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JSOU Report 10-7 Innovate or Die: Innovation and Technology for SO Spulak

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Innovate or Die: Innovation and Technology for Special Operations

Robert G. Spulak, Jr.
JSOU Report 10-7
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Joint Special Operations University and the Strategic Studies Department

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On the cover. U.S. Special Operations Forces on horseback in Afghanistan, 2001. DoD photo.

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Foreword

In *Innovate or Die* Dr. Robert Spulak advances a concept for enhancing the rapid innovation that enables Special Operations Forces (SOF) to stay ahead of our adversaries on the battlefield. He takes a look at how SOF might innovate in ways that are different from conventional forces and emphasizes that "innovation for SOF is a function of the attributes of SOF personnel and culture." Whereas the conventional General Purpose Forces must seek innovation within large organizations—often merely applying more of existing capabilities—SOF personnel have greater license to innovate during ongoing operations.

Dr. Spulak suggests that innovation can occur in science and understanding, new tools and technology, and new ways of performing the mission. He contends that SOF must learn to comingle these three areas in order to speed up the process of innovation—to bring new concepts quickly to bear at the point of the spear. He warns against the linear thinking and processes used to manage developmental risks by the services and joint community. The linear model of management of innovation is a factor that inhibits the quick throughput that SOF need: "For SOF, slow and methodical innovation is a risk to SOF creativity," he asserts.

The monograph invites reflection on the ways SOF currently provides for advancement in innovation. For example, The Joint Capabilities Integration and Development System (JCIDS) is a process that assesses and prioritizes joint military capability needs. The United States Special Operations Command (USSOCOM) affects this process via its SOFCIDS—SOF Capabilities and Integration Development System (a SOCOM JCIDS). In addition, when a SOF unit identifies an urgently needed capability or requirement based on survivability of the force or risk to mission success, the USSOCOM process provides for units to proffer a Combat Mission Needs Statement (identified as SOFCIDS—Urgent). This has the effect of speeding the development process toward battlefield implementation. But in this case SOF are working through a resourcing process that is designed to meet the needs of the joint force writ large. Despite some adroit maneuvering under the JCIDS umbrella, Spulak's thesis suggests that the nature of its linear process can inhibit innovation by SOF.

One answer might be Spulak's notion of a "rapid innovation braid" that wraps science and understanding, tools and technology, and missions and users into an interacting bundle of processes to facilitate communications and decision making in the innovation and development processes. A manifestation of this would find scientists, engineers, and industry experts embedded with battlefield elements, innovating and developing on location. Spulak's monograph suggests innovation needs to take place during operations.

Certainly the unique challenges of the SOF community demand that we encourage and facilitate creativity and innovation on the part of SOF personnel. While the traditional top-down model for innovation may be effective for the needs of General Purpose Forces, it can serve as a barrier to SOF innovation. Robert Spulak advises that a "rapid innovation braid" will help SOF to innovate from the bottom up.

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About the Author

Dr. Robert Spulak is manager of the SOF Program Office at Sandia National Laboratories. He is Sandia's principal point of contact for special operations and is the program area lead for internal Sandia investments in research with potential special operations applications. His previous experience included strategic studies in areas including technologies, weapon systems, defense policy, terrorism, and international relations, and he has published in *Strategic Review* and *Parameters*. Dr. Spulak received his Ph.D. in Physics from the University of New Mexico in 1988. His prior degrees were in Physics, Astronomy, and Nuclear Engineering.

Dr. Spulak has been an adjunct professor of Political Science at the University of New Mexico in U.S. National Security. He was one of the first members of the U.S. Special Operations Command (USSOCOM) Future Concepts Working Group and was a member of the Naval Special Warfare (NSW) Future Concepts Working Group. Dr. Spulak has invested significant time with special operations components—for example, observing training, operational planning, and field and fleet exercises—though cooperative arrangements such as a Memorandum of Agreement with NSW Group ONE. He contributed to USSOCOM concepts and publications such as the Special Operations Forces (SOF) Vision, Desired Operational Capabilities, and SOF Attributes. Dr. Spulak was a participant in the Bogota conference "Contemporary Counterterrorism and Counterinsurgency: The Colombian Experience" at the invitation of USSOUTHCOM and the Government of Colombia. He has widely briefed the special operations community, including the Office of the Assistant to the Secretary of Defense for Special Operations and Low-Intensity Conflict (SO/LIC), USSOCOM SOF Week, the National Defense Industrial Association SO/LIC Symposium, and a NSW commanders' conference on San Clemente Island.

As an associate fellow with the JSOU Strategic Studies Department, he continues his involvement with the U.S. special operations community and provides advice and assistance to USSOCOM strategic planning initiatives. His other JSOU Press publications are *Theoretical Perspectives of Terrorist Enemies as Networks* (October 2005) and *A Theory of Special Operations* (October 2007). Dr. Spulak is also a sponsored member of the UDT-SEAL Association.

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This monograph originated in a talk by the author to a special operations combat development directorate; I thank them for the invitation and subsequent lively discussions. My motivation to complete the research was an invitation from the United States Special Operations Command (USSOCOM) to talk on this subject at SOF Week 2010. I thank the leadership and members of a special operations task force who hosted me for several weeks in Afghanistan, which gave me an opportunity to test these ideas against reality. I also thank Dr. Jessica Glicken Turnley for reviewing the work in progress and providing many useful suggestions.

Innovate or Die: Innovation and Technology for Special Operations

1. Introduction

> We will lead the services in leveraging the latest technological advantages, but will actively strive to share this technology with them.
>
> — USSOCOM Vision

Like the well-known slogan, *hydrate or die*, Special Operations Forces (SOF) also must *innovate or die*. Innovation may be crucial to SOF personnel's actual physical survival, but die is also a metaphor for organizational oblivion: conformity and assimilation. One of the fundamental qualities of SOF that derives from the nature of the personnel and their organization is *creativity*.[1] Creativity for SOF is rapid operational innovation. (Operational innovation may or may not involve innovation in technology, but technical innovation has often been a critical contributor to creativity for SOF.[2]) Innovation for military forces is an inherently lengthy process, and initiatives to speed innovation are limited by the strength of the existing paradigm. Without a new paradigm of how to innovate rapidly, innovation for SOF will be conventionalized and the creativity of SOF will be at risk.[3]

In the environment where SOF are now in great demand performing strategically important missions, using unmanned aerial vehicles and precision-guided munitions and other technologies, expanding their numbers, and taking on new responsibilities for planning and synchronizing global operations, it may seem extremely pessimistic to claim that attention must be paid to some abstract danger of losing one of their unique qualities.[4] However, it is worthwhile to step back from the press of current events and assess how SOF should innovate in ways that are different from General Purpose Forces (GPF). There are inherent issues with the way military innovation

is executed in the existing paradigm—that is, the method constrains SOF, leads to a diminished ability to be creative, and ultimately could lead to the death of the SOF-unique contributions. The bulk of this monograph will seek to understand the factors that are necessary to innovate rapidly as well as the reasons GPF cannot (and should not) implement them. I then integrate these conditions for rapid innovation into a new paradigm that can be used for SOF to innovate rapidly.

Innovation can occur in three areas: advances in science and understanding, development of new tools and technology, and new ways of actually performing missions by the users. In the conventional model, which has been the basis of organization for innovation since World War II, progress in each area is assumed to occur independently over time, each is managed and funded separately from the top down, and an innovation in one area only leads to progress in the next area if the innovation is discovered when it has matured. For conventional forces, implementing new capabilities without this lengthy maturation of concepts or technology, without top-down direction and oversight, and without institutionalization would create new unacceptable risks, including financial and performance risks to the development program and operational risks in the field. Innovation for conventional forces creates the conditions for operational changes that require coordination across a large organization and a long time to implement. For SOF, however, rapid operational innovation is one of their fundamental qualities. Innovation for conventional forces is an institutional function, whereas rapid innovation for SOF is a function of the attributes of SOF personnel and culture.

This monograph continues with a discussion of SOF creativity and the need for rapid operational innovation as a means to change the nature of the risks of accomplishing military objectives. The following approach is used:

a. To understand the existing paradigm that limits rapid military innovation, overall conclusions from studies of military innovation are presented and the linear management of innovation is described.
b. To understand how innovation can occur rapidly, the characteristics of the creative act and the personality traits of innovators (for bottom-up innovation) are described and the speed of adoption of innovation is discussed.

A presentation of an alternative to the linear top-down model then demonstrates how innovation actually occurs as science and understanding, tools and technology, and missions and users each enable and inspire the others.

A new paradigm is then proposed; it replaces the linear top-down model with a rapid innovation braid, which incorporates the many factors that would allow SOF to innovate rapidly. The frame of reference should shift from concepts or technology development to rapid innovation, whether technical or otherwise. The ideal implementation would recognize that SOF creativity is an integral part of special operations and make the resources to innovate rapidly part of the resources to support the mission. Innovation for SOF should not be a separate function under top-down acquisition but bottom-up with operations. Advanced technology and understanding should no longer be thought of only as products that are supplied to SOF and which SOF use. The alternative is to integrate science and understanding with tools and technology and with missions and users, allowing the early adoption of concepts and technologies. A new understanding of the nature of innovation demonstrates how SOF can rapidly innovate and live.

The frame of reference should shift from concepts or technology development to rapid innovation, whether technical or otherwise.

2. SOF and the Need for Creativity

A *Theory of Special Operations* argues that SOF are differentiated from conventional forces by their fundamental qualities of elite warriorship, flexibility, and creativity.[5] In particular, in attempting to accomplish objectives, *creativity* is the ability to rapidly change the operational method to something different from what conventional forces can use: the ability to change the game in the middle of the game. In specific cases, SOF use creativity to avoid the methods used by conventional forces and the associated risks due to the unpredictability of war, yet still accomplish those objectives by changing the risks to those that can be overcome by SOF.

In theoretical terms, special operations are missions to accomplish strategic objectives where the use of conventional forces would create unacceptable risks due to Clausewitzian friction. Friction is a reality in war because "action in war is like movement in a resistive element," and "everything in war is very simple, but the simplest thing is difficult."[6] The effect of friction is to create risks of various kinds including physical risk to our forces and to noncombatants, risk of failure, and risk of negative political or strategic consequences. The new Joint Operating Environment (JOE) emphasizes the importance of friction:[7]

> There are other aspects of human conflict that will not change no matter what advances in technology or computing power may occur: fog and friction will distort, cloak, and twist the course of events. Fog will result from information overload, our own misperceptions and faulty assumptions, and the fact that the enemy will act in an unexpected fashion. Combined with the fog of war will be its frictions—that almost infinite number of seemingly insignificant incidents and actions that can go wrong. It will arise 'from fundamental aspects of the human condition and unavoidable unpredictabilities that lie at the very core of combat processes.'
>
> The constant fog and friction of war turns the simple into the complex. In combat, people make mistakes. They forget the basics. They become disoriented, ignoring the vital to focus on the irrelevant. Occasionally, incompetence prevails. Mistaken assumptions distort situational awareness. Chance disrupts, distorts, and confuses the most careful of plans. Uncertainty and unpredictability dominate.

> Thoughtful military leaders have always recognized that reality and no amount of computing power will eradicate this basic messiness.

In his comprehensive treatment, Barry Watts has derived the ultimate sources of friction:[8]

a. Constraints imposed by human physical and cognitive limits, whose magnitude and effects are inevitably magnified by the intense stresses, pressures, and responses of actual combat
b. Informational uncertainties and unforeseeable differences between perceived and actual reality stemming, ultimately, from the spatial temporal dispersion of information in the external environment, in friendly and enemy military organizations, and in the mental constructs of individual participants on both sides
c. The structural nonlinearity of combat processes that can rise to the long-term unpredictability of results and emergent phenomena by magnifying the effects of unknowable small differences and unforeseen events (or conversely, producing negligible results from large differences in inputs).

These sources of friction could be summarized as the inhumanity, uncertainty, and unpredictability of war, or more descriptively as follows: a) war is hell (inhumanity), b) we can't know what's out there (uncertainty), and c) we can't predict what will happen (unpredictability).

Conventional forces and SOF must deal with friction in operations to accomplish objectives. Conventional forces attempt to lower the risks by minimizing the effects of inhumanity, uncertainty, and unpredictability by (among other things) force protection, very lethal platform-based weapon systems, dispersion of forces, technology-based intelligence, deliberate planning, networking, economy of force, large numbers, uniformity and rigidity in doctrine and training, reserves, and caution.[9]

In many cases, depending on the nature of the conflict, the use of conventional forces is the most effective (or only) way to minimize risk and overcome friction by attempting to create certainty in the outcome. But there can also be some important objectives where the use of conventional forces would actually create unacceptable risks. Overcoming these risks and accomplishing these objectives requires SOF that directly address the ultimate sources of friction through qualities that are the result of the distribution of the

attributes of SOF personnel: elite warriorship, flexibility, and creativity. The definitions of these qualities follow:

a. **Elite warriorship.** SOF are specially recruited, assessed, selected, trained, and equipped and are engaged directly in the implementation of strategy.
b. **Flexibility.** A small SOF unit can have a much larger range of capabilities than even a large conventional unit as a result of the smaller range of (more capable) personnel.
c. **Creativity.** SOF rapidly change the combat process, which is made possible by greater attributes, training, and technology.

These fundamental qualities directly address the ultimate sources of friction, meeting inhumanity with elite warriorship, uncertainty with flexibility, and unpredictability with creativity:

a. **Inhumanity—war is hell—elite warriorship.** SOF have a smaller and tighter distribution of personnel with greater average attributes that exceed the constraints of conventional forces and which include among the attributes abilities to better deal with the intense stresses, pressures, and responses of combat.
b. **Uncertainty—we can't know what's out there—flexibility.** SOF units have a wide range of capabilities to apply to specific goals in the face of uncertainty (as well as a wide range of capabilities to discover the "ground truth," e.g., special reconnaissance, language and cultural knowledge).
c. **Unpredictability—we can't predict what will happen—creativity.** SOF execute operations to accomplish goals in ways that conventional forces cannot, avoiding the level of risk that would limit conventional forces by changing the process by which objectives are accomplished.

Flexibility can be thought of as tactical innovation using or modifying a wide range of existing capabilities, whereas creativity can be thought of as operational innovation to create new capabilities. While the three fundamental qualities of SOF are interrelated, the present discussion will concentrate on *creativity* as an expression of rapid operational innovation unique to SOF. This statement does not mean that conventional forces do not use innovation. Defense research, development, and acquisition as well

as concepts and doctrine development and organizational changes are almost all aimed at implementing innovation to establish new capabilities for conventional military forces. But creativity for SOF is *rapid operational* innovation. SOF need to innovate in ways and in places that conventional forces cannot.

It is worth emphasizing, therefore, that conventional forces cannot be reformed to give them the fundamental qualities of SOF (i.e., become more SOF-like). *A Theory of Special Operations* explains why SOF exist. Jessica Glicken Turnley uses the theory and insights from social science to explain why SOF operate effectively in small groups and why conventional forces cannot:

> SOF are organized and act in small groups because their comparatively homogenous, highly capable personnel allow small relatively undifferentiated teams to exercise flexibility and creativity, which mitigates friction in a fundamentally different way than the relative certainty of behavior exhibited by GPF, whose large manpower base with a wide range of distribution of critical attributes and capabilities requires large, functionally differentiated groups to be effective.[10]

In interviews, David Stirling (Figure 1) explained the origin of the Special Air Service (SAS) in World War II.[11] The British objective was the attack of landing grounds, remote airfields, and other German targets in North Africa. In conventional operations, the British used large numbers (mass and security) to overcome the risks due to friction caused by unpredictability, especially since the Germans initially had control of the air. "The commando technique was such that one entire commando, six hundred or so men, couldn't succeed in tackling more than perhaps two landing grounds on the same night, and more than three quarters of the force would be taken up with defending those who were actually operating." These numbers had to be transported to the site of the attack, sometimes by ship, "using a whole regiment to attack one landing craft."

The use of conventional forces created certain risks, especially risk of failure of the mission because of the large numbers and the need to provide transportation. While serving with the commandos, Stirling was "involved in a whole series of postponements and cancellations …" The idea of the SAS, on the other hand, was that they "should be capable of reaching a target by air, sea, or land without making any demands on expensive equipment, like

Figure 1. Patrol from L Detachment, Special Air Service (SAS), in North Africa during World War II, used by permission of The Imperial War Museum.

ships if it were a sea operation." Stirling related that, "We could use ancient aircraft, the Bombays, and be dropped by parachute and we could in due course create our own means of traveling behind the lines." This was possible because "We preferred for every sub-unit of four or five men to tackle a full target on their own, and if it failed it would be more than compensated for by the fact that with 60 men we could attack, theoretically up to 15 or 20 targets on the same night."

The SAS created both new operational concepts and equipment. They operated at night, built their own demolition charges, and mounted Vickers K aircraft machine guns on jeeps and trucks. Stirling's principles were that the SAS had to be regarded as a new type of force; had to be capable of approaching targets by land, sea, or air; had to exploit surprise to the greatest degree using guile and nighttime techniques; have a basic unit of four men; be independent with access to intelligence to select the correct targets; and have a special training center away from other units. The only way to implement these principles was to select special men with rare attributes.

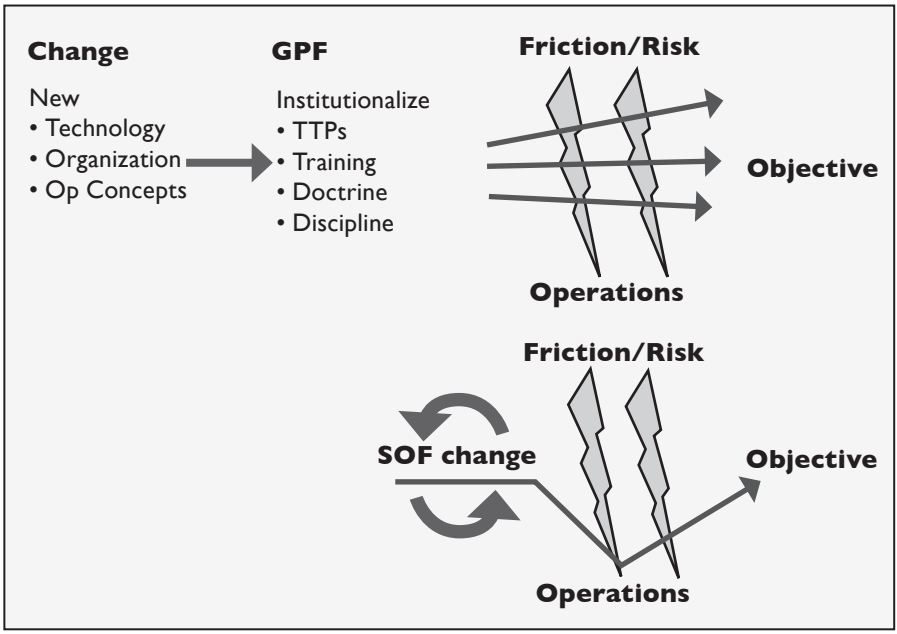

Figure 2. Innovation for GPF and SOF

Figure 2 illustrates the contrast between conventional forces (GPF) and SOF in how they can use innovation. In both cases friction and risk lie between the forces and their wartime objective and prevent the forces from easily accomplishing their goals. Both GPF and SOF may want or need to develop new capabilities by changing technology, organization, or operational concepts. Due to the need to assure the performance of conventional forces with large numbers of personnel with a wide range of individual attributes, new capabilities have to be institutionalized by a lengthy process of experimentation, training, and establishment of validated tactics, techniques, and procedures (TTPs). During operations, the only way for conventional forces to overcome the risks due to friction is to apply more of existing capabilities.[12]

For SOF, however, innovation can occur during ongoing operations to rapidly change the way to accomplish the objective, changing the nature of the risks away from those that would be experienced by conventional forces to risks that can be overcome by SOF. The SAS changed the risks from risk to executing the mission (coordinating large numbers of personnel and transport) and risk to the British forces from German air attack (easily detected slow-moving formations) to individual and small-unit risks of parachuting

or patrolling behind the lines and risks on the target of overcoming German security. The latter risks were more easily overcome by the special operators who could avoid detection and utilize surprise through superior individual attributes in specific areas. It is important to note that the SAS continued to innovate—for example, creating their own vehicles for patrolling and abandoning parachuting for airfield attacks. Creativity for SOF, therefore, is rapid operational innovation.

3. Military Innovation: Top-Down

According to Adam Grissom, a military innovation must have three characteristics:[13]

a. An innovation changes the manner in which military formations function in the field.
b. An innovation is significant in scope and impact.
c. An innovation is tacitly equated with greater military effectiveness.

Many authors have discussed the importance and the nature of military innovation.[14] This chapter will describe some of the characteristics and theories of conventional military innovation, which lead to the conclusion that it must be operationalized as a lengthy top-down process. SOF are military forces and have become more institutionalized and mainstream with the establishment of USSOCOM and integration into joint warfighting.[15] Thus, if performed under the same constraints as GPF, the way SOF innovate can be institutionally and fundamentally hampered in speed and effectiveness.

For a new capability to be created and implemented, various things usually must happen—for example:

a. Someone must devise a new concept.
b. Potential developers must accept the creative idea.
c. The innovation must be made useful.
d. The development must be transmitted to potential users.
e. The users must adopt and learn to use the innovation.

An innovation can be the creation of a totally new concept or the extension of an existing concept. Along the way, various resources may have to be captured to develop or purchase it. Often the assumption is that the various steps must occur independently and sequentially; because of this reductionism, past theories of innovation have usually only addressed isolated pieces of the overall problem. The large literature on innovation shows a variety of perspectives; some of the dominant ideas on military innovation are specifically discussed here.

Harvey M. Sapolsky, Brendan Rittenhouse Green, and Benjamin H. Friedman describe three political science theories of military innovation in the introductory chapter to their book, *U.S. Military Innovation since the*

Cold War.[16] The common theme is that military organizations are resistant to change:

a. The first theory is that military innovation is a gradual process. "Advocates of change find protectors, experiment doctrinally, and slowly climb the professional ladder."[17]
b. The second theory is that military innovation requires the intervention of influential civilians. (The creation of USSOCOM is cited as an example.)
c. The third theory is that innovation comes from competition among organizational rivals, such as interservice rivalry.

The point to be made about these three theories of military innovation is that they are theories about organizational change—that is, about the adoption of innovation. Technical or conceptual creativity is assumed to occur independently, and the issue that these theories address is how military organizations adapt or change. This premise is in direct contrast to the needs of SOF creativity where rapid innovation must occur during ongoing operations. Innovation for conventional forces creates the conditions for operational changes that require coordination across a large organization and a long time to implement. Innovation for conventional forces is an institutional function, whereas as discussed in chapter 2, rapid innovation for SOF is a function of the attributes of SOF personnel and culture.[18]

Turning to a more general discussion, Adam Grissom has described the overall landscape of military innovation studies.[19] One aspect of strategic studies is to understand how and why military praxis changes with time. See Table 1 for Grissom's four primary schools of military innovation research.

Table 1. Primary Schools of Military Innovation Research

Model	Description
Civil-military	Asserts that it is primarily civil-military dynamics that determines whether interwar militaries will innovate.
Interservice	Contends that it is competition for scarce resources in mission areas that are contested between services that promotes innovation.
Intraservice	Focuses on competition between branches of the same service and the establishment of new branches that embrace new military capabilities.
Cultural	Asserts that culture sets the context for military innovation, fundamentally shaping organizations' reactions to technological and strategic opportunities.

Examples of the applications of these models from Sapolsky et al. are the creation of USSOCOM, organizational competition, and advocates of change within a service. Further examples include the establishment of the Royal Air Force Fighter Command in World War II (civil-military), U.S. Army attack helicopters (interservice competition with the U.S. Air Force close-air-support mission), the Tomahawk cruise missile for surface warfare (intraservice competition with naval aviation), and the impact of service culture (e.g., the interest in standalone capabilities for the Navy, the emphasis on fixed-wing aircraft for the Air Force). Interestingly, the creation of USSOCOM is cited as an example of the management of intraservice politics (the relationships between SOF components and their parent services) as well as an example of civilian intervention.

Grissom puts these theories into context by describing all of them as top-down models. Because they all assume that military organizations are resistant to change and must be goaded into innovating, these models of military innovation operate from the top down:

> The civil-military model argues that senior civilian decision-makers interpret the geopolitical context and impose innovation on the military services with the help of maverick proxies within the service. The interservice model of military innovation argues that the senior service decision-makers, such as the chiefs of staff, determine the best course for the status and health of the service and then induce the service bureaucracy to innovate accordingly. The intraservice model contends that senior service members imagine a new 'theory of victory' then leverage the internal politics of their service to put the new theory into practice.
>
> Finally, the cultural model argues that a set of implicit beliefs exerts fundamental (if largely unseen) influence on the direction of military innovation. Senior leaders are the key to setting this culture. In instances where the culture is not amenable to the innovation that senior leaders view as necessary, they can and will manipulate the culture to ensure that the bulk of the service complies with the required innovation. According to the major models then, the senior officers and/or civilians are the agents of innovation. They recognize the need for change, formulate a new way of warfare, position their organization to seize the opportunity of innovation, and bludgeon,

politically leverage, or culturally manipulate the organization into compliance.

According to all the leading models of military innovation that have been used to organize historical experience, therefore, military innovation in general is top-down, and top-down innovation is a lengthy process. This is not to say that for GPF there are not good reasons that innovation works the way it does. For conventional forces, changing the *theory of victory* requires long times to develop concepts or acquire technology and institutionalize it (with validated requirements, acquisition planning, testing and evaluation, training, doctrine, and procedures, for example). For conventional forces, implementing new capabilities without institutionalizing them would create new unacceptable risks.

As an example of the risks of rapid innovation in conventional forces, over the last several years deployed forces have used operational needs statements (ONS) to obtain supplemental funds to purchase a variety of battle-command software systems, circumventing the Army Battle Command System (ABCS) implementation across the force. One analysis is highly critical of this bottom-up approach.[20] The intent of the ABCS is to enable network-centric warfare through the use of "information technology to provide warfighters a horizontally and vertically integrated digital information network that supports warfighting systems and assures C2 decision-cycle superiority." Due to the lengthy development and experimentation process in the 1990s, focusing on developing a First Digital Division (4th Infantry Division), units outside the experimentation process began to seek their own battle-command solutions. After 11 September 2001, deployed units used a combination of "Microsoft Office products, portals and emerging systems (e.g., CIDNE, FusionNet, TIGR, TACTICOMP, and effects-based tools)." According to Carol Wortman, the result is duplicative and inconsistent unit solutions that reduce the effectiveness of battle command and the efficiency of resources. "The impact of this nonstandardization is an inability of units to synchronize an approach to Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF) across the area of operations."

Throughout history, however, there have also been cases (within conventional forces) of successful bottom-up innovation that Grissom calls *anomalies*. He cites the application of the German Flak 18/36 antiaircraft

cannon as an antitank weapon during World War II, the development of U.S. Marine Corps small wars doctrine from 1915 to 1940, development of U.S. close air support in Europe during World War II, and the development of German storm troop tactics in World War I.

Creativity is innovation that can be applied rapidly to ongoing operations. Because top-down innovation is a protracted process, bottom-up innovation is the only way to innovate rapidly. Due to the attributes of SOF personnel, SOF can create and implement new capabilities without institutionalizing them to the same degree as GPF and without creating the same risks—that is, from the bottom up. Immediately changing the combat process without this lengthy institutionalization—that is, creativity—is part of SOF's *operational* capabilities. For SOF, bottom-up innovation must not be an anomaly.

4. Linear Management

Related to top-down innovation is the idea that innovation is a linear process. New basic understanding, creation of concepts, development of new applications, and actual use are assumed to be distinct and sequential activities that are funded and managed independently, each with top-down management and oversight. With regard to science and technology (S&T), for example, the National Science Foundation (NSF) funds basic science, the Defense Advanced Research Projects Agency (DARPA) was created to "foster advanced technologies and systems that create 'revolutionary' advantages for the U.S. military,"[21] and military technology acquisition is managed by the Department of Defense (DoD) 5000 Acquisition System "to translate users needs … and technology opportunities … into reliable and sustainable systems that provide capability to the user."[22] As shown in Figure 3, science and understanding, tools and technology, and missions and users are the three main areas in which innovation can occur, represented by (but not limited to) the NSF, DARPA and DoD acquisition, and actual use, respectively.

While Figure 3 is of course a simplified representation, it is the model that has guided the overall enterprise since World War II. The linear model is widely recognized and has been heavily influenced by Thomas Kuhn, a physicist and philosopher of science, and the thinking of Vannevar Bush, the director of the Office of Scientific Research and Development during World War II and the author of *Science: The Endless Frontier.*[23]

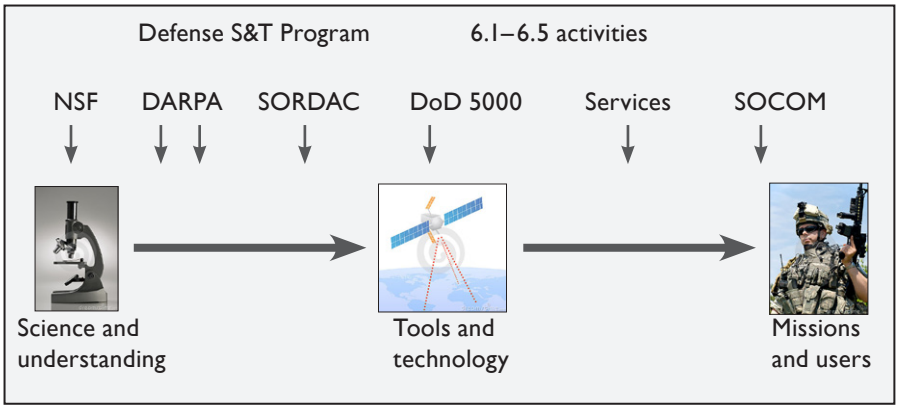

Figure 3. Linear View of Innovation

In the DoD acquisition system, technology opportunities are assumed to arise within the DoD laboratories and research centers, academia, and commercial sources (all managed and funded separately) and are identified by a process separate from acquisition (the Defense Science and Technology Program).[24] The DoD Financial Management Regulation establishes separate budget activities for basic research, applied research, advanced technology development, advanced component development and prototypes, system development and demonstration (otherwise known as *6.1* through *6.5* activities), as well as management support and operational system upgrades (*6.6* and *6.7*).[25]

In 1999 the U.S. General Accounting Office (GAO) produced a report on acquisition reform initiatives based on commercial practices to develop new products "faster, cheaper, and better"; it concluded that use of immature technology increased overall program risk.[26] The GAO recommended that the DoD adopt the National Aeronautics and Space Administration (NASA) technology readiness levels (TRLs). Therefore, TRLs are also included in managing military technology development; see Table 2 for the definitions.[27]

Table 2. NASA Technology Readiness Levels

TRL 1	Basic principles observed and reported
TRL 2	Technology concept and/or application formulated
TRL 3	Analytical and experimental critical function and/or characteristic proof of concept
TRL 4	Component and/or breadboard validation in laboratory environment
TRL 5	Component and/or breadboard validation in relevant environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment
TRL 7	System prototype demonstration in an operational environment
TRL 8	Actual system completed and qualified through test and demonstration
TRL 9	Actual system proven through successful mission operations

Note that various TRLs have separate processes for funding and managing (e.g., 6.2 vs. 6.3 funding). "Technology projects are not acquisition programs."[28]

Again, for conventional forces, developing or implementing new capabilities without managing technology maturity or institutionalizing capabilities (reliable and sustainable systems) would create new unacceptable risks, including financial and performance risks to the development program and

operational risks in the field. However, even for conventional forces, some believe that the process has gotten out of hand. Here is an extract from an editorial in *National Defense* by John Paul Parker:[29]

> Although volumes have been written about the need for defense acquisition reform, two key features of that process seriously impede the fielding of potentially revolutionary new capabilities … The first is the reliance of defense acquisition programs on formal and documented requirements, which specify the need and expected functionality of any new capability.
>
> The fundamental problem with requirements is the inability to specify a revolutionary new capability before the details of how it could be achieved are known. This is best expressed by John Chambers, editor of *The Oxford Companion to American Military History*, when he wrote: 'None of the most important weapons transforming warfare in the 20th century—the airplane, tank, radar, jet engine, helicopter, electronic computer, not even the atomic bomb—owed its initial development to a doctrinal requirement or request of the military.'
>
> The second issue confounding the process of adopting advanced technologies is the perceived risk associated with introducing anything 'immature,' meaning new. … While reducing reliance in immature technologies may lower the risk of cost and schedule problems, it also ensures that nothing revolutionary, innovative, or even new can make it into the system. … A common theme in the voluminous case studies spanning defense and commercial innovation success is that breakthrough capabilities often emerge not from the original vision of the technologists, nor the requirements of the end users, but through purposeful experimentation, and just plain tinkering, that occurs when imaginative early adopters have the ability to explore novel capabilities.

Both of these issues (requirements and technology maturity) address ways in which innovation is controlled and limited by the assumed linearity of the process. Requirements initiate the linear process, all of which is aimed at satisfying that specific requirement. (A common adage about military planning is that instead of accomplishing the mission, the objective becomes

executing the plan.) TRLs govern the development of innovation in a linear fashion as technology is assumed to progress from one TRL to the next.

In general, requirements as user needs do not represent bottom-up innovation because the requirements validation process results in top-down requirements that may have little resemblance to the original user requests or current needs by the time the technology is fielded. This point is illustrated by the formal USSOCOM process—that is, the long-range planning process at SOCOM headquarters provides the input to the requirements validation process, and no operator input is explicitly shown.[30] As a result, development projects (e.g., the Mk 23 offensive handgun) can show delivery of a capability that met the requirements but did not meet user needs.

Within the innovation area of *tools and technology*, the process has well-known gaps. For example, as previously discussed, advanced technology and acquisition are funded and managed separately; the result is a gap between prototype and production known as the much lamented *valley of death*:

> The traditional approach is for DARPA to produce a potential breakthrough technical capability and then rely on market forces to return that innovation to the military. … the problem with the passive market-driven model of technology adoption [is that it] … sometimes it takes a long time to catch on, or evolve, in ways not envisioned by the creators.[31]

The linear management of innovation has other gaps. Fundamental science and improved understanding are also done in relative isolation. For example, 6.1 funding, funding from the National Science Foundation, and funding from other sources are directed toward fundamental understanding. Gaps exist between that new understanding and whether it leads to new concepts or technologies and whether that understanding, tool, or technology is useful or used.

One significant characteristic of the linear model is that knowledge and information is forced to proceed from science and understanding to tools and technology and from tools and technology to missions and users (and perhaps back again). Another characteristic is that a tightly managed linear development process with validated requirements is designed to implement a preexisting idea. Here, *science and understanding* is not limited to new scientific knowledge, but includes creating new knowledge relevant to the missions and new knowledge about SOF themselves. *Tools and technology*

include new technical capabilities but also new concepts for operations. *Missions and users* include both the adoption of new technology for an operation and changes in the way existing technology is used.

If innovation is forced to proceed in the linear fashion by separately funding and managing components of the three areas of innovation, information flow among the areas is inherently slow and uncertain. In fact there may be almost no exchange of knowledge between the ends of the line, between missions and users, and those engaged in fundamental understanding. The limitations of the linear model may not be issues for conventional forces as the DoD acquisition process "represents a judicious balance of cost, schedule, and performance in response to the user's expressed need; that is interoperable with other systems (U.S., Coalition, and Allied systems, as specified in the operational requirements document); that uses proven technology, open systems design, available manufacturing capabilities or services, and smart competition; that is affordable; and that is supportable." [32]

If innovation is forced to proceed in the linear fashion … information flow among the areas is inherently slow and uncertain.

Overall, then, for conventional forces the linear model is used to manage various risks. However, the linear management of innovation is one of the factors that inhibit the rapid innovation SOF need. For SOF, slow and methodical innovation is a risk to SOF creativity. As will be discussed later, innovation in society as a whole often occurs in a far different fashion than the linear model imposes, and SOF can take advantage of a different model than the one that constrains the speed of innovation for conventional forces. Before that discussion, however, the next two chapters will introduce two important elements of rapid innovation that must be incorporated into a new model: the nature of individual creativity and the speed of adoption.

5. Genesis of Innovation

SOF creativity, as rapid operational innovation, is related to the general idea of creativity, per se. Creativity is defined as "the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful …)."[33] Creativity is the genesis of innovation, the generation of the new idea itself, whereas innovation is the implementation of change. The reason for choosing creativity (rather than innovation) to describe a quality of SOF in *A Theory of Special Operations* is the popular perception that creativity is a rapid process, a flash of insight. For SOF to implement operational change rapidly, SOF themselves need to produce novel and appropriate ideas to change ongoing operations. This is what it means to innovate from the bottom up. If SOF are to preserve and expand their creativity, it is worth examining what we know about it.

The creative act—the origin of a new idea that must be present for innovation to occur—has many theories and methods of study. Explanations of creativity have included mystical, pragmatic, psychoanalytic, psychometric, cognitive, and social-personality approaches. Suffice it to say there is no consensus on what makes an individual creative or even how to promote creativity. Some recent research supports the idea that multiple components must converge for creativity to occur. These may include a combination of cognitive and personality traits. For example, the investment theory cites intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment.[34] Since SOF are selected out of the general military population and the resulting distribution of individual attributes allows them to be creative (rapid operational innovation), the selection processes must at least implicitly favor individuals who have some of the required traits.[35] Of particular interest for SOF is the importance of intrinsic, task-focused motivation. People rarely do creative work unless they focus on the work rather than on the potential rewards.

Just as the many theories of military innovation portray a common theme (top-down innovation), the diverse literature on creativity also illustrates a few fundamental ideas. The foremost is that creativity (whether scientific or artistic) always consists of "novel combinations of preexisting mental elements."[36] Creativity involves the association of ideas that have not previously been connected. An example is the invention of the McCormack reaper that revolutionized agriculture in 1834. McCormack associated stalks of

grain with hair and since clippers cut hair, he visualized that something like clippers could cut grain.[37]

Another theme is that novel ideas do not arise from deduction or from a process of pure conscious calculation. As far back as Helmholtz (1896),[38] the creative process was observed to occur in four stages:

a. **Preparation** is the study of the problem and learning about ideas that might be relevant. In light of the importance of the association of disparate ideas for creativity, this study must include but cannot be narrowly focused on the issue and historical methods to approach it. A broad understanding far beyond the apparent applicability to the problem at hand is far more likely to lead to a creative solution.
b. **Incubation** is the second stage. Unless the problem is trivial, a solution will not be apparent by direct study. The creative mind needs time to make subconscious associations between the widely differing kinds of ideas that might be combined.
c. **Inspiration** occurs at some point, seemingly without effort, and the novel solution appears.
d. **Elaboration** is the last stage; it is where the new idea must be subjected to scrutiny and developed to make it useful.

Note that the linear model for innovation inhibits creativity because creativity is the combination of disparate ideas. An individual has little opportunity to develop understanding across the three separately managed realms of science and understanding, tools and technology, and missions and users. In addition, top-down innovation forces the adoption of a given idea. This approach inhibits incubation and the possibility of incorporating ideas far removed from the narrow field of development.

Although creativity is an individual trait, SOF are a collection of organizations organized into small units, and it is in these SOF units that rapid innovation must occur.[39] M. J. Kirton provides one instructive example of the role of individuals in institutional innovation in "Adaptors and Innovators: Why New Initiatives Get Blocked."[40] Kirton places the thinking styles of individuals on a continuum from "adaption" to innovation:

> *Adaptors* characteristically produce a sufficiency of ideas based closely on, but stretching, existing agreed definitions of the problem and likely solutions. They look at theses in detail and proceed within the

> established paradigm (theories, policies, mores, practices) that are established in their organisations (*sic*). Much of their effort in effecting change is improving and 'doing better' … *Innovators*, by contrast, are more likely in the pursuit of change to reconstruct the problem, separating it from its enveloping accepted thought, paradigms, and customary viewpoints, and emerge with much less expected, and probably less acceptable solutions … They are much less concerned with 'doing things better' and more with 'doing things differently.'

Within an organization, both adaptors and innovators bring strengths and weaknesses especially depending on whether the organization is dominated by one or the other and whether the organization is responding to a situation that is highly structured or is inherently unstructured. Table 3 lists the asserted behavior descriptions of adaptors and innovators.

Table 3. Behavior Descriptions of Adaptors and Innovators

Adaptor	Innovator
Characterized by precision, reliability, efficiency; seen as methodical, prudent, disciplined	Seen as thinking tangentially, approaching tasks from unsuspected angles; undisciplined, unpredictable
Concerned with resolving problems rather than finding them	Could be said to discover problems and discover less consensually expected avenues of solution
Seeks solutions to problems in tried and understood ways	Queries problems' concomitant assumptions; manipulates problems
Reduces problems by improvement and greater efficiency, with maximum of continuity and stability	Is catalyst to settled groups, irreverent of their consensual views; seen as abrasive, creating dissonance
Seen as sound, conforming, safe, dependable	Seen as ingenious; unsound, impractical
Does things better	Does things differently
Liable to make goals of means	In pursuit of goals liable to challenge accepted means
Seems impervious to boredom, seems able to maintain high accuracy in long spells of detailed work	Capable of detailed routine (system maintenance) work for usually only short bursts. Quick to delegate routine tasks
Is an authority within given structure	Tends to take control in unstructured situations

Adaptor	Innovator
Challenges rules rarely, cautiously, when assured of strong support and problem solving within consensus	Often challenges rules. May have little respect for past custom
Tends to high self-doubt when system is challenged, reacts to criticism by closer outward conformity. Vulnerable to social pressure and authority; compliant	Appears to have low self-doubt when generating ideas, not needing consensus to maintain certitude in face of opposition; less certain when placed in core of system
Is essential to the functioning of the institution all the time, but occasionally needs to be 'dug out' of his systems	In the institution is ideal in unscheduled crises; better still to help to avoid them, if can be trusted by adaptors
When collaborating with innovators: supplies stability, order, and continuity to the partnership	When collaborating with adaptors: supplies the task orientations, the break with the past and accepted theory
Sensitive to people, maintains group cohesion and cooperation; can be slow to overhaul a rule	Appears insensitive to people when in pursuit of solutions, so often threatens group cohesion and cooperation
Provides a safe base for the innovator's riskier operations	Provides the dynamics to bring about periodic radical change, without which institutions tend to ossify

Reproduced with permission from Dr. Kirton 2010[41]

Note that the individual characteristics needed for SOF creativity are exclusively in the innovator column—for example, approaches tasks from unsuspected angles, queries the assumptions of problems, does things differently, challenges accepted means, takes control in unstructured situations, and is ideal in unscheduled crises. This is not to say that innovators are *better* than adaptors or that SOF should be exclusively innovators. Organizations typically need a mix of innovators and adaptors, and individuals themselves are scored on a continuum. Use of Kirton's Adaption-Innovation (KAI) theory by Kenneth Poole at the Joint Special Operations University indicates that special operators already are mild innovators. The mean score on the KAI inventory for the population as a whole is 95 (in an observed range from 45 to 160); for military officers it is 96, and the mean score for special operators is approximately 102.[42] An important goal for SOF may be to maintain this implicit selection and protection of innovators. With regard to the latter, it is important to note that innovators in organizations dominated by adaptors are often punished for their ideas even when their ideas eventually prove to be valuable.[43]

Although the understanding of individual creativity includes great uncertainty, important themes are as follows:

a. Creativity involves the association of ideas that have not previously been connected.
b. Novel ideas do not arise from deduction or from a process of pure conscious calculation but from preparation, incubation, inspiration, and elaboration.
c. Intrinsic task-focused motivation is important.
d. The personality traits of innovators in organizations match attributes of SOF for creativity.

6. Speed of Adoption

In studying changes in technology in society, in general, one important issue is the speed with which a new technology is adopted.[44] For SOF, the answer is directly related to the speed with which innovation in operations can occur. Even when a new technology allows advantages in performing some business or social function, that technology is not immediately adopted by everyone who can benefit. In general, an S-shaped curve shows use over time where very few entities initially adopt the technology, followed by a period of more rapid adoption, and finally a decline in the rate of adoption (see Figure 4).[45]

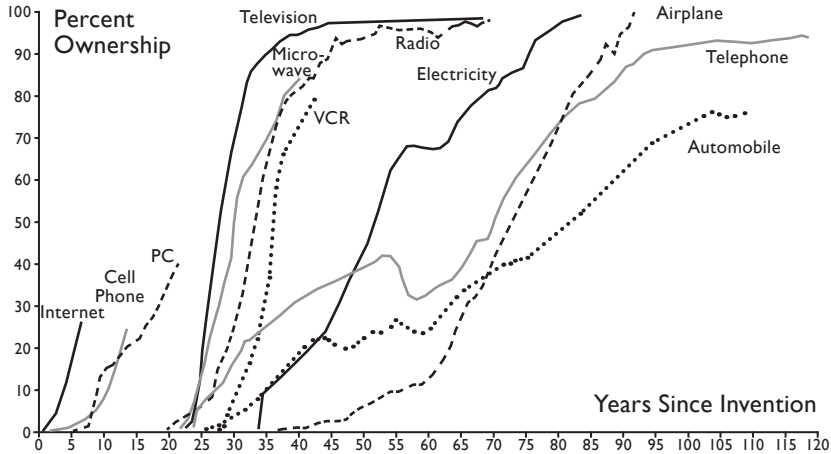

Figure 4. The S Curve of Adoption of Various Technologies (1996)[46]

The most common model that accounts for the S curve is the so-called epidemic model; it asserts that what limits the speed of usage is information about the technology, which could spread both from a central source and from user to user. Although knowledge of a new technology can spread from a central source, mathematically the observed S-shaped curve is the result of transmission from user to user. Limitations of diffusion models are that innovations often fail (do not diffuse at all) and as follows:[47]

> Diffusion stories that are designed to explain the S-curve usually take the appearance of '*the*' new technology for granted and focus on the question of why it takes so long to diffuse. However, it is rarely

> clear to anyone at the time that '*the*' new technology has arrived or which of several variants it is: it is only with the benefit of hindsight that '*the*' technology stands out.

Another important feature of the epidemic models is the need for a class of *early adopters*. Information does not diffuse until there is an initial base of users who do not depend on other users to provide knowledge of the advantages of the innovation. If the goal is to be rapid innovators, SOF must be early adopters (if not the actual originators of the innovation). This is another way of stating the need for bottom-up innovation.

One analysis of technology adoption identified four key variables for technology transfer within and among organizations:[48]

a. **Communication interactivity** ranges from passive media-based linkages that target many receptors to interactive person-to-person linkages.
b. **Distance** includes both geographic distance and differences in culture.
c. **Technology equivocality** refers to the concreteness of the technology. A highly equivocal technology is one that requires a lot of external knowledge to use (e.g., one without associated TTPs), whereas an unequivocal technology is self-contained in application.
d. **Personal motivation** refers to the variety of ways in which the activity is important to the individuals involved.

The most successful technology transfer occurs with high motivation, low geographic and cultural distance, highly interactive communication, and low equivocality. This monograph essentially argues that for SOF to be creative they need to adopt technology with high equivocality: early adoption leading to ambiguity in how the technology will be used with a lack of formal requirements and TTPs. Because of the lack of this one key element, the other three assume even greater importance. SOF (missions and users) are highly motivated, but the participants in science and understanding and tools and technology must also be highly motivated. The geographic and cultural distance between personnel engaged in missions and users, science and understanding, and tools and technology must be minimized. And the communication between all three must be personal and interactive.

A critical point is the nature of the transmission of an innovation. A common adage is that "innovation is a contact sport."[49] In fact, case studies have shown that personal contact is the most important factor in the

diffusion and adoption of innovation.[50] Personal contact is expensive in the short run but immeasurably cost effective in the long run.

David Stirling's creation of the SAS is an almost literal example of innovation as a contact sport. While in the hospital recovering from a parachuting accident during his first jump ("partly for fun, partly because it would useful to know how to do it"), Stirling wrote a paper on his proposal for a Special Air Service. How he managed to get it adopted is a legend:[51]

> I eventually recovered the use of my legs, but was still on crutches when I went to Middle East Headquarters with my plan. I didn't tell anyone who might have spoiled my surprise because I had to get to the generals like Ritchie and Auchinleck.
>
> There was no way you could put it in, except to the C-in-C. Never at Middle East HQ. … In the short gap between the First and Second World Wars, the great active soldiers who survived were in active command. But there was an enormous residue of staff officers from the First World War who didn't fight, who set the spirit of the administration. And it was ludicrously swollen, unnecessarily big, and wholly obstructive to anything that looked like a new idea.
>
> There was no way I could chance giving it through normal channels, because it would have been throttled long before it got up to anyone capable of making a decision. If it was intercepted at a lower level it would be sent upstairs with a very negative opinion attached to it. Whereas if I got it direct, I knew I could argue with a general.
>
> So I decided to go and see the Deputy Chief of General Staff, General Ritchie. I was going to indicate I wanted to see his military assistant, because he'd been in the Scots Guards, so it gave me an alibi to go there.
>
> Unfortunately I didn't have a pass, and I was refused admittance. I was still on crutches at the time, so I had to use my crutches as a kind of ladder to get over the wire when the guards weren't looking. Unfortunately they looked just after I got to the ground on the other side. And I wasn't able to run very fast because now I was lacking the crutches. So I had to dive into the first door—it looked like entering a burrow and I thought I might be able to escape the pursuit.
>
> And, by sheer good luck, it happened to be that part of Middle East Headquarters in which the chap I was looking for had his office.

But when I began talking to him, it became clear that he was the same chap whom I'd previously known in the Scots Guards at Pirbright and who'd tried very hard to get me sacked as I'd fallen asleep in one of his lectures. So when I appeared and put a paper in front of him, he was absolutely outraged.

Then he heard the noise of the pursuit, and as they came down the corridor I knew I was going to get no sympathy there, so I hopped out and into the next room, which was General Ritchie, which was another rare bit of good fortune, and asked him to read this paper.

It took him rather by surprise—it was only in pencil—but he was very courteous and he settled down to read it. About halfway through he really got quite engrossed in it, and had forgotten the rather irregular way it had been presented. There was a lot of screaming in the passage; Ritchie pushed a button without looking up from this rather grubby pencil-written memo, for his ADC to come in. And this ADC was astonished to find me sitting snugly in the general's office. "What's all the fuss in the passage?" says Ritchie. "Well, there's an individual who's got in here illegally and we're chasing him—we don't know where he's got to." "Oh well, sit down, I've got an important paper here." And Ritchie went on reading, didn't even look up.

And when he'd finished, Ritchie said he would submit it right away to Auchinleck, but in the meantime he would give an affirmative answer—he would like to take it up; it wasn't going to cost anything in troops or equipment. A lot of the commandos had been disbanded and were being drafted home, and I should get going in preparing a camp and recruiting the establishment of sixty-five men for which I'd asked, and that there things should start tomorrow.

7. A Rapid Innovation Braid

Colin Jackson and Austin Long assert that SOF are perhaps the most innovative force in the post-Cold War period:

> The development of precision weaponry and advanced communications enabled Special Operations Forces to influence major outcomes on the conventional battlefield. These technologies increased the interoperability of [SOF] and conventional forces. Once treated as marginal interlopers, [SOF] now offered conventional air and ground forces the ability to prosecute the deep battle more effectively.[52]

But there is a difference between innovation and rapid innovation. The capabilities Jackson and Long cite were developed over a relatively long period of post-Cold War time and adopted by SOF over the course of the current conflict. As previously discussed, SOF need to innovate rapidly to change the nature of the risks that arise from unpredictability due to friction. As we saw in the creation of the SAS, SOF change the nature of risks *during ongoing operations* to accomplish the mission by *rapid* innovation. If conventional forces must use top-down and linear innovation to overcome institutional resistance and manage programmatic, performance, and political risks, then SOF may also be able to overcome those risks if they do innovation differently.

Because military innovation as traditionally practiced is a lengthy process, current initiatives for concept development or rapid equipping emphasize the incorporation of mature technology or changing the way existing technology is used, even for SOF. In fact, SOF are better able to rapidly incorporate new operational concepts or existing technology without lengthy institutionalization. Without the ability to rapidly utilize new understanding as well as advanced technologies and concepts, however, SOF cannot as effectively create an asymmetrical advantage by creating new ways to accomplish objectives and fulfill their purpose. In addition to rapid innovation, per se, a goal here is to examine how to extend rapid innovation for SOF, including advances in science and understanding and the development of new tools (concepts) and technology.

Previously discussed were the factors that limit the ability of conventional military forces to innovate rapidly. In particular, top-down innovation and linear management of innovation are both lengthy processes. For SOF

creativity (rapid innovation applied to ongoing operations), innovation for SOF must originate with SOF at the military objective (bottom-up) and avoid the lengthy linear process.

The limitations of the top-down and linear model of knowledge production have been recognized for some time. In fact, successful innovation in society often does not fit this process at all. A more general description of innovation will allow us to understand how innovation can be done rapidly across the spectrum from the bottom up.

According to J. Y. Tsao et al.,[53] innovation can occur in the three areas of science and understanding, tools and technology, and societal use and behavior; for SOF, this monograph refers to the latter as mission and users. Each of these areas can yield a totally new idea that creates a new paradigm (what Tsao et al. call *research*) or that extends an existing paradigm (what Tsao et al. call *development*) within the area itself. All three categories of technical knowledge are produced in analogous stages. However, these three areas can also either inspire or enable research or development in the other two. Rather than being linearly arrayed, the three areas are actually

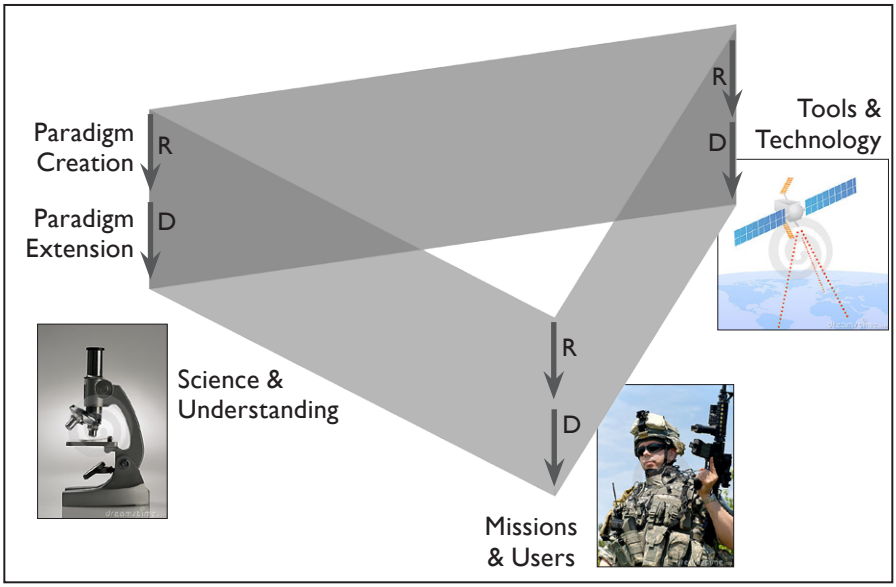

Figure 5. The Innovation Space. Adapted from *Research Policy*, Vol 37, Issue 2, March 2008i, J.Y. Tsao, K.W. Boyack, M.E. Coltrin, J.G. Turnley, W.B. Gauster, Galileo's stream: A framework for understanding knowledge production, pp. 330-352, Copyright 2008, with permission from Elsevier.[54]

connected in a fashion that allows the flow of ideas in a manner that is illustrated in Figure 5.

Isolated innovation paths occur in each area (along the legs in Figure 5) with basically no interaction among the areas.[55] These represent isolated scientific research and development, isolated concept or technology development, and isolated changes in user behavior or applications of existing technology, just like in the linear model where these areas are funded and managed separately. But there are also interactive innovation paths (visualized as occurring along the planes connecting the legs in Figure 5) where *research* or *development* in each area can either enable or inspire research or development in the other two.

The linear model (Figure 3) assumes that in bridging the gap between the isolated paths, interactive paths flow (however tenuously) from science to enable technology and from technology to enable behavior. A classic example is how a new understanding of solid state physics led to the invention of the transistor and transistor-based technologies, which led to all the uses of solid-state technology on the battlefield. However, this is only one example, and reality is much richer. Unlike the linear model, experience shows that the flow of innovation does not take a single path nor is it one-way. Examples of these interactions are shown in Table 4. (The reader will undoubtedly be able to think of more and better examples.) The conventional linear path for technology is shown as the dotted arrow.

For SOF, isolated innovation in *missions and users* is pure change in how SOF use existing technology or conduct operations.[56] Pure concept or technology development and pure understanding may be perceived to be of little interest if they do not transparently apply to changes in SOF operations. But recall that creativity is the association of disparate ideas. The interactive innovation paths are where missions and users, tools and technology, and science and understanding inspire or enable each other.

Highlighted examples in Table 4 show where science and understanding and tools and technology enable SOF (as missions and users) and where SOF inspire science and understanding and tools and technology. The first observation is that, as promised, these interactive innovation paths already exist for SOF. In the current paradigm, however, they are all thought of as separate functions. For example, operations inspiring technology (the need for better night vision) is now the function of the requirements process, whereas understanding that enables operations (changes in counterinsurgency due to

Table 4. Examples of the Interactive Innovation Paths

Enables	Science and Understanding	Tools and Technology	Missions and Users
Science and Understanding	Isolated science	Invention of the transistor due to solid state physics	Changes in counter-insurgency operations from cultural knowledge
Tools and Technology	Neuroscience because of the ability to measure electric potentials (EEG)	Isolated technology	Changes in operations because of digital technology
Missions and Users	Creation of the scientific method	Creation of SEMATECH by industry for semiconductor research	Isolated operations
Inspires	Science and Understanding	Tools and Technology	Missions and Users
Science and Understanding	Isolated science	Advances in supercomputers to study complex scientific problems	Behavior guided by understanding: SOF values, SOF selection
Tools and Technology	Combustion research to understand internal combustion engines	Isolated technology	New missions to address technology-related national security issues: counterproliferation
Missions and Users	JSOU Strategic Studies to understand SOF roles and missions	Advances in night vision to enhance operator effectiveness	Isolated operations

increased cultural understanding) is the function of concepts and doctrine development. In particular, technology innovation (the linear process represented by the dotted line) is divorced from all the other innovation paths. The separate functions are not synchronized and many (if not all) are performed in a lengthy deliberate manner with separate funding and management.

The new understanding is that all of these interactive paths are part of the same overall process of innovation, and we may be able to integrate them to make innovation more rapid and effective. Based on the previous discussion, SOF must avoid top-down innovation: SOF must be early adopters if not the actual originators of the innovation and have the ability to adopt technology with ambiguity in how the technology will be used. Individual creativity is the novel combinations of disparate ideas, so SOF personnel need to be exposed to a broad range of knowledge far beyond the apparent applicability to the problem at hand. SOF need to take advantage of the stages

of creativity—preparation, incubation, inspiration, and elaboration—and continue to select and nurture *innovators* who approach tasks from unsuspected angles, query the assumptions of problems, do things differently, challenge accepted means, and take control in unstructured situations.

To speed adoption, SOF creativity must occur with high motivation, low geographic and cultural distance, and highly interactive communication between missions and users, science and understanding, and tools and technology. SOF (missions and users) are highly motivated, but the participants in science and understanding and tools and technology must also be highly motivated toward accomplishing the SOF mission. The geographic and cultural distance between SOF and participants in science and understanding and tools and technology must be minimized. And the communication between all three must be personal and interactive: personal contact is the most important factor in the diffusion and adoption of innovation.

A new model for SOF creativity must take advantage of the entire innovation space (Figure 5) but create an intimate contact between the three areas of innovation, forcing personal contact, motivation, cultural understanding, and the direct influence of operations across the spectrum. In this model direct contact between the three areas of innovation for SOF will support the interactive innovation paths, making it possible and efficient for all of the enabling or inspiring interactions to occur rapidly and innovation to be adopted rapidly, a concept illustrated in Figure 6.

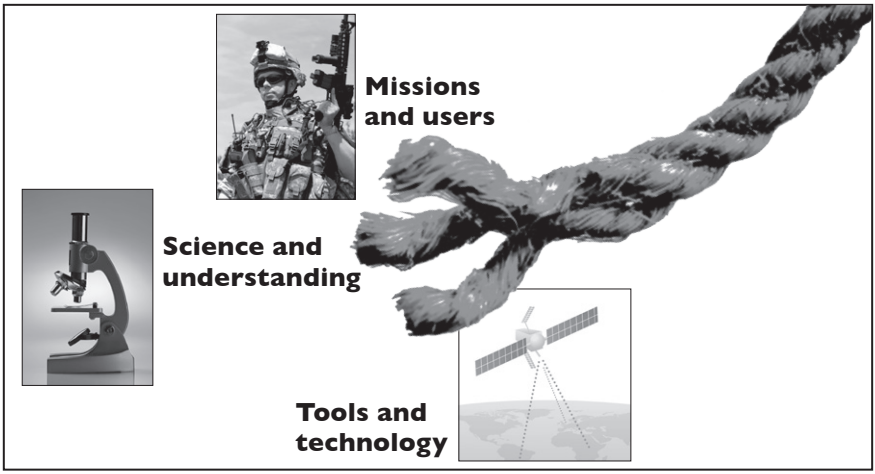

Figure 6. A Rapid Innovation Braid

In this model, science and understanding, tools and technology, and missions and users are entwined in a kind of braid. Just like the linear model, this concept is just a construct. However, just as the linear model determines the implementation of innovation through resources and management (e.g., TRLs, distinct budget activities), this new model can be used to guide the implementation of rapid innovation for SOF. The goal for SOF will be to support the entire innovation braid, integrating science and understanding and tools and technology with operations.

For example, experience in operations might reveal difficulties in a specific environment in identifying enemy combatants among a neutral population. The linear approach would result in validated requirements for a specific solution (e.g., biometric identification), research and development, technology acquisition, changes in TTPs, and ultimately changes in operations, all managed and funded separately. A new approach to counterinsurgency operations might incorporate experts with broad knowledge of culture and counterinsurgency, physics and chemistry, and surveillance and reconnaissance to experience the difficulties firsthand and create a solution that may or may not involve new technologies, the creation of which could be directed by the operational experts to be one best suited to the operational environment. This approach would not require new resources overall since the limited number of new operational personnel could replace personnel no longer supporting the old linear process.

The innovation braid incorporates several idealized features. Implementation of the braid can reduce the geographic and cultural distance between the three areas of innovation if practitioners are co-located and thus learn to understand each others' cultures. Since science and understanding as well as tools and technology are in direct contact with missions and users, practitioners in all three areas will be motivated to support the mission. The widest possible range of understanding will be available to the operators who can exercise creativity by the association of previously unconnected ideas. SOF can be early adopters of even ambiguous technology because they will have access to technology before widespread use. If less time is spent seeking only a preexisting technical solution to a given problem (how to do the existing mission better), more time will be available for incubation and inspiration to result in a creative solution. Finally, personal communication will be enhanced for communicating new ideas and innovation as a "contact sport."

Figure 7 illustrates the application of the innovation braid to SOF creativity for ongoing operations.

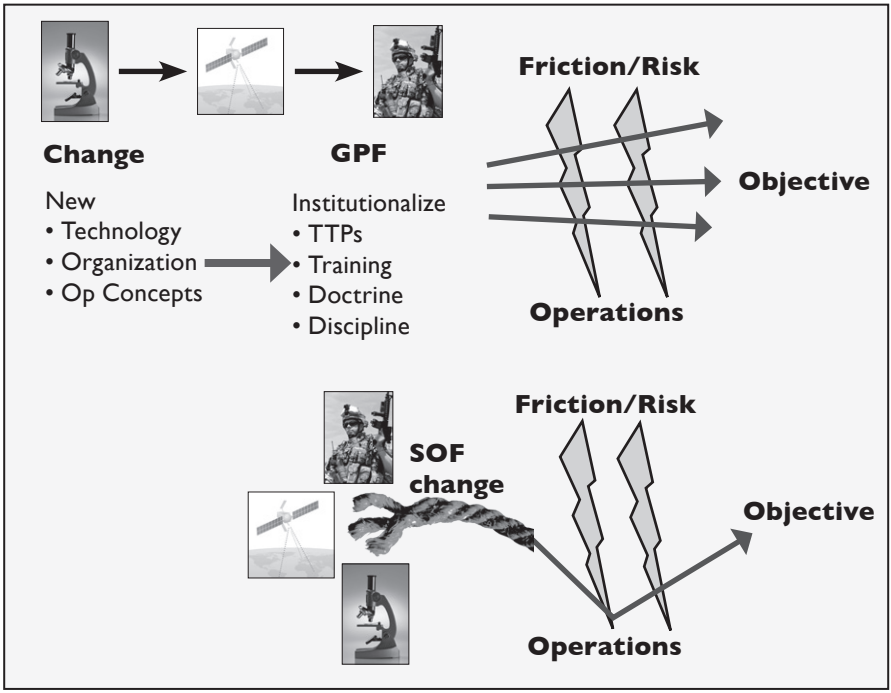

Figure 7. Innovation Braid as Part of Ongoing Operations

8. Rapid Acquisition in Context

This chapter will use the previous discussion to analyze some existing initiatives for rapid acquisition, thus placing them into context. Attempts have been made to more closely tie technology developers with operational needs for both conventional forces and SOF. The conventional example, in particular, will illustrate why rapid innovation is so difficult for conventional forces and why SOF should not rely on the mechanisms for conventional innovation.

In testimony to the House Armed Services Committee, Director of Defense Research and Engineering (DDR&E) Zachary Lemnios emphasized the importance of innovation, speed, and agility for military technology development as a whole:[57]

> I view outreach as an important element of our strategy to implement the SecDef's goals. During my first months as DDR&E, I made it a priority to visit all of the combatant commanders (COCOMs) to understand their near-term priorities and their future needs. I heard some common themes from our discussions and the need for immediate solutions. Each COCOM asked for the 80 percent solution today, rather than 100 percent solution years from now. The commanders asked for my help in finding ways to innovate in the field, and we did this by coupling our S&T workforce with the users in the field to provide immediate feedback to our rapid prototyping and formal acquisition programs. In fact, there are now over 70 embedded science and technology advisors that provide direct feedback and assessment of ongoing development programs. These are our technology scouts and transition agents in the field.

In light of the previous discussion, it is hard to be too critical of DDR&E's effort to promote more rapid innovation. This outreach is certainly an example of innovation as a contact sport. However, there are some key observations. First, the DDR&E initiatives are efforts to make the existing top-down linear system function more rapidly, essentially by accepting more risk ("the 80 percent solution today, rather than 100 percent solution years from now"). That risk may not be acceptable in the long run.

Second, the system is still top-down. With the exception of SOF, *innovation* in the field consists mostly of more S&T advisors to inform the linear

development of technology in rapid prototyping and acquisition. These S&T advisors provide greater contact between tools and technology and missions and users, but they support the linear interactive path through better *requirements*. In addition, as an example, DDR&E fast-ramp initiatives were directed and implemented from above:

> We examined cyber; computer science; electronic warfare; tagging, tracking, and locating, helicopter survivability, applied advanced mathematics; development of a rapid capability toolbox; and deployable force protection. Each study was tasked to develop a thorough understanding of the technical challenge and the emerging threats, to recommend mitigating capability concepts to mitigate the challenge and to identify and also devise a credible technology transition strategy. We captured ideas from across the S&T enterprise, industry, and academia. The reports were delivered in late summer and early fall and were used to confirm ongoing efforts and prioritize new S&T initiatives, which were included in the PBR-11.

Third, as documented by Lemnios's testimony, S&T is funded and managed separately through "67 DoD laboratories dispersed across 22 states . . . 10 Federally Funded Research and Development Centers (FFRDCs), 13 University Affiliated Research Centers (UARCs), and 10 Information Analysis Centers (IACs) . . . " as well as programs with industry and academia. To be fair, DDR&E is responsible for technology for the entire military, and the S&T enterprise must be correspondingly huge. However, this size is one of the reasons that the top-down linear model manages risk for the military as a whole.

In addition to DDR&E efforts to speed innovation in the linear model, USSOCOM also recognizes some of its limitations. According to William Shepherd, S&T advisor to the commander, USSOCOM, advanced capabilities are developed through the lengthy process from technology discovery through research and development and eventually make it into the Program Objective Memorandum (POM) that funds acquisition.[58] The gap in the timeline is the lack of capability to rapidly deliver technologies to the operators. This leads to initiatives for rapid equipping that emphasize the incorporation of mature technology or changing the way existing technology is used.

For SOF specifically, two key initiatives to promote rapid innovation are the Mobile Technology Complex (MTC) program and the classified Hardedge

Web site to promote a science and technology network.[59] The mission of the MTC is to "innovate, modify, adapt, and repair material 'in situ' to enhance capabilities of SOF." The MTC is more a contribution to *flexibility* as tactical innovation than an example of *creativity* as rapid operational innovation. The MTC consists of modules deployed to the theater that are essentially a mobile fabrication capability supported by engineers and technicians trained on innovative rapid fabrication, assigned to each MTC, as well as the capability for *reach-back* communication for collaborative engineering support and technology insertion from CONUS. Thus the MTCs represent a significant enhancement in the isolated innovation path in missions and users, changing the way SOF use existing technology, as well as an enhancement in the linear interactive path between tools and technology and missions and users in inserting new technology. These are both ways to make the linear model function more rapidly and effectively but could become part of the innovation braid if *science and understanding* were also co-located with the operators and engineers, increasing personal motivation and communication among all three, if there was effective interaction to reduce the cultural distance, and if the MTCs had the resources to direct innovation on a larger scale (bottom-up).

The S&T network supported by the classified Hardedge Web site is more directly related to implementing the innovation braid by linking the MTCs, a Global Mission Support Center at USSOCOM headquarters, various government laboratories, and industry and academia. This relationship would enhance the communication between the strands of the braid (missions and users, tools and technology, and science and understanding), supporting both the isolated and interactive innovation paths. The major issues with Hardedge are that "innovation is a contact sport" and resources are still managed top-down. Hardedge makes a communication resource available for operators to anonymously present issues and needs for which scientists and engineers can propose solutions that would be vetted and resourced through the headquarters, all linked electronically. However, as we have seen, personal motivation and personal contact are two of the most important factors in the diffusion and adoption of innovation. Personal motivation is also critical for the creative act itself. It is not clear whether scientists, engineers, and operators will be highly motivated to participate in the absence of personal trust built by face-to-face contact. Hardedge could be a useful communication tool for those who already had personal contact and

developed relationships, but the top-down control of resources will limit the speed of innovation.

9. Creative Possibilities for SOF

> They will face and solve problems that no one has faced before, and their successes will deter action against us by our adversaries or will be the triggers for the greater victories of our military and our nation.
>
> — SOF Vision

What would the implementation of rapid innovation look like for SOF? The innovation braid is an idealized concept that may never be fully realized in practice. The intent is to create a new way of thinking about innovation for SOF that can be used to guide new initiatives, and place existing initiatives into context, to assess to what degree they support rapid innovation. In that spirit, this chapter will explore some radical ideas about implementation.

Recall that for SOF, rapid operational innovation changes the nature of the risks in accomplishing an objective away from those that would be experienced (and be unacceptable) by conventional forces to risks that can be overcome by SOF. The risk of using conventional innovation is that operational objectives would only be met in a conventional manner, overcoming friction in the short run by applying more of the same existing capabilities, leading to the inability to accomplish strategic objectives that SOF otherwise could meet. Doing innovation differently will create a different set of risks that are generally unacceptable to conventional forces. Examples could include programmatic risks (cost, schedule, and performance) and risks to interoperability and sustainability. But with rapid innovation as part of the execution of operations, the role of SOF is to use the unique qualities of SOF to overcome those risks, making it possible to accomplish objectives that conventional forces cannot.

Doing innovation differently will create a different set of risks that are generally unacceptable to conventional forces.

To innovate from the bottom up, the ideal implementation of the innovation braid would recognize that SOF creativity is an integral part of special operations and make the resources to innovate rapidly part of the resources to perform the mission. Innovation for SOF should not be a separate function under top-down acquisition but bottom-up with operations. The frame

of reference should shift from concepts or technology development and implementation to innovation, whether technical or otherwise. This is a natural evolution of the *SOF truth* that "Humans are more important than hardware." It is rapid innovation, as a human activity, that is critical. In that context, advanced technology or understanding should no longer be thought of as products that are supplied to SOF and which SOF use. The alternative is to integrate science and understanding with tools and technology and with missions and users to make it possible for innovation to occur through all the isolated and interactive paths.

This process can be realized by co-locating innovators from all three areas, which means placing innovators in science and understanding as well as innovators in tools and technology with ongoing operations. Instead of placing S&T advisors at high levels and being limited to rapid engineering and fabrication in the field, a critical mass of personnel representing science and understanding and tools and technology should become integrated with SOF in solving problems and performing operations. The right kind of generalists could quickly bring their expertise to bear. This integration will also allow the early adoption of more ambiguous technologies or concepts because those who are most familiar with the innovation will be directly involved with the operations.

Since USSOCOM and the SOF components are responsible to provide, train, and equip SOF and rapid innovation would be recognized as an integral part of special operations, SOCOM and the components should also be responsible for providing, training, and equipping personnel as innovators in understanding and technology. These personnel when deployed would be involved in operations (many of them might actually be operators) and the components would have the resources to innovate as part of the resources to perform operations. Of course, science and understanding and tools and technology are huge enterprises, and co-located innovators cannot be expert practitioners across the totality of these areas. Personnel awaiting deployment would have the responsibility and resources to participate in innovation in their larger communities, advancing general science and understanding and tools and technology, as well as interface with deployed operators. Instead of *reach-back* to specific subject matter experts, this would integrate innovation with operations.

In some cases, knowledgeable individuals may bridge two or more of the areas of innovation. In fact, this is one of the goals of reducing the cultural

distance by creating understanding across areas of innovation. One of the elements of the USSOCOM S&T strategy is to "cultivate the intellectual capital of SOF"[60]—that is, to take advantage of operators who are already technically savvy or who could become more knowledgeable about areas seemingly far removed from their operational specialties. Cultivating broader intellectual capital could easily be extended to SOF selection. For example, in a recent study, education has already been identified as a significant factor in success at Naval Special Warfare Basic Underwater Demolition/SEAL training (BUD/S).[61]

Some former SOF operators who have pursued careers in science and technology as well scientists and engineers without previous SOF experience would be personally motivated to become knowledgeable and involved in ongoing operations. Recruiting and integrating these personnel with operations may seem to be a departure for SOF but in fact this idea is not new. For example, the USSOCOM Future Concepts Working Group published a concept entitled "SOF for Life" that sought to maintain the availability of former and retired SOF operators to add value to the force but also included several possibilities for recruit selection from nontraditional sources—for example, female warriors, contingency hires, the human weapon, short-term indigenous warriors, and IA (i.e., recruits from government agencies other than DoD, the *interagency* community).[62] Some analysis has already considered how to integrate nontraditional recruits into SOF.[63]

Historically, military personnel have been especially recruited from the areas of science and understanding and tools and technology to be directly involved in operations. The most famous example is the Office of Strategic Services (OSS) where "The success of the OSS depended on the quality of people it recruited: Rhodes scholars, lawyers, paratroopers, and debutantes."[64]

> They included Virginia Hall (the only civilian woman to receive the Distinguished Service Cross in World War II), Sterling Hayden (who received a Silver Star for his actions behind enemy lines), Moe Berg (who undertook a mission to learn about German efforts to create an atomic bomb), and Ralph Bunche (who would become the first African-American to win the Nobel Peace Prize). Its ranks also included two master forgers released from prison to work for the OSS. … William Fairbairn, the legendary expert in hand-to-hand combat and martial arts, was close to 60 years old when he joined the OSS and was still able to defeat men less than half his age.[65]

Less well known were the combat scientists of the Office of Scientific Research and Development (OSRD) of World War II.[66] OSRD was responsible for directing the development of such war-winning technologies as radar, radar countermeasures, antisubmarine warfare, the proximity fuze, amphibious vehicles, mine detectors, flame throwers, the bazooka, sea-launched rocket artillery, TV-guided bombs, torpedo improvements, smoke generators, and the atomic bomb.[67] OSRD concluded as follows:

> Obviously the most efficient use of scientific talent for the purpose of winning the war would be achieved if scientists were shifted at an appropriate rate from their laboratories to the field. It was recognized, however, that the laboratories at home would continue to have a very important function right up to the end in supplying their representatives in the theaters with information, equipment, and from time to time additional personnel.[68]

Some of these deployed combat scientists participated in operations. "From the days when American troops were driving up through Italy until MacArthur sailed into Tokyo Bay, OSRD sent some 60 scientists into enemy-occupied and finally into enemy territory"[69] most of whom were performing what is now called sensitive site exploitation. But others participated directly in operations to understand them and develop new technologies. For example, personnel working on antisubmarine warfare "flew with air patrols hunting submarines. One crossed the Atlantic with the first destroyer-escort group to accompany a convoy to England. Another went to the coast of Japan on a war patrol of one of our own submarines. One took a combat trip with a baby flattop to North Africa. Another was on a carrier under attack by the kamikaze in the Pacific."[70]

One mission was performed by Maurice P. Coon, a New England artist who spent almost a year in the forests and hinterlands of India, Burma, and western China.[71] Having aided in the development of a camouflage agent, his objective was to train indigenous personnel to manufacture this material in small quantities and direct them in using it behind enemy lines. "He lived with the natives and taught them to drive jeeps and to use the modern weapons we had furnished. Most of the time he worked with men from the OSS, but was occasionally sent on missions by himself."[72]

Thus, while integrating scientists and technologists of various kinds with operations may appear somewhat radical, it has a successful historical precedent, established in practice at the time as the most effective way to innovate. When considering all of the characteristics of rapid operational innovation, previously discussed, we are led to the same conclusion. SOF creativity is an integral part of special operations, and innovators in science and understanding as well as innovators in tools and technology should be part of ongoing operations.

10. Conclusions

Special operations are missions to accomplish strategic objectives where the use of conventional forces would create unacceptable risks due to Clausewitzian friction. One of the ultimate sources of friction is the *unpredictability* of events. During operations, the only way for conventional forces to overcome the risks due to unpredictability is to attempt to create certainty by applying more of existing capabilities. However, for SOF, innovation during ongoing operations can rapidly change the way to accomplish the objective, changing the nature of the risks away from those that would be experienced by conventional forces to risks that can be overcome by SOF. Creativity for SOF is rapid operational innovation.

This monograph has examined the nature of innovation to understand that which is necessary to innovate rapidly. According to the models of military innovation that have been used to organize historical experience, military innovation in general is *top-down*; and top-down innovation is a lengthy process. For conventional forces, implementing new capabilities without institutionalizing them would create new unacceptable risks. Innovation for conventional forces creates the conditions for operational changes that require coordination across a large organization and a long time to implement. However, due to the attributes of SOF personnel, SOF can create and implement new capabilities without institutionalizing them to the same degree and without creating the same risks—that is, from the bottom-up. Innovation for conventional forces is an institutional function, whereas rapid innovation for SOF is a function of the attributes of SOF personnel and culture.

SOF can create and implement new capabilities without institutionalizing them to the same degree…

Innovation in general has historically been managed as a linear process. New basic understanding, creation of concepts, development of new applications, and actual use are assumed to be distinct and sequential activities that are funded and managed independently, each with top-down management and oversight. For conventional forces, developing or implementing new capabilities without managing technology maturity would create new unacceptable risks, including financial and performance risks to the development program and operational risks in the field. However, the linear management of innovation is one of the factors that inhibits the rapid innovation that SOF

need. If innovation is forced to proceed in the linear fashion by separately funding and managing components of the three areas of innovation (science and understanding, tools and technology, and missions and users), information flow is inherently slow and uncertain. For SOF, slow and methodical innovation puts SOF creativity at risk.

Individual creativity, the ability to produce work that is both novel and appropriate, involves the association of ideas that have not previously been connected. A broad understanding far beyond the apparent applicability to the problem at hand is far more likely to lead to a creative solution. For SOF to implement operational change rapidly, SOF themselves need to produce novel and appropriate ideas to change ongoing operations. This is what it means to innovate from the bottom up. Of particular interest for SOF is the importance to creativity of intrinsic, task-focused motivation. However, novel ideas do not arise from deduction or from a process of pure conscious calculation. The creative process occurs in stages recognized as preparation, incubation, inspiration, and elaboration. Individual traits needed for SOF creativity are exclusively characteristics of innovator personality types—for example, approaching tasks from unsuspected angles, querying assumptions of problems, doing things differently, challenging accepted means, taking control in unstructured situations, and excelling in unscheduled crises. An important goal for SOF may be to maintain the selection and protection of innovators.

The speed with which innovation in operations can occur is affected by the speed with which a new technology or idea is adopted. SOF must be early adopters if not the actual originators of the innovation. The most successful technology transfer occurs with high motivation, low geographic and cultural distance, highly interactive communication, and low equivocality. For SOF to be early adopters, they must use equivocal technology accepting ambiguity in how the technology will be used. Because of the lack of this one key element, the other three assume even greater importance. SOF are highly motivated, but the participants in science and understanding and tools and technology must also be highly motivated. The geographic and cultural distance between personnel engaged in missions and users, science and understanding, and tools and technology must be minimized. And the communication between all three must be personal and interactive.

Innovation can occur in a far different fashion than the linear and top-down model imposes. All three categories of technical knowledge are

produced in analogous stages (*research*: paradigm creation, and *development*: paradigm extension) in isolated innovation paths. However, these three areas can also either inspire or enable research or development in the other two through interactive paths. Rather than being linearly arrayed, the three areas can allow the flow of ideas from one to the others. The linear model assumes that in bridging the gap between the isolated paths, interactive paths flow (however tenuously) from science to enable technology and from technology to enable behavior. However, reality is much richer. Unlike the linear model, experience shows that the flow of innovation does not take a single path nor is it one-way.

A new model for SOF creativity must take advantage of the entire innovation space but create an intimate contact between the three areas of innovation, forcing personal contact, motivation, cultural understanding, and the direct influence of operations across the spectrum. In this model direct contact between the three areas of innovation for SOF will support the interactive innovation paths, making it possible and efficient for all of the enabling or inspiring interactions to occur rapidly and innovation to be adopted rapidly. In this model, science and understanding, tools and technology, and missions and users are entwined in a kind of braid. This new model can be used to guide the implementation of rapid innovation for SOF. The goal for SOF will be to support the entire rapid innovation braid, integrating science and understanding and tools and technology with operations.

Current initiatives for rapid acquisition can be analyzed in the context of this new understanding of innovation. In general, they attempt to make the current linear top-down model more rapid by stronger ties between technology developers and operators (tools and technology to enable missions and users) and by accepting more risk (the 80 percent solution).

When considering all of the characteristics of rapid operational innovation, we can arrive at a new way of thinking about innovation for SOF. SOF creativity is an integral part of special operations. The frame of reference should shift from concepts or technology development and implementation to innovation, whether technical or otherwise. Advanced technology or understanding should no longer be thought of as products that are supplied to SOF and which SOF use. The alternative is to integrate science and understanding with tools and technology and with missions and users to make it possible for innovation to occur through all the isolated and interactive paths.

Implementing the SOF rapid innovation braid can be done by co-locating innovators from all three areas, which means placing innovators in science and understanding as well as innovators in tools and technology with ongoing operations. The resources and personnel to innovate rapidly should be part of the resources to perform the mission. USSOCOM and the components should be responsible for providing, training, and equipping innovators in understanding and technology. Recruiting and integrating these personnel with operations may seem to be a departure for SOF, but this is not a new idea. The USSOCOM Future Concepts Working Group "SOF for Life" sought to maintain the availability of former and retired SOF operators to add value to the force and included several possibilities for recruit selection from nontraditional sources. Integrating scientists and technologists of various kinds with operations may appear somewhat radical, but it has successful historical precedents in the OSS and the OSRD combat scientists, established in practice at the time as the most effective way to innovate.

SOF must innovate or die. Innovation may be crucial to SOF personnel's actual physical survival, but *die* is also a metaphor for organizational oblivion: conformity and assimilation. One of the fundamental qualities of SOF is creativity, which is the ability to *rapidly* change the combat process. Without a new paradigm of how to innovate rapidly, innovation for SOF will be conventionalized and SOF creativity will be at risk. SOF can innovate rapidly in ways that conventional forces cannot, but if they do not, it may lead to a diminished ability to be creative and ultimately could lead to the death of their unique contributions. A new understanding of the nature of innovation demonstrates how SOF can rapidly innovate and live. ↑

Endnotes

This work was performed at Sandia National Laboratories. Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation, a wholly-owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

1. Robert G. Spulak, Jr., *A Theory of Special Operations* (Hurlburt Field, FL: JSOU Press, October 2007).
2. Examples of technical innovation that have been important for special operations include night vision, man-portable satellite communications, underwater breathing (starting with the Lambertson Lung), ground laser-designated targeting, underwater mobility (SEAL delivery vehicles and dry-deck shelters), and gunships.
3. In another example—risk of SOF becoming conventionalized—Jessica Turnley has addressed the risk to retaining the core value of SOF—the importance and quality of their people—as USSOCOM assumes greater importance and legitimacy. See *Retaining a Precarious Value as Special Operations Go Mainstream* (Hurlburt Field, FL: JSOU Press, February 2008).
4. Before 11 September 2001 with the most recent major conflict (Desert Storm) involving only limited use of SOF, there was concern about keeping SOF relevant with the advent of sensors such as unmanned aerial vehicles (UAVs) displacing special reconnaissance and precision-guided munitions (PGMs) displacing direct action. Partly to address these concerns, USSOCOM created a future Concepts Working Group (FCWG), now disbanded, that reported directly to the commander.
5. Spulak, *A Theory of Special Operations*.
6. Carl von Clausewitz, *On War,* Michael Howard and Peter Paret, eds. (Princeton, NJ: Princeton University Press, 1984).
7. United States Joint Forces Command, *The Joint Operating Environment*, February 2010, p. 7.
8. Barry D. Watts, *Clauswitzian Friction and Future War (Revised Edition)*, McNair Paper 68 (Washington, D.C.: National Defense University, 2004). Note that in Watts's analysis *fog* is a part of friction.
9. See, for example, David S. Alberts, John J. Garstka, and Frederick P. Stein, *Network Centric Warfare* (Washington, D.C.: DoD C4ISR Cooperative Research Program, 1999), p. 72.
10. Jessica Glicken Turnley, "Creating the Conditions for a Possible Masterpiece: Small Groups and Special Operations Forces" draft (slated for JSOU Press publication in December 2010).
11. Gordon Stevens, *The Originals: The Secret History of the Birth of the SAS in Their Own Words* (London: Edbury Press, 2005), p. 17.
12. Spulak, *A Theory of Special Operations*.

13. Adam Grissom, "The Future of Military Innovation Studies," *The Journal of Strategic Studies*, Vol. 29, No. 5, October 2006, pp. 905-934.
14. For example, Max Boot, *War Made New* (New York: Gotham Books, 2006) or Stephen Peter Rosen, *Winning the Next War* (Ithaca, NY: Cornell University Press, 1991).
15. Turnley, *Retaining a Precarious Value as Special Operations Go Mainstream*.
16. Harvey M. Sapolsky, Benjamin H. Friedman, and Brendan Rittenhouse Green, eds., *U.S. Military Innovation since the Cold War* (Abingdon, Oxon: Routledge, 2009), pp. 1-13.
17. Ibid.
18. In *The Culture of Military Innovation* (Stanford, CA: Stanford University Press, 2010), Dima Adamsky discusses how three different cultures (Russian, U.S., and Israeli) responded differently to the recent so-called Revolution in Military Affairs (RMA), an attempt to promote organizational change to incorporate the assumed revolutionary advantages of information technologies (IT) in military operations (the IT-RMA). The technologically inferior Soviet Union led the U.S. and Israel in conceptualizing the IT-RMA without possessing technology or weapons, and the U.S. was the first to produce IT-RMA weapons but only much later embarked on a program of transformation, whereas Israel was the first to use the new technologies in war without first reforming its military. The implementation of the IT-RMA took many years, from conceptualization in the late-1970s to transformation in the mid-1990s. If culture has such a profound effect, SOF as a unique culture may be able to innovate differently.
19. Adam Grissom, "The Future of Military Innovation Studies."
20. Carol A. Wortman, "Inefficient Battle Command Results from Unique Commanders Solutions," U.S. Army War College Strategy Research Project, March 2008.
21. Richard van Atta, "Fifty Years of Innovation and Discovery," in *50 Years of Bridging the Gap*, Defense Advanced Research Projects Agency, 2008, p. 20.
22. Department of Defense (DoD) Instruction 5000.2, "Operation of the Defense Acquisition System," 5 April 2002.
23. J. Y. Tsao, K. W. Boyack, M. E. Coltrin, J. G. Turnley, and W. B. Gauster, "Galileo's stream: A framework for understanding knowledge production," *Research Policy*, 37 (2008), pp. 330-352:

    > The influential views of Thomas Kuhn and Vannevar Bush are most consistent with the basic streams. These streams are unencumbered by a use motivation, hence allow for: (a) optimal choice of puzzles (difficult enough to be challenging, but not so difficult as to be insoluble; Kuhn, 1962) and (b) subsequent *play* with those puzzles ('in order for tool using to develop, it [is] essential to have a long period of optional, pressure-free opportunity for combinatorial activity' Bruner et al., 1976, p. 38). And, once new knowledge in one category has been produced, it can be harvested through the push streams into other categories, enabling an 'endless frontier' of knowledge production (Bush, 1945, p. 15).

24. DoD Instruction 5000.2, "Operation of the Defense Acquisition System," p 12.
25. DoD Financial Management Regulation 7000.14-R, Vol. 2B, Chapter 5, "Research, Development, Test, and Evaluation Appropriations," pp. 5-2 through 5-4, July 2008.
26. General Accounting Office, *Better Management of Technology Development can Improve Weapon System* Outcomes, GAO/NSIAD-99-162, July 1999.
27. DoD Deskbook 5000.2-R, Appendix 6.
28. DoD Instruction 5000.2, "Operation of the Defense Acquisition System," p. 37.
29. John Paul Parker, "At the Age of 50, it's Time for DARPA to Rethink its Future," *National Defense*, September 2009, pp 16-17.
30. USSOCOM Directive 71-4, "Special Operations Forces (SOF) Capabilities Integration and Development Systems (CIDS)," 24 March 2005.
31. John Paul Parker, "At the Age of 50, it's Time for DARPA to Rethink its Future."
32. DoD Instruction 5000.2, "Operation of the Defense Acquisition System," p. 4.
33. Robert J. Sternberg and Todd I. Lubart, "The Concept of Creativity: Prospects and Paradigms," Chapter 1 in *Handbook of Creativity*, Robert J.Sternberg, ed. (New York: Cambridge University Press, 1999).
34. Ibid.
35. The selection processes perhaps also explicitly favors individuals who have some of the required traits. Two of the characteristics that Special Forces Assessment and Selection (SFAS) "screens in" are *high tolerance of ambiguity and stress* and *situational awareness and flexibility*, briefing by LTC Mark Baggett, USASOC Directorate of Psychological Applications, September 2008.
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37. Ibid.
38. Ibid., pp. 137-138.
39. Jessica Glicken Turnley, "Creating the Conditions for a Possible Masterpiece: Small Groups and Special Operations Forces."
40. M. J. Kirton, "Adaptors and Innovators: Why New Initiatives Get Blocked," *Long-Range Planning*, 1984, 17, pp. 137-143; reprinted in Hellriegel & Slocum (eds.), Companion to Organisational Behaviour, West Publishing and Richards, M.D. (ed.), *Readings in Management*, South-Western Publishing Co., 1986.
41. M. J. Kirton, *Adaptors and Innovators: Styles of Creativity and Problem Solving*, revised edition, p. 10 (New York: Routledge, 1989/2000).
42. Kenneth H. Poole, presentation to the Joint Special Operations Senior Enlisted Academy, Class 2 given on 21 September 2010, titled "Problem Solving Leadership using Adaption-Innovation Theory."
43. M. J. Kirton, "Adaptors and Innovators: Why New Initiatives Get Blocked."
44. For example, Everett M. Rogers, *Diffusion of Innovations* (New York: The Free Press, 1995).

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47. P. A. Geroski, "Models of technology diffusion."
48. David V. Gibson and Raymond W. Smilor, "Key variables in technology transfer: A field-study based empirical analysis," *Journal of Engineering and Technology Management*, 8 (1991) pp. 287-213.
49. The author most recently heard this cited by Zachary J. Lemnios, director of Defense Research and Engineering, U.S. Department of Defense, in remarks at the SPIE Conference, Orlando, Florida, 6 April 2010.
50. R. P. Schmitt, E. A. Beimborn, and M. J. Mulroy, *Technology Transfer Primer*, Report FHWA-TS-84-226, University of Wisconsin, July 1985.
51. Gordon Stevens, *The Originals: The Secret History of the Birth of the SAS in Their Own Words*, pp. 19-20.
52. C. Jackson and A. Long, "The fifth service," in *U.S. Military Innovation since the Cold War* (New York: Routledge, 2009), pp 149-150.
53. J.Y. Tsao et al., "Galileo's stream: A framework for understanding knowledge production."
54. Ibid.
55. I have changed the nomenclature from Tsao et al. What I call an innovation path, they called a stream; what I call isolated paths, they call pure streams; and what I call interactive paths, they called mixed streams.
56. Unrealistic expectations for the effectiveness of innovation using existing technology may have been generated by the television character MacGyver who produced clever solutions to seemingly insoluble problems, often in life-or-death situations, requiring him to improvise complex devices in a matter of minutes using only common household items and a Swiss Army knife. See http://en.wikipedia.org/wiki/MacGyver, accessed September 2010.
57. Zachary J. Lemnios, Statement Testimony before the United States House of Representatives Committee on Armed Services Subcommittee on Terrorism, Unconventional Threats and Capabilities, 23 March 2010.
58. William Shepherd, S&T advisor to the commander, USSOCOM Strategic Plan, briefing at Sandia National Laboratories, 3 September 2009. SOCOM emphasizes a strategy of leveraging and influencing existing scientific research and advanced technology development at universities, the National Laboratories, and other government research institutions. However, very little advanced S&T is performed with a potential SOF end user in mind.
59. William Shepherd, personal communication, 23 April 2010.
60. United States Special Operations Command, "Science and Technology Strategic Plan," May 2009.

61. "SEAL Recruiting Releases Research Findings," *The Blast*, Vol. 42, No. 1, Spring 2010, p. 53.
62. USSOCOM Concept: Special Operations Forces (SOF) for Life, Version 2, 22 May 2003.
63. Robert G. Spulak, Jr., "Perspectives on Recruit Selection from Nontraditional Sources for Special Operations Forces (SOF) for Life (S4L)," white paper for USSOCOM Future Concepts Working Group, June 2003.
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65. Charles Pinck, president of The OSS Society, "Glorious Amateurs Needed"; available at www.ossreborn.com/index_files/48.html, accessed September 2010.
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69. Ibid., p. 52.
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