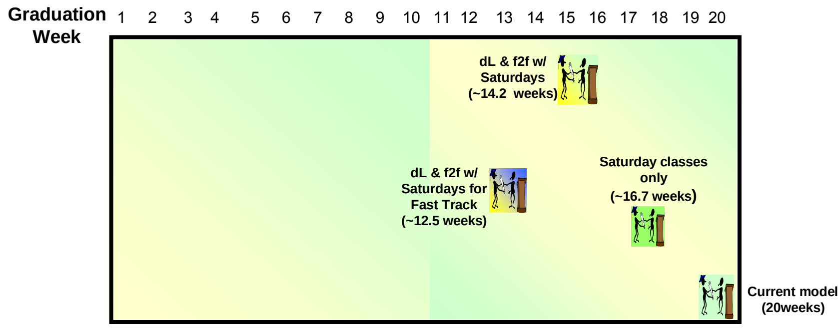
Course Length Comparisons:
Efficiency for a 20 Week Fast Track Course

If we use…	Then we save…	Reducing course to …
Saturday Classes	3.33 weeks	16.67 weeks
The remaining 16.67 weeks for: • ~50% dL @ ~40% efficiency, &	~3.33 weeks (8.34 wks x .4)	~13.34 weeks
• ~50% f2f instruction @ ~10% efficiency for accelerated learners	.83 weeks (8.34 wks x .1)	~ 12.5 weeks



10

Summary of Course Length Comparisons



Significant Advantages of the Model (1 of 2)

- **Learning Effectiveness Achieved through:**
  - **Self-regulation**
  - **Guided Experiential Learning**
  - **Supervisor feedback to improve instruction**
- **Learning Efficiency Achieved through:**
  - **Self-pacing & testing-out of content already mastered**
  - **Technologies & strategies for efficient learning**
  - **Opportunity to establish homogeneous groups entering resident instruction**
  - **Less attrition in Phase I than other choices for pre-resident dL**
  - **Less learning decay between Phase I & Phase II than other choices**
- **Cohesion Achieved through Structured Collaboration**
- **Potential Choice of Phase I Learning Location – Commanders have a say**

Significant Advantages of the Model
(2 of 2)

- **Burden on Unit Reduced through:**
  - **Students do not have to complete pre-resident Phase I dL at unit**
  - **Soldier's post-resident sustainment provided *via* dL reach-back multi-media**
  - **No new supervisor requirement to validate Soldier performance**

- **Potential to shorten courses and save instructor contact hours**

- **Allows for some novel approaches:**
  - **Diagnostic testing allows for the creation of "ability groups" aka the "fast learners"**
  - **Allows for possible staggered start and end dates for groups of students – time away from unit is minimized**
  - **Truly blended approach to training possible**
  - **Students learn just what they need for the next assignment**

13

Milestones

ARI Learning Conference: Aug 06

- **Refine Model: Sep 06**
- **Coordinate Pilot Evaluation: Sep 06**
- **Select Pilot School(s) (1 or 2): Oct 06**
- **Brief Leadership at:**
  - **TRADOC Schools: Sep 06 – Dec 06**
  - **TRADOC Senior Leader Conference (30 Oct – 2 Nov 06)**
- **Design Pilot CCC Courseware: Dec 06 – Apr 07**
- **Deliver Training: May 07 – Aug 07**
- **Evaluate & Report Results: May 07 – Oct 07**
- **Refine Model: Nov 07**
- **Implement New Model within five CCC: 2008**

14

Human Performance Technology

Definition:

- According to the International Society for Performance Improvement (ISPI), HPT is "a set of methods and processes for **solving problems—or realizing opportunities related** to the performance of people, and organizations.

- The focus is on the factors that impact individual and organizational performance not just training.

- What are those factors?

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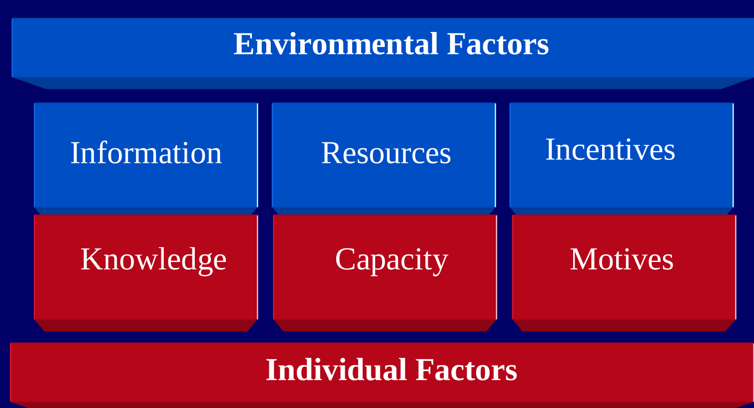
Gilbert's Behavioral Engineering Model



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Gilbert's Behavioral Engineering Model

Environmental Factors		
Information 35.3%	Resources 29%	Incentives 11.3%
Knowledge 10.5 %	Capacity 7.5%	Motives 6.3%
Individual Factors		

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Four Tenants of HPT

1. Begin with the end in mind
2. Systemic analysis starting with identifying the optimal state
3. Many factors influence performance
4. HPT is data driven

UNITED STATES COAST GUARD

#1 Begin With the End in Mind

- Everything we do must be business driven
  - Designed to meet organizational goals or needs
  - Resist temptation to prescribe before diagnosing the problem
  - Focus on desired end state and then work backwards to identify what must happen to reach desired state
  - All solutions must provide ROI.

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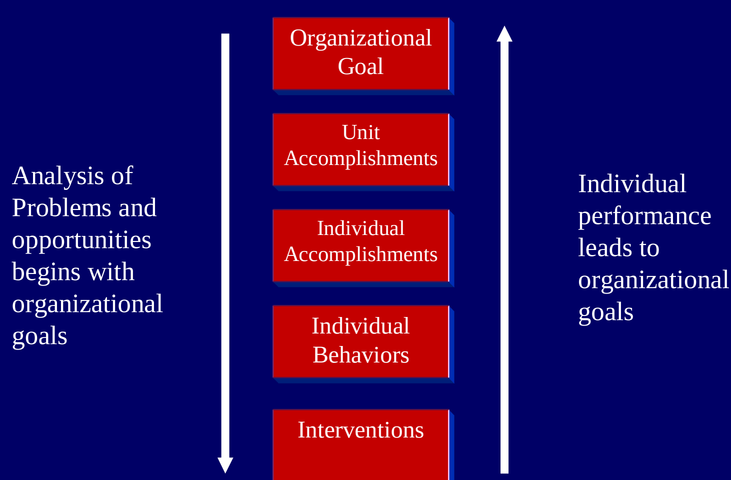
Begin With the End in Mind



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#2 Systematic Analysis Starts with the Optimal/Desired State

- How should things really work in order to meet individual, unit and organizational goals (Assumes goals identified and inplace).
- Performance Analysis: Optimals (should be)
  -Actuals (is)

  = Performance Gap
- Treat root cause vs. a symptom of the problem
- Evaluate the results through metrics.

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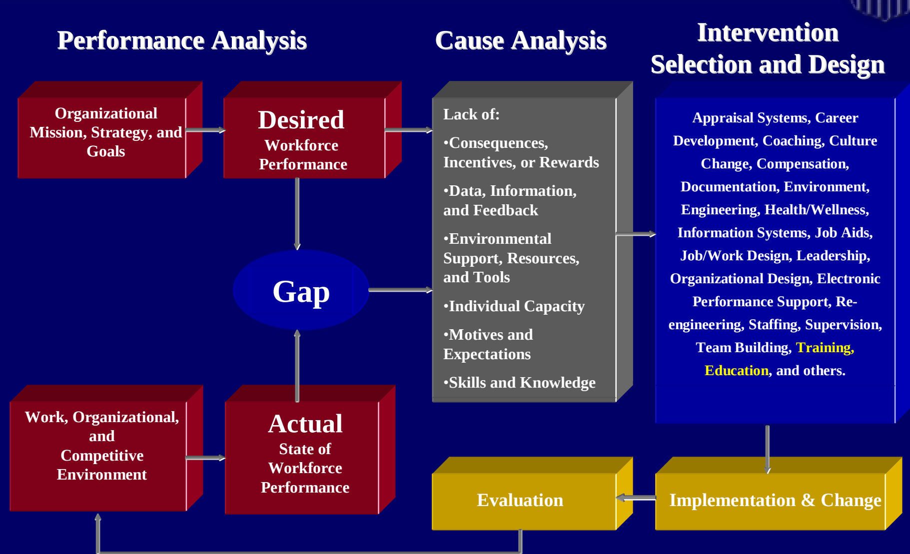
One Good Model of Performance Technology



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#2 Systematic Analysis Starts with the Optimal/Desired State (cont.)

- HPT is systematic and systemic
  - Systematic: follows a prescribed process & output from one element is the input for another
  - Systemic: relating to or affecting the entire body or organism. HPT examines the totality of the problem across the entire system
  - The goal is joint optimization of factors impacting the **work, worker** and **workplace.**

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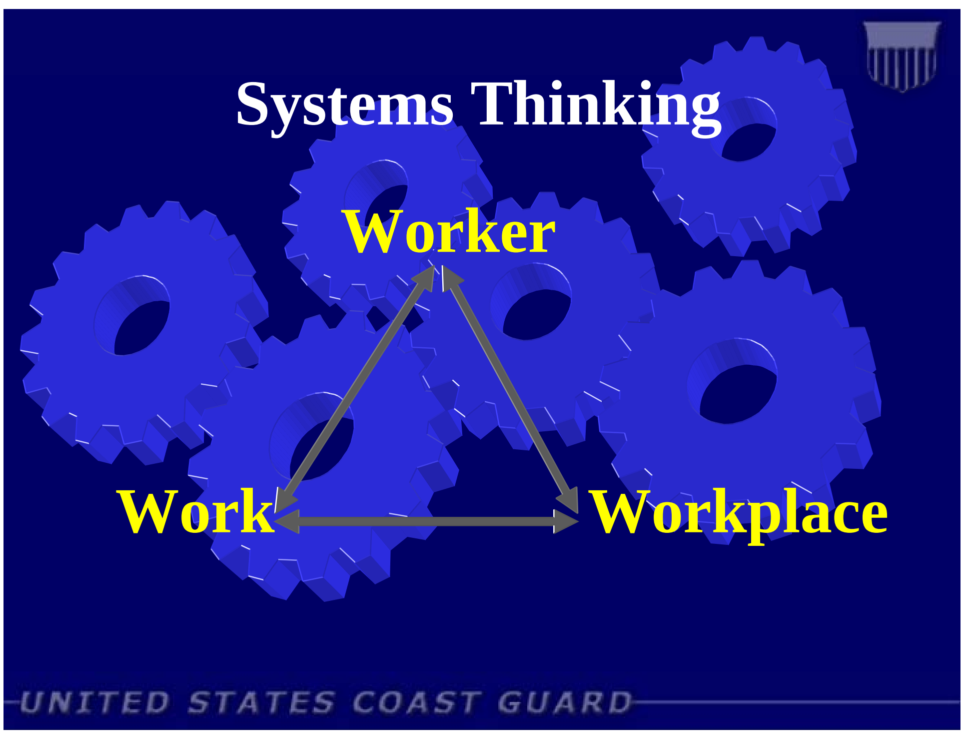

#3 Many Factors Influence Performance

- Impact can be positive or negative
- Training does not = performance
- Yet most commonly relied upon solution, yet only appropriate for 10-15% of performance problems. Why??
- Everything we do must be targeted at an organizational goal…otherwise don't do it.

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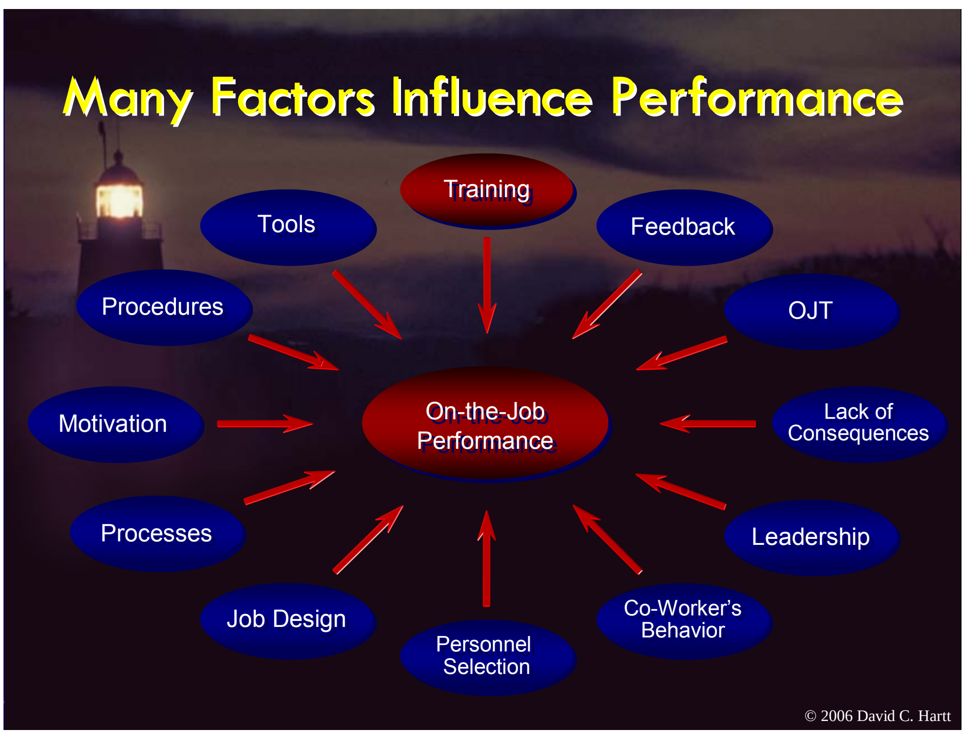

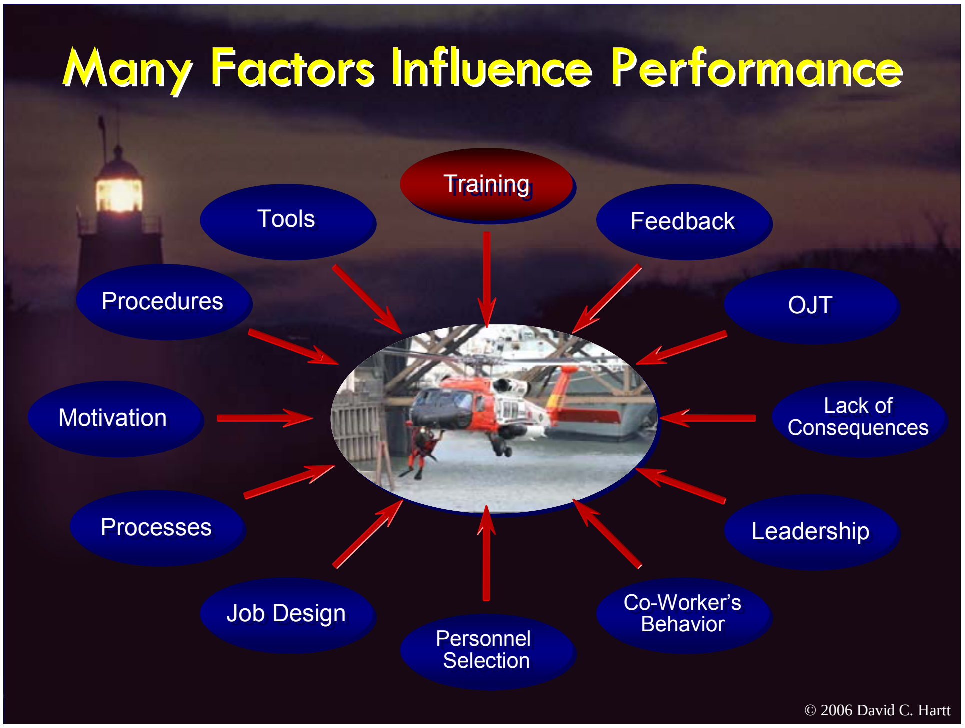

#4 HPT is Data-Driven

- Solutions are based on disciplined, systematic data collection and analysis
- Little if any room for intuition and anecdotes
- Opinions are like @$$&*!&)…everybody has one.
- Data related to better, faster, cheaper will rule the day!

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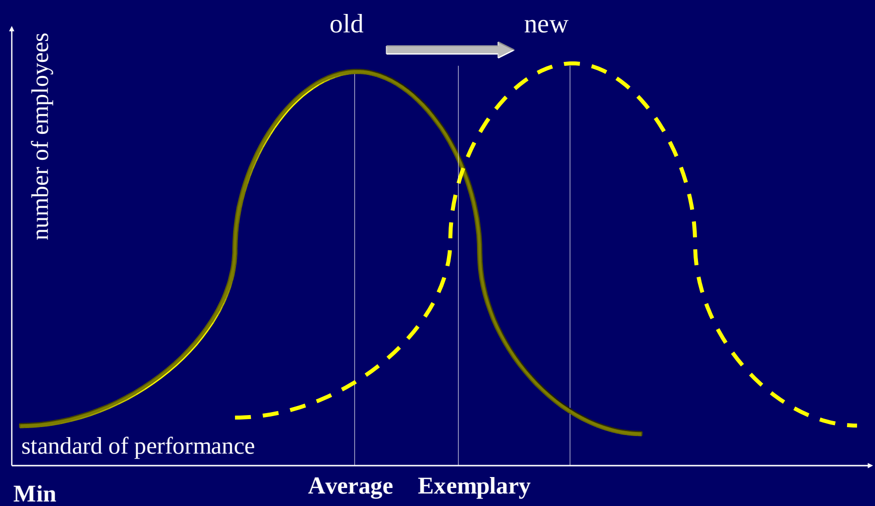
Raise the Overall Performance



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Alignment

- Must have something to align with.
- Organizational mission, vision, values must be clear and well communicated.
- Executive behavior must be aligned with the organizations stated mission, vision, values.

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Examples

- Bank teller scenario
- Robert Mager and the gun to the head test

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Review

- Focus on end state; begin with the end in mind
- HPT is systematic and systemic
- Many factors influence performance: the work, the worker and the workplace
- Data from disciplined collection always trumps intuition and “operators with opinions”. Ensures we treat the root cause and not just a symptom
- Organization must have a vision, mission or purpose to align with

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Questions

CDR David C. Hartt,
Chief, U.S. Coast Guard Performance Technology Center, Yorktown, VA
david.c.hartt@uscg.mil
757 856 2356

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BRIEFING SLIDES FROM TRAIN SOLDIERS WORKING GROUP

Training Soldiers Panel

Scott Graham
ARI Infantry Forces Research Unit
Fort Benning GA

Mike Faughnan
Training Development & Delivery Directorate
HQ, TRADOC
Fort Monroe, VA

Army Institutional Training: Some Initial Thoughts

- **Trains life and death knowledge and skills to broad range of Soldiers**
  - **70,000 new recruits to executive level leaders**
  - **Basic/Advanced NCO Courses, Captains Career Course, Long Advanced Individual Training**
- **Army training is transforming**
  - **Centers of Excellence**
  - **Need for better integration of school house and unit training**
- **Looking to become more agile**
  - **Responsive to changing operational realities**
  - **Less bureaucratic**
- **Large looming budget and personnel cuts**

Panel Process

- Introductory presentations

- Discuss series of topics/questions
  - What we know (best practices, high drivers, pitfalls)
  - What we don't know (knowledge gaps, researchable issues)
  - Low hanging fruit (easily implemented, high payoff)

- Hear/discuss Army Learning Model for Professional Military Education (PME) brief

- Prepare outbrief for GEN Wallace and Dr. Killion
  - List of topics discussed
  - More detailed discussion of 3 topics

Training Soldiers

ISSUE: What are effective methods for streamlining Army courses?

- **What we know:** (Slide note - *scientific findings*)
  - …
  - …
- **What works:** *(Slide note - implementation examples)*
  - …
  - …
- **What we don't know:** *(Slide note - what we need to explore further)*
  - ….
  - ….

POTENTIAL IMPACT: *(Slide note – tie back to workshop objectives)*

(Slide note - Issues may require, and include more than one slide)

U.S. Army Research Institute
3 AUG 06
4

Proposed Discussion Topics

1. Determining appropriateness of distributed learning
   – Alternative instructional methods
   – Best fit for various courses or parts of courses
   – Critical factors for effective simulated environments

2. Effective course development
   – How to streamline courses
   – Key considerations for effective blended learning
   – How to prepare instructors

3. Assessing cost and effectiveness
   – Front end and life cycle costs
   – Appropriate decision models

Proposed Discussion Topics

4. Training (Development) Management and Maintenance
   – How to ensure quality control in contracting
   – Review of prototype deliverables
   – Procedures for updating courses

5. Effects of Army (DoD) Transformation
   – Centers of Excellence, e.g., Maneuver Center
   – Modularity
   – ARFORGEN

Reminder of Purpose of Workshop

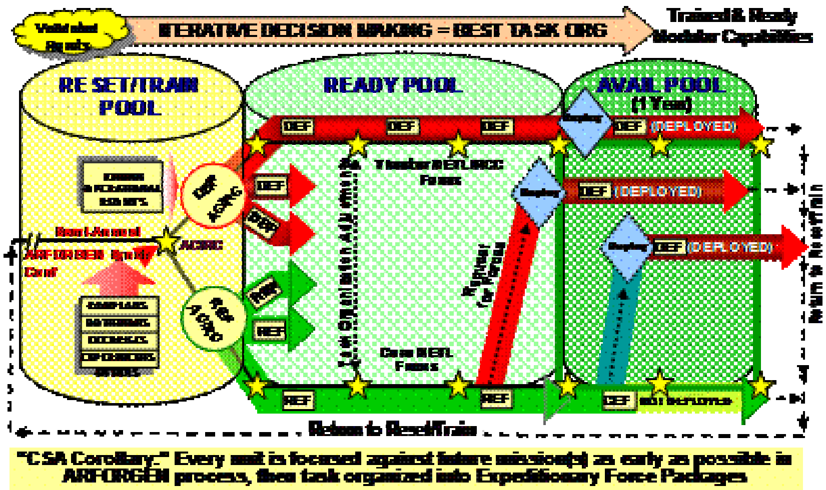
<u>Purpose</u>: *Identify learning science findings and technologies to help the Army train Soldiers and grow leaders for today and tomorrow.*

Objectives:

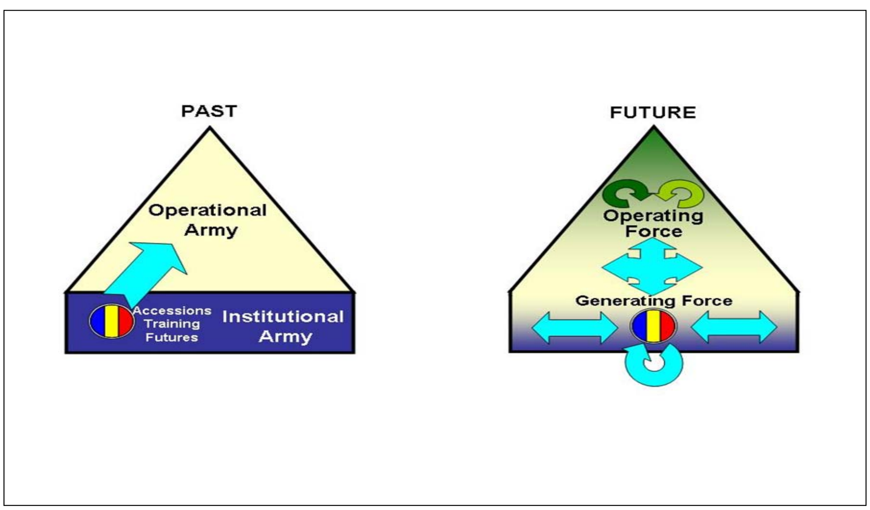
- **Accelerate learning while maintaining effectiveness**
- **Minimize resource requirements (time, cost, people)**
- **Minimize impacts on relationships (personal, professional, unit cohesion)**

HQ TRADOC Perspective

ARFORGEN Model



TRADOC Transformation



TRADOC Campaign Plan Objectives

- **Recruit, assess, and train Soldiers and develop adaptive leaders.**
- ***Posture TRADOC to support ARFORGEN implementation.***
- ***Reshape the fundamental Army learning process for a dynamic operating environment.***
- **Redesign TRADOC for excellence.**
- **Adapt requirements processes.**
- **Support continued development of the Generating Force.**
- **Integrate current and future Army modular forces.**

Posture TRADOC to support ARFORGEN

- **Develop training strategy to support individual and unit training throughout ARFORGEN cycles**
- **Prioritize units in Reset/Train Phase**
- **Develop enlisted contract lengths in support of ARFORGEN**
- **Develop IMT/PME/functional courses to meet Operating Force requirements**
- **Develop assignment-based curricula**
- **Update training publications**
- **Transform Combat Training Center Program**
- **Assess feasibility of transitioning NCO education to distribued delivery**

Reshape Army Learning Process

- **New Learning Model**
- **Process to link the Operating and Generating Forces**
- **Architecture for Adaptive Learning Environment**
- **Refine Program of Instruction (POI) and Training Support Package (tsp) Process**
- **Provide Tng Spt and TSP products to Operating Force**
- **Incorporate Joint context into individual and collective training**

Knowledge Types, Training and Measurement

Phillip L. Ackerman
Georgia Institute of Technology
Atlanta, Georgia USA

ARI Science of Learning Workshop
August 1-3, 2006

Types of Knowledge

- Knowing that (Ryle, 1949) [declarative]
- Knowing how (Ryle, 1949) [procedural]
- Tacit Knowledge (Polanyi, 1966)/ Knowing With (Broudy, 1977)

Declarative Knowledge

- Discrete (e.g., names, foreign language equivalents for words or phrases)
- Principled (e.g., organizational chart, major veins and arteries in circulatory system, positions played in a football game, trigonometry)

Procedural Knowledge

- Sequences of actions (e.g. operating an automobile or disassembling and assembling a weapon)
- May involve declarative knowledge (especially early in training)
- Requires extensive practice
- At high levels of skill, may be automatized (i.e., operation requires little or no attentional effort)

Knowing With

- Knowledge is tacit (not readily decomposed into declarative or procedural forms; not easily articulated)
- Foundation upon which the individual “thinks, perceives, and judges”

Measurement Issues

Declarative
  – Recall
  – Recognition
- Issues
  – Speeded tests (confounding of reading speed and comprehension)
  – Real-world is often not readily ‘multiple-choice’
- Challenges
  – Make assessment more representative of naturalistic demands (e.g., natural language processing, voice recognition)

Measurement Issues, continued

- Procedural
  - “Hand’s-on” assessment
  - Declarative test for procedural knowledge (e.g., “write down all the steps for disassembling/assembling the M240B”)
    - Requires translation from procedural to declarative knowledge
    - May not capture fluent procedural skill
  - Simulations
    - Issue of stimulus/response fidelity needs

Measurement Issues, continued

- Knowing with (tacit knowledge)
  - No current methods exist for adequately measuring this kind of knowledge (except in relatively narrow contexts)

Other challenges

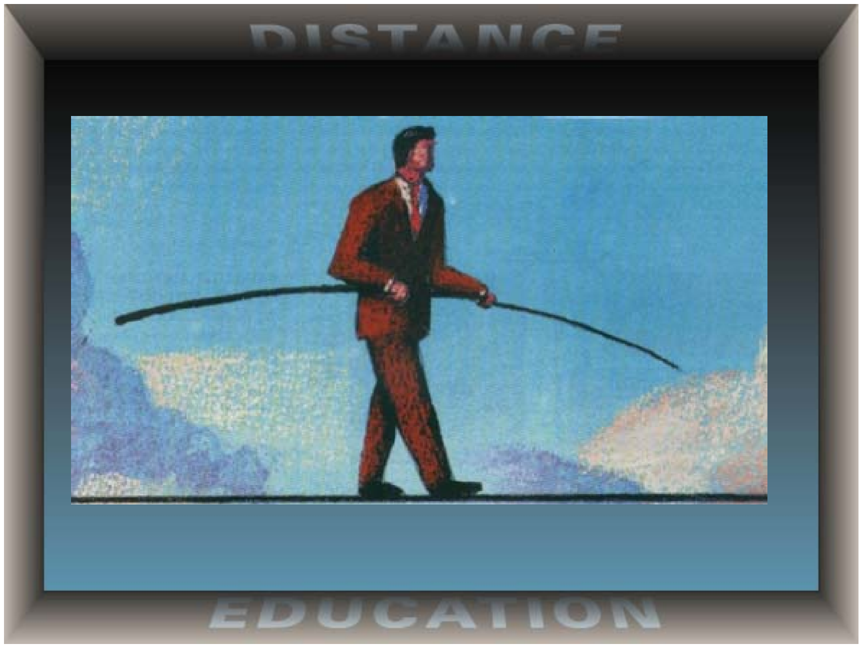
- Knowing vs. *using* knowledge
  - Determining whether the individual will use knowledge when appropriate (e.g., mindfulness)
- Training for transfer
  - Near vs. far transfer
- Self-Assessments (and self-regulated learning)
  - Constructing system for self-assessments that lead to self-regulated learning

Best Practices and Course Organization for Distance Education

Michael Simonson, Ph.D.
Program Professor
Instructional Technology and Distance Education
Fischler School of Education
Nova Southeastern University
Florida, USA

Change Our Thinking

Teacher as Skeumorph



What do we know?

DISTANCE

Coldeway's Quadrants

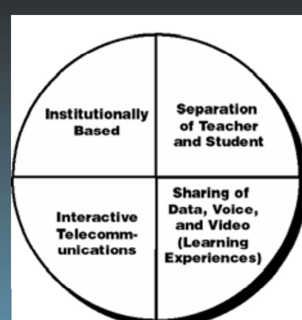
ST SP	DT SP
ST DP	DT DP

EDUCATION

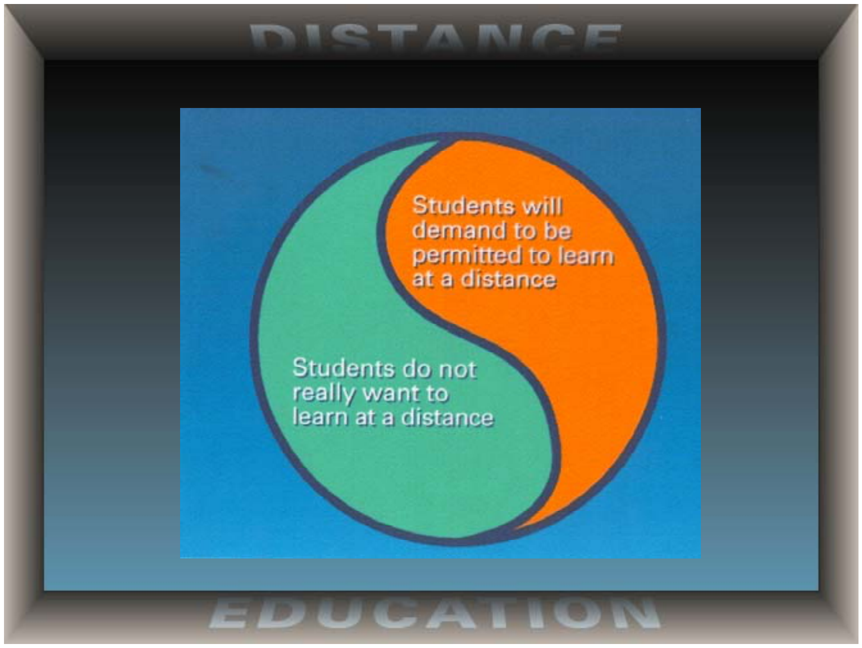
DISTANCE

Definition of Distance Education

Institution-based formal education where the learning group is separated, and where interactive telecommunications systems/media are used to connect learners, resources and instructors.



EDUCATION



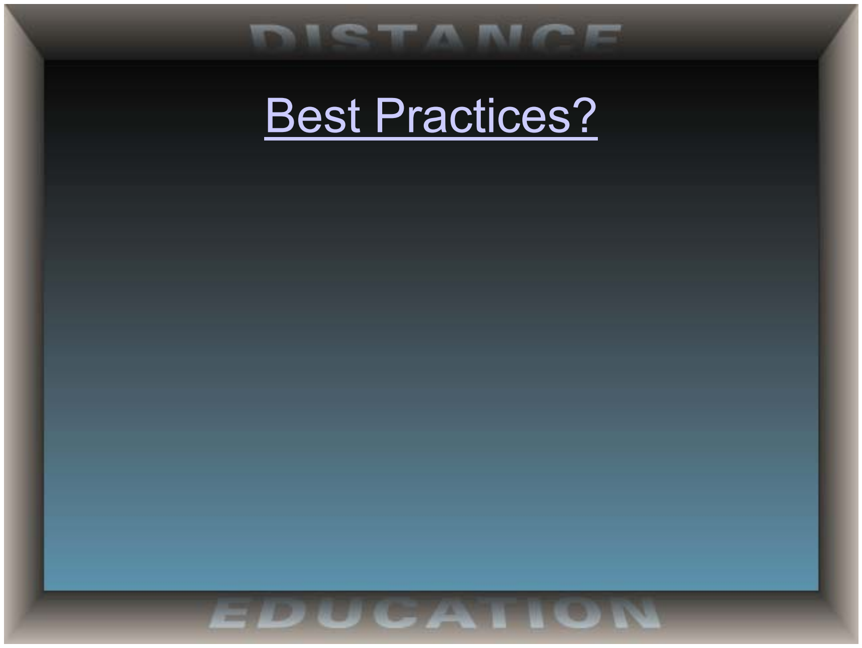
DISTANCE

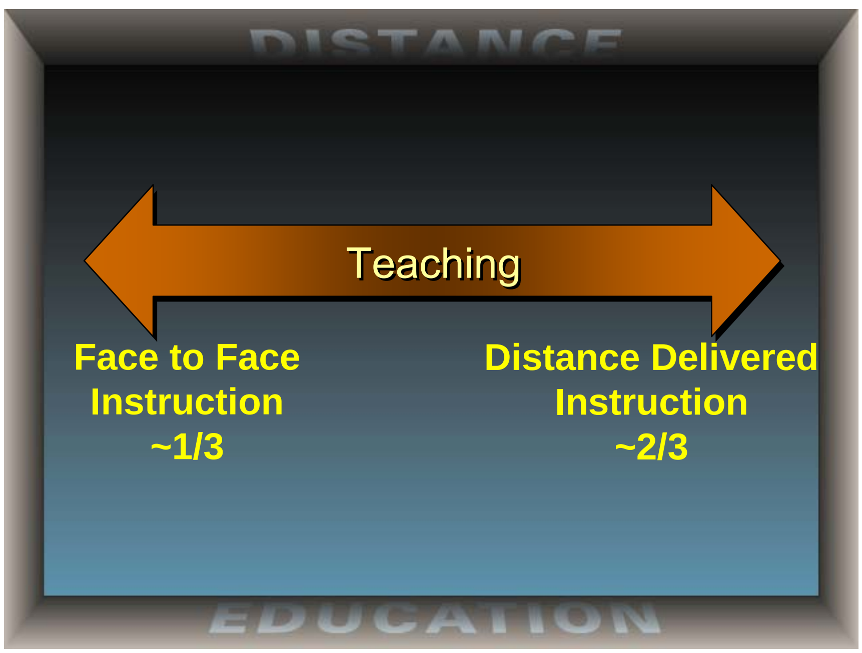
What's Next?

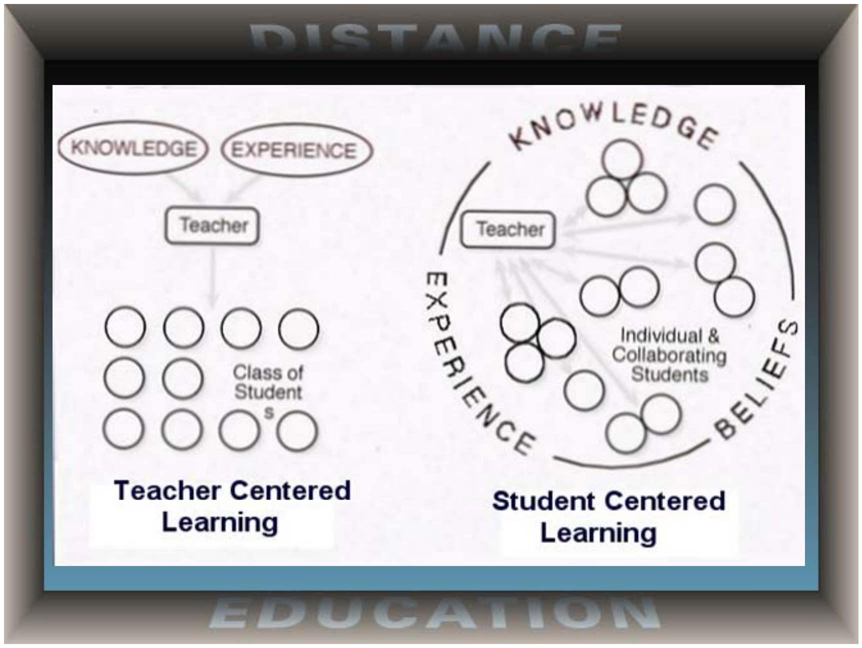
Best Practices?
Course Organization?
Producing Simple Media?

FIN

EDUCATION


DISTANCE
Best Practices?
EDUCATION


DISTANCE
Teaching
Face to Face
Instruction
~1/3
Distance Delivered
Instruction
~2/3
EDUCATION



DISTANCE

Best Practices

- Logical and Intuitive Organization
- Multimedia Use to Present Content
- High Quality Production Standards
- Content-Rich Design
- Meaningful Interaction
- Self Pacing Apparent
- Continuous Evaluation and Revision

EDUCATION

DISTANCE

Rules of Thumb

For a typical course

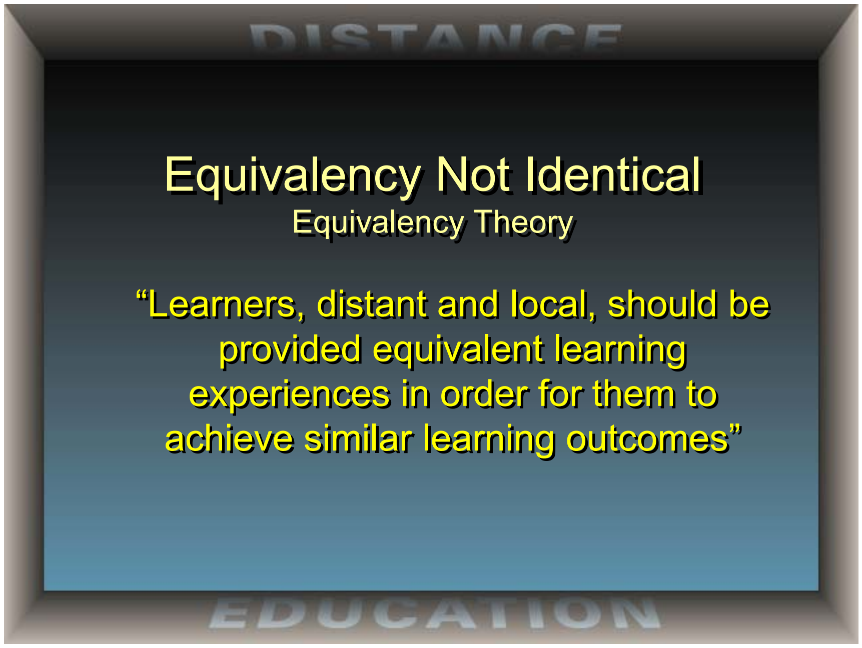
- 90 -130 hours of student involvement
- 10 – 25 students/instructor
- Clear organization ~ 45 topics, 15 modules, and 3 units
- Build Communities >5 <10
- Grade often and everything

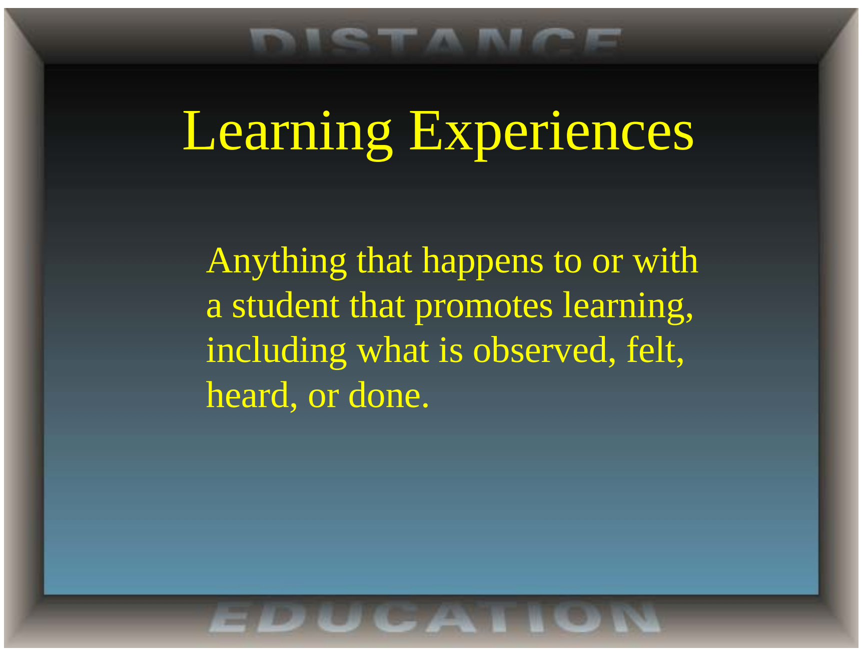
EDUCATION

DISTANCE

Organizing a Course

EDUCATION


DISTANCE
Equivalency Not Identical
Equivalency Theory
“Learners, distant and local, should be provided equivalent learning experiences in order for them to achieve similar learning outcomes”
EDUCATION


DISTANCE
Learning Experiences
Anything that happens to or with a student that promotes learning, including what is observed, felt, heard, or done.
EDUCATION

DISTANCE

Equivalency Units
(vs. Carnegie Units)
Modules (3-5/Unit)
Learning
Object\Experience
(3-5/Module, each with a Learning
Outcome)

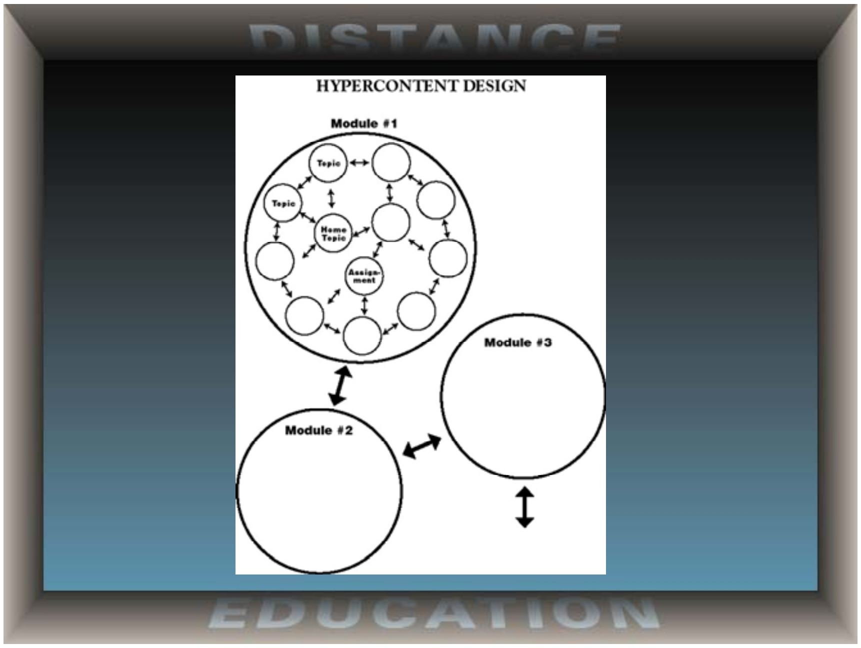
EDUCATION

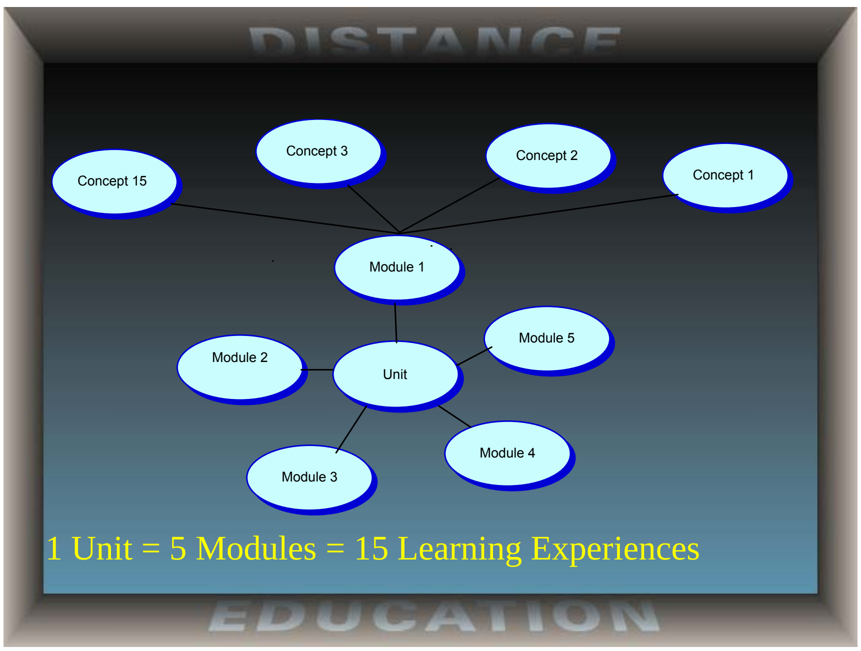
DISTANCE

3 x 5 x 5 Approach

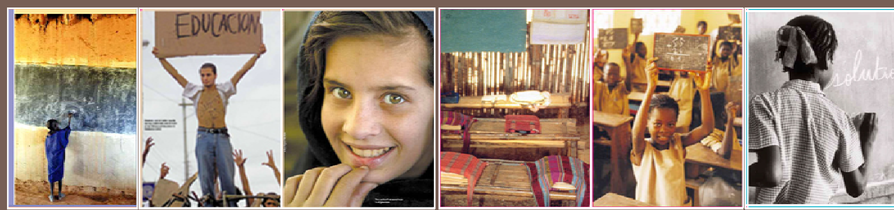
3 Units/Course
5 Modules/Unit
5 Learning Experience/Module
&
1 Objective/Concept

EDUCATION


DISTANCE
HYPERCONTENT DESIGN
Module #1
Topic
Topic
Home Topic
Assign-ment
Module #3
Module #2
EDUCATION


DISTANCE
Concept 15
Concept 3
Concept 2
Concept 1
Module 1
Module 5
Module 2
Unit
Module 4
Module 3
1 Unit = 5 Modules = 15 Learning Experiences
EDUCATION


DISTANCE
"I forgot the message!"
EDUCATION



PARTNERS IN LEARNING

Microsoft

Leveraging School of the Future

Overview

- Context and Experience
- Observations and Considerations
- Recommendations for Consideration

Observations and Consideration

- Content vs. Methodology
- Research / Practitioner Balance
- Commonalities

6 Essential Questions

- What are you trying to create?

Creating Common Vision ?

- Who are you creating it for?

Know Thy Customer ?

- How will your organize your work?

Define Scope ?

- What process will discipline your effort?

Disciplined Methodology ?

- What factors are critical for success?

Establish Common Language ?

- What assets are required to support your success factors?

Remember… Less is More ?

What are you trying to create?

5

Establishing the Environment Principles

1 continuous d place

2 relevant rent and relevant

3 adaptive individual student

Who is your customer?

6

MOTIVE

- **M**otivations
- **O**bstacles
- **T**rends
- **I**nterests
- **V**alues
- **E**nvironment

Today's Student

- Today's avg. student has 6 applications running at once on their computer
- Today's average students has 4 – 5 email addresses
- 26% of US students access a foreign news service
- The fastest growing segment of computer users today in the US is 5 – 7 year olds.
- 96% of US students say school is important to their success… only 20% believe it is meeting their needs.
- 56% of teenagers say they would rather use email than a telephone
- >20% of students report doing internet research for parent purchases
- 56% of teenagers say they would rather use email than a telephone
- 30% of kids that enroll in college require remedial courses ($1-2B in taxpayer costs)
- 30% of kids - 50% of blacks and Latinos - do not graduate high school
- Since 1985, The real income gap between high school grads and college grads has doubled

What assets will you need?

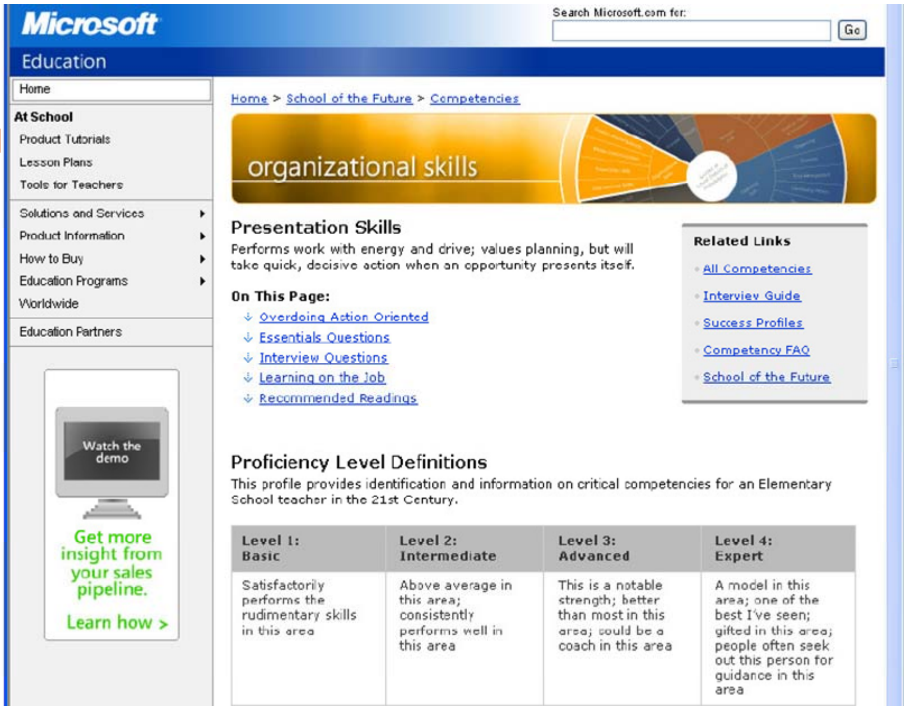
Success Factor	Asset
Professional Leadership	Competency Wheel
	Professional Leadership Development Model
Proficient and inviting curriculum-driven setting	Learning Space Matrix
Cross-Curricula Integration of R&D	R&D Integration Framework
Involved and Connected Learning Community	Device Strategy
	Community Inclusion Plan
	School Procurement System
	Time Reporting and Payroll Management
	Home/School Broadband Connection
	Community Information Portal and Content Repository
	Space and Time Management Solution
	InfoPath Form Development
	Virtual Library / Virtual Teaching Assistant
	Food Service Management Control
Flexible and sustainable learning environment	Assessment Dashboard

The Right Tool for the Right Job

9

Learning Blocks	Instructional Implication	Institutional Implication	
Generate Interest	Medium and Method of Instruction	Appropriate Access	Device Strategy Cross-Curriculum R&D Integration Learning Space Matrix
Identify & Address Prior Knowledge	Personalized Instructional Plan	Portfolio Management	
Gather New Information	Learning Resources	Distributed Resources	Virtual Library
Observation	Community of Learners	Collaborative Infrastructure	Home/School Broadband Connection
Replication	Rich Delivery Tools	Standardized Tool Set	
Reinforcement Drill	Self-Directed Mechanisms	Self-Directed Mechanisms	Virtual Teaching Assistant
Reinforcement Educate	Best Practice Sharing	Collaborative Infrastructure	
Reflection	Peer Environments	Collaborative Infrastructure	
Demonstration of Learning	Assessment	Integrated Data Environment	Assessment Dashboard

 10



Building and Space Design Principles

12

6 Characteristics of Effective Learning Spaces

- Motivating
- Flexible
- Collaborative
- Reflective
- Performance Focused
- Community Centric

Thank you.

- www.microsoft.com/education/sof
- marycul@microsoft.com

Engineering "Force Multipliers" for Training & Education

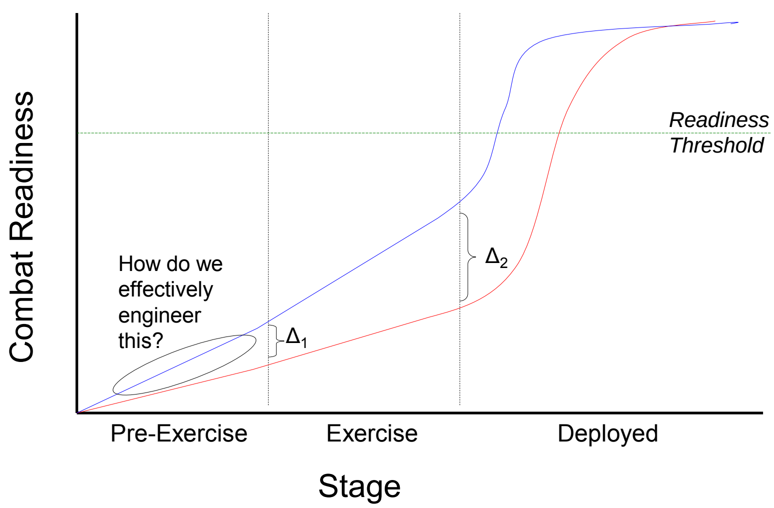
Science of Learning Workshop

Frederick J. Diedrich & Daniel Serfaty

August 1, 2006

www.aptima.com
Woburn, MA • Washington, DC

The Challenge: Making an Impact



APTIMA HUMAN-CENTERED ENGINEERING

The Problem

- To meet this objective, the Army needs to enable training and education that is increasingly relevant to the modern operational context.
  - However, it must also be increasingly reliant on fewer resources, and increasingly distributed.

    → Alternative learning technologies need to be leveraged.

    How can we ensure that these technologies are truly effective force multipliers?

APTIMA HUMAN-CENTERED ENGINEERING

An Example: Games

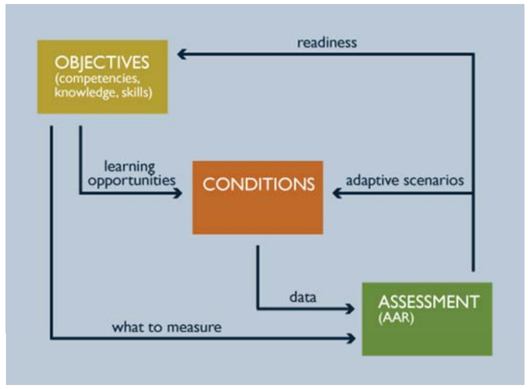
- Gorman's Gambit (DARPA DARWARS)
    - Aptima & BBN Technologies
  - What are the requirements for moving from gaming to training?
    - Neverwinter Nights^{TM} by BioWare Corp. + Added VOIP comms net
  - Key Finding
    - Training should be built on *modifiable* objectives, conditions, & measures

APTIMA HUMAN-CENTERED ENGINEERING

Objectives, Conditions, Measures (OCM) Framework

Strategy

- Identify training needs and goals
- Create simulated and live exercises that fit learning needs
- Measure, assess, and provide feedback



APTIMA HUMAN-CENTERED ENGINEERING

Challenges

- Technical Issues
  - Authoring infrastructure
  - Measurement and feedback infrastructure
- Broader Context
  - However, authoring won't be useful unless current lessons learned are incorporated.
    - Expeditionary Force & adaptive enemy – Static scenarios and environments will not suffice.
  - Start with competencies/objectives
    - For a given set of objectives, what are the best conditions to meet the training needs? (Fit)
    - Assess potential investments with respect to ability to impact learning conditions given objectives (Return on Investment)

Technology + Training Context will lead to Effective Force Multipliers

Pedagogical Considerations in the Application of Technology

Thomas M. Duffy
Indiana University

Pittsburgh, PA
31 July 2006

School of Education

Assumption

- The application of what is learned will be in complex environments where there are multiple demands and decision requirements.
  - Virtually all applications of learning are in problem solving or decision making contexts.
- The goal of instruction is to prepare Soldiers to function effectively in these complex environments.

Indiana University

Propositions About Learning

1. **The problem or goal <u>of the learner</u> determines**
   - What is attended to
   - How information is interpreted
   - How knowledge is organized (schema)

- **This is true of all learners and learning contexts**
  - In school and out

Proposition 2

- **Context is a central determiner of what is learned. Context includes:**
  - Other concepts
  - Situational cues
  - The problem
  - Time demands
  - Emotions

Implications for Instruction

- **Learning should be wholistic**
  - Move from whole to part
  - Experiential learning
- **The learning must take ownership of the problem**
  - Take ownership of the problem.

But It Is Not That Easy
Propositions 3 & 4

- **Rich environments become difficult to manage**
  - o Cognitive demands are great
  - o Unsure where to direct attention
  - o Abstract concepts difficult to understand
  - o ……
- **Learning is initially context bound**
  - o Tend to over generalize
  - o Tend to fail to transfer to new situations

School of Education

Design Propositions:
Managing Complexity

1. **Provide subgoals (much as we do for any complex work assignment)**

2. **Support the development of metacognitive skills.**
   - Promote the asking of the questions any good learner would ask
   - Provide tools to help them structure their thinking (not do it for them)
   - Provide alternatives to evaluate in the context of decision making

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Design Proposition:
Managing the Complexity (contd)

3. **Provide tools to support their testing of their own understanding of the parts**
   - Test the part separate from the whole
   - Like regular textbook stuff
   - Team mates to try ideas out on.

4. **Provide tools to help them understand concepts (parts)**
   - Visualization of abstract relations
   - Simplified text (job aids)

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Design Propositions:

Breaking Free of the Context

5. Promote/guide reflection

- Helps index what was learned and what work needs to be done

6. **Present "What if" problems (Same situation, different variables)**

- At the end of each step or at the end of the problem, ask how they would do things differently if a particualr parameter were changed.

7. Assure concepts occur in multiple problems (Different situations).

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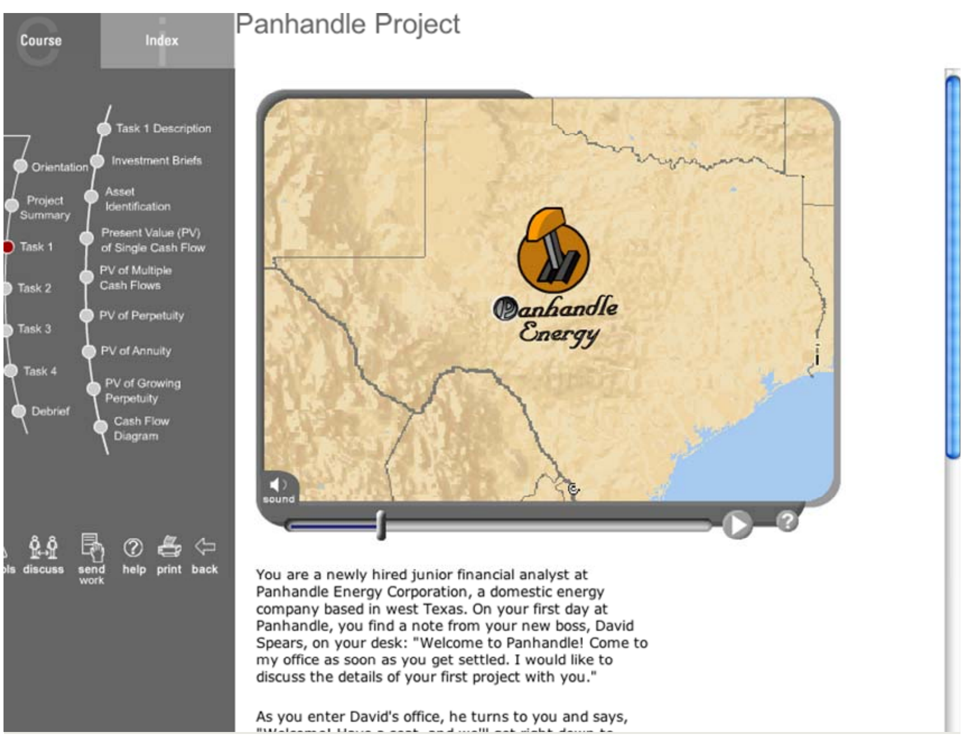
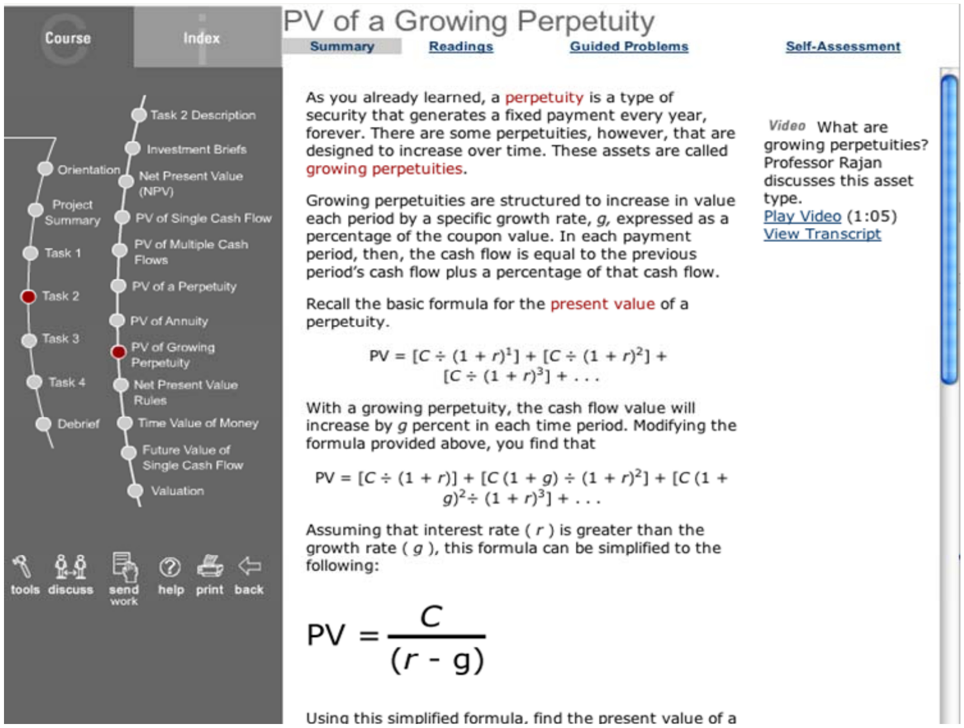




PV of a Growing Perpetuity

Summary Readings Guided Problems Self-Assessment

As you already learned, a perpetuity is a type of security that generates a fixed payment every year, forever. There are some perpetuities, however, that are designed to increase over time. These assets are called growing perpetuities.

Growing perpetuities are structured to increase in value each period by a specific growth rate, *g*, expressed as a percentage of the coupon value. In each payment period, then, the cash flow is equal to the previous period's cash flow plus a percentage of that cash flow.

Recall the basic formula for the present value of a perpetuity.

$$PV = [C \div (1 + r)^1] + [C \div (1 + r)^2] + [C \div (1 + r)^3] + \ldots$$

With a growing perpetuity, the cash flow value will increase by *g* percent in each time period. Modifying the formula provided above, you find that

$$PV = [C \div (1 + r)] + [C (1 + g) \div (1 + r)^2] + [C (1 + g)^2 \div (1 + r)^3] + \ldots$$

Assuming that interest rate (*r*) is greater than the growth rate (*g*), this formula can be simplified to the following:

$$PV = \frac{C}{(r - g)}$$

Using this simplified formula, find the present value of a

Video What are growing perpetuities? Professor Rajan discusses this asset type.
Play Video (1:05)
View Transcript

TE401

Supporting Internet Exploration with WebQuests:

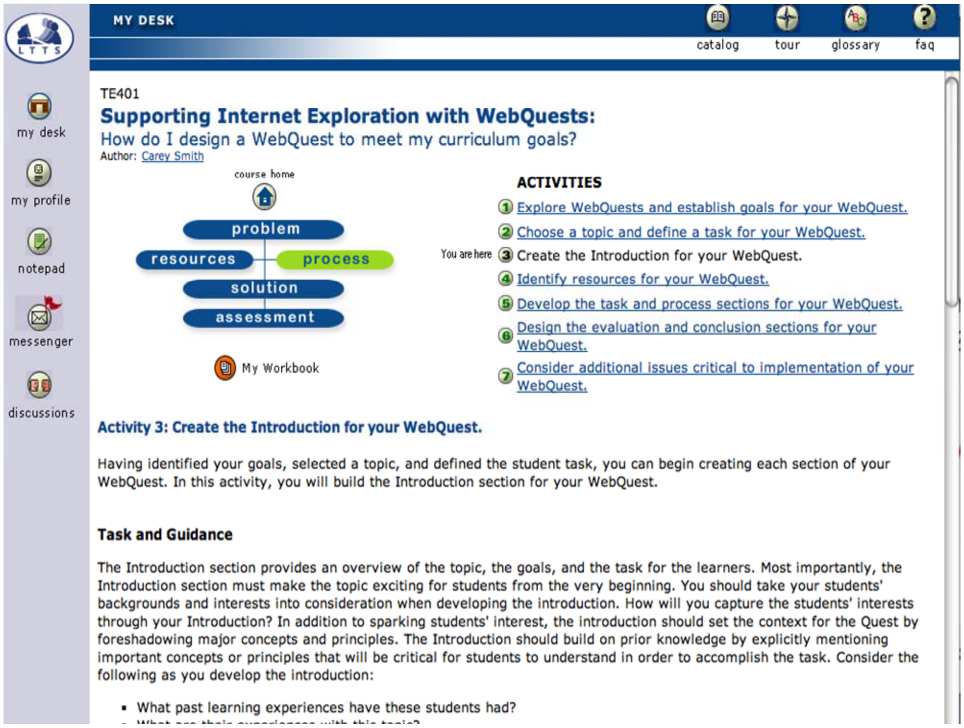
How do I design a WebQuest to meet my curriculum goals?

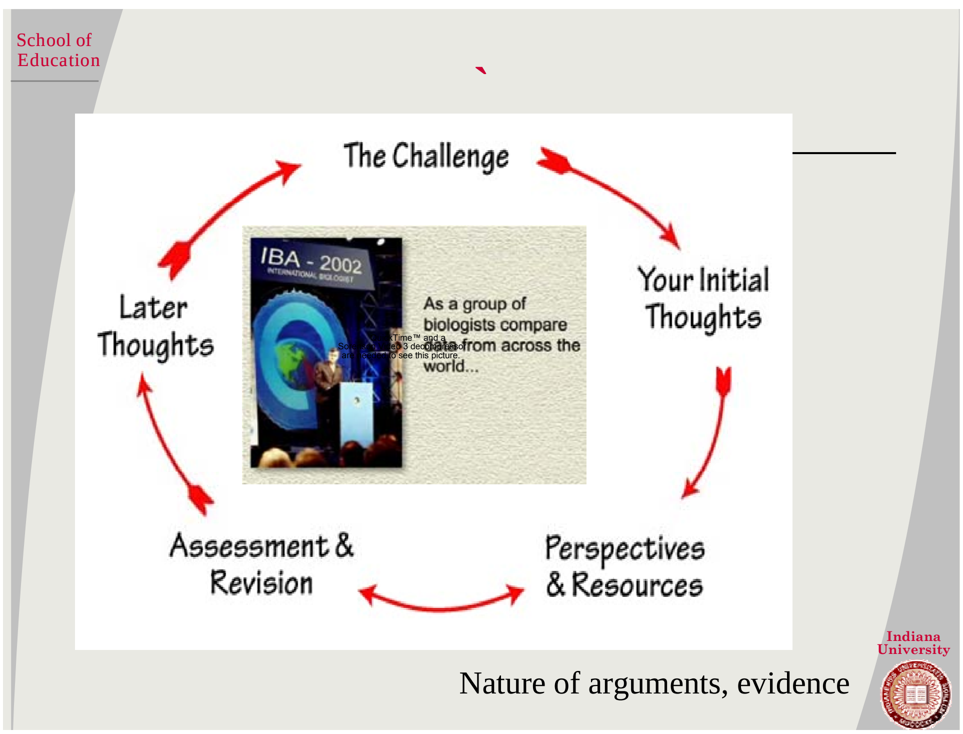
Author: Carey Smith

Defining the Problem

Locating information on the Web presents different challenges for each user. The information may be difficult to find, or, conversely, so much information may be found that users have a difficult time distinguishing high-quality results from irrelevant ones. Students need guidance in developing skills to analyze and synthesize information in order to apply it in useful and meaningful ways. Helping students learn these skills can be an overwhelming task for teachers. Not only do teachers need to teach the skills of searching for and applying reliable information, they must also find ways to make the research activities interesting and useful to students. The fear of Internet misuse further complicates this task. Many administrators restrict Internet use and/or require strict supervision. For this reason, many teachers are hesitant to use this technology in their classrooms.

The impact of these issues on students is profound. The Web is a way for students to find answers to their own learning questions and to address real-world problems. The Web can be a tool for critically examining other perspectives, values, and cultures. It is critical that today's students be skilled in searching out and analyzing such information. However, without the


MY DESK
catalog
tour
glossary
faq
my desk
my profile
notepad
messenger
discussions
TE401
Supporting Internet Exploration with WebQuests:
How do I design a WebQuest to meet my curriculum goals?
Author: Carey Smith
course home
problem
resources
process
solution
assessment
My Workbook
ACTIVITIES
1 Explore WebQuests and establish goals for your WebQuest.
2 Choose a topic and define a task for your WebQuest.
You are here 3 Create the Introduction for your WebQuest.
4 Identify resources for your WebQuest.
5 Develop the task and process sections for your WebQuest.
6 Design the evaluation and conclusion sections for your WebQuest.
7 Consider additional issues critical to implementation of your WebQuest.
Activity 3: Create the Introduction for your WebQuest.
Having identified your goals, selected a topic, and defined the student task, you can begin creating each section of your WebQuest. In this activity, you will build the Introduction section for your WebQuest.
Task and Guidance
The Introduction section provides an overview of the topic, the goals, and the task for the learners. Most importantly, the Introduction section must make the topic exciting for students from the very beginning. You should take your students' backgrounds and interests into consideration when developing the introduction. How will you capture the students' interests through your Introduction? In addition to sparking students' interest, the introduction should set the context for the Quest by foreshadowing major concepts and principles. The Introduction should build on prior knowledge by explicitly mentioning important concepts or principles that will be critical for students to understand in order to accomplish the task. Consider the following as you develop the introduction:
• What past learning experiences have these students had?


School of Education
The Challenge
Your Initial Thoughts
Perspectives & Resources
Assessment & Revision
Later Thoughts
IBA - 2002
INTERNATIONAL BIOLOGIST
As a group of biologists compare data from across the world...
Nature of arguments, evidence
Indiana University

Training Challenges in a Complex World -Supporting Training and Leader Development During War

- Overcoming short unit dwell time.
  - Training full spectrum operations--offense, defense, stability, support (requires more time, when we have less).
  - Compresses or eliminates opportunities for unit and individual training.
  - Training young leaders who will not have practiced good training management principles.
  - Delivering training at home station (Functional Training delivered by MTT when appropriate or if available).
- Assisting the training of teams consisting of geographically dispersed modular forces (requires seamless live-virtual-constructive domains). BCKS' potential for virtual teaming will be useful for developing cohesion.
- Educating leaders as to the training resources available early in the process (COIN Seminar).

Training Challenges in a Complex World -Supporting Training and Leader Development During War

- Changing how and when to update doctrine (finding right balance between promulgating best practices and capturing enduring changes).
- Streamlining information access for commanders (Road to Deployment web site).
- Integrating the latest TTP from theater and integrating it into unit training at homestation. The real challenges of OPSEC must be solved.

Specific Training Challenges in Today's Environment

- **Counterinsurgency Operations**
  - **Training leaders, soldiers and units for a "different kind of war."**
  - **War of Perceptions: methods, principles, paradoxes, logical lines of operation**
  - **Cultural Awareness: language, culture, traditions, religion, trends**

- **Counter-IED Operations**
  - **How to fight the enemy where IEDs have become the weapon of choice**
  - **Battle staff processes: predictive analysis, pattern analysis, route analysis in planning to counter IEDs**
  - **Kill chains: from financier to executor; how do we ID and defeat**
  - **Training leaders, soldiers and units to defeat IEDs as they are employed in numerous ways**

- **Escalation of Force**
  - **Balancing force protection and preventing civilian casualties that could have 2nd and 3rd order consequences**
  - **Training soldiers to react appropriately with little time to react (seconds)**
  - **Proper techniques for establishing effective TCPs to mitigate "shoot – don't shoot" situations**

Specific Training Challenges in Today's Environment

- **Information Operations**
  - **Training leaders, soldiers and units how to effectively use IO in today's environment**
  - **Impact of what we say and do in theater (strategic corporal)**
  - **Cultural Awareness: language, culture, traditions, religion, trends**
  - **More than just public affairs and the media (PA, CA, PsyOps, Targeting, CMO, etc)**
  - **Focus more on "non-kinetic" solutions vs "kinetic" solutions**

Research, Development & Engineering Command

SFC Paul Ray Smith Simulation & Training Technology Center

Adaptive Learning Environments

Robert Sottilare

Chief Technology Officer

SFC Paul Ray Smith Simulation & Training Technology Center

robert.sottilare@us.army.mil

Topics of Discussion

- **Experience: Training for Non-Kinetic Operations**
- **Feedback: Adaptability of Intelligent Tutoring Systems (ITS)**

Good training = clear objectives, relevant experience and feedback

Non-Kinetic Operations

- Traditionally, most military simulations have focused on kinetic-based operations and effects – “putting steel on the target”
  - (e.g., First-person shooters, task trainers, staff and strategy trainers)
- Growing awareness that simulations and training must also address non-kinetic operations and effects as well
- Many definitions of “non-kinetic operations and effects”
- For this discussion, non-kinetic refers to wide-range of actions which do not include firepower (e.g., developing strong interpersonal skills, leadership, cultural awareness; information operations; negotiation skills)
- Significant portion of the STTC/ICT’s $40M annual research portfolio focused on developing tools and technologies which support non-kinetic operations

Sampling of STTC and ICT Prototypes Which Support Non-Kinetic Operations

- Virtual Humans
  - Learning with Adaptive Simulation and Training (LAST)
  - Stability and Support Operations – Simulation and Training (SASO-ST)
  - Tactical Questioning
  - Cultural Cognitive Combat Immersive Trainer - Demonstration (C3IT-D)
- Hollywood Technologies
  - Army Excellence in Leadership (AXL)
  - NTC – Comprehensive Enhanced Fidelity Program
- Game Engine – Based Trainers
  - Every Soldier a Sensor Simulation (ES3)
  - Asymmetric Warfare – Virtual Training Tool (AW-VTT)
  - Tactical Iraqi Language Trainer (TILT)
- Role Playing Simulation
- Distributed Interactive AAR
- Human Terrain Annotation

Non-Kinetic Operational Gaps Not Being Addressed by STTC/ICT

- Sensors and metrics – track learning and adaptive environment
  - Collaborative research discussions underway with ICT/ICB
- Individual and/versus small unit learning
- Parallel processing concept with ARL HPC
- Macro to micro cultural and human representation – similar to economics in that it is very different at each of the two levels

Adaptability of Intelligent Tutoring Systems

Limits of dL technology

- Per Abell (2006) "There are limits to the content technology is able to deliver, and DCSOPS&T is providing instructional designers with Clark, Bewley, and O'Neil's three criteria for considering whether material can be delivered via distributed learning (dL) or face-to-face (f2f)."
  - if sensory input beyond the audio visual is necessary (i.e. taste, touch, smell), instruction should be kept in a f2f environment.
  - if complex conditions are required for instruction, such as simulating a riot, and electronic media cannot adequately depict these conditions, instruction should be kept in a f2f environment as well.
  - if the learner is engaged in whole-task practice of a complex task, then an instructor must observe, evaluate, and provide feedback. For practice of complex tasks, a medium must allow synchronous observation of the learner as well as audio and visual feedback from the instructor to the learner. If a medium is inadequate for this, the practice should be kept in f2f instruction.

dL or f2f

dL
high throughput
flexible delivery times
high efficiency
effective performance ?
cost effective?
<u>less adaptable</u>

f2f (one-to-one)
low throughput
limited delivery times
time intensive
effective performance
not cost effective
very adaptable

f2f (one-to-many)
high throughput
limited delivery times
efficient
effective
cost effective
somewhat adaptable

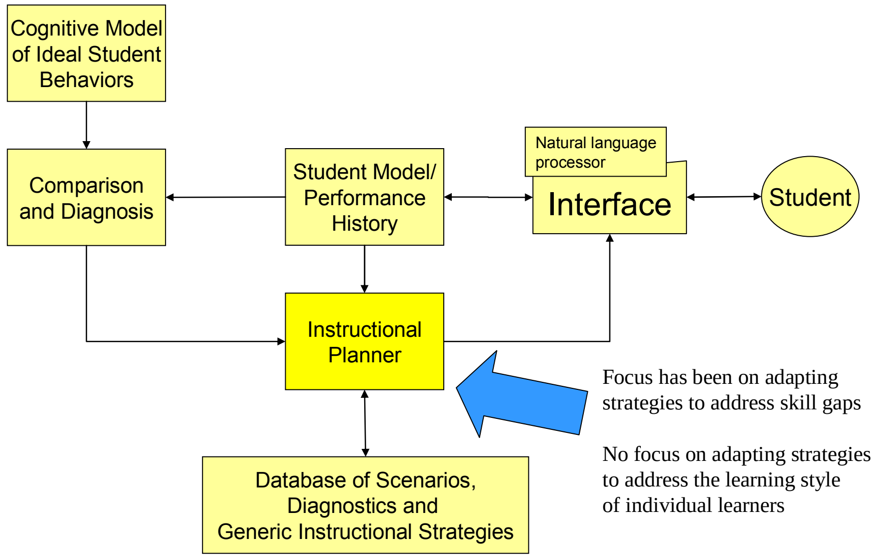
Intelligent Tutoring Systems (Loftin 2004)

An early promise of intelligent tutoring systems (ITS) was their potential to truly adapt to the individual learner, much as a human tutor engaged in a one-on-one encounter with a student. This goal has proven elusive.

Low adaptability to learner needs and preferences:

ITS still, in most cases, lack the capability for doing dynamic diagnosis (during a learning experience) and, in real time, adapting the current scenario to provide the student with the 'optimal' learning experience.

Generic Intelligent Tutoring System Model



Learning styles models matched against minimal criteria (Coffield, 2004)

Table 44
13 learning-styles models matched against minimal criteria

✓ criterion met
× criterion not met
— no evidence either way or issue still to be settled

Note
The evaluation is in all cases 'external', meaning an evaluation which explored the theory or instruments associated with a model and which was not managed or supervised by the originator(s) of that model.

		Internal consistency	Test-retest reliability	Construct validity	Predictive validity
1	**Jackson**	—	—	—	—
2	**Riding**	×	×	×	×
3	**Sternberg**	×	×	×	×
4	**Dunn and Dunn**	×	×	×	✓
5	**Gregorc**	×	×	×	✓
6	**Honey and Mumford**	×	✓	×	×
7	**Kolb**	—	✓	×	×
8	**Entwistle**	✓	—	✓	×
9	**Herrmann**	—	✓	✓	—
10	**Myers-Briggs**	✓	✓	×	×
11	**Apter**	✓	✓	—	✓
12	**Vermunt**	✓	✓	✓	×
13	**Allinson and Hayes**	✓	✓	✓	✓

Institutional Training Challenges

Warrior Logisticians

Critical Issues

- Streamlining of Resources
- Increased throughput
- Accelerated Training
- Creating White Spaces

Warrior Logisticians

Quartermaster, Relevant and Ready:
Supporting Victory Now and in the Future

Questions?

BG MIKE TUCKER

Currently Deputy Commanding General, US Army Armor Center

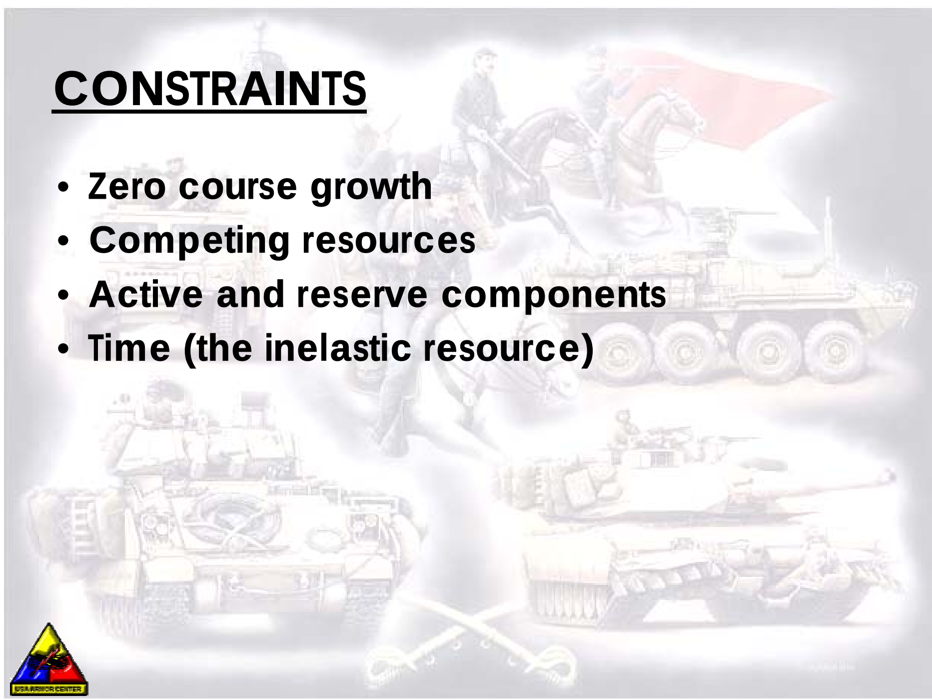
- **Assignment Background**
  - 7 years enlisted service as Scout, Drill Sergeant
  - Multiple Armor assignments in Germany
  - Asst Prof at West Point
  - Combat tours as Battalion S-3 and Brigade Commander
  - Last assignment - Asst Division CG for Support and Maneuver
- **Education**
  - B.S. in Psychology
  - M.P.A in Public Administration
  - M.A. in Military Art and Science
  - Military courses culminating in Army War College
- **Educational Focus**
  - Tactical training/Leader Development
  - Combined arms operations
  - Joint and coalition battle-staff training

DR BOB BAUER

Currently Deputy Director for Training, Doctrine, Combat Development

- **Assignment Background**
  - 7 years active duty in CONUS, KOREA
  - 20+ years in Army Reserve culminating in Brigade Command
  - 30+ years as a civilian training developer in Armor, Military Police, dL, and Europe
  - Last 4 years integrating training, doctrine, and combat development
- **Education**
  - B.S. in Psychology
  - M.A. in Education
  - Ed.D. in Education
  - M.A. in Strategic Studies
  - Military courses culminating in Naval War College
- **Educational Focus**
  - Training/Education development methodology
  - Turning civilians into new officers and soldiers
  - Structured simulation-based exercises


REQUIREMENTS
• Train as we fight
• Support the Army force generation (ARFORGEN)
• Task force stabilization
• Stay current and relevant
• Joint training
• Full spectrum environments
• Contemporary operating environment
• Task organized at lowest level
• Decentralized operations/training
• Link institution to unit
USA ARMOR CENTER


CONSTRAINTS
• Zero course growth
• Competing resources
• Active and reserve components
• Time (the inelastic resource)
USA ARMOR CENTER

TACTICS, TECHNIQUES AND PROCEDURES

- Useful lessons learned
- Battle Command Knowledge System (BCKS)
- Army Knowledge Online (AKO)
- Distance learning (dL)
- Distributed/deployable simulations
- OCs to the field
- Mobile training teams
- Senior Leader Course/Tactical Leader Course

STILL NEED TO MAINTAIN WARRIOR ETHOS ARMY VALUES

PROCESSES

- Why?
  - Requirement for critical thinkers, adaptive leaders, flexible decision-makers in ambiguous environments
    - Procedural skills
    - Complex problem-solving skills
- For whom?
  - Limited military for training development
  - Combination of Department of the Army civilians and contractor training developers
- To do what?
  - Combine procedural actions (training) with ideas and critical thinking (education)
  - Define what ‘right’ looks like
  - Apply appropriate learning models
  - Best answer versus right answer

BRIEFING SLIDES FROM DEVELOP LEADERS WORKING GROUP

Competency Based Leadership

LEADERS IN THE 21ST CENTURY

Competency Areas	Core Leader Competencies
Leads	Leads others Extends influence beyond chain Leads by example Communicates
Develops	Creates a positive environment Prepares self Develops others
Achieves	Get results

Leadership is influencing people – by providing purpose, direction, and motivation – While operating to accomplish the mission and improving the organization (FM 6-22)

July 2006 FM 6-22 1

Full Range of 8 Core Leader Competencies

Near-term → *Far-term*

Lead	Achieve	Develop
Focus on people – • Purpose, • Motivation • Influence • Balance mission with welfare of those led	Focus on task – • Assigns • Manages • Executes • Adjusts	Focus on organization – • Build • Improve
Who – • **Lead others in chain of cmd** • **Extend influence outside chain of cmd**	What/Why – • **Get results**	What – • **Create positive environment** • **Prepare self** • **Develop leaders**
How – • **Lead by example** • **Communication**		

July 2006 FM 6-22 2

Organizational Socialization:
Leaders and Developmental Networks for Work Adjustment

Georgia T. Chao
The Eli Broad Graduate School of Management
Michigan State University

Army Science of Learning Workshop
August 1-3, 2006

Organizational Socialization: A Primer

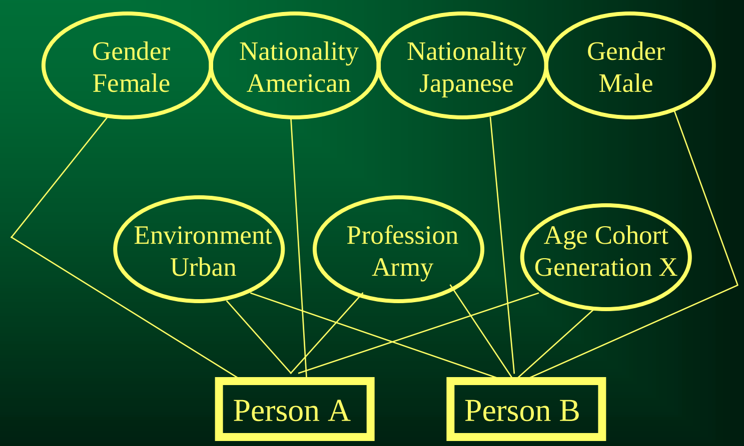
- *"...One who knows how to unite upper and lower ranks in purpose will be victorious..."*-Sun-tzu.
- Organizational socialization describes an interaction of individuals and an organization as these individuals adapt to a new organization or to a new organizational role.
- Organizational content and process

Leadership, Developmental Networks, and Organizational Socialization

THE CULTURAL MOSAIC

- Acknowledges multiple group identities with cultural frameworks that help shape the individual's self-concept
- Extends cultural psychology beyond national borders and broad ethnic groups
- Proposes new research directions that embrace cultural complexity

BIPARTITE REPRESENTATION OF A CULTURAL MOSAIC



Interactions between individuals are influenced by network of common and unique cultural tiles

CHAOS & COMPLEXITY THEORIES AND THE CULTURAL MOSAIC

- Chaos and complexity theories as a new science
  - focus on global nature of systems from dynamic, nonlinear perspectives
  - identify patterns from seemingly random, unpredictable phenomenon
  - abandon reductionism in favor of examinations of complexity in systems *(the whole is more than the sum of its parts)*

METATHEORY OF CULTURE

- Freeman's (2000) research on the physiology of perception
- Cultural Mosaic
  - Array of cultural identities may help researchers identify stable carrier waves of culture
  - Cultural identities may reorganize or change when new identities are acquired and/or old ones shed or evolve
  - Cultural mosaic is greater than the sum of its parts
  - The Cultural Mosaic behaves like a complex system with localized structures

A COMPLEX SYSTEM WITH LOCALIZED STRUCTURES

- International reception analogy
- Cultural Mosaic
  - Some tiles dominate others
  - Some tiles self-organize into local structures, consolidating into a unifying identity
  - Some tiles maintain independent influences, manifesting themselves in unpredictable ways (ex. Role conflict)

THE CULTURAL MOSAIC AND CROSS-CULTURAL TEAMS

- Interpersonal interactions are facilitated by shared cultural identities. Shared cultural identities are localized structures in an interpersonal network, providing common frames of reference, values and behavioral expectations between people.
- Teams can bridge some cultural structural holes by identifying shared cultural identities
  - Homophily
  - Distinctiveness
  - Tipping Points

IMPLICATIONS FOR NCW

- Apply cultural mosaic to quickly build unified team culture via networks
  - Build on commander's intent – baseline
  - Evoke team behaviors by creating a context that signals appropriate roles:
    - Trust building behaviors establish common carrier wave for operations – capitalize on shared tiles
    - Transparency in the network helps identify paths for flexibility/adaptation – capitalize on unique tiles

IMPLICATIONS FOR NCW

- Train leaders to:
  - Build on commander's intent – baseline
  - Employ organizational socialization practices to build strong culture
  - Identify structural holes within and between teams via cultural mosaic
    - Prime common cultural tiles

CONCLUSIONS

- Cultural mosaic integrates several streams of psychological, sociological and anthropological research
- Challenge is to find simple patterns from this complexity
- Accelerated globalization demands psychology meet these challenges

Developing Adaptive Teams: Dynamic Team Leadership:

Steve W. J. Kozlowski
Michigan State University

Current work supported by Army Research Institute for the Behavioral and Social Sciences
Klein, Kozlowski, & Xiao, Principal Investigators

The Changing Nature of Organizations …

- Increasing environmental turbulence and unpredictability
- Emphasizes rapid, flexible, and agile responses
- Shift to team-based work structures to enable

- ***Need for individual and team adaptability …***
  - *Change to resolve shifting environmental contingencies*

Team Adaptation Necessitates a *Process* Perspective … Leadership Theories Generally Focus on *Structure*

Features	Leaders in General	Team Leaders
Approach:	▪*Structure* of leadership	▪*Process* of leadership
Contingencies:	▪If considered, fixed to leadership situation ▪*May* vary *across* situations	▪Dynamic task and developmental contingencies ▪Varies *within* situation
Level of Focus and Member Role Linkages:	▪Ambiguous, primarily individual level ▪Roles not distinguished, loosely connected; additive contributions	▪Individual *and* team levels ▪Distinctive roles, tightly coupled; coordination requirements
Emphases:	▪Universal ideal ▪Or, if contingencies, fitting leader to situation, task, subordinates, etc.	▪Regulating team processes to build skills, fit to shifting internal and external demands ▪Transitioning focus of development as skills compile
Distinctive Features and Conclusion:	▪Focus on structure of leadership ▪Focus on individuals ▪Context free or fixed ▪Universal and static	▪Focus on process of leadership ▪Focus on individuals and teams ▪Contingent on context dynamics ▪Leadership and team processes as dynamic, fluid, and emergent

(Kozlowski et al., in press, SIOP Frontiers Series)

Leaders and Team Adaptation: Three Research Streams

- Self-regulation, learning, and adaptation (Kozlowski et al., 2001)
  - Adaptation is a learned cognitive, motivational, behavioral capability; well captured by SR theory; can be shaped/trained
- Team-regulation, development, and adaptation
  - Team regulatory skills compile developmentally (Kozlowski et al., 1999)
  - Multilevel homology of regulation (DeShon, Kozlowski et al., 2004)
- *Leaders can shape regulatory processes & team development*
  - *Leaders have the potential to play a key role in developing and shaping adaptive team capabilities (Kozlowski et al., 1996, in press)*

Team Leadership as a *Dynamic Process*

- Attention to key contingencies that <u>qualify</u> *what leaders should do* to build individual and team skills
- And *how* and *when* leader behavior should change *in response to critical contingencies*
  - Environmental variation
  - Task cycles or episodes
  - Team development
- This is the essence of *dynamic team leadership*

Dynamic Team Leadership: Three Key Contingencies

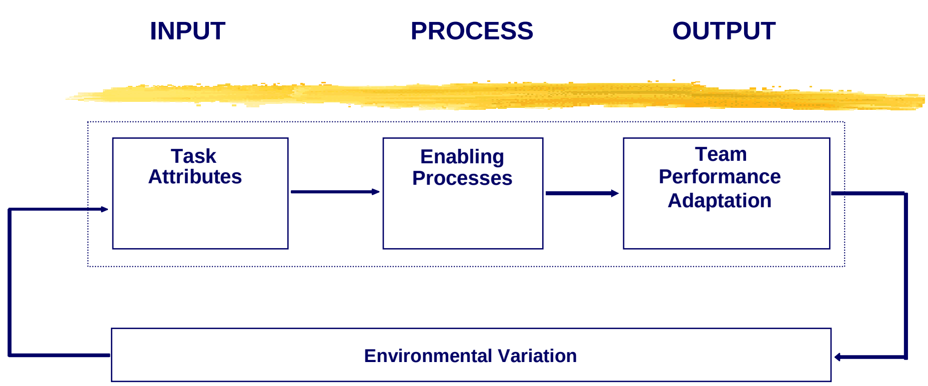
- (1) System or Task Environment => Team Task Impact
- (2) Team Task Cycles / Episodes => Ebb and Flow of Task Engagements
- (3) Developmental Progression => Skill Compilation Over Time and Across Levels

(1) Variations in Externally Driven Task Complexity

- Task Complexity
  - Component, coordinative, and dynamic complexity (Wood, 1986)

- (a) Task complexity drives team task cycles / episodes and
- (b) The extent to which member resources are engaged to resolve those task demands

- *Increases in the variance of task complexity create demands for team adaptability*



- Environmental variation and shifts drive team task demands
- Team outputs influence the environment
- Cycles are reciprocal

(Adapted from Kozlowski et al., 1996, RPHRM)

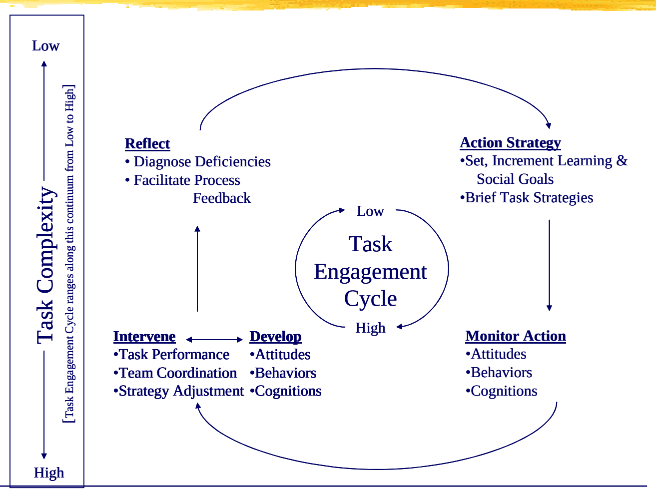
Steve W. J. Kozlowski
Michigan State University
Dynamic Team Leadership
stevekoz@msu.edu
Science of Learning
Hampton, VA,, 2006

(2) Task Cycles / Episodes

- Team tasks have a cyclic / episodic quality that drives the cognitive & behavioral load placed on team members as they engage the task
  - (Kozlowski et al., 1996a, 1996b, 1999; Marks, Mathieu, & Zaccaro, 2001)
- Task Cycles / Episodes are linked to action regulation processes at the individual and team levels (DeShon, Kozlowski et al., 2004)
  - Goal-setting, Monitoring / Intervention, Diagnosis, and Process Feedback
- *The integration of leader functions with the cycle of task episodes will enhance team member skill acquisition*

Dynamic Team Leadership: Task Cycles and Leader Functions (Kozlowski et al., in press)

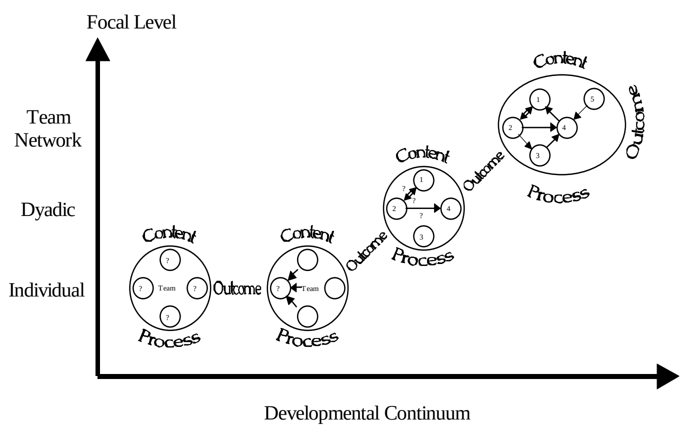
Team Leader explicitly links the task cycle to a regulatory process to build team member skills



(3) Developmental Transitions
(Gersick, 1988; Tuckman, 1965)

- Learning provides a foundation for developmental transitions
  - Team members develop successively more complex skills
  - Progress from individual to team focus
  - Teams progress from new to novice to expert to adaptive
- Team development -- linear progression punctuated by transitions that signal the acquisition of new capabilities and a readiness for more complex skill development
- *Each phase represents a specific skill building focus for leadership functions, accomplished via task cycles*

Team Development and Performance Compilation
(Kozlowski, Gully, Nason, & Smith, 1999)

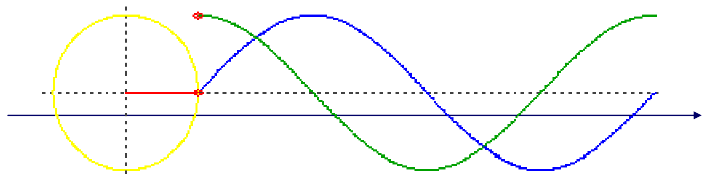


•Team Performance compiles across levels and time, with different developmental foci (content, processes, and outcomes) at points along the continuum… progressing from Individual to Dyadic to Team… *yielding a flexible and adaptive team workflow network*

•Specifies Content, Processes, and Outcomes by phases:
•Content focus shifts to successively build knowledge, attitude, and behavioral skill sets
•Posits different processes by phases
•Outcomes are indicative of skill accomplishment, readiness to transition

Steve W. J. Kozlowski
Michigan State University
Dynamic Team Leadership
stevekoz@msu.edu
Science of Learning
Hampton, VA,, 2006

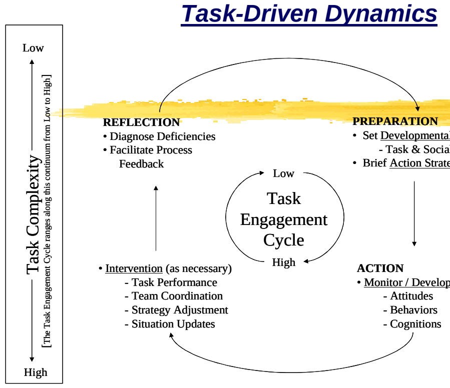
Task Cycles and Developmental Phases



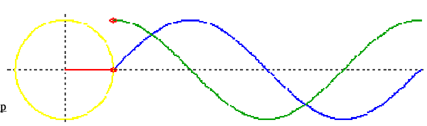
Temporal Dynamics

Figure 1. Core Dynamics: Variations in Task Complexity, Task Engagement Cycles, Phase Transitions, and Developmental Progression.

Task-Driven Dynamics



Cycle Iterations and Phase Transitions



Team Development Dynamics

Phase	***Formation***	***Task/Role Development***	***Team Development***	***Refinement***
Team	New	Novice	Expert	Adaptive
Leader	Mentor	Instructor	Coach	Facilitator
Focus	Identification & Commitment	Taskwork Capability	Teamwork Capability	Adaptive Capability

(Kozlowski et al., in press, SIOP Frontiers Series)

Figure 2. Team Developmental Phases, Targeted Knowledge and Skills, and Phase Transitions.

Phase:	***Team Formation***	***Task & Role Development***	***Team Development***	***Team Improvement***
Focus:	Team Identification & Commitment	Individual Taskwork Capability	Teamwork Capability	Adaptive Capability
PREPARATION				
Developmental Goals				
Task-Related	*Team Orientation* - Mission - Objectives	*Taskwork* - Individual Task Mastery - Self-Efficacy	*Teamwork* - Task Role Interactions - Task Role Revision	*Adaptation* - Team Self-Management - Continuous Improvement
Social	*Team Socialization* - Norms - Social Integration	*Role Socialization* - Acceptance - Attachment	*Cooperation* - Role Interaction - Mutual Trust	*Social Cohesion* - Synergistic Interaction - Conflict Management
Action Strategy	- Provide Action Strategy	- Provide Rationale for Action Strategy	- Facilitate Action Strategy Selection	- Facilitate Development of New Action Strategies
ACTION				
Monitor	Member Interaction	Individual Performance	Team Performance	Adaptive Performance
Develop				
Attitudes	*Commitment* - Team Mission - Other Members	*Self-Efficacy* - Individuals' Task Focus - Social Self-Efficacy	*Team Efficacy* - Team Task Focus - Mutual Trust & Respect	*Team Potency* - Novel Team Task focus - New Team Contexts
Behaviors	*Interaction* - Bonding - Reciprocal Commitment	*Taskwork* - Self-Regulation - Individual Help-Seeking	*Teamwork* - Coordination - Backup Behaviors	*Adaptation* - Shared Leadership - Exploration & Risk-Taking
Cognitions	*Team Identity* - Boundaries - Shared Responsibility	*Individual Mental Models* - Task Mental Model - Interpersonal Mental Model	*Shared Mental Model* - Members' Task Interactions	*Compatible Mental Model* - Knowledge Specialization - Transactive Memory
Intervene	- Individual Task Assistance - Team Coordination	- Individual Task Assistance - Team Coordination	- Team Coordination - Task, Strategy, & Goal Revisions	- Situation Updates - Final Decisions
REFLECTION	- Diagnose Deficiencies - Provide Individual-Level Developmental Feedback	- Facilitate Member Reflection - Provide Individual-Level Developmental Feedback	- Facilitate Team Reflection - Provide Team-Level Developmental Feedback	- Monitor Team Reflection & Developmental Feedback

A Multilevel Infrastructure for Organizational Learning

(Kozlowski, Chao, & Nowakowski, in prog)

Team Leaders Link Levels and Informal/Formal Processes

	Informal Process		**Formal / Augmented Process**
Macro	▪ Organizational Culture ▪ Organizational Climate		▪ Knowledge Management Systems ▪ Multi-Team Simulations
Meso	▪ Role Development ▪ Team Cohesion	Team Leaders	▪ Team Development ▪ Team Training
Micro	▪ Socialization ▪ Informal learning		▪ Cases, Stories, TDG ▪ Simulation, Embedded

Other Dynamic Features of the Theory

- Leader progresses from social to task to balanced emphasis
- Shifts from leader internal focus on team process to external focus on environment and resource management
- Over time, leader evolves from building self-regulatory skills to team regulatory skills, enabling team self-management and adaptation

Implications

- The theory treats leadership as a dynamic and adaptive process, rather than a set of static, universal characteristics
- It identifies shifting environment, task, and team contingencies …
- That dictate the evolution of the leadership functions
- Provides a foundation to specify team leadership competencies (in progress)

Broader Objectives

- Theoretical models and research at multiple levels
  - Systematic examination of self-regulation, learning, and adaptability
  - Extensions to understand team learning, regulation, and adaptation
  - Role of leaders in leveraging team learning, development, and adaptation
- Application targets
  - Current: Simulation & Distributed Learning Design (Kozlowski & Bell, in press)
  - Near Term: Extension to Distributed Team Learning; Team Leader Competencies; "Virtual" Team Leadership (Bell & Kozlowski, 2002);
  - Future: Foundation for Organizational Learning Systems
- Longer term goal…
  - *Apply the science to create learning systems that enhance the development of adaptive people, teams, and organizations*

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Key Principles in Leadership Skill Development

- Information Processing and Knowledge Change
  - Less demands on working memory
  - More use of context-specific knowledge
- Meta-Cognitive Processes Develop
- Understanding based on Deep Structure not Surface Features
- More Sensitivity to Others
- Leadership Identities Solidified & Changed
  - Provisional leadership identity→ central
  - Different Identities Active at Different Times (WSC)
  - Individual → Relational → Collective
- Leadership Identity
  - Key Motivational Structure → Proactive Skill Development
  - Cues Goals & Knowledge

Table 1. Differences in the Content, Access and Use of Knowledge by Leader Skill Level

SKILL LEVEL	KNOWLEDGE USE	KNOWLEDGE CONTENT	KNOWLEDGE CUES
Novice	▪ Heavy reliance on working memory dependent processing ▪ Composition of novel responses that integrate generic knowledge with situation	▪ Implicit leadership theories and heuristics representing generic leadership and problem solving behavior	▪ Surface level problem features ▪ Self-view as leader, ▪ Emphasis on individual level identities & differentiation from others

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Intermediate	▪ Fewer uniquely created solutions, more use patterns stored in memory ▪ Integration with meta-cognitive processes	▪ Domain specific productions for leadership and problem solving behavior ▪ Greater knowledge of others	▪ Same as Novice, plus … ▪ Match social situation to patterns of associations in memory

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Intermediate	▪ Fewer uniquely created solutions, more use patterns stored in memory ▪ Integration with meta-cognitive processes	▪ Domain specific productions for leadership and problem solving behavior ▪ Greater knowledge of others	▪ Same as Novice, plus … ▪ Match social situation to patterns of associations in memory
Expert	▪ Greater dependence on understanding of situation ▪ More collaboration with others	▪ Principle level knowledge	▪ Same as Intermediate, plus … ▪ Principled understanding of situation & others based on values, emotions, and identities

Alternate Identity Levels

Level	Emphasis	Sense of Worth	Justice & Social Beh.
Individual	Personal Traits that Differentiate Self from Others	Favorable Comparisons to Others	▪Distributive ▪Competition
Relational	Appraisals of Others	Benefit to Other	▪Interpersonal ▪Collaboration
Collective	Fit of Traits with Group Prototype	Status of Group	▪Procedural ▪Cooperation

Figure 1. Leadership Skill Development, Identity Level, Knowledge Type, and Knowledge Use

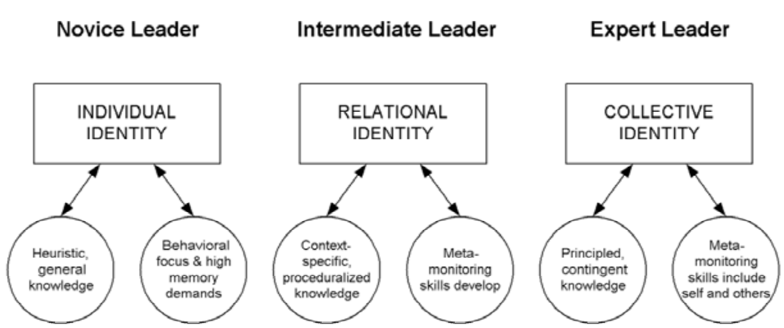

Table 2. Knowledge Content Emphasis of Different Leadership Skill Levels

Skill Domains	Novice	Intermediate	Expert
Task	• Technical & task skills • Generic Decision Making and Problem Solving Skills	• Domain specific task skills • Meta-monitoring capacity	• Principled understanding of task and self-regulation
Emotional	• Expression	• Empathy and understanding of others • Domain specific emotional regulation techniques	• Formal principles of emotional regulation • Principles specifying the effects of situational labeling, change, and social justice on emotions • Understanding the synthesis of cognitions and emotions

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Emotional	• Expression	• Empathy and understanding of others • Domain specific emotional regulation techniques	• Formal principles of emotional regulation • Principles specifying the effects of situational labeling, change, and social justice on emotions • Understanding the synthesis of cognitions and emotions
Social	• Fit with Implicit Leadership Theories • Understanding agentic behaviors & social influence tactics	• Integration with dyad or group • Communal Behaviors • Self-monitoring skill	• Capacity to develop others • Authentic, principle-based leadership
Meta-Monitoring	• Largely based on social reactions and task progress • Focused within one's own emotional and motivational orientation	• Leadership integrated with identities • Greater adjustment to others • Flexibility in emotional and motivational orientations	• Based on formal principles relating identities to value structures • Principled understanding of positive and negative emotions/motivation
Value Orientation	• Value orientation learned and applied implicitly	• Integration of identities and values	• Principled understanding of value structures and their relation to authentic leadership

BRIEFING SLIDES FROM FUTURE CAPABILITIES WORKING GROUP

Future Capabilities Work Group Objectives

- Identify future doctrine, organization, materiel, logistics, and personnel changes that will impact training and leader development over the next 10-15 years.
- Project likely training system capabilities during that period.
- Identify gaps in training systems or subsystems capabilities.
- Identify significant gaps in understanding of learning, and in leader development and training methods to meet future requirements.
- Propose lines of research to address the gaps in training system technologies and pedagogical approaches .

Questions

- How can training, leader development, and self development be managed as one integrated system across a Soldier's career and in a variety of environments?
  - How should the approach vary for enlisted Soldiers and Officers?
  - How would this system work with the personnel system for promotions and assignments (in an ARFORGEN Army)?
- How can future embedded training systems be designed and employed to provide effective training?
- How can emerging technologies be leveraged to
  - accelerate learning and improve effectiveness?
  - incorporate lessons learned from operational environments?
  - automate measurement and feedback, especially for complex tasks and collective performance?

Agenda

- Wednesday Morning
  - White Papers and Briefings
    - Dr. Alice Healy-What We Know and What We Need to Know in Learning Science
    - Mr. Lou Iorizzo-Enabling the Adaptive Warrior
    - Dr. Chad Lane-Intelligent Tutoring Systems
    - Mr. Adam Pease-The Future of Semantics
  - Discussion
    - What are the gaps in pedagogy, leader development methods and training system technologies that will require research.
- Wednesday Afternoon
  - Other presentations or discussion topics
  - Discussion of Objectives and Development of Positions
  - Briefing development
- Thursday Morning
  - Refinement of Positions and Conclusions
  - Finish Briefing
- Thursday Afternoon
  - Outbrief

Agenda

- Tuesday Afternoon
  - Introductions
  - Work Group Objectives-Goldberg
  - TRADOC Future Operational Capabilities and Requirements Process-Tierney
  - Possible Future Scenario-Burnside
  - White Papers and Briefings
    - Dr. Anna Cianciola-Assessing Future Army Leadership
    - COL Jim Shufelt-Future of Virtual Training
    - Dr. Jim Blake-Future Training System Technologies
  - Discussion
    - What will a likely future look like for Army Training
    - What are some of the top training challenges the future will face

Our Work Group

- Use white papers and briefings to stimulate discussion.
- Keep objectives and questions in mind.
- Develop findings and draw conclusions as we go.
- Divide the work in developing the brief out.
- Brief out isn't the final product of the workshop.

Brief Out Assignments

- Describe future training environment
  - COL Brown
  - Dr. Cianciola
  - COL Shufelt
  - Mr. Shadrick
  - Dr. Tierney
  - BG Warner
- Project Training System Capabilities and Gaps and Research Needs
  - Dr. Blake
  - Dr. Lane
  - Mr. Iorizzo
  - Mr. Hodgins
  - Dr. Roberts
- Identify Significant Gaps in Understanding of Learning, Training and Leader Development Methods.
- Project Research Needs
  - Dr. Bjork
  - Dr. Chalmers
  - Dr. Durlach
  - Mr. Fedder
  - Dr. Healy
  - Mr. Pease

Assignments are suggested and subject to change by request.

Future Training Capabilities

Bill Burnside
ARI-Ft Knox
billy.burnside@knox.army.mil

Science of Learning Workshop
1 August 2006

EMBEDDED TRAINING

Soldiers must be able to access training anytime, anywhere.

- Embedded training is the preferred method (a Key Performance Parameter).

- Embedded training will be implemented through training support packages for individual instruction (interactive multimedia instruction) and collective simulation-based exercises.

- Training will be accessible through any network portal.

- Training will be increasingly distributed; institutions and fixed simulation sites must change (or fade away).

PERFORMANCE SUPPORT

The Army can't sustain training of all the Soldiers on all the things all the time.

- Not all tasks are safe, reasonable, or cost-effective for embedded training.
- Performance support (e.g., interactive electronic technical manuals) must be integrated with training.
- Performance support systems must become more than they are today (more helpful, more cognitive, more readily updated).
- Access to human advisors and wargaming tools must be provided.

TRAINING MANAGEMENT

A training management system is key to achieving the future training capabilities needed.

- Integrate training with self and leader development as a career management system.
- Rapidly incorporate lessons learned, new tactics, techniques, and procedures, and evolving standards (adaptive training).
- Instill automated performance measurement throughout training and operational systems.

Future Army Training, Leadership and Education (TLE) Shortfalls—Focus Areas for the Contributions of Learning Science

Presentation for the TRADOC Learning Science Workshop Aug 1-3, 2006

Dr. Diana Tierney
TRADOC, DCSOPS&T

Our Role in TRADOC, DCSOPS&T

- Within the Army, TRADOC is responsible for providing the “warfighter” perspective on science and technology research requirements
- TRADOC’s warfighter perspective is based on our best definition of future warfighting capability requirements
- Within TRADOC, DCSOPS&T has the lead for identification of training, leadership and education (TLE) future capability requirements and S&T research shortfalls.

Learning Science and TLE Capabilities

- Learning science continues to have broad applicability to all future capabilities required by Army TLE
  - Leader training and development
  - Accessible training
  - Realistic training
  - Responsive training development
  - Training for JIIM
  - Managing unit performance
  - Providing universal training support

- However, the one future TLE capability most in need of additional attention by learning science is **“efficiency**”.

Learning Science and Improved Efficiency

- The Army needs the ability to train, educate and develop soldiers in the shortest amount of time and using the fewest resources possible, while ensuring that effective, transferable learning has occurred

.

- **Implications:**
  - Using innovative instructional approaches and technologies to streamline learning
  - Doing assessment and evaluation to ensure we maintain or improve effectiveness
  - Understanding soldier variables that can slow or disrupt learning
  - Taking advantage of all sources of knowledge and experience in the soldier’s environment as opportunities for learning

Seven Focus Areas for Learning Science and Example Questions

- **Defining "Knowledge" and "Learning" for the Future Force**
  - How should we define "knowledge" and what will "being knowledgeable" mean in the future? Is accessing and using knowledge the same thing as learning?
  - How do we facilitate and take advantage of experiential learning (informal, unstructured learning on the job)? How do we intensify soldier development during operational assignments? How do we expand the boundaries of the TLE "system" to incorporate these sources of learning?
- **Individual Soldier Issues**
  - Do soldiers have beliefs and/or misconceptions about learning that hinder or facilitate their learning?
  - How much of soldiers' personal time should be devoted to learning?
  - How do we motivate soldiers to learn in general, and more specifically, in the area of dL?

Seven Focus Areas for Learning Science and Example Questions

- **Developing and Applying Improved Instructional Methods**
  - How should we sequence and interrelate courses/material to improve retention of knowledge? How do we build on and connect the knowledge soldiers gain over time to reduce forgetting?
  - How can we do a better job of evoking learning transference? In other words, what instructional methods would best ensure soldiers can spontaneously use the skills and knowledge they have learned in the classroom in other situations?
- **Team Training**
  - How does distributed reasoning/cognition work in teams/small groups?
  - How can we teach soldiers to be cooperative learners and enable them to apply that ability to learn cooperatively in an operational setting?

Seven Focus Areas for Learning Science and Example Questions

- **Individualized Instruction**
  - How can technology be used to assess competence in order to tailor instruction to the needs of individual soldiers?
  - How do we develop a "learner centric" model of education in which individual knowledge, skills and other developmental needs are used to tailor timing, delivery and duration?
- **Enabling Technologies for Efficient Learning Methods**
  - Can technology in some way (s) help us ensure that soldiers focus their attention on a learning task?
  - What are the most important attributes of intelligent agents for use within the TLE domain?

Seven Focus Areas for Learning Science and Example Questions

- **Measures and Research Methods**
  - How do we evaluate the effectiveness of life long learning?
  - How do we measure the totality of a soldiers' learning (e.g. from training, communities of practice; on-the job learning)?

Science of Learning Workshop
Army Research Institute

Hampton, Virginia
August 1-3, 2006

What We Know and What We Need to Know in Learning Science to Achieve Greater Efficiency and Effectiveness in Training

Alice F. Healy
Center for Research on Training
University of Colorado

Three Aspects of Training

- **Efficiency/Speed**
- **Durability/Long-Term Retention**
- **Transferability/Flexibility**

ARI Contracts (1986-2006)

Optimizing the long-term retention of skills: Structural and analytic approaches to skill maintenance
ARI Contracts MDA903-86-K-0155 and MDA903-90-K-0066

Towards the improvement of training in foreign languages
ARI Contract MDA903-93-K-0010

Optimizing the durability and generalizability of knowledge and skills
ARI Contract DASW01-96-K-0010

Optimizing the speed, durability, and transferability of training
ARI Contract DASW01-99-K-0002

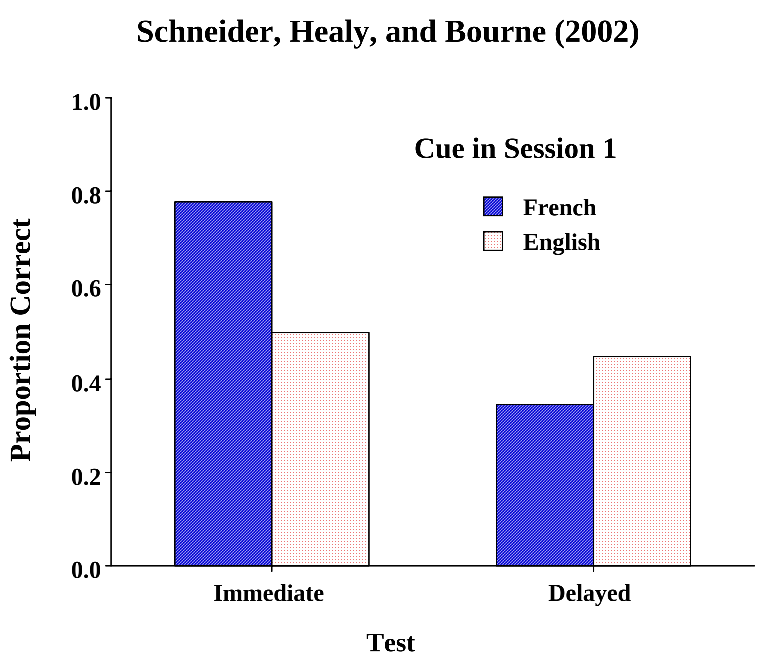
Training for efficient, durable and flexible performance in the military ARI Contract DASW01-03-K-0002

Training Difficulty Principle

Any condition that causes difficulty during learning may facilitate later retention and transfer.

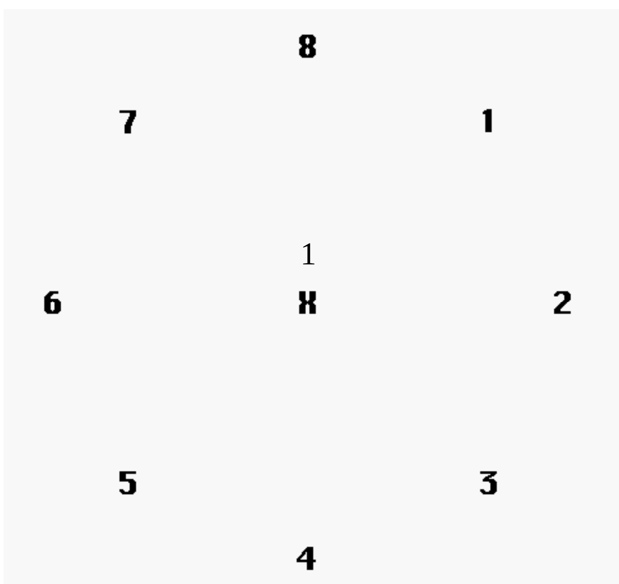
Schneider, Healy, and Bourne (2002)

Week 1	Week 2
English-French	English-French
English-French	French-English
French-English	English-French
French-English	French-French



Specificity of Training Principle

Retention and transfer are depressed when conditions of learning differ from those during subsequent testing.



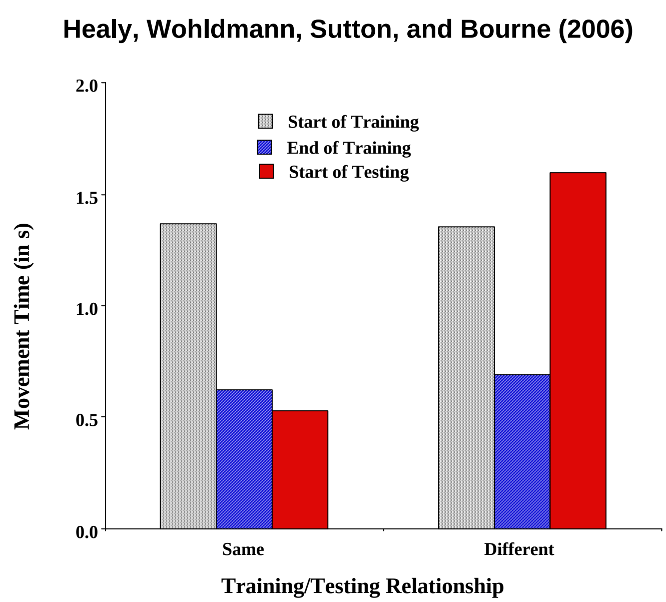
Healy, Wohldmann, Sutton, and Bourne (2006)

Three Mouse Reversal Conditions

Horizontal Reversal

Vertical Reversal

Combined Reversal



Strategic-Use-of-Knowledge Principle

Learning and memory are facilitated whenever pre-existing knowledge can be employed as a mediator in the process of acquisition.

Kole and Healy (in press)

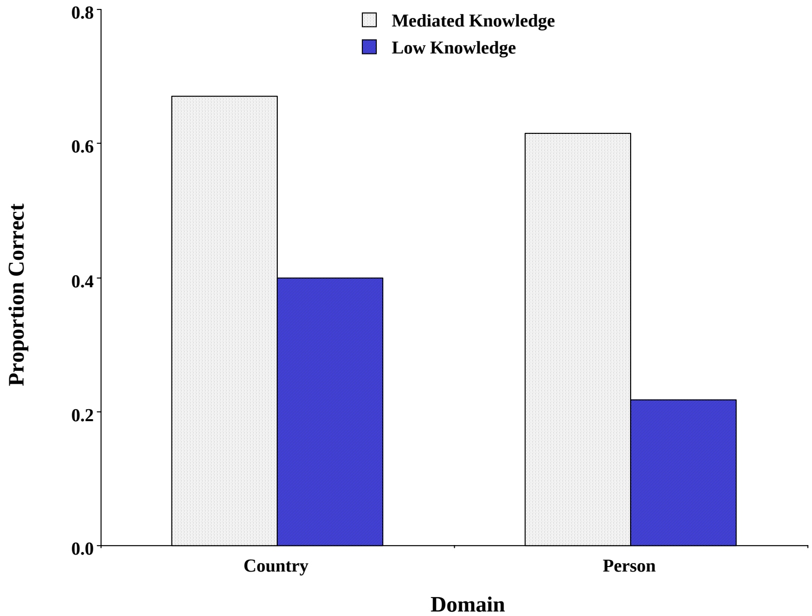
Domain:

- **Person**
- **Country**

Knowledge Group:

- **Low Knowledge**
- **Mediated Knowledge**

Kole and Healy (in press)



Multidisciplinary University Research Initiative (MURI)
Training Knowledge and Skills for the Networked Battlefield

ARO Award No. W9112NF-05-1-0153
May 1, 2005 - April 30, 2010

Alice Healy and Lyle Bourne
Principal Investigators
University of Colorado

Parts of MURI Project

- **Experimental Tests of Training Principles**
- **Taxonomic Analysis**
- **Predictive Computational Models**

Experimental Tests of Training Principles

- **Tests of the Generality Across Tasks of Individual Principles**
- **Tests of Multiple Principles in a Single Task**
- **Tests of Principles in Complex, Dynamic Environments**

Taxonomic Analysis

- **Training Methods**
- **Task Types**
- **Training Principles**
- **Performance Measures**

Measures of Performance

- **Speed/Accuracy Tradeoffs**
- **Different Patterns for Component Measures**

Predictive Computational Models

- **Formulated from Experimental Data**
- **Applicable to Military Tasks**
- **Incorporating Taxonomic Analysis**
- **Two Platforms**
  - **ACT-R**
  - **IMPRINT**

Beyond the MURI

- **Continue Basic Empirical Research into Training Principles**
- **Extend Computational Models to Complex Military Tasks**
- **Conduct Applied Research in the Field to Test MURI Conclusions**

Networked Battlefield Scenario

(1) Identify and locate enemy positions.
(2) Receive information about squad location and enemy targets.
(3) Follow commands involving location and route information from dispatchers.
(4) Estimate time intervals and distances.
(5) Make decisions and respond logically to danger signals.
(6) Enter data into computers or communication devices.
(7) Retrieve facts from both human and computer memory.
(8) Make both mental and computer calculations.
(9) Coordinate hand and eye movements.
(10) Keep track of the state of several concurrent variables.

Out of Many, One:
Assessing Future Army Leadership

Anna T. Cianciolo, Ph.D.

Command Performance Research Inc

U.S. Army Science of Learning Workshop
1-3 August 2006

The Future Leader
How He/She is Different from the Past Leader

Extends interpersonal influence, providing purpose, direction, and motivation to acco NOT NEW ions and improve the organization (FM 22-100*)

Operates in a more complex, difficult environment than ever before:

Complexity
- Greater # of sensors involved in "seeing first"
- Larger body of specialists to integrate to "understand first"
- Greater diversity of assets to synchronize and mobilize to "act first"
- Multiple lines of operation to coordinate to "finish decisively"

Difficulty --
- Rapid change in knowledge requirements

Is adaptive, innovati NOT ENOUGH nd a rapid decision maker

*This characterization is consistent with FM 6-22, the FM 22-100 revision currently in publication

The Nature of Future Tactical Leadership

A collective process enacted by humans and technology by which operations are visualized and orchestrated to enable mission accomplishment

- Envisioning operations and making effective decisions inextricably linked to the knowledge, expertise, and collaborative behavior of others
- Consistent with network-centric initiatives and intent
- Adds the critical human dimension to leveraging future technology

Training and assessment requires a model of collective information processing

- Distributed cognition (Hutchins, 1988) **-- "I know what you know"**
- Transactive memory (Wegner, 1986) **-- "I know how to find what you know"**
- Knowledge management **-- "I have a systematic process for transforming the knowledge of my organization members into something of value"**

Assessing Future Tactical Leadership

What to Assess

Collective action – Information and knowledge sharing of the C2 team as a whole to accomplish C2 goals

Determinants → Processes → Outcomes

Determinants:
- Digital skills
- IM SOPs/TTPs
- Domain knowledge
- Turnover/absences
- Technical difficulty

Processes:
- C2 KM practices

Outcomes:
- Planning products
- Quality of DM process
- Mission Outcomes

Long-term goal:
A concrete, validated logic/causal model for conceptualizing and assessing tactical leadership performance in terms of unit KM (with associated metrics and measures for a range of mission tasks/types)

Assessing Future Tactical Leadership
Assessment Techniques

Determinants

- Knowledge tests
- Part-task skills assessment
- Surveys
- Archival data analysis

Processes

- Observation/checklists
- Automated measurement/ System data collection

Outcomes

- Collective DM analysis (lens modeling)
- Doctrine-based, expert-derived scoring keys

Assessing Future Tactical Leadership
The (Feasible) Way Forward

Focus on Process: Combine observation and automated measurement to capture the effectiveness of KM practices in the C2 team

Step 1. Select 2-3 high-payoff or commonly executed full-spectrum C2 tasks to manage scope in a way consistent with organizational need

- Conduct a raid in part of a large city
- Train local police force
- Secure and maintain local utilities

Step 2. Learn everything there is to know about the concrete performance requirements of these C2 tasks

- Expected planning outcomes and quality DM processes
- Key players and what they do, independently of the tech they use
- Review doctrine and professional literature
- Interview SMEs
- Conduct observations of live or constructive training simulations

Assessing Future Tactical Leadership

The (Feasible) Way Forward, contd.

Step 3. Determine/review the IM SOPs/TTPs associated with conducting the the selected C2 tasks; Identify:

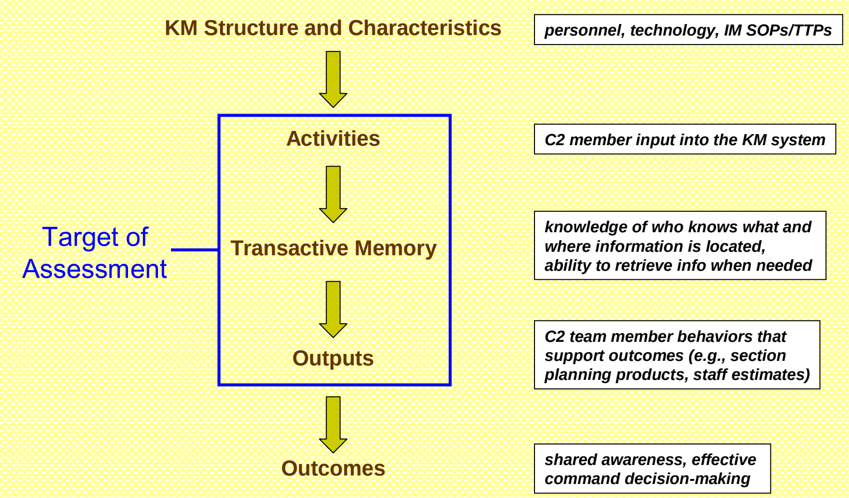
- Who should be involved in sharing information (including the CDR) and what they need to do to make personal information public
- What means (digital or otherwise) should be used to share information and knowledge
- How the input, organization, and processing of information in digital displays should be standardized to facilitate collaboration (including workarounds

Step 4. Determine how implementing these SOPs/TTPs enables C2 team members to perform their duties (identified in Step 2); Specify:

- How people or "things" who know are made salient to people who need to know, when they need to know
- How knowing what needs to be known when it needs to be known affects C2 task outcomes

Assessing Future Tactical Leadership

The (Feasible) Way Forward, contd.



Assessing Future Tactical Leadership

The (Feasible) Way Forward, contd.

Step 5. Develop metrics and measures to capture KM activities, transactive memory, and KM impact on information sharing outputs

- Activity Metrics – Automated measures of system data on what information was entered into the system, when, and by who – compared to a criterion-based standard

- Transactive Memory Metrics – Automated measures of system data to capture whether available information was accessed by the people who needed it, when it was needed; Observation-based checklists apply here too to capture system workarounds and calibrate system data with training mission events

- KM Output Metrics – Observation-based checklists to capture C2 team member contribution to the collective outcomes; Quality assessments are also desirable to capture degree to which only relevant information was used and how much analysis was conducted

Assessing Future Tactical Leadership

A Related Example – Assessing Army Professional Forums*

Forum Structure and Characteristics — *personnel, plans, leadership, online meeting space*

↓

Social and Intellectual Capital — *connections, content, context, conversation*

↓

Professional Self-Development — *technical, tactical, conceptual, and interpersonal competence, leadership effectiveness, professional self-identity, sense of professional community*

↓

Organizational Effectiveness – The Unit — *mission accomplishment*

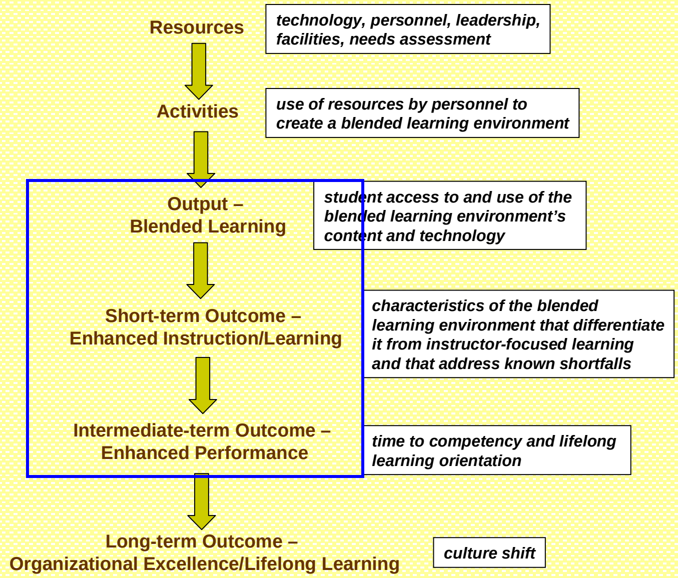
↓

Organizational Effectiveness – The Army — *national defense: deter war, win war*

*Cianciolo, Heiden, Prevou, & Psotka (2005)

Assessing Future Tactical Leadership

Another Related Example – Assessing Lifelong Learning Centers*



*Research is ongoing

Conclusions

The nature of the future tactical environment necessitates assessing leadership as a collective activity

The collective activity of a C2 team is enabled by transactive memory, which stems from effective KM practices

It is possible and feasible to assess KM practices within the context of a unit, using a combination of observation and automated performance measurement

Existing methods for assessing KM are generalizable and facilitate the development of a program of measurement

ARI/TRADOC Science of Learning Workshop
Hampton, VA

Intelligent Tutoring Systems: Prospects for Guided Practice and Efficient Learning

H. Chad Lane

Institute for Creative Technologies

www.ict.usc.edu/~lane

Aug 1-3, 2006

The need for efficient learning

I made a perfect simulation about growing a company.
The only problem is that it takes twenty-five years to play.
– Steven Wright

We need to look in every nook and cranny for opportunities to improve learning.

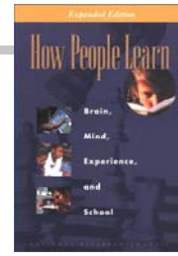
but learning must be robust,

and the target skill/knowledge set has doubled,

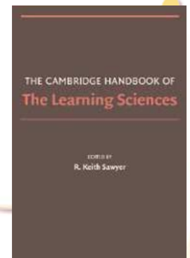
and there is less time for training,

and there are less resources, ...

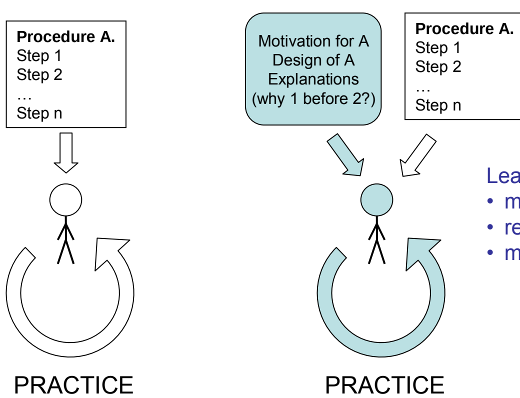
The new science of learning



- several consensus points:
  - incoming knowledge
  - active learning
  - metacognitive approach to instruction and learning
  - deep conceptual understanding
- intelligent tutoring research involves...
  - application of learning science outcomes
  - contributions to learning science

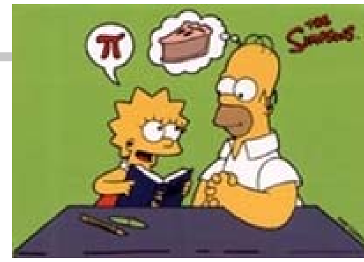


Deep conceptual understanding



Learned knowledge is…
- more flexible
- retained longer
- more likely to transfer

What is tutoring?



- 1-1 (individual attention)
- questions and answers
- a delicate balance:
  - students do as much of the work as possible and maintain feeling of control
  - tutors provide just enough guidance to prevent frustration and confusion
- errors are detected and repaired
- support for metacognitive activities

How effective is tutoring?

Kind of tutor	effect size	Reference
"Expert" human tutors	2.0	Bloom 84
Best ITSs	1.0	Anderson 95 Anderson & Koedinger 97 VanLehn 01, 05
Computer-Aided Instruction	.42	Niemiec & Walberg 87
Inexperienced tutors	.4	Cohen, Kulik, & Kulik 82

- Precisely why tutoring works so well has remained elusive.
- Similarly, no broad consensus on what constitutes tutoring expertise has emerged.

Why aren't intelligent tutors everywhere?

Three major obstacles:

1. lack of mass adoption & transition
- realities of integrating with classrooms
- lack of understanding of technology; fear of being replaced

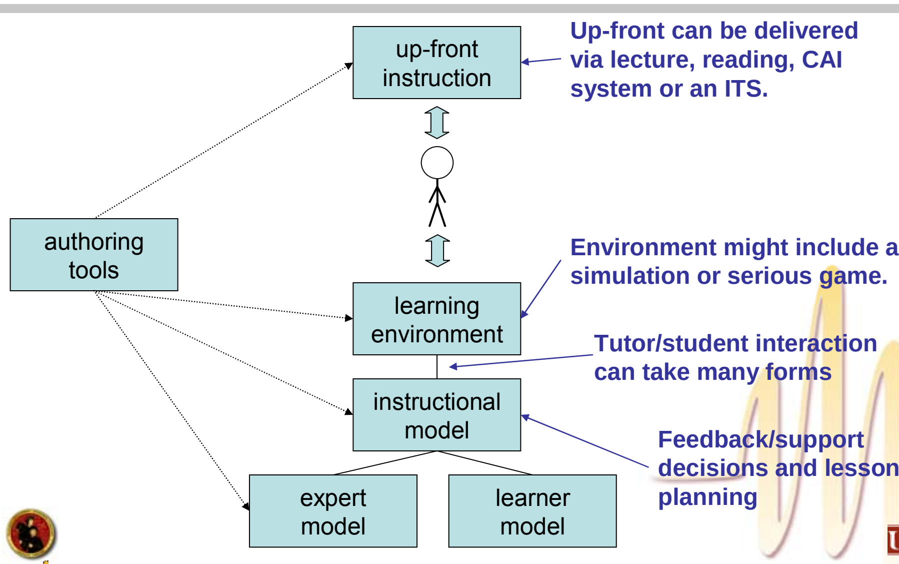
2. development time and effort is high
- learning environment
- instructional and student models
- capturing expertise; building expert model

3. modifiability is rarely a goal
- especially for end users
- requires AI and programming expertise

Computer-based learning

	"bare" simulation or games	computer-aided instruction systems	intelligent tutoring systems
relative effort to build	variable	low to middle	high
modifiability	easy, when tools are provided	tedious, but easy with tools	difficult – requires AI expertise
learning issues	guidance comes from human instructors	guidance is rigid, less reusable, and often shallow	best fit for deep conceptual understanding

Typical ITS architecture & components



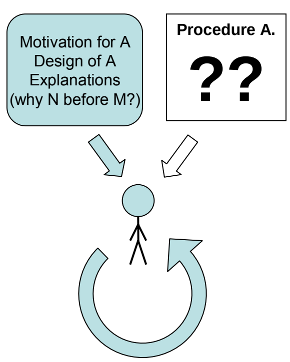
Areas of ITS research

- learner modeling
- tutorial dialogue systems
- cognitive modeling
- complete systems & evaluation
- authoring systems
- group/collaborative/online learning systems
- …

Mapping ITS research to Army needs

- Some are a good fit:
  - well-defined and clear skills
- Some clear gaps are also revealed:
  - tutoring in *ill-defined* domains
  - team training & collaboration support
  - tutoring in serious games & narrative environments
  - metacognitive tutoring
  - automatic detection of unproductive learning behaviors

Tutoring in ill-defined domains



- Some domains are difficult to characterize.
- Experts sometimes disagree what “right” looks like.
- Most ITS architectures assume a crisp boundary between right and wrong.
- Metacognitive (planning, design, reflective) knowledge seems to play a much more critical role.

A few examples of ill-defined domains

- leadership
- interpersonal skills
- cultural awareness
- negotiation
- teaching, coaching, mentoring, …
- legal reasoning
- art inquiry/investigation

We need…

1. more Sternberg-like basic research into
   - knowledge and skills that are difficult to characterize.
   - how novices acquire these skills.
2. to learn how expert instructors assess, teach, and tutor ill-defined skills.
3. to understand the fit of current ITS technology to ill-defined domains.
4. a new focus on *consensus-based team authoring tools*
   - highlight "calm" and "hot" areas in a domain

Serious games & narrative learning environments

- Story should play an important role in teaching tacit knowledge (Sternberg, 2000)
- Retooling entertainment technology for learning:
  - case-method, vignette-based teaching
  - interactive storytelling
- But… there is an unfortunate lack of evidence that games alone improve learning.
  - is pure discovery/constructivist learning to blame?
  - what role can intelligent tutoring play?

USC

Tensions

- efficient learning "vs." robust learning
  - need a clear path for where the right learning investments lie
- creativity "vs." science
  - e.g., resistance from game designers to listen to learning scientists
- authorability "vs." richness of AI models
  - need research to explore how to derive rich models from

USC

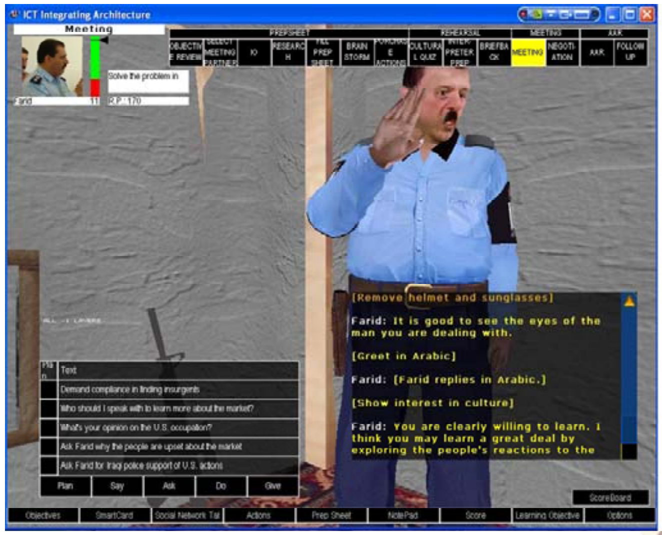
Goals of some ICT projects

- **Support the 'strategic corporal'**
  - Leadership as the ultimate battlefield force multiplier (Ulmer, 1998)
  - Leadership tasks have migrated downward (Brown, 2003; Wong, 2004)
- **Accelerate the development of adaptive leaders**
  - Learning orientation (Kolditz, 2004)
  - Complexity of roles, warfare, change (Wong, 2004)
- **Enhance cultural awareness**
  - Operations in a cultural context (Quadrennial Defense Review, 2006)
  - Social interaction
  - Second and third order effects
- **Rapidly transfer lessons learned from Contemporary Operating Environment**
  - Stories and experiences
  - New tactics

Intelligent tutoring research at ICT

- two related streams:
  - coaching: feedback during an exercise
    - distraction vs. guidance
  - reflective tutoring: knowledge-rich individual after-action reviews
    - explainable AI
    - "why" & "what else" questions
- target domains
  - XAI for OOS, FSC
  - RT & XAI for SASO-ST (virtual humans)
  - Coaching for DARWARS Ambush!
  - Coaching, RT, & XAI for ELECT (cultural & negotiation trainer)

ELECT demo



Other questions & comments

- are officers trained to be teachers/coaches?
  - reciprocal teaching (Palinscar & Brown, 1984)
  - teachable agents (Blair, Schwartz, 2006)
- a possible motivator for distance learning:
  - open-learner modeling
  - relates to VADM Moran's resume approach
- leveraging research efforts and institutions outside the Army
  - increased importance to Army of public education
  - 4 NSF SL Labs (www.scienceoflearning.org)

continued…

- “stealth” tutoring:
  - automatic game or simulation adaptation to achieve pedagogical goals (“intrinsic feedback”)
  - fidelity, difficulty, content, intensity
- gaming, floundering, and other unproductive behaviors
  - learning how to win a game should *depend on* learning domain knowledge

Future of Knowledge Representation and Language Understanding

ARI Workshop, August 1-3, 2006

Adam Pease
Articulate Software
apease at articulatesoftware dot com
http://www.ontologyportal.org/
http://home.earthlink.net/~adampease/professional/

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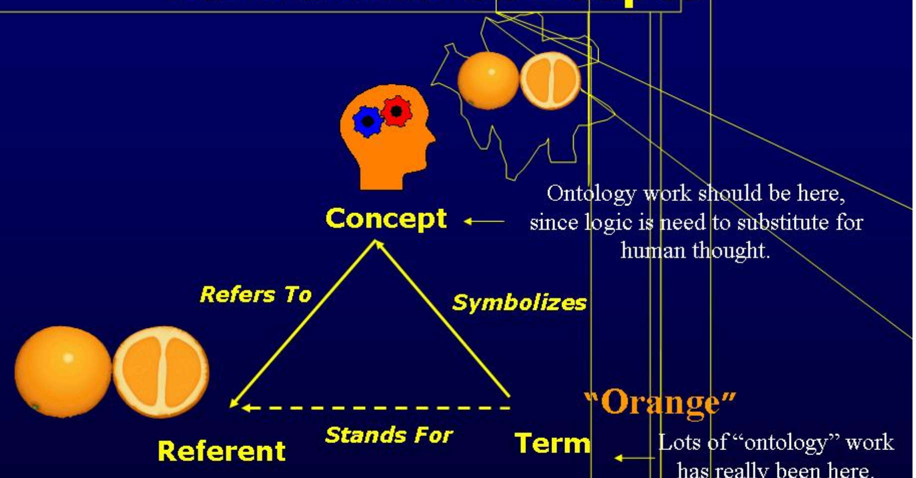
v 1.00

Terms and Concepts



Slide adpated from (c) Key-Sun Choi for Pan Localization 2005

from the slide of [Bargmeyer, Bruce, Open Metadata Forum, Berlin, 2005]

C.K. Ogden/I.A. Richards, The Meaning of Meaning
A Study in the Influence of Language upon Thought and The Science of Symbolism
London 1923, 10th edition 1969

2

Application

- Semantic word sense disambiguation
  - “The board approved the pay raise.”
    - Piece of wood, or corporate government?
- Anaphoric resolution
  - “Betty saw Susan asleep on the couch. She put her to bed.”
    - Sleeping people do not perform intentional actions

Imagine...your view of the web

Joe Smith — name

education: BS Case Western Reserve, 1982
MS UC Davis, 1984

private: Married, 2 children

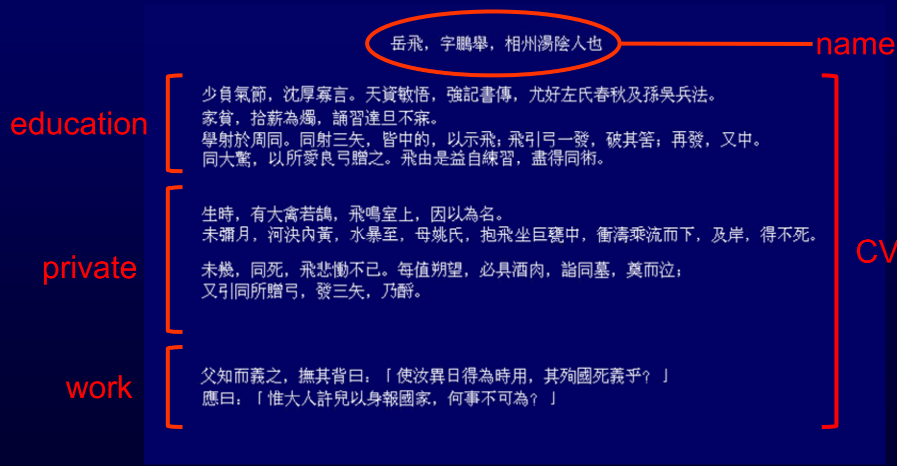
work: 1985-1990 ACME Software, programmer

CV

Slide with thanks to Frank von Harmelan

...and the Computer's View

(assuming you don't read Chinese)



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State of the Art - Representation

- Handcrafted computer data
  - Limited to a very specific application
    - Or very general, and specifying very little, like HTML
  - Meaning implicit in the names of the fields
    - Or somewhat explicit in explanatory text that must be read by a human

6

State of the Art – Language Understanding

- Search and retrieval
  - Measure of similarity of text

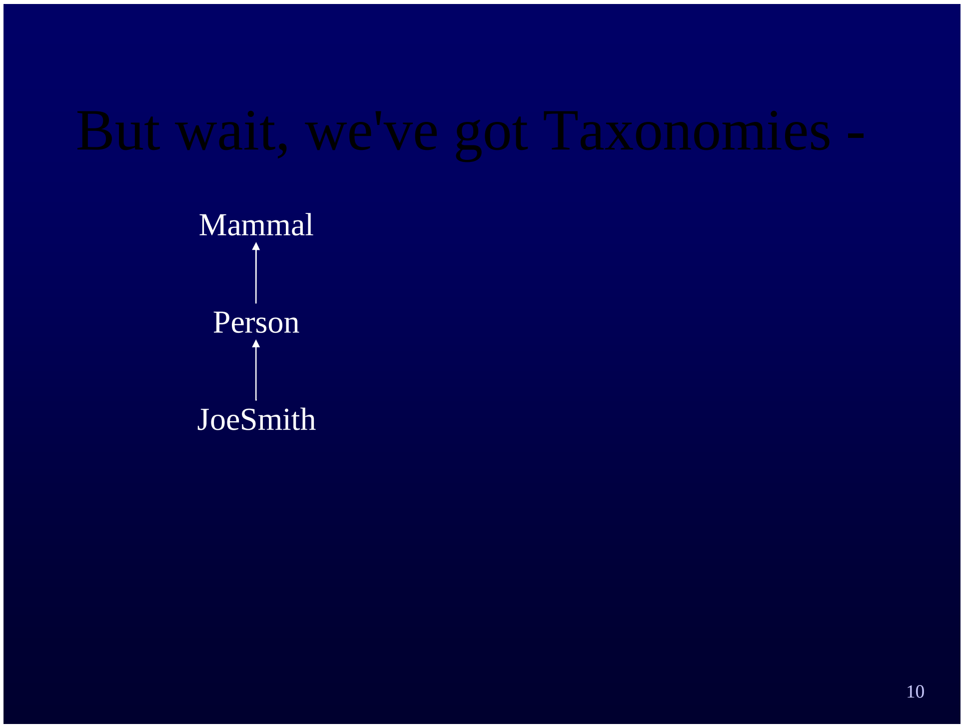
7

But wait, we've got XML -

<job name=”Joe Smith” title=”Programmer”>

8


But wait, we've got XML -
<job name=”Joe Smith” title=”Programmer”>
<x83 m92=”||||||||” title=”.............”>
9


But wait, we've got Taxonomies -
Mammal
Person
JoeSmith
10

But wait, we've got Taxonomies -

x931

o4839

i3729

11

Wait, we've got semantics -

Mammal

subclass

Person

instance

JoeSmith

implies

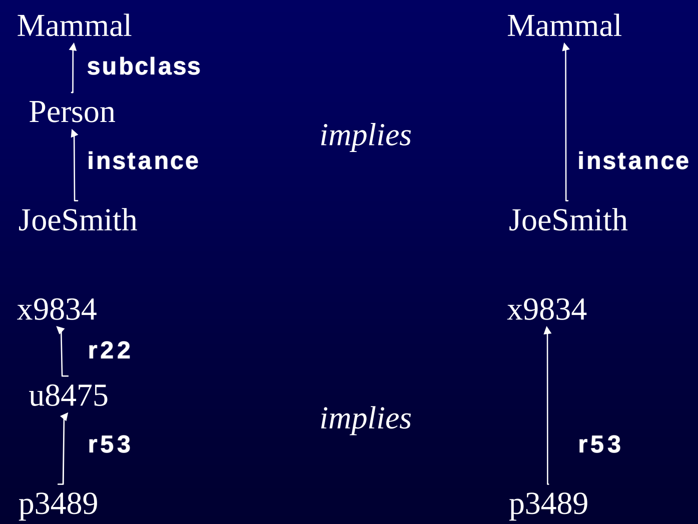
Mammal

instance

JoeSmith

12

Wait, we've got semantics -



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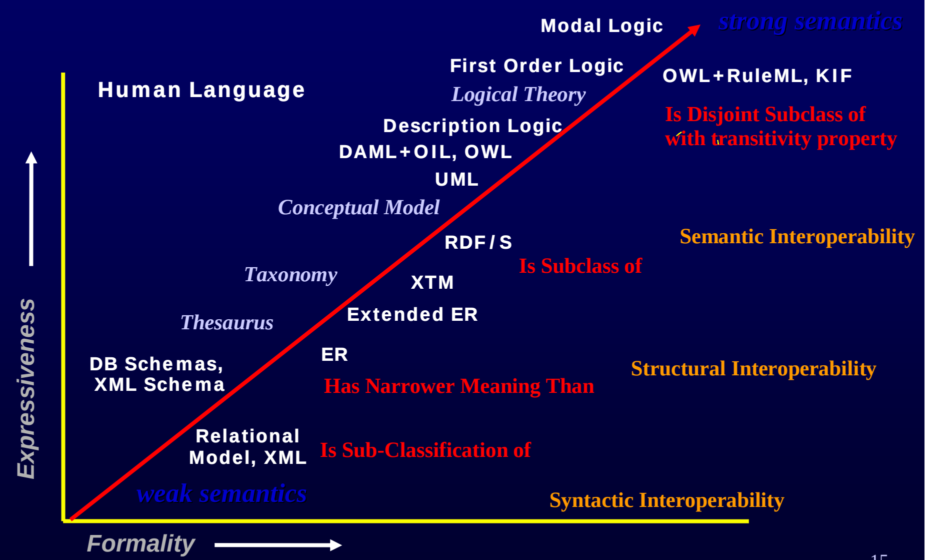
Semantics Helps a Machine Appear Smart

- A “smart” machine should be able to make the same inferences we do
- (let's not debate the philosophy about whether it would actually be smart)

14

Language Formality & Expressiveness



Thanks to Leo Obrst, MITRE

15

The Future – of Knowledge Representation

- Vast amounts of knowledge encoded in logic
  - Common sense knowledge about the world
  - Specialized knowledge about different topics
  - Common terms and meaning across all applications – no stovepipes
- Powerful theorem proving
  - Elimination of “dumb” answers
  - Machine understands some common sense implications of known facts

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The Future – Of Language Understanding

- Ask a question, get an answer
  - Not a chunk of text where an answer may appear
  - Machine combines knowledge from different sources to synthesize the answer
- Talk or type commands in simple English (or German, Chinese etc)
  - Treating the computer as a somewhat slow non-native speaker

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APPENDIX G

FINAL OUTBRIEFS

Learning Model

Working Group Participants

Lead Facilitator: Dr. Kathy Quinkert, U.S. Army Research Institute
Co-facilitator: Mr. Ron Stump, U.S. Army Research Institute
Co-facilitator: Dr. Millie Abell, HQ, TRADOC
IDA Member: Dr. John Morrison, Institute for Defense Analyses

Dr. Robert Ainsley, DAU
Dr. Richard Clark, USC
Ms. Ruth Freiseis, CASCOM
CDR David Hartt, U.S. CG PTC
COL Bob Morris, JFCOM/J9
CAPT (R) Matt Peters, DIA
Dr. Connie Wardell, U.S. ATSC

Dr. Jan Cannon-Bowers, UCF
Dr. Aubteen Darabi, FSU
Dr. Paul Gade, U.S. ARI
COL Jim Markley, HQ, TRADOC
BG O'Neill, CGSC
Ms. Rachel Serio, TRADOC QAO
Dr. Jonathan Woods, U.S. Navy HPC

Learning Model

Focus Areas

- How do people learn?
- What instructional strategies are most effective and efficient?
- What other opportunities exist to optimize soldier performance?
- How can we preserve the learning benefits of cohort socialization in a blended learning environment?

Learning Model

ISSUE/QUESTION: How do people learn?

What we know: Anderson's ACT-R model is a widely accepted conceptual model of learning

- Specifies types of knowledge (Declarative & Procedural)
- Describes psychological processes for acquiring each type
- Provides an evidence-based foundation for instructional design
- Applies across generations

Learning Model

ISSUE/QUESTION: What instructional strategies are most effective and efficient?

What we know: Independent of the specific delivery system, instruction should be:

- Experiential
- Authentic/current/relevant
- Guided
- Motivational/Engaging
- Tailored to the learner
- Collaborative (sometimes)

Learning Model

What works: Guided Experiential Learning (GEL)

- Conduct cognitive task analysis
- Clarify learning objectives
- Provide rationale/explain relevance
- Present advance organizers to activate prior knowledge
- Present declarative knowledge
- Demonstrate procedural knowledge
- Requires problem solving and giving feedback

What we don't know:

- Cultural shift and acceptance
- How to efficiently assess prior knowledge

Value Added:

- Decreases time and enhances learning, based on evidence from science of learning
- Applies independent of training delivery system
- Potential to standardize across Army Training

Learning Model

ISSUE/QUESTION: What other opportunities exist to optimize soldier performance?

What we know: By focusing on performance, significant savings have yielded the following example returns on investment (ROI):

- 37:1 (Navy based on FY06 summary)
- 32:1 (Coast Guard example of the LST-5D)
- 10:1 to 100:1 (Industry anecdotes based on proprietary data)

Potential benefits include:

- Alignment of HR, training, and acquisition systems
- Focus on performance rather than training
- Eliminates unnecessary training
- Validate and better understand the requirements
- Standardized methodologies, adaptable solutions, and optimal outcomes

What we don't know in HP:

- Organization structure for implementation in Army

Return on Investment for HPI

“Industry-wide estimates on the return associated with HPI vary from about 2:1 to about 100:1.” [paraphrased from Clark & Estes (2002).]

Actual DOD/DHS Experiences:

Navy

Background/Problem: A supply & logistics command was third such entity converting to an Oracle-type databasing system. Past similar conversions had experienced high cost over-runs in post-implementation Help Desk support. Command sought to increase allocation for sustainment support.

HPI Solution: Mission and performance analyzed, revealing poor alignment between requisite skills and tools provided. Suggested conducting TA/CTA on the requisite skills which discovered inclusion of unnecessary LOs and exclusion of critical LOs.

ROI: 3:1

Coast Guard

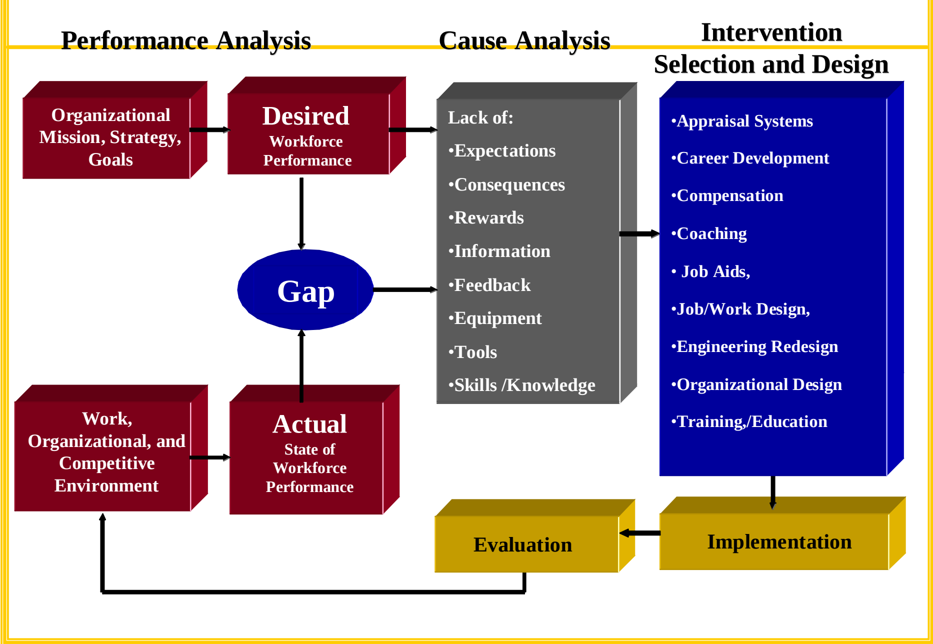
Background/Problem: Poor HF communications in geo-specific locales resulted in supplemental funding for transceiver to improve satellite connectivity. Systems command began training request process.

HPI Solution: Performance Technology Center instead looked at all factors affecting performance on the new transceiver and discovered that a job aid would suffice far better than formalized training.

ROI: 70:1

- DOD/DHS experience bears out industry numbers
- Value of ROI is scope dependent

Model of Performance Improvement



Learning Model

ISSUE/QUESTION: How can we preserve the learning benefits of cohort socialization in a blended learning environment?

What we know:

Evidence suggests early f2f interaction:

- enhances learning
- increases satisfaction
- decreases attrition

What we don't know:

- Minimum amount of required f2f time
- Optimal class size
- Appropriate Instructor:Student ratio
- Applicability of university research to the Army environment
- Effectiveness of virtual vs. physical f2f

Learning Model

Overarching Issues

- Implications for training workforce development
- Alignment of HR, training, and acquisition functions
- Standardization of model implementation
- Focus on performance
- Performance measurement process and metrics
- Policy, process, and structural changes
- Continual improvement

Cultural Change/Change Management

The Way Ahead

- Using lessons learned from the Navy, Coast Guard, and Industry, a high-priority dedicated team should devise a plan to
  - Implement GEL instructional methodology
  - Implement HPI technology
  - Pilot test the impact of cohort socialization on learning in a dL/f2f course

An Army-Wide Solution

Train Soldiers

Working Group Participants

Lead Facilitator: Dr. Scott Graham, U.S. Army Research Institute
Co-facilitator: Mr. Michael Faughnan, HQ, TRADOC
IDA Member: Dr. Dexter Fletcher, Institute for Defense Analyses

Dr. Phillip Ackerman, Georgia Inst. of Tech.
Dr. Herb Bell, U.S. AFRL
Ms. Mary Cullinane, Microsoft Corp.
Dr. Tom Duffy, Indiana University
Mrs. Rosanne May, HQ , TRADOC
COL(P) Joe E. Ramirez, DC, CACT
Dr. Mike Simonson, Nova Southeastern U.
BG Michael Tucker, DCG, U.S. Army Armor School
Dr. Bob Bauer, U.S. Army AC&S
Mr. Al Blocker, Microsoft Corp.
Dr. Fred Diedrich, Aptima Inc.
Dr. Jean Dyer, U.S. ARI
Mr. Dean Norman, Naval Ed/Tng Cmd
Dr. Scott Beal, U.S. ARI
CSM Jose Silva, HQ, U.S. Army QC&S
Mr. Bob Sottilare, U.S. Army RDECOM

Train Soldiers

Issues

- **How can the Army leverage Distributed Learning (dL) solutions to overcome resource shortfalls? dL refers to education, training, performance aiding anytime anywhere.**
- **How can the Army streamline institutional training courses and make them better synched with needs of operational units?**
- **How should we prepare instructors and training developers to best use new training technologies and approaches?**
- **What are the effects of ARFORGEN on Army institutional training?**
- **How do we fully assess cost and effectiveness of dL training solutions?**

Effective dL

ISSUE: **How can the Army leverage dL technologies to overcome resource shortfalls**?

What we know:

- **TRADOC can reasonably expect to reduce training time by 30% in many areas while maintaining comparable effectiveness**
  - **Upfront costs – savings realized over time**

- **The effectiveness and acceptability of the dL courses largely depends on quality of instructional content**

- **Significant cultural barriers will have to be overcome**
  - **General resistance to change and technology**
  - **Potential loss or change of jobs**
  - **Greatest resistance from mid level leaders**

– **Change management tools and guidance are available**
  - **Educate/demonstrate efficacy to opinion makers**
  - **Reward early adopters**
  - **Ensure adequate infrastructure for development, revision, and sustainment**

Effective dL

- **Selection of course modules for dL presentation**
  - **All course modules considered as candidates for dL, i.e., select what cannot be taught with dL vice what can be**
  - **Analysis at the Learning Module level**
  - **Simultaneous top down (TRADOC HQ) and bottom up (Proponent) analyses of dL conversion**
  - **Common instruction (within and across schools) should have single proponent/manager**
  - **dL course modules should be "Equivalent" vice "Identical"**
  - **Civilian experts/consultants should assist in determination of potential dL solutions**

Effective dL

- Anticipate 2nd/3rd order effects
  - Identification/elimination of duplicate training modules
  - Budget metrics, e.g., instructor contact hours
  - Impact on installation and local economy
  - Enhanced AC/RC commonality
- Integrate evaluation in development process
- Success hinges on completion of Army Learning Management System
- Unit leadership must support online learning process, e.g., develop contract with commander on how much dL time is allowed
- Soldiers and instructors must be trained on how to optimally use dL
  - Instructors still needed, but roles will change
- Group generally agrees with Army Learning Model for PME
  - Strong reservations about fast tracking students through Captains Career Course

Effective dL

- Two (not one) fundamentally different models of guided experiential learning are needed to train both the Art and Science of War.
  - More directed approach for procedural/declarative knowledge
  - Less directed approach for decision making, critical thinking, and leadership
  - Guidelines for implementing two approaches are available now as foundation of staff and faculty training programs already under development

<u>What works:</u>

- Navy Integrated Learning Environment
- USMC Tactical Leader Games
- RC dL training
- “Role Guides,” Air Force Civilian Competency Tool
- Programs to educate senior leaders on dL, e.g., Distance Learning Leaders’ Certificate Program (Nova University)

Effective dL

What we don't know:

- **Generally, how to quickly bring about large cultural changes**
- **How to really lead a Army training revolution?**
  - **Unrelenting commitment of senior DA and TRADOC leaders**
  - **Spiral development with honest evaluations**
  - **Early successes**
- **How to rapidly transition new training technologies into course TSPs?**
  - **Intelligent tutoring**
  - **Automated feedback**
- **Guidelines for selecting most effective dL designs for desired training outcomes**
- **Potential Impact: Accelerates training, reduces long term costs and personnel requirements without adversely affecting soldiers and their families**

Streamlining Army Courses

ISSUE: How can the Army streamline institutional training courses and make them better synched with needs of operational units?

What we know:

- **Happy with the current product – looking for efficiencies**
- **Tension in role of the schoolhouse between training professional development (PME) vs. near term tasks (AOT) Assignment Oriented Training**
- **Navy's ILE training model based on knowledge and skills needed to perform next job**
- **Assignment Oriented Training based on equipment and/or theatre can reduce course lengths and increase near term operational effectiveness**
- **Portions of resident institutional training might be delivered in units**
  - **Unit cohorts during ARFORGEN reset phase**
  - **Better (and resourced) use of Mobile Training Teams**
  - **New equipment, doctrine, and organizational training**

Streamlining Army Courses

- Increased use of job and decision aids can reduce the demand for training
  - Technology should allow better integration of training and job aids

- Army could require completion of annual continuing training for military skills, analogous to “Continuing Education Units”
  - Would put teeth in self-development program
  - Fleshes out gaps from AOT

- Tailoring Army modules to match student abilities
  - Would likely require competency based assessment

What works:

- Navy’s Integrated Learning Environment

- Advanced and Enhanced Basic Combat Training at Fort Jackson

Streamlining Army Courses

What we don’t know:

- The full ramifications and effectiveness of an Assignment Oriented Training program

- Given ARFORGEN, do we need to modify the training of the 40/11 warrior tasks and drills in IET?

- How to tailor courses and course length to soldier abilities, competency based training

Potential Impact: Accelerates training, reduces costs and personnel requirements

Instructor/Training Developer Support

ISSUE: **How should we prepare instructors and training developers to best use new training technologies and approaches?**

What we know:

- **Development and delivery of dL based courses require different knowledge and skills than current classroom instruction**
- **Training/developing the Art of War and the Science of War require different knowledge, skills and approaches**
- **Training research on the effective use of simulations and games consistently demonstrate the need and/or value for train-the-trainer tools**
- **A trainer and training development support system should be built to include:**
  - **Communities of practice**
  - **Sample models of excellence**
  - **Mentors/coaches**
  - **Continuing training/education in learning theory, new evaluation techniques, and educational technologies**

Instructor/Training Developer Support

What works:

- **Academic and industry dL instructor training program**
- **Team approach to training development**
- **New and better authoring tools**

What we don't know:

- **What are effective and sustainable "train-the-trainer" tools for dL instructor and training developers**
- **What is the best return on investment between course development costs and dL/training effectiveness?**
- **How does the Army ensure quality control when contracting for dL development, e.g., how to write effective statements of work**
  - **Review of interim prototype training materials**
  - **Procedures for rapid updating of course materials**

Potential Impact: Makes or breaks dL training programs

What next?

- Research needed to better understand and implement/transition:
  - Refresher training
  - Alternative dL solutions
  - Training transfer
  - Retention of learning
  - Integration of training for Operating and Generating Forces
  - Evaluation/refinement of alternative training models

- Identification and adaptation of DoD/Industry Best Practices
  - Leverage Navy's ILE

- Build systematic, resourced process to transition R&D products

- Better utilize civilian experts/consultants who are well versed in organizational change and dL training implementation

- Well thought out "marketing plan" as to why the Army is moving toward a widespread dL solution

Develop Leaders

Working Group Participants

Lead Facilitator: Dr. Stan Halpin, U.S. Army Research Institute
Co-facilitator: COL Bruce Reider, Center for Army Leadership
IDA Member: Dr. Frank Moses, Institute for Defense Analyses

Dr. Georgia Chao, Michigan State University
Mr. Harry Crumling, HQ DA, G-3/5/7 TR
Dr. Jon Fallesen, Center for Army Leadership
Mr. John Hennessey, Jr., HQ, TRADOC
Dr. Steven Kozlowski, Michigan State U.
COL Julie Manta, U.S. Army War College
MG David C. Ralston, CG, U.S. Army FAC & Fort Sill
Mr. Don Vandergriff, U.S. ARCIC (Forward)
Mr. Al Crane, U.S. ARCIC
Dr. David Dorsey, PDRI
Dr. Jay Goodwin, U.S. ARI
COL Mike King, U.S. Army CGSC
Dr. Robert Lord, University of Akron
Dr. Cindy McCauley, CCL
LTC(P) Charles Rogerson, HQ, TRADOC

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Develop Leaders

Issues

- ✓ What is the process of forming personal and professional relationships within the Army (i.e., socialization)?
- ✓ What are the characteristics of adaptive individuals and leaders?
- ✓ What are some strategies to accelerate growth in adaptive behavior?
- How does one determine measures of effectiveness and quality?

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Key Points

- Socialization process can positively impact leader development
- Adaptive performance can be developed and trained
- It is possible to accelerate leader growth

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Socialization: What We Know

- Socialization is about bringing new people (entry level, also leaders) into the existing organization
  - Create stakeholders of all organizational members
  - A process of cultural change
- Socialization happens whether you like it or not
- Leaders play a strong role in the process of socializing new organizational members (small unit, Big Army)
- Early, challenging assignments and mentoring lead to more effective organizational socialization
- BOLC, CCC, SCP are critical venues for preparing leaders to leverage/influence the natural socialization process

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Socialization: What We Know (cont)

- Socialization affects self-identity, values (e.g., warrior ethos), knowledge of organization, language of the organization, knowledge of the existing networks, organizational history
- Linking people together is a fundamental aspect of socialization
  - Can be influenced by Army leaders (unit, IMT, Big Army)
- On-Line Social Networking technology
  - Platform to assist in the socialization process, may augment face-to-face interactions in the relationship building process
  - Capability/Desire to access this technology varies across generations

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Socialization: What Works

- 1/25 IN (SBCT)
- Formalized unit reception & orientation programs
- AMC DAC Greening course & Intern program
- Role modeling / virtual staff ride, right seat ride
- BOLC II
- AURA: role modeling in USAFAC IMT (?)
- Industry experience: positive impact of leader involvement with entering personnel (e.g., IBM)

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Socialization: What We Don't Know

- What are our intended outcomes and goals for socialization processes?
- Metrics for success in socialization?
- What tools do leaders need to leverage socialization?
- How effective is on-line/network-based socialization?
  - What are time requirements for different socialization methods?
  - How much of early socialization can be managed through on-line interactions?
  - Does professional interaction within communities of practice lead to effective socialization?

Socialization: Value

- Leveraging the socialization process can help a commander effect organizational change in a unit or organization
- Most inputs are low- or no-cost:
  - Clear communication
  - Consistency of message and action
  - Leader as a role model

Develop Leaders

<u>Issues</u>

✓ What is the process of forming personal and professional relationships within the Army (i.e., socialization)?

➢ What are the characteristics of adaptive individuals and leaders?

✓ What are some strategies to accelerate growth in adaptive behavior?

• How does one determine measures of effectiveness and quality?

The Mentally Agile Leader…

(from Army War College Agile Leader Study, 2004-2005)

Looks

Scans for new info (both internally and externally)
Expects the unexpected
Identifies changing roles and paradigms
Anticipates the enemy

Thinks

Identifies causality, connections, root causes, 2nd/3rd order effects
Thinks critically and creatively from open-minded perspective
Looks for patterns that define new TTPs

Evaluates

Assesses impact of decisions from multicultural, systems perspective
Revisits decision/plan as required
Recognizes personal biases and dispositions

Decides

Makes timely decisions without all the data and outside comfort zone
Develops mental models to help understand ambiguous situations
Considers typical and atypical solutions
Exercises mature judgment; accepts risk

Implements

Identifies Communicates decision and thought processes
Persists through obstacles & demonstrates endurance
Appraises effect of decision
Assimilates new info and is open to candid feedback

AND <u>establishes a climate</u> for subordinates to do the same!

Adaptive Performance: What We Know

Stage (uniformed leaders) / Leader cohort	Officer	Warrant Officer	NCO	Civilian
4: 17 yrs and beyond				Manager
3: 8-16 yrs				Supervisor
2: IMT - 7 years				Team Leader
1: Pre-recruitment – IMT				Team Member

•Adaptive Performance Factors

•Skills, knowledge, behaviors

•Pre-disposition

The "What"

Adaptive Performance: What We Know

- Influences on adaptive behavior
  - Education & training
  - Organizational climate & systems
  - Individual capabilities & experience
- Adaptive performance is multi-dimensional
- Adaptability requirements differ by position – Target training/selection procedures accordingly

Adaptive Performance: What Works

- Use of individual & team characteristics to predict adaptive performance
- Targeted adaptability training:
  - US Army War College: Leadership Adaptability
  - SF Team Leaders & WOs: Mental, interpersonal, leading adaptive teams
  - CA/PSYOPS: mental, interpersonal, leading adaptive teams

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Adaptive Performance: What We Don't Know

- What are the adaptability requirements at different levels and positions?
- Does adaptability in one context have utility in other contexts?
- What are the potential negative outcomes of adaptability for individuals? (e.g., "going native", exceeding legal/moral bounds)
- What are the collective consequences of all Army leaders pursuing adaptability across the board ("1000 flowers blooming")?

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Adaptive Performance: Value

- Having more adaptive leaders may lessen burden on training systems
- Develops potential for coping with change & stress
- Leaders & Soldiers prepared to operate in contemporary and future operating environments

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Develop Leaders

Issues

✓ What is the process of forming personal and professional relationships within the Army (i.e., socialization)?

✓ What are the characteristics of adaptive individuals and leaders?

➢ What are some strategies to accelerate growth in adaptive behavior?

- How does one determine measures of effectiveness and quality?

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Accelerating Growth: What We Know

Principles of Accelerating Growth

- Need sound foundational knowledge
- Growth requires practice with repetition under varied, challenging conditions, with adequate time for feedback and reflection
- Growth requires a supportive climate of innovation, autonomy, and freedom to fail
- Social/people networks enable learning from experiences of others
- Self-identification as adaptive leader impacts behavior and growth
- Daily events can serve as broad opportunities for learning
- Need to emphasize improving critical and creative thinking

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Accelerating Growth: What Works

- Georgetown Army ROTC 2001-Pres
  - Adaptive Leader Course - aspects are being used in BOLC
- Adaptive Performance Model (Special Forces)
  - Clarify adaptive performance requirements
  - Use a combination of developmental interventions
- Agile Leader Module (CCC)
  - Pilot test of AWC Agile Leader Study recommendations

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Accelerating Growth: What We Don't Know

- How is growth affected by emotional processes (e.g., orientation to change)?
- What are the limits on accelerating growth?
- How identify when is a person ready to learn?
- What are the optimal intervention points in a person's career? What interventions?

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Accelerating Growth: Value

- Leaders prepared to assume increased responsibility sooner
- Leaders better prepared for full spectrum operations

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Develop Leaders

Issues

- ✓ What is the process of forming personal and professional relationships within the Army (i.e., socialization)?
- ✓ What are the characteristics of adaptive individuals and leaders?
- ✓ What are some strategies to accelerate growth in adaptive behavior?
- How does one determine measures of effectiveness and quality?

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Recommended Actions

- Integrate social networks, communities of practice, and AKO to supplement socialization and relationship building
- Leverage key intervention points (WLC, BOLC, CCC, SCP) to influence leaders' ability to use socialization to effect change in their units
- Capture and publicize personal leader development experiences from Army leaders
- Add adaptability to Doctrine (FM 7-0) & Personnel systems
- Review available training practices for opportunities to enhance adaptability
- Focus instructor preparation on adaptability principles

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Future Capabilities

Working Group Participants

Lead Facilitator: Dr. Steve Goldberg, U.S. Army Research Institute

Co-facilitator: Dr. Diana Tierney, HQ, TRADOC

IDA Member: Dr. Eric Roberts, Institute for Defense Analyses

Dr. Robert Bjork, U. of California, LA
COL Kevin Brown, ARCIC
Dr. Patricia Chalmers, JFCOM
Dr. Paula Durlach, U.S. ARI
Dr. Alice Healy, University of Colorado
Mr. Alex Hoover, J7, JWC
Dr. H. Chad Lane, U. of Southern California
Mr. Scott Shadrick, U.S. ARI
BG Jim Warner (USA, Ret)

Dr. Jim Blake, U.S. Army PEO STRI
Dr. Bill Burnside, U.S. ARI
Dr. Anna Cianciolo, CP Research Inc.
Mr. Jack Fedder, HQ, TRADOC
Mr. Wayne Hodgins, Learnativity
Mr. Lou Iorizzo, U.S. ATSC
Mr. Adam Pease, Articulate Software
COL Jim Shufelt, U.S. Army TRADOC

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Future Capabilities

Assumptions about the Future

- Decision making is being pushed downward
  - need to develop skills earlier in Soldiers' careers
- Cultural/Social Skills becoming more important
  - integrated operations are the norm
- Rate of change is increasing exponentially
  - differential rates of change
  - increasing complexity
- Learning is a continuous process that lasts past formal training (life-long learning)
  - learning how to learn becomes a competency
- Unmanned devices/systems play a greater role
- Increased openness, quantity and interconnectedness of information
  - knowledge is becoming more distributed

2

Future Capabilities

Future Warrior Attributes

- Decision making skills - when to act
- Social/Interpersonal/Cultural skills
  - inter-service/inter-agency
- Life-long learning commitment and skills
- Technologically savvy
- Comfortable with complexity and uncertainty

3

Future Capabilities

Why Research?

- Constrained resources
  - fewer trainers in institutions and field
  - less time in institution
- New training approaches without infrastructure (embedded training)
- Need to accelerate acquisition of expertise
- Need to perform the right kind of practice
- Given future environment, practice is at a premium
- Technology is needed to guide practice and provide feedback
  - both in institution and field

4

Future Capabilities

Needed Capabilities

- Individualization of training processes for Soldiers, teams and small units based on performance assessment and management
- Provide relevant training support through management of knowledge and tailored training approach
- Rapidly develop low cost, effective training tools for individual, team and small unit training

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Future Capabilities

Capability: Individualization of training processes for Soldiers, teams and small units

- **What we know:**
  - Timely assessment and feedback can positively affect performance
  - Assessment tools need to be easy to administer, interpret, and use
  - How to automatically collect outcome measures
- **What we don't know:**
  - How to automatically collect process measures
  - How to aggregate system data to reflect complex processes
  - How to integrate performance measurement and tailored instructional delivery
  - How to provide automated delivery, assessment and management of embedded training
- **Future Application:**
  - Tailored Training for individuals, teams and small units
  - Embedded training and performance support

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Future Capabilities

Capability: Individualization of training processes for Soldiers, teams and small units

- **What Research is Needed**:
  - Automating coaching, mentoring, red team and management processes for embedded and distributed training
  - Methods to prescribe training based on current state of knowledge and ability
  - Validation of promising laboratory findings with militarily relevant tasks
  - Collective performance modeling
    - > Generalized means of aggregating training data to support automated collective performance assessment

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Future Capabilities

Capability: Relevant knowledge-based training support

- **What we know**:
  - How to train for specific situations
  - How to train for more general situations
  - Link between relevance and training motivation
- **What we don't know**:
  - How to sequence different training experiences for maximum performance impact within allotted resources
  - The best way to encode data and reason with encoded data
  - How to define/determine relevance
  - How to encode relevant information in a reusable way
  - How to minimize negative transfer when jobs, equipment and procedures change
- **Future Application:**
  - Rapid scenario development tailored to the current mission
  - Personalized dialog-enabled training agent
  - Knowledge management techniques to acquire and apply Lessons Learned

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Future Capabilities

Capability: Relevant knowledge-based training support

- **What Research is Needed**:
  - Applying AI to knowledge management
    - > creating large bodies of formal reusable and computable knowledge
    - > reach-back capability/lessons learned
  - Creating a catalog of design principles that do and do not create durable and flexible learning
    - > learning to learn
    - > intelligent tutor applications
    - > social cohesion and influence
  - How to design authoring tools for non-specialized users to include scenario development
  - Incorporate social and behavioral characteristics in force modeling
  - Dynamic performance-contingent guided learning

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Future Capabilities

Capability: Develop low cost, effective training tools (TADSS)

- **What we know**:
  - Low technology, inexpensive simulators can be effective
  - Reuse of instructional content facilitates development of flexible training tools
  - Domain-specific training tools are the most effective, but the least transferable
  - Collaborative learning can be both effective and inexpensive
  - The application of standards is critical
- **What we don't know**:
  - How to define "good enough" training in advance
  - How to more effectively store and exploit reusable, decomposable learning objects
  - How to draw on social/affective/cognitive neuroscience to accelerate and improve training
- **Future Applications**:
  - Unified collaborative training environment
  - Interface designs that facilitate Soldier, instead of specialized operator, use and modification of training tools

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Future Capabilities

Capability: Develop low cost, effective training tools (TADSS)

- **What Research is Needed**:
  - Integrating effective learning principles into training tools
  - Techniques for automated acquisition of expertise
  - Developing interface design principles for learner-centric training tools for tomorrow's Soldiers
  - Basic research on social/affective/cognitive neuroscience
  - Optimizing human computer interaction
  - Methods of benchmarking performance that are training-tool and training-scenario independent

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Future Science of Learning

Multidisciplinary research (psychology, biology, sociology, and computational sciences)

- Learning and performance
- Social and cultural behavior
- Human-Machine performance
- Predictive models of readiness and performance

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