A Systemic Concept for Operational Design

By John F. Schmitt

I am quite ready to admit that there is a method which might be described as the one method of philosophy. But it is not characteristic of philosophy alone; it is, rather, the one method of all rational discussion and, therefore, of the natural sciences as well as of philosophy. The method I have in mind is that of stating one's problem clearly and examining its various solutions critically. … [W]henever we propose a solution to a problem, we ought to try as hard as we can to overthrow our solution, rather than defend it. Few of us, unfortunately, practice this precept; but other people, fortunately, will supply the criticism for us if we fail to supply it ourselves. Yet criticism will be fruitful only if we state our problem as clearly as we can and put our solution in a sufficiently definite form—a form in which it can be critically discussed.

—*Karl Popper, The Logic of Scientific Discovery*[1]

To comprehend and cope with our environment we develop mental patterns or concepts of meaning. … [W]e destroy and create these patterns to permit us to both shape and be shaped by a changing environment. … [W]e cannot avoid this kind of activity if we intend to survive on our own terms.

—*John R. Boyd, "Destruction and Creation"*[2]

1. Introduction

Commanders at all levels today face highly complex, dynamic and novel problem situations which they are called on to resolve, but for which the known and practiced solutions of doctrine will not suffice.[3] These situations cover a wide range and variety, extending well beyond conventional combat. They are fundamentally social problems, comprising numerous individuals interacting in countless ways according to various motivations. Involving the interplay of human will, intellect, and creativity, these situations are essentially unknowable: no amount of information collection or analysis will reveal objective truth or provide the ability to predict events with certitude. Despite the most careful observation, these situations maintain the ability to surprise. They change unpredictably over time. Enemies adopt and quickly adapt methods designed to negate perceived U.S. strengths and exploit perceived U.S. weaknesses. Purely military problems amenable to the conventional application of combat power through fire and maneuver are increasingly rare. Instead, situations require the integration of more than only military action, and at increasingly lower levels of application. Conversely, the effects of military action are not only military. Military action can have significant social, economic, psychological and political implications beyond the immediate battlefield outcome. Situations are influenced by factors beyond the commander's ability to control, or even to perceive. The relationships between causes and effects are dynamic and only vaguely discernible at best. At the same time, the implications of action are far-reaching, often well beyond the extent of a commander's authority or understanding. These conditions may apply most to higher commanders, who face greater complexity and for whom every situation is truly one of a kind, but in today's environment they apply frequently at all levels.

In this environment, past experience can provide only limited insight into a new situation. Commanders cannot apply the time-tested methods learned from experience with the confidence they will work as they have in the past. Under these conditions, before they can begin to apply established techniques effectively, commanders must first be able to form an understanding of a situation on its own terms and conceive an approach for dealing with that situation uniquely. That is, they must first *design*. Design is the subject of this paper.

Operational design is not new. Joint doctrine defines operational design as "the key considerations used as a framework in the course of planning for a campaign or major operation."[4] Doctrine also lists "elements of operational design," but nowhere does doctrine describe the design *process* or how to perform it.[5] Some commanders historically have designed effectively, while many others have designed poorly or not at all. When commanders have designed, it has usually been idiosyncratically and implicitly rather than as an explicit, structured process.

This paper proposes a concept for performing operational design that is intended to help commanders and staffs to better deal with the complex operational situations they routinely face today. This paper argues that commanders should precede current planning procedures with an iterative, conversational design process based on systems thinking. This process is intended to build a systemic understanding of the situation such that a course of action emerges intuitively. Informed by an explicit design that provides a governing logic for the operation or campaign, subsequent planning can proceed more effectively. The underlying premise of this concept is that if we understand a problem well enough, a solution to the problem becomes self-evident. This paper will distinguish carefully between designing and planning, defining the former essentially as problem *setting* and the latter essentially as problem *solving*.

This concept does not constitute a radical departure for the Marine Corps, but rather proposes an alternative methodology to better apply established principles. Current Marine Corps doctrine recognizes a difference between *conceptual planning* and *detailed planning*, which roughly equate to design and planning respectively.[6] Nor is a systemic approach a departure for the Marine Corps. Maneuver warfare is inherently systemic in its approach. Consider the following example, one of many, from Marine Corps Doctrinal Publication (MCDP) 1, *Warfighting*:

> *Rather than pursuing the cumulative destruction of every component in the enemy arsenal, the goal is to attack the enemy "system"—to incapacitate the enemy systemically. Enemy components may remain untouched but cannot function as part of a cohesive whole. … Success depends not so much on the efficient performance of procedures and techniques, but on understanding the specific characteristics of the enemy system. … [T]he element of … local attrition is not merely to contribute to the overall wearing down of the entire enemy force, but to eliminate a key element which incapacitates the enemy systemically.*[7]

This concept proposes a methodology for applying that systemic outlook to operational design.

While not a radical departure from current Marine Corps doctrine, this concept promotes several ideas that it suggests in aggregate constitute a qualitative difference from current practice. First is the distinction between design and planning, in both purpose and approach, and the especial importance of design in dealing with complex and unique operational situations. Second is the recognition of significant and irreducible uncertainty as the fundamental challenge of command.[8] This concept amounts to a proposal for coping with pervasive uncertainty rather than trying to eliminate it. Third is the idea that design thus takes the form of an iterative inquiry into the nature of a situation to build and test hypotheses. Inherent here is the recognition that our design will get some things wrong, and that a big part of design is redesign to clarify and strengthen our thoughts by continuously subjecting our hypotheses to critical review. Fourth is the idea that design is fundamentally conversational—that is, design unfolds most naturally as a discourse among stakeholders. This is significant especially with respect to operational situations that cut across domains and cultures because conversation is a universal process whereas many planning procedures are unique to a particular culture, domain or even organization. Fifth is the relationship between intuition and reason, the two main modes of thinking. This paper proposes that design decisions are ultimately intuitive—that is, the product of internalized judgment rather than conscious logic—but that in this case intuition is activated by extensive reasoning about the situation to build the necessary level of insight, rather than by direct experience. Sixth, as already mentioned, is the premise that if we understand a situation, an appropriate course of action emerges intuitively, and the process of generating candidate courses of action to compare against one another is unnecessary. This concept thus concentrates on *formulating* the problem to be solved rather than on developing potential solutions. This is not performing mission analysis as described in current planning procedures, but involves hypothesizing the causes and dynamics of the situation. And seventh is the idea of taking a systems-thinking approach to dealing with operational situations as a response to the intrinsic nature of those situations. Importantly, systems thinking promotes a broader view of situations and may thus encourage the consideration of other possible solutions than merely military.

2. Purpose

This document has three related purposes:

- To provoke discussion, within both the Marine Corps and the broader Defense community, on the nature and role of operational design and planning and the methods used to conceive operations and campaigns

- To motivate military experimentation into these methods

- If eventually validated, to provide the basis for capabilities development, especially in the areas of doctrine and education

3. Scope & Applicability

This concept discusses operational design and its relation to planning. It discusses the conditions that make design important and the underlying principles of design. It proposes a particular philosophy of design and describes a generic design process, but it does not provide a specific set of techniques and procedures for performing operational design in a particular organizational setting. These would have to be developed through subsequent experimentation.

This concept describes a deliberative approach. It applies to situations in which decision makers have time to deliberate, and not to situations requiring rapid action, which are the province of intuition alone. That said, deliberations undertaken early in a situation can inform executive decisions required quickly during the flow of events.

This concept applies to any commander having to resolve highly complex, dynamic and novel problem situations. It applies to all types of military operations and all operational settings. It describes an approach to operational design that is independent of operational method—that is, it does not imply any particular style of operating. Although the concept addresses operational situations, the underlying principles of design can apply equally to non-operational situations, such as force development, especially to the extent that those situations are dynamically complex and unique. This is a military concept written primarily for a military audience, but the process of design described here can likewise apply to any agency having to resolve highly complex and novel problems. In fact, one argument of this concept is that a systemic design approach will promote a wider view of a situation and thus encourage the consideration of a wider range of capabilities in resolving the situation. In that sense, a systemic design approach could facilitate integrated operations combining multiple elements of national power.

4. The Distinction Between Design and Planning

To understand this concept, it is important to understand the distinction this paper makes between design and planning. Although MCDP 5, *Planning*, uses the terms *conceptual planning* and *detailed planning*, this paper adopts the more widely used terms *design* and *planning*. The pairs of terms are roughly synonymous, although not exactly. According to MCDP 5, conceptual planning "establishes aims, objectives, and intentions and involves developing broad concepts for action. In general, conceptual planning is a process of creative synthesis supported by analysis. It generally corresponds to the *art* of war."[9] Design certainly includes these activities, but where conceptual planning focuses on generating solutions, design also includes an even more fundamental inquiry into the nature, factors and dynamics of the problem situation which should inform the initial establishment of aims, objectives and intentions and the development of broad concepts of action.

Design and planning obviously are related in that both deal with formulating ways to bring about preferable futures. For the purposes of this paper, design is the process of working out the initial form of something. The word connotes preliminary, intellectual, abstract and even artistic activity. In contrast, planning is the process of devising, generally through the application of established procedures, a series of actions to be taken. Planning connotes a more detailed and standardized process and a more finalized product. By way of a metaphor, design is the thematic sketches of an architect based on conversations with the client and an appreciation of the surrounding environment within which a building will exist. Planning is the blueprints of the engineer, based on the architect's design, from which the building will actually be constructed.

Design can be thought of as problem *setting*—locating, identifying and formulating the problem, its underlying causes, structure and operative dynamics—in such a way that an approach to solving the problem emerges. In the words of Nobel laureate Herbert Simon, "solving a problem simply means representing it so as to make the solution transparent."[10] In contrast, planning can be thought of as problem *solving* once the problem has been set (by design or default). Where design starts with a "blank sheet of paper," planning occurs within an established conceptual framework, whether created through design or the result of unquestioned defaults or assumptions. Where planning focuses on generating a plan—a series of executable actions—design focuses on learning about the nature of an unfamiliar problem. Planning thus focuses on the physical, devising actions intended to have a direct effect in the physical world. In comparison, design is more conceptual, even abstract, hypothesizing about underlying causes and dynamics that explain events in the physical world. In this sense, design guides planning, but also requires planning to translate it into terms applicable to the physical world.

In addition to occurring at different times in the problem-solving process, design and planning can also be thought of as different approaches. The "design approach" implies the exercise of creative judgment resulting from implicit knowledge or understanding by commanders or other executives. The "planning approach" implies the application of established procedures, a staff-centered, stepwise approach in which each step produces an output that is the necessary input for the next step. Design does not proceed in a stepwise fashion, but unfolds conversationally.

Design logically precedes planning, and in fact should provide the context that allows planning to proceed effectively. Planning breaks the design down into manageable pieces assignable as tasks—an essential process in transforming the design concept into an executable plan. Design and planning can be thought of as occupying a continuum. At either end of the continuum they are qualitatively different cognitive activities, but in the center they merge. See figure 1. The "back end" of design and the "front end" of planning overlap at the point at which a course of action is initially conceived. The two approaches would conceive the course of action very differently: the design approach intuitively through learning about the problem until the solution emerges and the planning approach logically through the application of method to generate and evaluate one or more options. Most operational situations call for a design approach to conceiving a course of action because of their complexity and novelty.

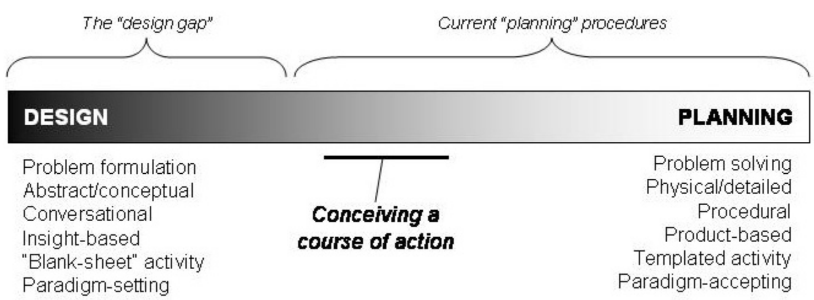

Figure 1.
The Design-Planning Continuum

Figure 1 is meant to show the differences and relationship between design and planning activities. It is not meant to imply that design ends when planning begins. Design generates ideas that continue into planning to be operationalized, but even after planning begins, the design process continues—and continues to inform planning.

Design and planning are both necessary for dealing with complex operational situations, but while planning activities are well represented in both doctrine and practice, design is largely absent. When design occurs today, it usually occurs implicitly within the mind of an individual, and not as an explicit group activity leveraging the intelligence of the group.

Current "planning" procedures include some steps that more correctly qualify as design activities. This is not an issue in itself. The issue is that other, fundamental design activities are not included and rarely get performed—and then only implicitly and idiosyncratically. The result is a critical "design gap" that leaves fundamental questions about the nature of the situation unanswered. When situations are well understood and fit within an established frame of reference, this may not be a problem, and planning can be sufficient. But when situations do not conform to established frames of reference—when the hardest part of the problem is figuring out what the problem is—planning alone will be inadequate and design becomes essential. In these situations, absent a design process to come to grips with the essential nature of the problem, planners will default to doctrinal norms, developing plans out of habit rather than out of any deep understanding of the real problem at hand. Planners will tend to try to solve the problem they are used to solving rather than the problem that actually exists. In other words, planning addresses a problem within the boundaries of an existing paradigm, while design is about questioning assumptions and creating new a paradigm for addressing the problem on its own terms.

5. The Problem of Operational Design: Devising Solutions to Wicked, Socially Complex Problems

The essential problem this concept addresses is how to formulate operations and campaigns in the face of complexity, uncertainty and novelty. Commanders must devise ways to resolve a wide variety of highly complex and unique problem situations spanning the entire spectrum of military operations. This paper will refer to these as complex operational situations. This problem is defined by three main elements:

- Complex operational situations are "wicked" problems.
- Complex operational situations exist in an environment of social complexity.
- Any approach to resolving complex operational situations should be compatible with natural human cognitive processes.

Together these three elements establish the conditions that define the problem this concept is intended to solve. This paper will treat each in turn.

Complex Operational Situations as "Wicked Problems"

Operational problems fall into a category of problems that have been labeled *wicked*, which in this sense does not imply evil, but rather intensely challenging and complex.[11] Urban designers Horst Rittel and Melvin Weber coined the term to refer to primarily social problems that are particularly difficult and confusing, though not necessarily irresolvable. Wicked problems stand in contrast to *tame problems*, which are by no means necessarily trivial or simple. Tame problems may be very challenging, but they are sufficiently understood that they lend themselves to established methods and solutions.[12] Wickedness and tameness are not binary conditions. Most problems exhibit varying degrees of wickedness. That said, complex operational situations tend to be extremely wicked. Wicked problems are characterized by several traits.

There is no definitive way to formulate a wicked problem. First of all, a problem does not exist objectively. What exists is a *mess*—a complex tangle of conditions—which only becomes a problem when someone decides that the conditions are unsatisfactory and require resolution.[13] We can attribute the problem to any number of different causes and can formulate the problem in any number of different ways. The formulation of the problem depends on individual perspective—different people see the problem differently—and so it is difficult, if not impossible, to formulate the problem in a way that all stakeholders can agree to. Any understanding of a wicked problem is an interpretation—a creation based on a particular perspective—rather than an objective truth. In this sense, a wicked problem cannot be *known*, but must be *constructed*—that is, the problem to be solved must be created out of the mess. Understanding a wicked problem is not a matter of capturing reality sufficiently correctly, but of constructing an interpretation that is sufficiently useful in dealing with the reality.

We cannot understand a wicked problem without proposing a solution. The information needed to understand the problem depends on the idea for solving it. We propose potential solutions as a way of hypothesizing about the problem. Establishing the problem and conceiving a solution are identical and simultaneous cognitive processes, since every instance of creatively formulating the problem points in the direction of a particular solution.

Wicked problems have no "stopping rule." It is impossible to say conclusively that a wicked problem has been solved. Wicked problems are rarely solved conclusively, but are resolved conditionally and temporarily. Work on a wicked problem does not cease because the problem is definitively solved, but because the problem solvers run out of time, resources or resolve—the solution is deemed "good enough" or "the best that can be done under the circumstances."

Wicked problems have better or worse solutions, not right or wrong ones. There is no objective measure of success in dealing with wicked problems. No objective method exists for determining the correctness of a solution, as exists for a mathematics or physics problem. Different stakeholders will judge the quality of a solution based on individual perspectives, and there can be significant disagreement. The quality of a solution depends on how we have formulated the problem. For example, if we see the problem as defeating guerrillas, a kinetic solution may work, but if we see the problem as preventing the population from supporting the guerrillas, that same solution could be counterproductive.

There is no immediate and no ultimate test of a solution to a wicked problem. The perceived quality of a solution can change over time. Any solution will generate waves of repercussions that ripple outward over an extended or even indefinite period. A solution that seems to achieve positive results initially could generate delayed negative consequences that outweigh any initial good that was achieved. One cannot judge the full consequences of a course of action until these waves of repercussions have run out, by which point it will long have become impossible to isolate individual causes and effects, since in the mean time numerous other events will have affected the situation.

Every solution to a wicked problem is a "one-shot" operation. Every attempted course of action has repercussions that will change the situation and cannot be undone. Even if a course of action does not solve the problem satisfactorily, and another attempt becomes necessary, it will be an attempt to solve a different problem—and often a problem that is more difficult than before. As a result, every attempt matters significantly.[14] Wicked problems thus pose a dilemma: we cannot learn about a wicked problem without trying out solutions, but cannot try out solutions without changing the problem.

Wicked problems have no fixed set of potential solutions. Solutions to wicked problems do not pre-exist as alternatives from which to choose, like buying a new car. Wicked problems are not multiple-choice. Solutions must be *created* rather than chosen. A whole host of potential solutions may emerge, or it may be that no satisfactory solution appears.

Every wicked problem is essentially *unique and novel.* Each wicked problem is a one-of-a-kind situation requiring a custom solution rather than a standard solution modified to fit circumstances. No classes of wicked problems exist for which common principles apply and to which generic solution "templates" can be applied.

Every wicked problem is a symptom of another problem. Wicked problems tend to be interconnected in cause and effect. Any attempt to establish the cause of a problem reveals a preceding problem, of which the original problem is only a symptom. Significant judgment is required merely to decide how widely to define the problem.

Wicked problems are interactively complex. Interactive complexity is a function of the freedom of interaction of the elements that make up a situation: the greater freedom, the greater the interactive complexity. Interactively complex situations are highly sensitive to inputs; immeasurably small influences can generate disproportionately large effects. With interactive complexity it is often impossible to isolate individual causes and their effects, since the parts are all connected in a complex web. Interactive complexity produces fundamentally unpredictable and even counterintuitive behavior. Cause and effect may be separated in time and space: an input at a given time and place produces an output much later at a different place. Effects will rarely remain steady; some causal chains may dampen over time, eventually dying out, while others may amplify through reinforcing feedback. Effects may reverse themselves over time: a cause that has one effect initially may produce the opposite effect later—only to return to the original effect still later. A single cause can have multiple effects, while a single effect can be the result of multiple causes. Major inputs can have little effect, but a minor input beyond a tipping point can push a situation into a qualitatively different state.

Social Complexity

Another key characteristic of complex operational situations is social complexity, which refers not to the problem itself, but to the network of stakeholders that is engaged with the problem.[15] Social complexity is a function of the number of stakeholders and the diversity among them: the more stakeholders and the greater their diversity, the greater the social complexity. Social complexity tends to go hand-in-hand with wicked problems because wicked problems tend to impact multiple stakeholder groups. Social complexity can be a significant source of disunity and fragmentation. Recall that one of the properties of a wicked problem is that there is no definitive way to formulate the problem. Social complexity increases the likelihood that different stakeholders will formulate the problem differently.

Social complexity is greatest for joint force commanders, who must interact with political leaders, component commanders representing different functions or services, host-nation and coalition military partners, and non-military agencies and organizations. That said, commanders at other levels face significant social complexity as well, as the need to integrate capabilities is pushed to lower and lower levels.

Diversity is important to problem solving because it allows different perspectives, skills and methods to be brought to bear against the problem. But diversity can also threaten the effort by preventing agreement among stakeholders. Diversity exists at several levels. Individuals bring with them different experiences, temperaments and skills. Additionally individuals come from different disciplines—each with specialized language, unique culture and established methods. Finally, individuals come from different organizations—each with its own charter, function, objectives and chain of authority. As a result, stakeholders will bring differing perspectives and agendas to the problem-solving process. The commander must find a way to give these differing perspectives and agendas an opportunity for expression and to reconcile them.

Because of social complexity, operational problem solving is fundamentally a social process. The answer to social complexity is shared understanding of the problem and shared commitment to the solution. Any operational problem-solving process should provide a mechanism for building shared understanding and commitment in the face of social complexity.

Human Problem-Solving Processes

Current planning procedures, including the Marine Corps Planning Process, portray decision making as a rational process of generating multiple courses of action and comparing those options in parallel in order to reach at the optimal solution. The problem-solving process proceeds logically and steadily from studying the problem to working out the details of the solution. This approach is based on the classical, analytical model of decision making that initially predominated the field, but which has been largely invalidated in the last three decades.[16]

Today, human decision making is widely recognized to be a largely intuitive process based on the ability to size up a situation and mentally project how a course of action might turn out.[17] Especially in the complex situations described in this paper, decision makers do not try to optimize, but instead "satisfice"—look for the first satisfactory solution. When they consider more than one option, it is in series until they find one they judge will work, rather than in parallel. Research shows that experienced decision makers spend considerably more time than inexperienced decision makers do assessing a situation, but that once they have assessed the situation they decide on a course of action much more quickly.[18] In other words, experienced decision makers focus their efforts on understanding the situation rather than generating courses of action.

Additional research suggests that problem solvers do not progress steadily and logically from the problem to the solution.[19] They start by trying to understand the problem, but quickly jump to conceiving potential solutions before jumping back to problem formulation. (This should come as no surprise given the wicked-problem rule that it is impossible to understand a problem without formulating possible solutions.) The problem-solving process continues this way until the end. Even as problem solvers are working out the final details of execution, they continue to revise their understanding of the problem.[20] Problem solvers using this approach are not being irrational or undisciplined, but are exploiting complementary cognitive abilities to advance the process as effectively as possible. This nonlinear, apparently chaotic process is not a sign of indiscipline or lack of training, but a mark of an intelligent and creative learning process. Any proposed method for solving operational problems should accommodate and facilitate this natural process.

The process becomes more complicated in group problem solving, which is what most complex operational situations will involve, because different members of the group will be in different stages of the process at different times. Some members will be working on understanding the situation while others will be ready to explore a course of action. This is not a case of one subgroup being right and the other wrong, but a natural feature of group problem solving. A method that imposes synchronization on the entire group will inhibit the natural problem-solving process.

Group problem solving requires communication within the group. There is no universal communication medium or language. The appropriate communication medium will depend on the problem domain. That said, in social situations, people communicate naturally through speech, gesture and sketch, and so these will play a key part in any group problem solving activity.

Conclusion

Commanders today are required to take action to resolve complex operational situations that by any standard qualify as extremely wicked. Many of these situations exceed any one person's ability to comprehend, much less solve. Commanders often must resolve these situations in an environment of social complexity. Many of these situations cross institutional boundaries, so that even if commanders have the necessary comprehension, they lack the authority to act unilaterally. Any solutions or methods they adopt must satisfy various groups of stakeholders.

Finally, any method they employ should be compatible with natural cognitive and communication processes so that the methods they adopt are not at odds with natural human behaviors.

Current planning methods are inadequate for this task. This is not to say that commanders today cannot successfully meet this challenge, but when they do it is not by following established planning methods. When commanders succeed today, it is despite the prescribed planning procedures. The remainder of this concept paper describes an alternative approach to resolving complex operational situations that could meet this challenge more effectively.

6. The Controlling Idea: An Explicit, Systemic Design Process to Ground Planning and Execution

The way to deal with a complex operational situation is to carry out a heuristic[21] operational design to provide a logical foundation for all planning and execution, and continuously to assess and revise the design over time in response to changes in the situation. As the design evolves, so too will plans and actions. In this way the organization can learn and operations can evolve toward greater effectiveness. See figure 2. The process of operational adaptation works as follows. A mess—some set of conditions—exists in the world as the result of some unobservable physical causality. The designers can observe the conditions (although not comprehensively), but not the causality, which they can only infer from the conditions. Through design the designers formulate out of the mess the problem to be solved and hypothesize a causality to explain the existence and behavior of the situation. This hypothesized causality stands in for the actual causality they cannot observe and provides the basis for conceiving a logic for action. This design becomes the basis for planning. The design and the plan may iterate as the implications of operationalizing the design impose constraints back upon the design. The plan leads to the implementation of a solution through action. The actions change the physical situation according to the actual causality that is in place. This leads to changes in plans and execution within the framework of the existing design, but also to an assessment and eventual revision of the design. The cycle iterates, with design, plans and actions coevolving with the situation.[22] The effectiveness of our actions in the physical world depends on how well our hypothesized causality reflects the actual causality. Of course, there is no way to determine this directly; we can only infer it heuristically based on how closely the results of our actions approximate what our hypothesized causality has led us to expect.

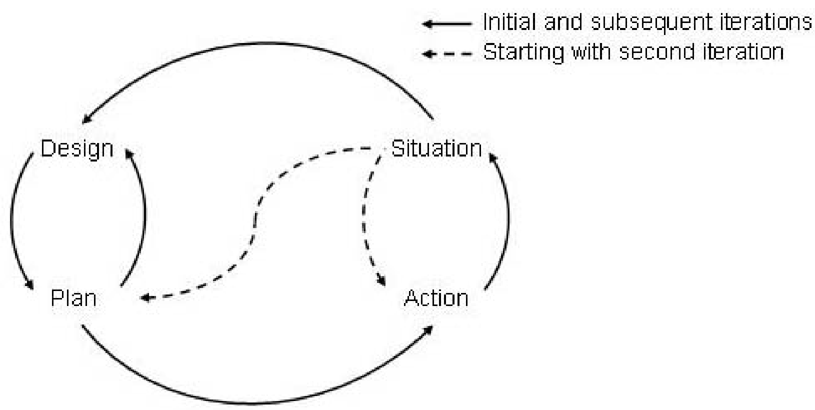

Figure 2.
The process of operational adaptation.

While current planning procedures can encourage planners to jump quickly into perceiving the problem in terms of preferred, existing solutions, this concept calls for taking the time to rationalize[23] the problem on its own terms first. Facing a complex operational situation, the commander assembles a design team and holds an iterative, conversational discourse. The purpose of this discourse is to imagine the situation as a system, to hypothesize a causal logic to explain the behavior of that system and to conceive a logical approach, a *counter*logic, for transforming that system through action. The design team uses extensively *abductive* reasoning—the process of inferring best explanations from limited facts. The resulting operational design is a logic system that permeates all operations by establishing a context for all planning and execution. The rationale is to pull out of the problem itself the logic for solving the problem rather than to apply or adapt some predetermined logic. Once the designers have created the design they continue to test and modify it through argumentation, but more importantly through feedback from the results of implementing the design through action. This feedback becomes the basis for subsequent design iterations which refine or reconstruct the design.

The design team engages in constructing and continuously modifying two complementary logics, or mental models. The first is the causal logic—the hypothesized causality—of the problem. The aim here is to rationalize the problem situation—to construct a logical explanation, in the form of an abstract model, of events observed in the physical world. The second is the *counterlogic*—the guiding logic of the campaign or operation that unravels the problem logic. The essence of this counterlogic is the defeat mechanism (or success mechanism if the problem is not a combat situation), the sequence of interactions that are expected to cause the desired transformation of the object system. The first logic hypothesizes the systemic nature and dynamics of the problem, and the second dictates the broad logical approach to solving that problem. Both logics become constraining upon subordinate commanders who plan and execute in accordance with these guiding logics.

Design must be iterative because by nature complex operational situations defy comprehension and resolution in a single iteration. Such problems require designers to make repeated passes from different perspectives to see all the various factors and relationships and then to be able mentally to hold them together as an integrated whole. Each iteration is an opportunity to learn more about the situation and make incremental improvements to the design.

Because a system can be understood only in context, this design process should be expansionist, which is to say that the discourse should expand to include the broader situation within which the immediate problem exists. Designers should generally converse about at least two different systems. First, they converse about the object system—the system they intend to act upon and transform—envisioned as a system in its own right. Then they converse about the broader system of which the object system is merely one element to gain an appreciation for the broader repercussions of acting upon the object system or to identify other potential ways to bring pressure to bear against the object system. They may continue to expand the inquiry outward to broader and broader systems as necessary to achieve the required level of appreciation.

7. Supporting Ideas

This section elaborates the controlling idea of the concept into its necessary supporting ideas. These include:

- Conversational discourse, the basic mechanism by which the design team designs
- The design process, the general pattern of cognitive activities that occur during design
- The composition of the design team
- Systems thinking, the mental discipline the design team follows
- Model making, the central activity of systems thinking
- Intuitive decision making activated by conscious reasoning that builds the necessary insight
- Continuous assessment, by which the design team tests its conceptual models
- Structured learning, which describes the essential outcome of the design process

This paper will treat each of these in turn.

Conversational Discourse

The design team designs through a process of continuous and iterative conversational discourse, the basic mechanism of design. Faced with a wicked, socially complex problem, the commander holds a conversation—but not a casual conversation. The commander holds a rigorous, structured discussion with a group of stakeholders. The discourse is an interactive learning session. It is an ongoing process of inquiry and argumentation that leverages the collective intelligence of the design group. The specific structure of the discourse is less important than that it is structured. Discourse is a universal human process—everybody knows how to argue—so there are no specialized procedures to learn. Discourse as a method cuts across organizations, domains and cultures.

Rittel and Weber concluded that wicked problems can be solved only through an "argumentative process in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument"[24]—which is to say, by discourse.

The aim of the discourse is to generate a key insight about the situation or its resolution—an "Aha!" moment that provides intuitive understanding. As a result, the discourse focuses on rationalizing the problem rather than on explicitly developing courses of action, which instead emerge naturally out of the discourse as the result of deep insight.

Conversational discourse has important social implications. From a social perspective, discourse is a way to allow the various stakeholders to have their positions heard and recognized. It facilitates appreciating and reconciling different views among the stakeholders. Importantly, discourse is not only about reaching a solution, but also about building social commitment to the solution. Dealing with social complexity requires

> *creating shared understanding about the problem and shared commitment to the possible solutions.* Shared understanding does not mean we necessarily *agree* on the problem, although that is a good thing when it happens. Shared understanding means that the stakeholders understand each other's positions well enough to have intelligent dialogue about the different interpretations of the problem, and to exercise collective intelligence about how to solve it.[25]

Discourse follows the classic dialectic dynamic of thesis-antithesis-synthesis, which strengthens ideas by submitting them to criticism and argument and revising them in response. The discourse should thus be conducted in a way that encourages disagreement and requires people to speak their minds. Tensions within the design group should be expected and tolerated—even exploited.

The discourse requires a medium or language that is appropriate to the problem domain and the requirements of each of the stakeholders. Because discourse is a conversation among people, whatever domain-specific medium may be required, the conversation will also involve speech, gesture and sketch. The design team talks about the operational problem, develops schematic diagrams to represent the situation, and accentuates both with gestures. A visual representation helps the group to better rationalize the system under consideration. Diagrams tend to enforce precision where words can be vague. They tend to make explicit relationships that words leave implicit. Diagrams are useful for capturing the situation as a whole—its structure, relationships, processes, etc.—but cannot capture nuance or deep content particularly well. Where purely military situations tend to involve physical entities, such as units, with locations that lend themselves to geographical representations, complex operational situations tend to involve more abstract factors that cannot be pinpointed on a map and will probably require other visual representational systems.[26] Text can capture nuance and richness of ideas that diagrams cannot, but it is not very good at providing an overall image of the situation. Text and images are both important. Together they provide a record of the discourse.

Since the discourse is a learning process, it is important to capture the learning that takes place. This means capturing discussion and any accompanying visual representations. With respect to capturing the discussion, the object is not merely to provide a transcript of what was said, but to provide a structured "map" of the ideas brought out. The discourse is likely to raise as many questions as it does answers, so it is also important to capture the information needs that arise in the discourse so that they can be acted upon.

The Design Process

Design is a process—a set of related activities. The process model described here provides a general flow of activities that designers will go through, but not a strict sequence of prescribed steps.[27] The designers schedule and structure whatever discourses they need to accomplish these activities. Figure 3 shows design activities as envisioned in this concept. The rough sequence in the diagram is clockwise, although as we have discussed, humans will jump back and forth between activities as needed rather than following a "logical," linear sequence. They often will perform multiple activities simultaneously. The activities are listed numerically for ease of reference only.

In Activity 1, designers first try to gain an impression of the situation—the mess that must be given structure as a problem before it can be resolved. They gather perceptions of the situation as it appears in the world. The designers are rarely starting from scratch in this activity, since each has an individual impression, but are usually trying to fill out that impression with other perspectives. The objective is simply try to gain as rich a sense of the complex reality as possible. In Activity 2, the designers try to identify the problem in the mess and to provide it some structure. Since there can be no definitive formulation of the problem, this stage amounts to actually constructing the problem to be solved. The language of this description is the normal language of the problem situation—that is, the language of politics, warfare, etc.

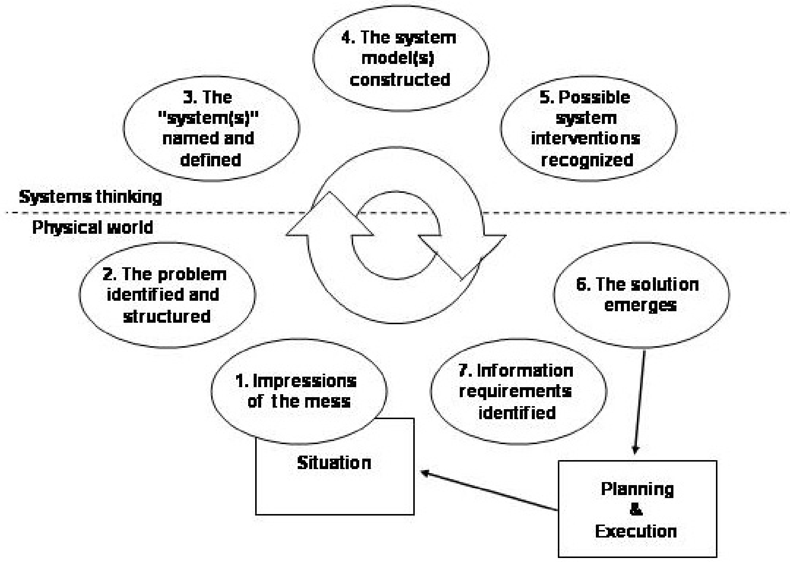

Figure 3.
The Design Process. [28]

With Activities 3 and 4, designers cross into systems thinking, creating a systemic abstraction of the problem they have begun to identify in Activity 2. They distill the complex reality into conceptual terms. In Activity 3, the designers identify the object system and posit an essential definition for it.[29] They decide what constitutes the system they intend to transform.[30] In Activity 4, the central activity of the design process, the designers create a system model that provides a rational explanation of the problem, to include underlying causes of the problem and problem dynamics. The model explains what is defined in the essential definition. While the essential definition defines what the system is, the model establishes what the system does in order to satisfy that definition. It is important to keep in mind that Activity 4 is not an attempt to capture objective reality, since that is not knowable. There are no right or wrong conceptual models—only models that are more or less defensible, more or less useful in guiding actions to resolve the situation.

Activity 5 involves conceiving possible ways to intervene in the conceptual model to transform it—to identify the potential leverage points, critical variables, etc. Activities 3-5 all take place within the realm of systems thinking. The effort is to create and operate with an abstract model at one remove from reality—to work in terms of conceptually pure factors and interactions.

With Activity 6 the designers cross back into the physical world, translating the abstract system interventions into broad lines of practicable action. The logic of these lines of action informs planning and eventually execution. In Activity 7 the design team identifies specifically the information it will need to falsify or corroborate its design hypotheses. Meanwhile, executors put the course of action into effect, which changes the situation and thus renews the cycle. The information requirements developed during Activity 7 provide the lens for reviewing the new situation.

A key element of this process model is the repeated intellectual transitioning between the physical and conceptual worlds. As they move from one activity to another, the designers shift from considering physical events and issues to dealing with abstract constructs, and back again. In the physical world they gather information about the situation and see the results of actions informed by their design. Since the commander is an executor responsible for results and a leader responsible for his people, it is important that the designers stay grounded in this reality. At the same time, the commander and other designers need to detach themselves intellectually from this physical domain to deal logically with the abstract problem they have created. If they fail to do this they risk being trapped by individual events rather than focusing on the underlying causality—they focus on the visible symptoms and miss the underlying causes.

Composition of the Design Team

The design team should consist of a relatively small group of key stakeholders with a compelling interest in the outcome of the situation. The commander is necessarily a central member because the ultimate responsibility for any decisions rests with him. In effect, the process exists to produce in the commander the insight that activates intuition. This does not mean that the commander is necessarily the chief designer driving the process and responsible for originating all the ideas. But he should be a direct participant, contributing but also learning from the other designers. The design team should not consist of a designated, segregated group of “expert designers” who create a design and hand it down to others for planning and execution. Rather, it should include those who will have to live with the result, particularly the subordinate commanders who will ultimately have to execute the plan. The team may also include other key military and non-military partners, as well as functional or other experts. The design process will almost certainly include a recurring discourse with the higher authorities to ensure that the emerging design is consistent with expectations.[31]

Diversity of perspective is a valuable trait in the composition of the design team. It promotes the competing ideas and opinions that are critical to a dialectic discourse and militates against the development of group think. Giving stakeholder groups representation in the design team will tend to provide this diversity naturally. Including “heretics” in the design team can likewise inject creative tension into the design process.

The composition of the design team will almost certainly change over time as design needs change. Some members may be more-or-less permanent, even continuing on to lead subsequent planning (and providing essential corporate memory), while others are brought in temporarily to advise on some aspect of the situation. Some members will play a central role in the design process, while others may be peripheral contributors—and those roles may change over time, with designers migrating inward to the center or outward to the periphery as requirements change. The design team need not meet as a complete group, but core designers may hold separate conversations with various stakeholders as needed. Essentially, the design team consists of anybody the commander desires to involve in the ongoing conversation.

Systems Thinking

Systems thinking is a mental process that seeks to understand and represent subjects as interactively complex wholes functioning within a broader environment.[32] It is a particular approach to trying to reason why and how things work based on the premise that practically any situation or problem can be thought of as a system of interdependent elements. While discourse is the mechanism of this design concept, systems thinking provides its mental discipline.

Systems thinking consists of contemplating a situation as a system distinguished from a broader environment within which it exists. See figure 4. Systems thinking treats the system as primarily internally-driven, and tries to rationalize its internal purpose, structure and processes as a way of understanding its behavior. That said, systems thinking also considers the system "open" in that it interacts with and is influenced by the surrounding environment, which can include other systems. The system receives inputs from the environment and generates outputs to the environment. In this way, systems thinking looks at a system as a "transformation engine" which receives certain inputs, transforms them according to its internal logic, and exports them to the broader environment as outputs.[33]

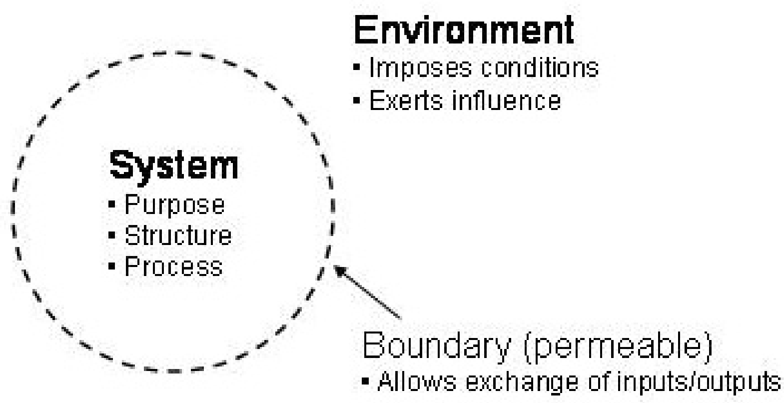

Figure 4.
The systems thinking framework

Systems thinking seeks to explain situations in terms of *closed-loop* causality, in which causal chains link back to the original cause via a feedback loop, as opposed to *open-loop* (or *straight-line*) causality.[34] See figure 5. In this sense, systems thinking is the process of "thinking in circles" as opposed to "thinking in straight lines." Where open-loop causality tends to generate predictable, linear outcomes, closed-loop causality generates through combinations of negative (balancing) and positive (reinforcing) feedback loops the interactive complexity that characterizes complex operational situations.

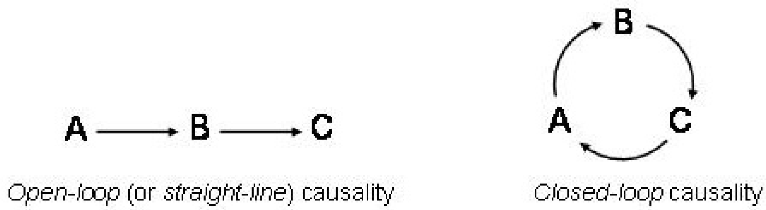

Figure. 5.
Open-loop versus closed-loop causality

Systems thinking does not presume to capture the objective reality of a situation. A system is not reality, but a *construction* meant to explain the relevant aspects of the situation. Just as there is no definitive formulation of a wicked problem, there is no constructed system that reflects objective reality; different systems can explain the same situation in different ways.

Systems thinking stands in contrast to the analytical thinking that underlies conventional planning procedures. Analytical thinking decomposes a subject successively into parts until it can explain the behavior of each of the separate parts and then seeks to explain the whole as an aggregation of the behaviors of the parts. This process is sometimes called *reductionist.* In contrast, systems thinking puts the system in the context of the larger environment of which it is a part and studies the role it plays in the larger whole. Systems thinking is thus *expansionist*, progressing outward to consider broader and broader systems.

Model Building

Systems thinking involves building conceptual models of the system or systems in question. While discourse is the mechanism of this design concept and systems thinking provides the mental discipline behind it, conceptual modeling is its central activity. The design team constructs a system model intended to explain the workings of the operational situation and its resolution, and then continues to test and refine that model over time based on feedback about whether events in the physical world seem to conform to that model. The conceptual models are captured primarily in the schematic diagrams produced during discourse and fleshed out by the textual record.

The power of models increases as they become more explicit and commonly understood. Building explicit conceptual models of the situation helps promote understanding among stakeholders of the various forces at work. It helps stakeholders build a shared understanding of the problem—reach agreements about just what the problem is—and how to solve it. It exposes unstated assumptions and implicit reasoning. It forces designers to make explicit assertions about causal relationships.

Because a key principle of systems thinking is that a system can be understood only within the context of the broader system within which it exists, the conceptual model of the object system should be embedded within a model of the broader system—or at least those elements of the broader system that are germane to the situation. This can help designers to identify external factors influencing the object system.

Because there is no system that can be established as objective reality, the effort here is not to faithfully capture the reality of the situation, but to *create* a model that reasonably and meaningfully explains observed reality. The model is not an attempt to map the situation in all its complexity. Simplicity is a virtue in model building. The model should be the simplest construct that adequately represents the essential, relevant nature of the situation. Because any situation can be represented by more than one system, it may be desirable to develop more than one model to explain the same situation, either to maintain different perspectives or with the intention of eventually selecting one over the others.

A key aspect of model building is establishing the terms of reference for design, and therefore for the operation or campaign. The designers must establish the terminology, symbology and constructs that will constitute the language and grammar of all planning and execution. Because each complex operational situation is essentially unique, it should be treated on its own terms rather than by using generic terms or terms developed for a different problem. There are no objectively correct terms. What terms are appropriate to a situation depends on how the designers have envisioned the problem. These terms will emerge naturally out of the discourse as the designers search for the most meaningful way to communicate. In other words, the design process actually creates out of the problem the tools that will be used during subsequent planning to solve the problem. Establishing a meaningful grammar so that people can communicate effectively about a wicked problem is part of taming the problem so it can be solved.

Intuition Activated by Reasoning

There are two basic modes of thinking: intuition and reason.[35] This concept involves both. Intuition is subconscious knowing, immediate cognizance or certainty without reasoning or inferring.[36] Intuition here is not some supernatural gift, but simply knowledge born of internalized understanding, whether that understanding results from experience or some other process. Reason is rational knowing, the process of coming to knowledge or certainty as the result of logical inference. Where intuition is fast, automatic and effortless, reason is deliberative, conscious and effortful.[37]

Existing decision-making or planning models tend to emphasize one mode of thought or the other, but fail to integrate the two effectively.[38] This concept sees design decisions as ultimately intuitive, but based on an intuition triggered by considerable reasoning through discourse. Conventional wisdom holds that intuition is based on experience: we see something we recognize from past experience and we know what do without having to think about it consciously.[39] For this reason, intuitive decision making is often associated with relatively simple, repeatable situations rather than complex, unique ones. Lack of direct experience has been used as a justification for a proceduralized and analytical approach to deliberative decision making. However, intuition does not apply only to split-second situations in the heat of battle, but can apply equally to deliberative situations. Subconscious knowing can be triggered not only by instant recognition based on experience, but also by a structured and rational inquiry that incrementally builds insight into a situation. The logic for dealing with a complex operational situation emerges intuitively as a product of this inquiry. Reason—structured and effortful thinking—thus becomes the basis for intuition—effortless and automatic knowing. The assertion here is that rational thinking through the application of logical inference does not directly produce a design decision—like some mathematical calculation—but instead produces the insight that causes a design idea to spring to mind spontaneously. If we gain sufficiently meaningful insight into a situation, the situation loses its complexity—the wicked problem becomes tame—and we *know* how to proceed.[40] While the moment of intuition may be effortless, the process of reaching that moment can require significant effort—especially if the situation is particularly wicked.

The idea behind this concept is thus to concentrate on understanding the situation until intuition activates and the decision emerges naturally. In we reason about the problem until the solution becomes intuitive. If a course of action does not emerge, the answer is not to explicitly try to develop one, but to renew the effort to understand the situation. This concept thus includes no steps intended to methodically build a course of action or to compare multiple courses of action. The suitability of the decision is based on how well it relates to the problem, not on how well it compares to other solutions according to some set of criteria.

Continuous Assessment

Continuous assessment is a fundamental element of design as envisioned in this concept. Continuous assessment is the mechanism that enables learning and adaptation to occur. Having created an initial design, the design team continuously tests it. There are two basic reasons for this. First, the designers will have gotten some things wrong, and mismatches will exist between the design and reality. This is inevitable given the nature of complex operational situations. Second, the situation will change. The changes may be only gradual, but even gradual changes accumulating over time will eventually create a qualitatively different situation requiring a new design. Recognizing shortcomings in the original design or qualitative changes in the situation requires continuous assessment.

The design process creates expectations. When results fail to meet expectations, the commander must decide whether this is due to a failure to implement the logic of the design (that is, poor execution) or because the design logic itself is mistaken, in which case no level of execution will matter because the actions are mismatched with the reality of the situation. The natural tendency is to assume the former. This is especially true if commanders do not appreciate the design role: not understanding the need to establish a design logic to guide planning and execution in the first place, commanders certainly will not see the need to question that logic; they will have little choice but to focus on execution. In other words, because they are not equipped to question their own logic, commanders will conclude that the inability to meet expectations is due to failure to execute. This will tend to encourage commanders to micromanage subordinates.

It is incumbent on the designers to identify specifically the type of information needed to test the operational hypothesis. These information requirements are likely to be very different from those needed to assess execution. While the latter focuses on how closely unfolding events conform to the plan, the former should focus on how well the logic that underlies the plan seems to match with reality. Developing meaningful metrics for testing the design is not a trivial task. Whereas execution assessment tends to have standardized information requirements, assessing the relevance of the design tends to demand custom-made information requirements because each complex operational situation is essentially unique. Crafting these information requirements is an essential task of design.

Learning and Adaptation

Design as described in this paper is fundamentally a structured and continuous process of learning and adaptation. Any design we create with respect to a complex operational situation will necessarily have mismatches with reality. The reason for design assessment is to figure where and how our design fails to match up with reality, and thus to allow us to revise the design. The design process essentially amounts to making assertions about the operational problem, testing those assertions through action, and revising our assertions based on the feedback. Forcing ourselves to construct explicit models to explain the problem we face amounts to proposing explicit hypotheses that we can test. If events corroborate the hypothesis, we maintain the hypothesis; if not, we have the basis for revising the hypothesis to account for the unexpected result. The object of design as described here is not to come up with a perfect solution, because this is impossible. Instead the object is to develop a reasonable initial approach and then to improve it iteratively and continuously as we learn more about the systemic dynamics of the situation.

8. Implications & Issues

This section discusses some of the likely implications and issues related to implementing this concept in the Defense establishment. This discussion is not meant to be comprehensive, but merely to identify broad vectors of implication. In fact, it is impossible fully to anticipate the implications and issues related to implementing this concept before beginning the implementation.[41] Implications and issues will emerge only incrementally over time. In general, the greatest implications and issues of this concept are likely to be in the social realm—education, training, doctrine and culture—rather than in the materiel and organizational realm.

Doctrine

Implementing this concept would involve instituting it in doctrine. Here "doctrine" refers not only to fundamental principles by which military forces guide their actions, but also to techniques and procedures for performing specific functions or tasks. The primary implications would have to do with procedures, which are important for facilitating the efficient functioning of staffs, but which necessarily limit flexibility. There are three basic issues. The first has to do with reconciling this design methodology with existing planning procedures, especially with respect to conceiving courses of action, the area of overlap between this design concept and current planning models. The second issue has to do with instituting a design concept as formal doctrine without sacrificing the necessary flexibility. Since every operational problem is unique, requiring a unique design effort, design cannot be proceduralized in the way that planning can. The third has to do with the applicability of existing doctrinal constructs, such as center of gravity, which systems thinking may call into question. It is likely that other, "systemic" constructs will come into usage as the result of implementing this concept.

Leader Development

By far the greatest implications of this concept will come in the area of leader development. Officers will need to be educated in systems theory and practiced in the techniques of systems thinking. Staff exercises will have to provide opportunities for practicing design as well planning, which could have implications for exercise design. Effective discourses, critical to this concept, will require officers who are skilled as facilitators. As with doctrine, a key issue will be in how to train officers in the techniques of design without proceduralizing the process. One solution might be the use of historical case studies of design, done well and poorly, during professional education. Another issue is at what grade level to begin teaching design techniques.

Culture

This concept will have significant implications for military culture, especially with respect to the requirements of discourse. It will require commanders who are comfortable engaging in the give-and-take of argument with their subordinates and subordinates who are comfortable disagreeing with their commanders. It will require a culture that does not equate disagreement with disloyalty, a culture that tolerates, even protects, heretics and iconoclasts.

Technology

This concept requires no technological advances—although information technologies applied wisely could enhance the design process, just as the same technologies applied unwisely could significantly hamper it.

Technological efforts should concentrate on helping the designers develop shared understanding despite the wickedness and social complexity that characterize complex operational situations. This effort breaks down into three basic areas. The first is extending the design discourse to include people who are not collocated—turning the discourse into a distributed conversation. The goal is to allow designers who are geographically distributed to collaborate at least as well as if they were collocated. This would allow the commander to tap into any source of expertise located anywhere. The technology should help these distributed individuals build trust and common ground as quickly as possible. The second area in which technology could help would be in providing visualizations that help designers to represent and discuss complex operational situations systemically. These visualizations would be intended to help designers apprehend the temporal, spatial and other dynamics of the situations they wrestle with. The third area in which technology could help is in capturing the learning that takes place during the discourse. This would mean technology to better capture the discussion and diagramming that take place. Capturing the conversation is not merely a matter of providing a transcript. Conversations often do not follow a logical flow, but tend to jump around and repeat themselves. Instead, the need is to capture the content of the conversation in a logical, structured way.[42] With respect to diagramming, the goal should be to help designers create, modify, share and animate the system diagrams they develop during the discourse.

Simple collaboration technologies, such as white boards, are best because of their ease and flexibility of use. Any technology applied to design should not constrain the designers by forcing them to adopt predetermined sequences of steps or use predetermined constructs. To do so would in effect force designers to adopt the paradigm of the technology developer, defeating the premise of design, which is to look at the problem with a "blank sheet," without any preconceived notions. In general, the technology should be as simple to use as a white board or word processor.

9. Conclusion

To the extent that we face socially complex, wicked problems, we should design before we plan and execute. Design is essentially the process of rationally formulating the problem to be solved out of the mess that confronts us, and doing it in such a way that the logic for solving the problem emerges intuitively. We design by holding a conversational discourse among stakeholders during which an image of the problem and the solution emerges gradually through the collective intelligence of the group subjected to critical argument. During operational design, we think systemically—we imagine the problem as a system driven primarily by its own purpose, structure and processes, but also influenced by the broader environment within which it exists. We do this by developing, testing and modifying conceptual models hypothesized to explain the workings of the system in its environment. Because we cannot observe the physical causality that underlies the situation, we test our hypothesis heuristically through action. We observe the results of our action to see if they conform to the expectations of our design, and we redesign accordingly. In this way, design provides the basis for assessment and for adapting our operations to the situation through learning.

Appendix A: An Illustration of the Design Process

This appendix provides an illustrative example of this design concept at work. The simplified scenario is not meant to capture the complexity of a true operational problem, but simply to illustrate the main stages of the design process. See figure 3 on p. 13. Despite the simplicity of the scenario, the resulting conceptual model is fairly complicated—which testifies to the extreme complexity of actual operational problems. The reader is encouraged to work through the complexity to appreciate the concept. The causal-loop diagramming notation used in this example is not meant to be prescriptive, but is one possible option. The design "language" chosen for any given situation should depend on the requirements of the situation.

In this scenario, the central Asian country of Destablia, a stalwart ally in the Long War, has requested U.S. assistance in defeating a budding insurgency with links to the global Islamist movement. The President agrees and establishes the following strategic goals:

- Provide security for the national population, institutions, resources and infrastructure.
- Maintain law and order.
- Defeat anti-government forces.
- Establish conditions necessary for the social, economic and governmental rehabilitation of Destablia.

The regional combatant commander (COCOM) establishes a joint task force. The COCOM and joint task force commander (CJTF) assemble a design team, consisting of key staff, other area and functional experts, host-national stakeholders and other key allies—and intentionally representing different perspectives. The design team first comes together to build a rich impression of the mess before them (Activity 1 of the design process). The discourse reveals the following:

- The situation within Destablia has been deteriorating for 6-8 years, although the pace has accelerated significantly within the last year.

- Destablia has engaged in a border war for the last 12 years with Irkistan, a militaristic neighbor to the north; fighting has been cyclical (and is currently in a lull), but a resulting arms race has been significant and continuous.

- Destablia is suffering from an influx of refugees from southern neighbor Vicinia that is overwhelming Destablian services and infrastructure.

- Destablia has been suffering from several years drought summers which have greatly decreased the output of the agricultural plain shared by Destablia and Vicinia.

- Backwards agricultural policies and methods in both Destablia and Vicinia have exacerbated the agricultural problems caused by the run of dry weather.

- Protection against Irkistan is the primary element of the Destablian government's policy.

- The origins of the Irkistan-Destablia border conflict are unclear, apparently even to the principals.

- Disruptive behavior within Destablia has increased from looting and other crime to subversion and now into insurgency, with increasing calls for removal of the existing government. Violence that began as crime has evolved into acts of intimidation, sabotage and terrorism, and even some small-scale guerrilla warfare in rural areas.

- The Destablian government is not thoroughly corrupt, but includes numerous inefficiencies dating from the days of Soviet rule.

- Irkistan's military is disproportionately large given the country's size and status in the region.

- The Destablian government has attempted several rounds of crackdowns against the disruptive behavior. The first crackdown had an immediate suppressing effect, but that effect was temporary and the disruptive behavior eventually returned at an increased level. With each successive attempt, the crackdowns have been more forceful, but the results have been less effective and shorter lived.

- Internal disruptive behavior is being sponsored by Irkistan as part of its ongoing border clash. Sponsorship has taken the form of funding and training.

- The global militant Islamist movement seems to be developing Destablia as a base of operations in the region, whether as retribution for Destablia's alliance with the United States or to exploit the growing disorder—or both.

- Economic conditions in neighboring Vicinia are worse than in Destablia, although Vicinia has not suffered the same political and social disintegration. Vicinia seems to exhibit greater social stability, possibly for reasons of greater ethnic and religious homogeneity.

Having collected a rich impression of the various elements of the situation through their discourse, the designers synthesize these observations to formulate the problem they face (Activity 2). From their differing perspectives they see a variety of internal and external catalysts. Members of the design team argue their differing positions, but eventually they reach a working agreement on the nature of the underlying problem—a growing insurgency at the same time that the country descends into poverty and chaos—although they cannot agree which is the cause and which the effect. All of this discussion occurs in the language of the physical situation: political mismanagement, poverty and disease, economic depression, terrorism and guerrilla war, popular dissatisfaction, agricultural collapse, etc.

By this time at least some of the designers are beginning to appreciate the situation as a system (Activity 3). The discourse gradually transitions into the language of systems thinking. The designers imagine an object system "Destablia" and define it essentially as a "disorder engine" that transforms structure—national resources, social institutions, government policy and economic effort—into disorder. They elaborate this definition using the abbreviation CATPOE:

- Customers (or in this case, victims): the people of Destablia who suffer as the result of the instability.

- Agents: government leaders who exercise control, disruptive elements who resist that control or fight to gain control, and the population who react to both.

- Transformation: national potential turned into disorder and popular suffering.

- Perspective: a third party interested in maintaining stability under the current Destablian government.

- Owners: the Destablian government.

- Environmental factors: drought conditions leading to agricultural collapse, the border clashes and arms race with Irkistan, external subversion by Irkistan, and the refugee influx from Vicinia.

The design team next begins to develop a conceptual model (Activity 4) to explain the essential definition they have asserted. See figure A-1. They do not initiate this as a separate, explicit task; rather, the model has begun to take shape intuitively for some of them during the discussions, which have involved frequent sketching and diagramming. (In fact, a couple of designers developed the initial model during a break in the discourse and proposed it to the larger group the following day.) They posit that existing instability or the Destablian government's inability to execute its governance responsibilities with respect to the people leads to popular grievances and suffering, which in turn promote disruptive behavior, which in turn generates more instability and increases the government's inability to function. This creates a reinforcing loop or vicious cycle (R1) by which Destablia spirals into chaos. They posit that the Destablian "system" will remain trapped in this disintegrating spiral unless there is an external injection of energy into the system to break the cycle. They assert that the disruptive behavior in the system increases from simple looting or other criminal behavior to intentional subversion to active insurgency as the system iterates through the vicious cycle. The designers also envision that there is a second reinforcing loop (R2) between this disruptive behavior and popular grievances as subversive elements use propaganda directly to increase popular dissatisfaction with the government. The designers see this loop as accelerating the disintegration.

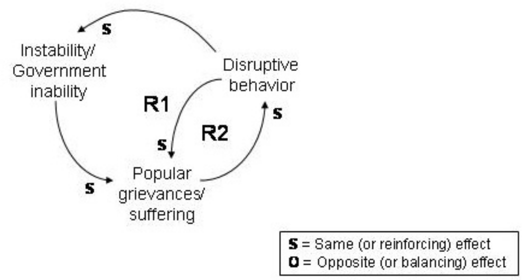

Figure A-1.
Basic conceptual model: Destablia as a "Disorder Engine"

The designers build on the base model to capture the government's repeated crackdowns on the disruptive behavior. See figure A-2. Initially, the crackdowns seem to work as intended, damping the disruptive behavior, causing a balancing loop (B1). But the crackdowns also inflict collateral damage, which eventually adds to the popular suffering and grievances. The subversive elements realize that by increasing the level of disruption they can provoke more severe (i.e., less discriminate) responses from the government, resulting in even greater suffering and generating another, delayed reinforcing loop (R3) that contributes to the vicious cycle of growing instability. In this way the designers account for the observation that the government crackdowns seem to have less positive effect for a shorter period each time they are tried.

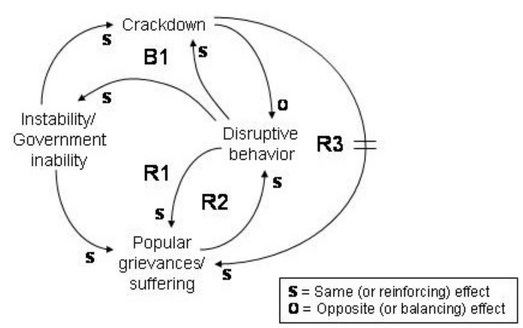

Figure A-2.
The Destablia Model Grows: Delayed Effects of Crackdowns

Next the discourse expands beyond the object system to consider the broader environment in order to capture the external factors that contribute to the Destablian problem. See figure A-3. The designers posit that the ongoing border clash and arms race with Irkistan contributes to government inability by claiming resources and attention that could otherwise be given to the domestic situation. Likewise, the dry conditions and resulting lack of agricultural production have contributed to popular suffering. The designers assert that this is not entirely an external factor, but partly the result of poor government policies—not only on the part of the Destablian government, but also on the part of the Vicinian government. The designers identify this as another reinforcing loop (R4) accelerating the disintegration of Destablia. The designers also assert that the influx of refugees from Vicinia has contributed to popular suffering by overwhelming already-weakened Destablian infrastructure and services. The designers conclude that disruptive behavior is being fomented by both the global Islamist movement, which sees an opportunity to exploit the growing chaos in Destablia, and Irkistan as part of its ongoing conflict with Destablia. This exercise in expanding the discourse makes plain to the designers that Destablia's fortunes are closely tied to those of both Irkistan and Vicinia. Strengthening Destablia without changing the relationships in this broader system might simply result in a greater expenditure of resources on the showdown with Irkistan and greater influx of refugees from troubled Vicinia. The designers recognize that any solution to the Destablian problem should actually address all three elements in this broader system. They develop additional conceptual models imagining the behavior of the systems "Irkistan" and "Vicinia" (not shown) and link those models to the "Destablia" model.

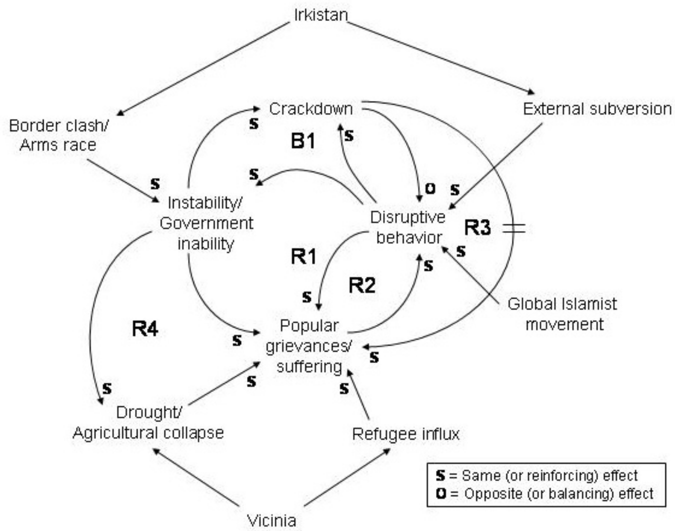

Figure A-3.
The Effects of External Factors on the System.

At this point the joint task force commander declares himself satisfied with the system the team has created. He knows this is not by any means a complete or necessarily accurate mapping of the reality of the situation, but it is a reasonable construction that will allow the force to take a logical and informed approach to solving the problem. With the logic of the problem established, the counterlogic of the solution becomes self-evident. The overall logic that will guide all planning and execution is to interrupt and then reverse the vicious cycle of disintegration that has captured Destablia. Looking at the model they have created, some of the designers have already intuitively begun to identify possible interventions—ways to intervene in the behavior of the system—to implement that logic (Activity 5). There are a finite number of places to inject "energy" into the system. See figure A-4. Many of these will require non-military efforts, and some of them are not even targeted at Destablia, but at Irkistan and Vicinia. The designers observe that some of these interventions are merely symptomatic, meaning they treat the symptoms rather than the underlying problem and will have effect only while energy is being applied. The designers identify other interventions as structural—that is, actually changing the structure and functioning of the system. For example, they identify that providing relief aid to the Destablians and Vicinians will relieve suffering, but will do nothing to change underlying dynamics. On the other hand, reforming the

Destablian government and providing agricultural training will change the system dynamics.

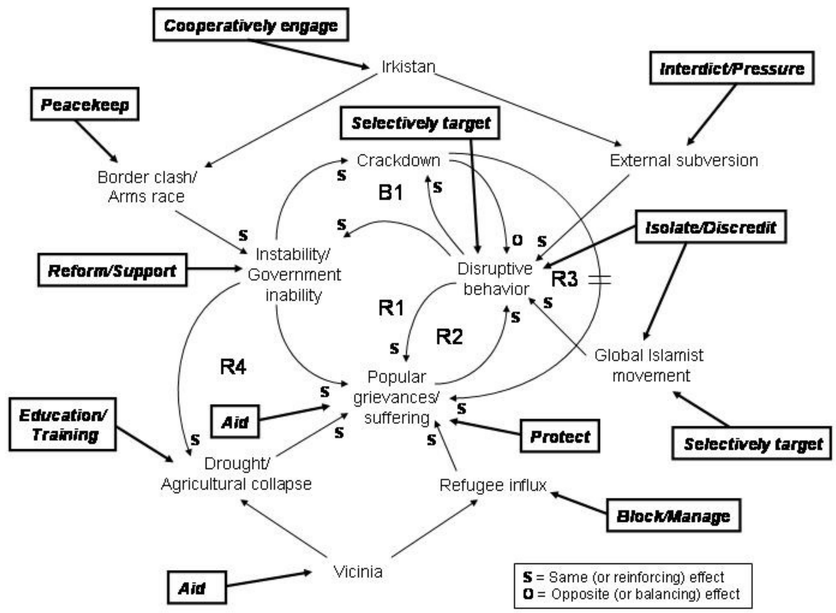

Figure A-4.
Possible Interventions in the System "Destablia"

Based on the familiarity the designers have developed with the system in question, the solution emerges naturally (Activity 6). At this point, the discourse crosses back from systems language to the language of the physical situation. The designers recognize intuitively what some of the conceptual system interventions will look like as physical actions. For example, one of the logical interventions that emerged out of the system model was to block or manage the refugee influx that overwhelms the Destablian system; in practical terms this could involve patrolling the border, establishing refugee camps, and providing aid to Vicinia to mitigate the conditions that are causing the flight. The course of action becomes some combination of the various possible activities, which become the main lines of effort that will govern all subsequent planning and execution. In this case, the design includes lines of effort to:

- Intervene in and diffuse the border conflict with Irkistan—to include a peacekeeping force along the border to maintain the current truce and prevent Irkistani infiltration in support of insurgency, diplomatic efforts to curtail Irkistani subversion of Destablia, cooperative engagement with both Destablia and Irkistan with the eventual aim of tripartite military exercises. This becomes the main effort because the commander perceives this dynamic as the dominant factor in the problem.

- Reform and strengthen Destablian governmental institutions—largely a non-military effort, but including foreign internal defense.

- An agricultural education program to reform both Destablian and Vicinian agricultural policies and practices in order to improve production—again, non-military.

- A comprehensive information program designed to isolate and discredit the insurgent cause and to offer as an alternative and attractive government message promising to address legitimate grievances.

- Provide immediate aid to relieve suffering, in Vicinia as well as Destablia.

- Address the refugee issue—by controlling refugee movements, establishing relief camps along the Vicinian border, and through the relief packages mentioned above.
- Provide security to protect the local populace from pressure by the insurgency—through extensive patrolling and the establishment of secure zones which are steadily expanded.
- Attack hardened insurgent and Islamist elements through highly discriminate military action, with particular sensitivity to the potential blowback effects of heavy-handed action.

The design calls for as much of this effort as possible to be accomplished by Destablian or international organizations to promote self-sufficiency.

The COCOM and CJTF re-engage with the political leadership to gain approval for this broadened approach and to determine what support can

be expected from other agencies or international partners and what efforts the joint force must accomplish itself.
The CJTF organizes the joint task force around the major lines of effort, with task groups or functional components assigned the different efforts. He establishes a command structure specifically designed to integrate these efforts and to learn from the process. He establishes a theater logistical apparatus specifically intended to provide the required aid and support.

Next the designers identify the information they will need to validate or invalidate the particular design they have created (Activity 7). Since designers have imagined that the primary dynamic has to do with the circular relationship among governmental performance, popular grievances/suffering, and disruptive behavior, the designers focus on identifying indicators of changes in those trends. Since they have also asserted that the agricultural collapse and refugee influx, for example, are contributing to popular dissatisfaction, the designers also establish information requirements in those areas to test whether that assertion is true.

The designers transition the "design" to the planners. This is not actually much of a turnover, since planners have been invited to observe the design process and several of the designers go on to become key members of the planning team. The design consists of the logical description of the problem—the spiraling disorder—and the counterlogic of the solution—arresting and reversing the spiral by selectively injecting stability into the system—as well as the main lines of effort intended to implement that counterlogic. This becomes the binding description of the problem that all stakeholders agree they are trying to solve and the logic they will follow in solving it.

The planners transform the broad design into a campaign plan, which is then implemented. The designers reconvene periodically to consider how appropriate the design is to the unfolding situation in the theater and whether they need to redesign. They are prepared to revisit any of the design stages as necessary. If the information they receive indicates that they got the situation mostly wrong, the designers realize they may need to start from scratch with impressions of the new mess (Activity 1). If the feedback suggests that the designers assessed the situation mostly correctly, they may only need to modify their conceptual model slightly (Activity 4). In this case, feedback over time indicates that the relief aid to Vicinia has improved living conditions, and that the agricultural situation has eventually begun to improve as well, but that the refugee flow into Destablia has not lessened—in fact, as conditions in Destablia have also improved, it has increased. This forces the designers to take another look at their model and to conclude that there are other, structural issues going on in Vicinia which they had missed previously and which need addressing. They re-imagine the Vicinian system, revise the design accordingly, and convey the modified governing logic to the force. The design process continues this way throughout the operation, modifying the logic of action and providing continuing context for all planning and execution.

Appendix B: 1st Marine Division Design for Operations in Western Iraq, 2004

As an example of design at work, this appendix describes the design efforts of the 1st Marine Division staff prior to the division's second deployment to Iraq in early 2004 as part of Operation IRAQI FREEDOM. Commanding general Maj. Gen. James N. Mattis recognized that the problem the division would be facing was sufficiently complex and novel that the situation warranted a design phase to come to grips with the problem prior to the commencement of tactical planning.

The division had been one of the two major U.S. ground combat formations during the initial invasion of Iraq during OIF I in the spring of 2003, fighting its way to Baghdad and then pushing on further north to secure Tikrit. After the invasion, it settled in to conduct stability operations in relatively tranquil, predominantly Shia southern Iraq before returning to the United States in the summer of 2003. Many of the Marines who had been with the division during OIF I would also be participating in OIF II, Mattis included.

Mattis knew that the second deployment would be very different from the division's experience in OIF I. The Sunni-led insurgency was growing. Mattis was determined to make certain that the division did not make the mistake of preparing for the last war rather than for the next one. Consequently, he pulled key members of his staff together for a design session. Mattis and his staff did not talk explicitly in terms of "design" and did not precisely follow the concept laid out in this paper, but they clearly undertook a design process to formulate the problem they expected to face in western Iraq.

Through their discussions the designers came to identify the system in question as the population of western Iraq. They asserted that this population constituted a system consisting of three major components: the *tribes*, *former regime elements* and *foreign fighters.* The *tribes* constituted the primary identity group in western Iraq. They included various internal tribal affiliations and looked to a diverse array of sheiks and elders for leadership. The *former regime elements* were an important minority that included individuals with personal, political, business and professional ties to the Ba'ath Party, including civil servants and career military personnel with the skills needed to run government institutions. This group initially saw little to gain from a democratic Iraq. The *foreign fighters* were a small but dangerous minority of transnational Islamist guerrillas. The designers reasoned that, as in any society, each of these groups would include some criminal element that would need to be dealt with. To be successful, the division would have to distinguish among these different groups and take a different approach to dealing with each within the framework of an overall logic.

The designers further asserted that the population would take three possible positions with respect to the coalition: supportive, neutral or hostile. Some segment of the population—mostly coming from the tribes—would be inclined to support coalition efforts, although this support would not be unconditional and could certainly be lost through acting inappropriately. Another segment—the foreign fighters and some former Ba'athists—would be opposed to coalition efforts at any cost and would have to be destroyed. In between these positions would be the "fence sitters" who would take a "wait and see" attitude. This attitude was expected from some of the tribes and even some former regimists. This segment was considered a critical and winnable constituency and would be addressed as such in the division's design.

This conception of the population and its possible attitudes constituted the designers' conceptual model of the problem. The governing logic of the division's operations flowed naturally from this model. See figure B-1. The division would follow a two-part approach:

- Work to gain the support of as much of the population as possible, and thereby diminish support for the insurgency.

- Destroy the remaining elements that cannot be won over.

This basic design was even captured in a motto that became popular in the division: "No better friend, no worse enemy."

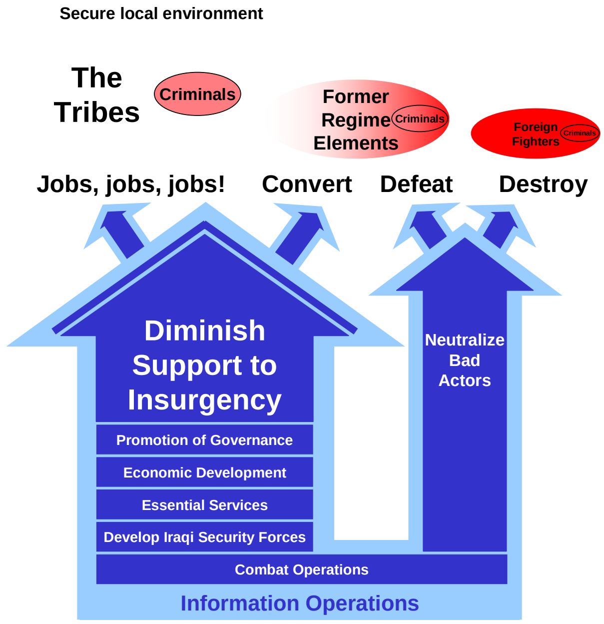

Figure B-1.
First Marine Division's design for operations in western Iraq, 2004-05.

The first element, and the main effort, was *diminishing support for the insurgency*. The objective was to establish a secure local environment for the indigenous population so that people could pursue their economic, social, cultural and political well-being and achieve some degree of local "normalcy." Establishing a secure environment involved both offensive and defensive combat operations with a heavy emphasis on training and advising the security forces of the fledgling Iraqi government. It also included putting the population to work. Simply put, an Iraqi with a job was less likely to succumb to ideological or economic pressure to support the insurgency. Other tasks included the delivery of essential services, economic development, and the promotion of governance, all geared towards increasing employment opportunities and furthering the establishment of local normalcy. Essentially, diminishing support for insurgency was about gaining and maintaining the support of the tribes, as well as converting as many of the former regime members as possible.

The second element involved *neutralizing the bad actors*, a combination of irreconcilable former regime elements and foreign fighters. Offensive combat operations were conducted to defeat former regime members who remained recalcitrant. The task was to make those who were not killed outright see the futility of resistance and give up the fight. With respect to the hard-core extremists, who would never give up the fight, the task was more straightforward: their complete and utter destruction. Neutralizing the bad actors supported the main effort by improving the local security environment. Neutralization had to be accomplished in a discrete and discriminate manner, however, in order to avoid unintentionally increasing support for insurgency.

Both main elements of the design were wrapped in what the designers referred to as an overarching "bodyguard" of *information operations*. These information operations, both proactive and responsive, would be conducted aggressively to favorably influence the populace's perception of all coalition actions while simultaneously discrediting the insurgents. The aim was to gain and maintain the support of the tribes and those former regime elements that could be converted, as well as to gain support in the effort to destroy the remaining regime elements and the foreign fighters. It was recognized that these tasks would be incredibly difficult for a number of reasons. Corruption had historically been prevalent among Iraqi officials, generating cynicism toward government. Additionally, decades of Arab media mischaracterization of U.S. actions had instilled distrust of American motives. The magnitude of that cynicism and distrust highlighted the critical importance of using information operations to influence every situation.

The division would still have to develop tactical plans to translate this broad design into action. It would have to modify the design over time as the situation changed qualitatively, especially with respect to the fierce fighting in and around Fallujah. But the design developed in the months preceding the division's second deployment to Iraq remained throughout that deployment the broad logic that guided the division's actions there.

[1] Karl Popper, *The Logic of Scientific Discovery* (London: Routledge, 2002), p. xix.

[2] John R. Boyd, "Destruction and Creation" (unpublished article, 1976), included in *A Discourse on Winning and Losing* (unpublished briefing slides, 1989), p. i.

[3] This concept is directly motivated and strongly influenced by the pioneering work of Brigadier General Shimon Naveh (retired), of the Israeli Defense Force. Naveh calls his methodology Systemic Operational Design (SOD). SOD has its genesis in Naveh's book, *In Pursuit of Military Excellence: The Evolution of Operational Theory* (London: Frank Cass, 1997). This concept is an offspring of SOD, following in SOD's footsteps philosophically, but differing with respect to implementation. SOD was introduced in the United States in a series of exercises conducted by the Concept Development & Experimentation Directorate of the U.S. Army Training and Doctrine Command (TRADOC) starting in 2004, including during *Unified Quest* 2005 and 2006.

[4] Joint Pub 1-02, *DOD Dictionary of Military and Associated Terms*, online version as amended through 31 August 2005. http://www.dtic.mil/doctrine/jel/doddict/.

[5] U.S. Army doctrine describes the "elements of operational design" as "tools to aid designing major operations. They help commanders visualize the operation and shape their intent." They include:

- End state and military conditions
- Center of gravity
- Decisive points and objectives
- Lines of operation
- Culminating point
- Operational reach, approach, and pauses
- Simultaneous and sequential operations
- Linear and nonlinear operations
- Tempo

See FM 3-0, *Operations* (Washington: Headquarters, Department of the Army, June 2001), p. 5-6. The Marine Corps has a different, non-doctrinal list:

- Factors of mission, enemy, terrain and weather, troops and support available-time available (METT-T).
- CBAE consisting of the commander's analysis of the battlespace, commander's intent, center of gravity analysis, and commander's critical information requirements.
- Commander's guidance.
- Decisive actions.
- Shaping actions.
- Sustainment.
- Principles of war and tactical fundamentals.

- Battlefield framework.
- Operation plan or order.

See Marine Air-Ground Task Force (MAGTF) Staff Training Program, "Marine Corps Gazette Article #6, Operational Design," http://www.mstp.usmc.mil/SPTS/Doctrine/MSTP%20Gazette%20Articles/Operational%20Design%20(6).pdf. Joint doctrine does not include "elements of operational design," but lists 14 "facets of operational art" which have some overlap with the Army list:

- Synergy
- Simultaneity and Depth
- Anticipation
- Balance
- Leverage
- Timing and Tempo
- Operational Reach and Approach
- Forces and Functions
- Arranging Operations
- Centers of Gravity
- Direct versus Indirect
- Decisive Points
- Culmination
- Termination

See Joint Pub 3-0, *Doctrine for Joint Operations* (Washington: Joint Chiefs of Staff, 10 Sep 2001), pp. III-9 through II-25.

[6] U.S. Marine Corps, *Planning*, Marine Corps Doctrinal Publication 5 (Washington: Department of the Navy, 1997), pp. 35-37

[7] U.S. Marine Corps, *Warfighting*, Marine Corps Doctrinal Publication 1 (Washington: Department of the Navy, 1997), pp. 37-38. Italics in original.

[8] See Martin van Creveld, *Command in War* (Cambridge, MA: Harvard University Press, 1985), especially chapters 1 and 8. Marine Corps doctrine recognizes the need to deal with uncertainty as the defining feature of command and control, although this recognition is generally not reflected in current planning practices. See U.S. Marine Corps *Command and Control*, Marine Corps Doctrinal Publication 6 (Washington: Department of the Navy, 1996), pp. 54-56.

[9] MCDP 5, p. 35.

[10] Herbert A. Simon, *The Sciences of the Artificial*, 3rd edition (Cambridge, MA: MIT Press, 1996), p. 132.

[11] Horst W.J Rittel & Melvin M. Weber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4 (1973), 160-167. See also Jeff Conklin, "Wicked Problems and Social Complexity," *Dialogue Mapping: Building Shared Understanding of Wicked Problems* (Chichester, England: John Wiley & Sons, 2006), pp. 3-23. Much of this discussion is adapted from these sources.

[12] A simple example of a tame problem is a crossword puzzle. Solving the puzzle may in fact be very difficult, but there is little doubt about how to go about it or when the puzzle has been solved correctly. And solving one crossword puzzle improves the skills needed to solve others, whereas solving one wicked problem does not provide skill in solving others.

[13] Russell L. Ackoff, *Redesigning the Future: A Systems Approach to Societal Problems* (New York: Wiley and Sons, 1974), p. 21.

[14] This does not even consider the ethical implications of experimenting with complex social situations in which the results can have dramatic and irreversible effects on human suffering and quality of life.

[15] Much of this discussion is adapted from Conklin, pp. 23-30.

[16] See Gary A. Klein, Judith Orasanu, Roberta Calderwood and Caroline E. Zsambok, eds., *Decision Making in Action: Models and Methods* (Norwood, NJ: Ablex Publishing, 1993). See also Maj. John F. Schmitt, "How We Decide," *Marine Corps Gazette*, Oct95, pp. 16-20.

[17] See Gary Klein, *Sources of Power: How People Make Decisions* (Cambridge, MA: MIT Press, 1998).

[18] See D.A. Kobus, S. Proctor, T.E. Bank and S.T. Holste, *Decision-Making in a Dynamic Environment: The Effects of Experience and Information Uncertainty*, Technical Report A154383 (San Diego, CA: Pacific Sciences and Engineering Group, Aug 2000).

[19] Raymonde Guindon, "Designing the Design Process: Explaining Opportunistic Thoughts," *Human-Computer Interaction*, 1990, vol. 5, pp. 305-344. See also Conklin, pp. 8-13.

[20] Conklin., p. 9.

[21] "heuristic: involving or serving as an aid to learning, discovery, or problem-solving by experimental and especially trial-and-error methods <*heuristic* techniques> <a *heuristic* assumption>; *also* **:** of or relating to exploratory problem-solving techniques that utilize self-educating techniques (as the evaluation of feedback) to improve performance." *Merriam-Webster Online Dictionary*. 2006. www.merriam-webster.com (accessed 12 Jun 06).

[22] This is, of course, a variation of Boyd's OODA loop as applied to the specific challenge of design and planning. See John R. Boyd, "Patterns of Conflict" in *A Discourse on Winning and Losing* (unpublished briefing slides, 1989), p. 5.

[23] "rationalize: to bring into accord with reason or cause something to seem reasonable." *Merriam-Webster Online Dictionary*. 2006. www.merriam-webster.com (accessed 12 Jun 06).

[24] Rittel and Webber, p. 162.

[25] Conklin, p. 29. Emphasis in original.

[26] Systems diagrams, also known as causal-loop diagrams, are one possible visual representational system. For an example, see Appendix A of this paper. See also Peter M. Senge, *The Fifth Discipline: The Art & Practice of the Learning Organization* (New York: Doubleday, 1990).

[27] A *process* as used here is distinct from a *procedure*. A procedure is a prescribed sequence of actions instituted to perform a process within an organization. A process is a description of principles of activity. The process described here is adapted from Peter Checkland, *Systems Thinking, Systems Practice: A 30-Year Retrospective* (Chicester, England: John Wiley & Sons, 1999), pp. 161-183.

[28] Adapted from Checkland, p. 163.

[29] Checkland calls this the *root definition*, pp. 224-227 and 287-293. Checkland suggests building a root definition using the acronym CATWOE:

- Customer—the direct beneficiaries or victims of the system.
- Actors—the agents who carry out the main activities of the system.
- Transformation—the transformative process the system performs.
- *Weltanschauung*—the particular perspective from which the system is viewed and defined.
- Ownership—those who control the system.
- Environment—those external constraints that significantly affect the behavior of the system.

Checkland argues (p. 224) that the core of the root definition is the transformation process by which the system converts inputs into outputs.

Another possible method for defining the system is to use a metaphor—for example, asserting that an insurgency is essentially a viral infection spreading through a population.

[30] In conventional combat situations, deciding who is "the enemy" may seem like a relatively trivial exercise, but in today's complex operational situations, deciding who is the proper object of our actions is anything but trivial.

[31] In the case of joint force commanders this will mean conversations with political leaders. A key objective of these conversations will likely be to educate the political leaders on reasonable expectations as to the use of military or other power and on the potential implications of initiating action.

[32] Systems thinking is based on the "system sciences," which include, as examples, general system theory, cybernetics, chaos theory, complex adaptive systems, and network science. See "Systems Thinking," *Wikipedia, The Free Encyclopedia*, http://en.wikipedia.org/w/index.php?title=Systems_thinking&oldid=45056794 (accessed 13 Apr 06).

[33] Checkland, p. 169.

[34] Closed-loop causality is not at odds with open systems. A system can have a closed-loop causal chain among several interactive elements and still be open to the surrounding environment in terms of inputs and outputs.

[35] According to Nobel-laureate psychologist Daniel Kahneman. See Rich McManus, "Nobel Laureate Kahneman Posits Two Forms of Thought in WALS Talk," http://www.nih.gov/news/NIH-Record/04_13_2004/story02.htm [accessed 11 Aug 06]. See also Daniel Kahneman, "Maps of Bounded Rationality: A Perspective on Intuitive Judgment and Choice," Nobel Prize

lecture, 8 Dec 02, http://nobelprize.org/nobel_prizes/economics/laureates/2002/kahnemann-lecture.pdf [accessed 11 Aug 06].

[36] "intuition." *Webster's Third New International Dictionary, Unabridged*. Merriam-Webster, 2002. http://unabridged.merriam-webster.com (24 Aug. 2006).

[37] See McManus, "Nobel Laureate Kahneman Posits Two Forms of Thought."

[38] See William Duggan, "*Coup D'Oeil:* Strategic Intuition in Army Planning," Strategic Studies Institute monograph (Carlisle, PA:. U.S. Army War College, Nov2005). Klein's recognition-primed decision (RPD) model is the quintessential intuitive model. See Klein, *Sources of Power*. The Marine Corps Planning Process (MCPP) and Military Decision Making Process (MDMP) are typical rational models.

[39] For this reason, intuitive decision making has also been called *recognitional*, e.g., Gary Klein's recognition-primed decision (RPD) model. See Klein, *Sources of Power.*

[40] Understanding here is not a matter of mastering objective truth, but of creating a compelling interpretation of the situation.

[41] Force planning is a wicked problem.

[42] One possible method for doing this is the issue-based information system (IBIS), a notation system developed by Horst Rittel in the 1960s and 1970s, which has since been encoded in software applications. Other similar notation systems exist. See Conklin, p. 87.

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