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Sustaining Competitive Advantage: Mental Models and Organizational Learning for Future Marines

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Doctrine is doctrine on day one. Every day after, it becomes dogma.

-- John Boyd[1]

Napoleon shocked the Prussians at Jena. The Prussian generals could not conceive of an entity capable of defeating the system designed by Frederick the Great. Wedded to a scheme that brought them past successes, the Prussians were unable to see the new conditions confronting them. The Prussians never fully recognized the true extent of the mental rigidity and deterioration afflicting the generals until that October afternoon in 1806, at Jena and Auerstedt.[2] The Prussian generals did not see what was happening in the world around them because their collective frame of mind would not allow new ideas to intrude. This historical example – and countless others like it – includes the elements of change and an inability to perceive change.[3]

In this case and many others, warfare changed in form to such a degree it triumphed over the preceding form, and the people involved believed their era witnessed the advent of rapid and fundamental conversion. Complexity theory says the people in each era were correct. Systems capable of the most complex, sophisticated responses will always have the edge in a competitive world. Warfare represents the ultimate in human competition, and as such, warfare will continually evolve in form toward increasing sophistication and complexity.[4] So why were the Prussians, among many others, unable to recognize change and then successfully adapt?

The answers lie in mental models and organizational learning. They explain how people make sense of and act in the world, and how organizations learn and adapt to achieve winning results. The Marine Corps leveraged innovation in the past to achieve advantage over its enemies. Through future use of mental models and organizational learning principles, Marines can sustain their competitive advantage against adversaries in any rapidly evolving operating environment.

Mental Models

People do not hold the world in their minds; they hold a model of it. Quite literally, these are models people carry with them to serve as an explanation of how the world operates, guide a person's perception of the surrounding environment, and influence the actions a person will take in the world. As with all models, they are a simplification of what actually exists, and this leads to differences among individual mental models. Additionally, individuals build and modify mental models based on their experiences, assumptions, and cultural norms. As a simplification of reality based on aspects unique to each individual, mental models differ among individuals and are generally incomplete and incorrect.[5] (See Appendix A for further discussion)

Espoused theory represents what people say underlies their perceptions and actions, while theory-in-use actually accounts for these perceptions and actions; most people remain unaware they hold a difference between the two (see Figure 1).[6]

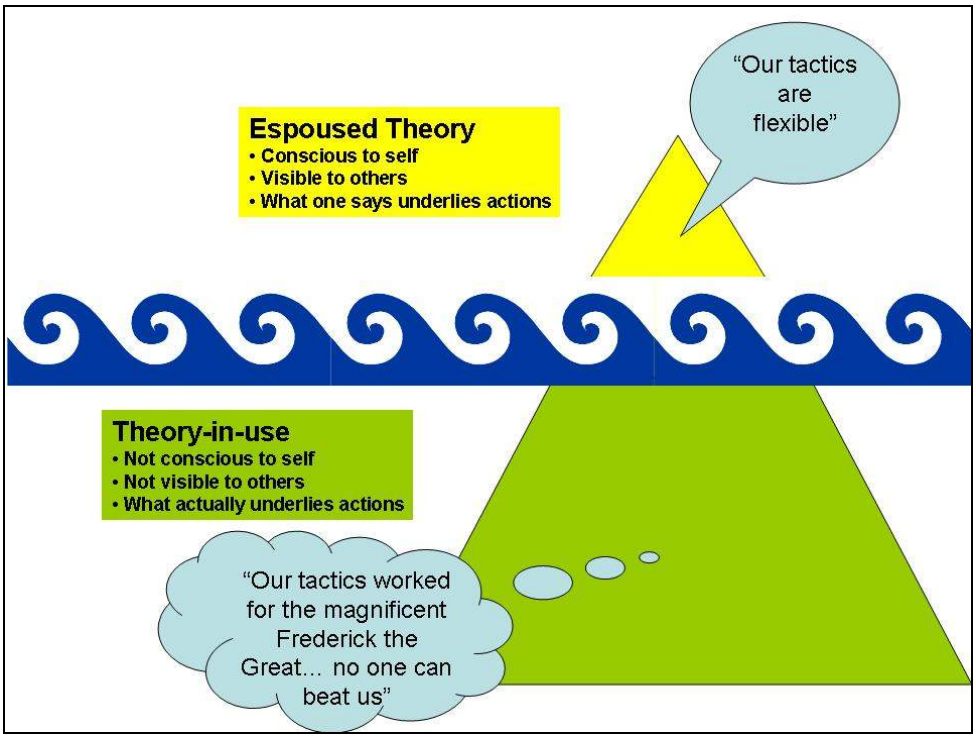

Figure 1 – Espoused Theory vs. Theory-in-Use Iceberg Diagram
Theory-in-Use is the majority but it is below the surface.

When individual mental models change, they change through drift, disruption, or design. Drift occurs naturally over time as a person adds to experience. Disruption happens when a significant event not accounted for within the existing model occurs, forcing a change. Drift and disruption are implicit, as the individual remains unaware of a change to the model. Design occurs when a person applies conscious thought to modifying the existing mental model, and is therefore explicit (See Figures 2 through 4).

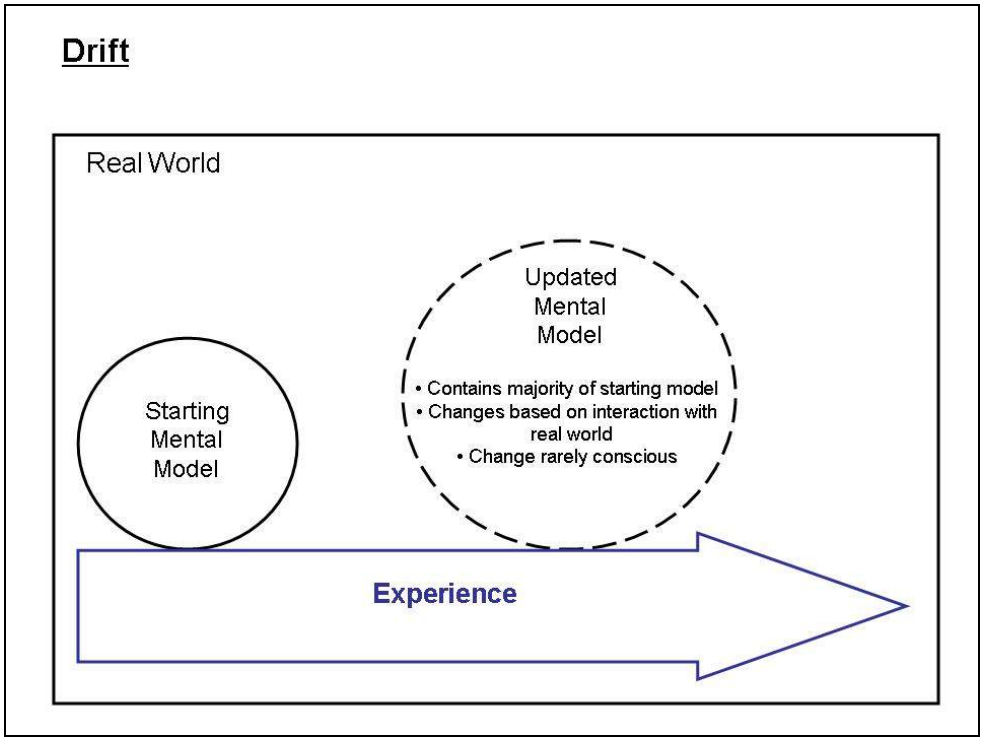

Figure 2 – Mental Model Change by Drift

- The starting mental model grows and changes based on experiences from the real world that become included into the updated mental model. Both mental models are a subset of the real world, because models are inherently a simplification of the real world.

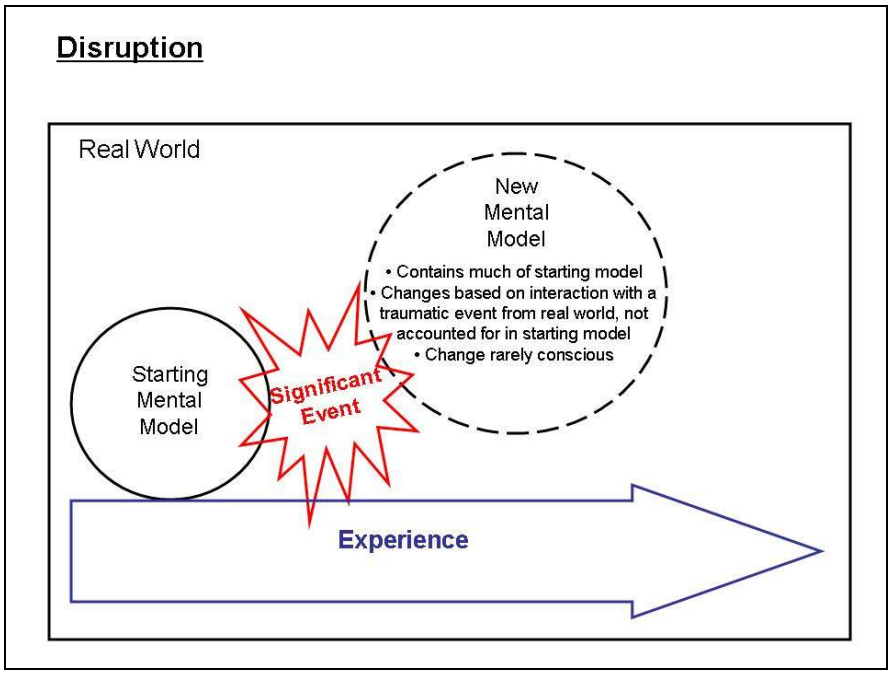

Figure 3 – Mental Model Change by Disruption

- The starting model changes abruptly due to a significant event introduced into the mental model from the real world. This event represents trauma because the person did not account for it in the underlying assumptions of the starting model.

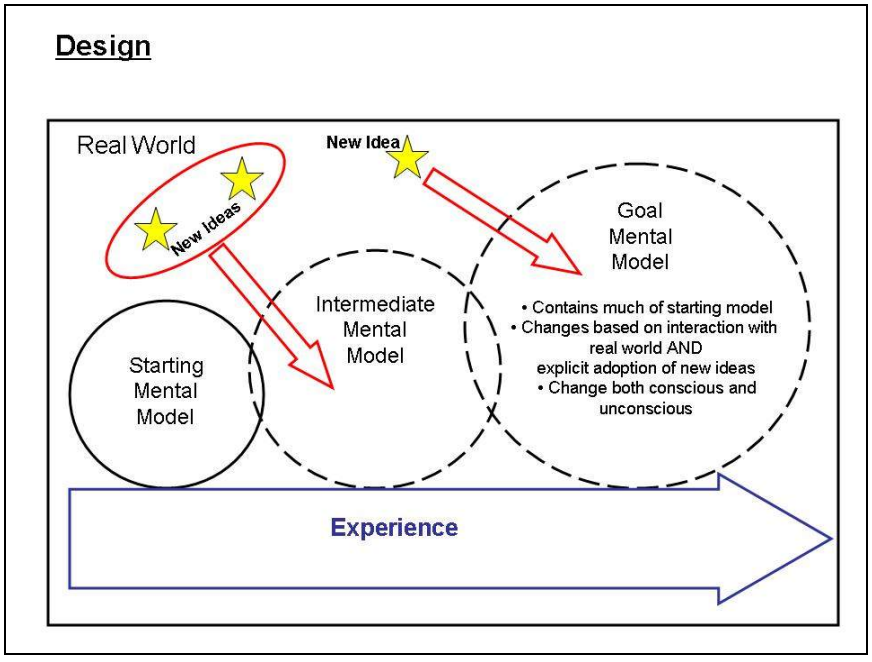

Figure 4 – Mental Model Change by Design

- Mental models changed by design explicitly seek new ideas from the real world to include into updated mental models.

Shared mental models produce a common understanding by individuals within an organization. This is not the sum of the individual mental models, but rather the agreed upon framework of organizational definitions, values, and belief systems that then are incorporated into each individual model. Such shared understandings support learning and act as the context for new organizational knowledge development.[7] The shared mental model achieves alignment when it gains wide acceptance within the organization and the members of the organization strive with a common purpose toward the same goals.[8]

Organizational Learning

The difference between single- and double-loop learning comprises a central idea in organizational learning. Single-loop learning occurs when an organization discovers performance gaps and seeks to improve existing methods and policies, which improve efficiency (see Figure 5). Double-loop learning takes place when an organization responds to performance gaps by modifying methods and policies, improving effectiveness.[9] Explicit awareness of the need to learn aids the employment of double-loop learning (see Figure 6).

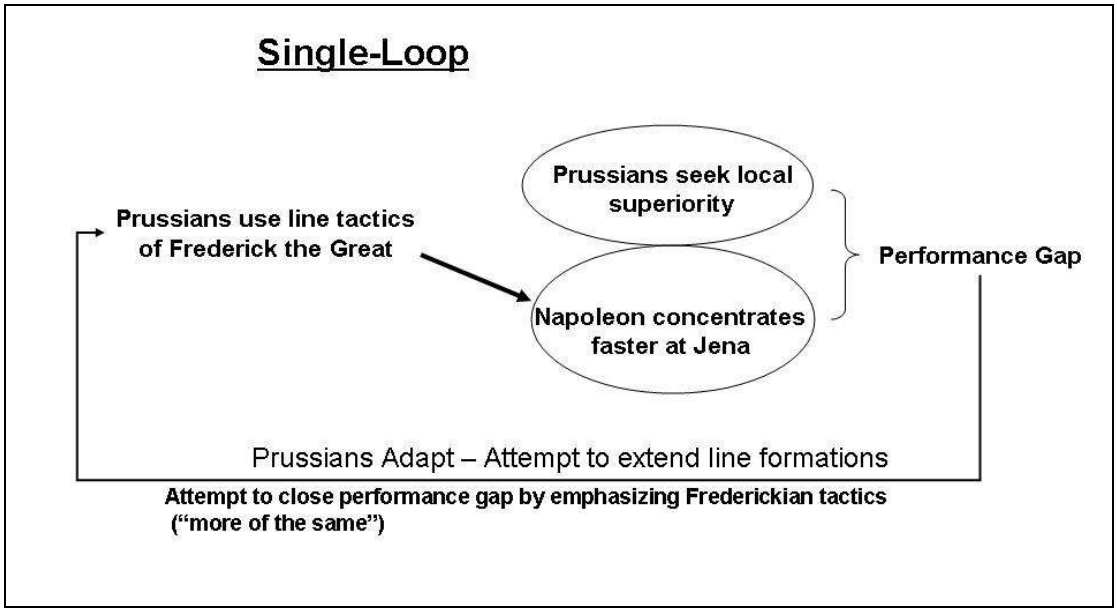

Figure 5 – Single-Loop Learning Example

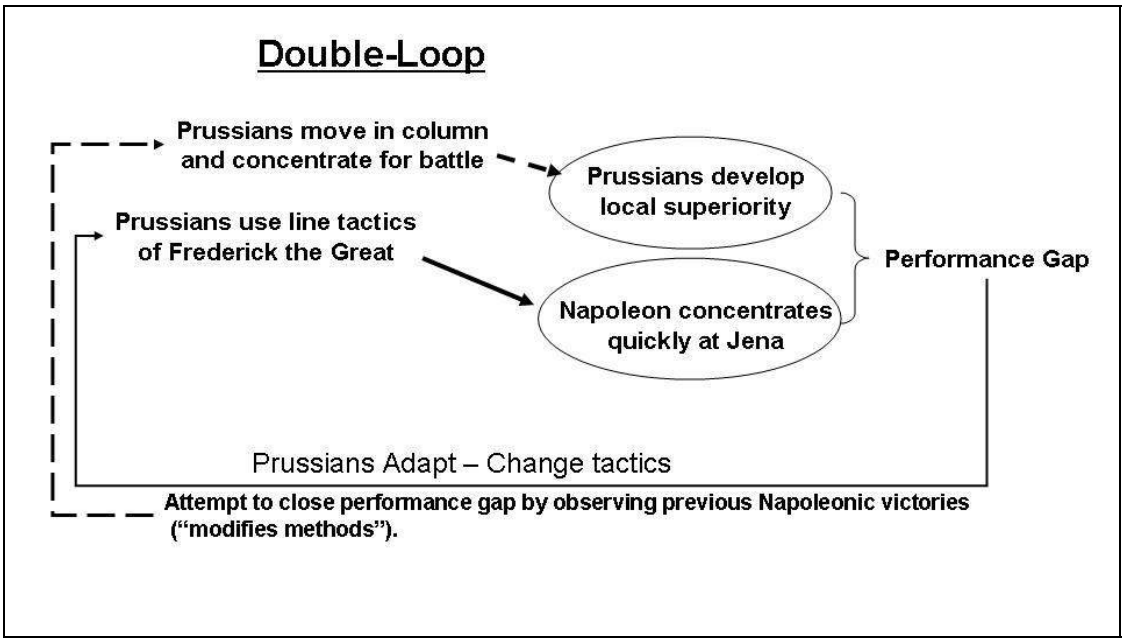

Figure 6 – Double-Loop Learning Example

Organizational learning typically takes one of three forms (see Figure 7). Maintenance learning tries to discover better ways of doing what an organization already knows how to do, encouraging the correct way instead of asking if it is the right way to do things. Its focus is short term and crisis often overcomes organizations employing it. Shock learning occurs when crisis happens. At best, this is reactive and at worst, it aggravates the existing problems. Under intense stress, most people fail to exercise creativity and fall back on the ways of doing business that worked in the past. The first two are typical of single-loop learning; the third is normally associated with double-loop. This last type, anticipatory learning, addresses both the long-term consequences of present actions and the best ways to deal with a future environment. Participatory in nature, anticipatory learning acknowledges no one party or group has all the answers and explores alternatives, and achieves consensus.[10]

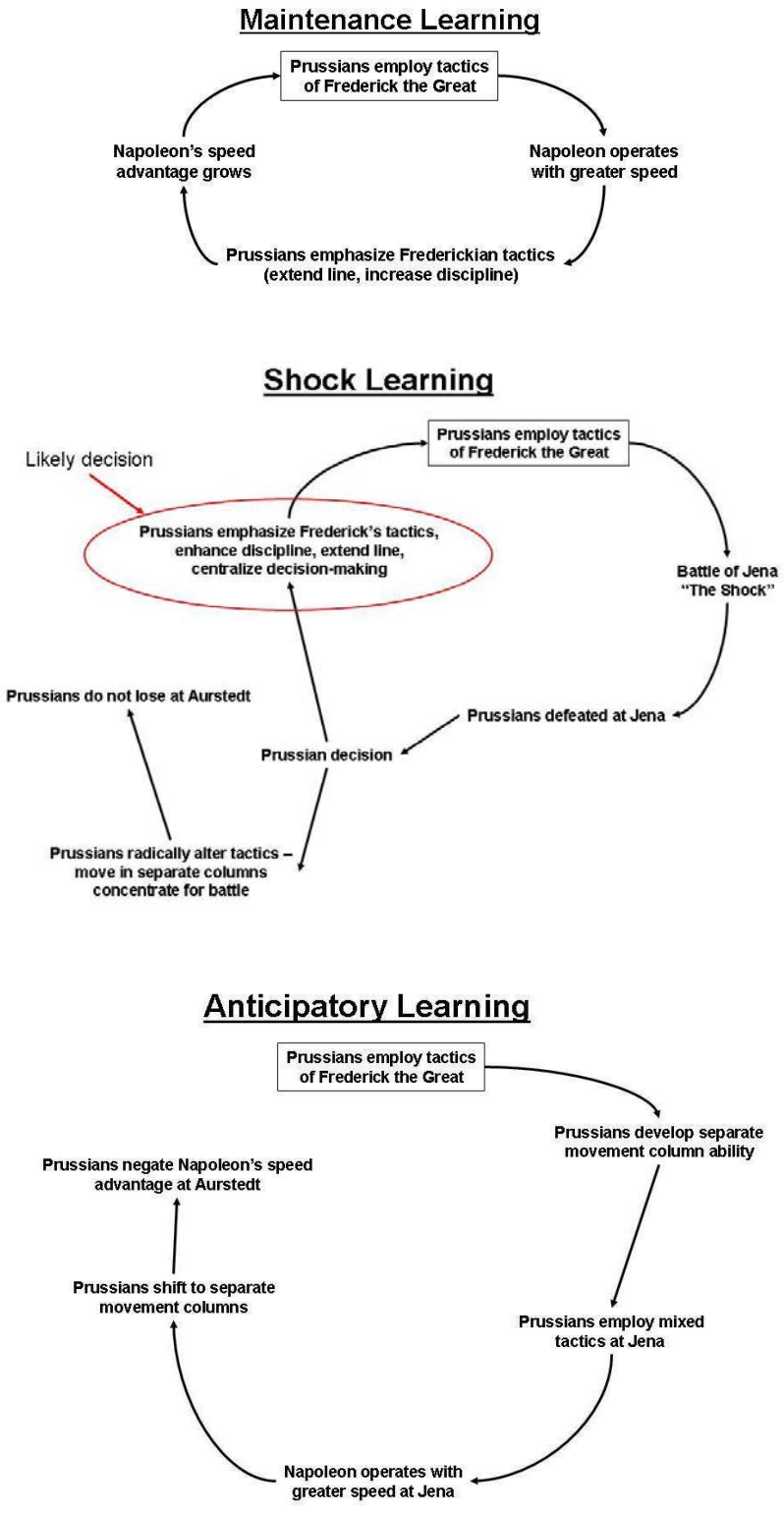

Figure 7 – Maintenance, Shock, and Anticipatory Learning Examples

Developing Competitive Advantage

Shared mental model formulation for Marines begins before entry-level training. The population from which the United States draws her Marines shares a mental framework about the Marine Corps. Marines deepen and modify their shared understanding during entry-level training, then continue to do so in follow-on training (Marine Combat Training, The Basic School, etc). While many instructors and leaders refer to "what it means to be a Marine," they build this shared mental framework implicitly, or without conscious thought.

The historic success of this foundational, shared mental model cannot be overstated. As T. R. Fehrenbach wrote almost a half century ago, "Marine human material was not one whit better than that of the human society from which it came."[11] Despite this, the Marine Corps shares an ethos that it repeatedly leverages to produce success in battle. Marines see themselves as mission-driven, aggressive, and flexible. Yet so much of this historic shared mental model building remains implicit. The Marine Corps tells its Drill Instructors at the beginning of Recruit Training to "Make them Marines." Implicitly, the Drill Instructor knows what this means.

Structure influences human behavior, and a person's mental model is a major component of this. "Structure" here means the basic interrelationships that control behavior, including how people make decisions. (Example human structures include family ties, teacher-student interactions, police-to-motorist relations, etc.) Additionally, structure in human systems is subtle, normally implicit and therefore unacknowledged.[12] This hidden substrate channels the possible outcomes of human activity into a predictable range. Achieving awareness of this structure lends the first step in breaking free from predictability and discovering novel solutions that provide power in a given situation. Against a thinking, motivated enemy, avoiding predictability and employing novel solutions confers competitive advantage.

For example, the hidden structure facing the Prussians was their belief that an army general should avoid study, should be from the nobility, and need only employ the tactics of Frederick the Great to achieve success on the battlefield. When confronted by the new methods of Napoleonic warfare in the shock at Jena, this hidden structure caused the Prussians to fall back on what they knew – the tactics of Frederick – instead of employing innovative methods to solve their new problem.

Few Marines realize they rely on the hidden structure of mental models, and this provides a clue on how to leverage mental models in developing competitive advantage. To develop shared mental models and achieve alignment, the first step is to make them explicit. Revealing this tool of the mind will allow individual Marines and groups of Marines to manipulate them – change them by design –to achieve action that is more effective.

To do this, Marines need to build relevant shared mental models *explicitly* and practice rapid, meaningful organizational learning. Marines could conduct this activity in a scalable manner, from the smallest team to the largest Marine Expeditionary Force. The leader at each level would also lead the construction of the shared mental model and ensure it nests with the shared model developed by his immediate superior. In a similar manner, leaders at each level would remain alert for single- and double-loop learning activities. Marines today practice many of these elements *implicitly*. The key to sustaining future competitive advantage lies in performing these functions *explicitly*.

Building on the common ethos shared by Marines begins the process. Because people base their models on how they see themselves (their experiences, assumptions, and cultural norms), reiterating a shared understanding of what it means to be a Marine in a particular unit

forms the foundation for how Marines will perceive their environment and act in ambiguous, stressful situations.

After achieving agreement on the foundational mental model, the group then "operationalizes" the model, developing agreement on the relationship among the foundational model, the desired outcome, and the expected operating environment. This process generally answers the questions, "Who are we? What do we want to achieve? How will we organize to achieve this?" Leaders focus on building explicit agreement among the group on the shared mental model.

Leaders must recognize the strengths and limitations of the tools they work with, and mental models are no different. Shared mental models are subject to the same assumptions, limitations, and decision biases of individual mental models. Herbert Simon first advanced the concept of "bounded" or limited rationality. Because of limits in human mental capacity, he argued, the mind cannot cope directly with the complexity of the world. Rather, we construct a simplified mental model of reality and then work with this model. We behave rationally within the confines of our mental model, but this model is not always well adapted to the requirements of the real world.[13] (This concept helps explain how witnesses to the same event often provide different versions of what happened.)

Leaders deal with these mental model limitations by helping their subordinates imagine alternative futures. These mental scenarios are not predictive in nature, but rather expose people to a range of possibilities for the purpose of expanding the shared mental model. This also makes the model more flexible and better able to deal with future uncertainty. This allows each individual sharing the mental model to appreciate events as a pattern – with associated implications – they recognize. The scenarios examining the shared mental model must span the

whole organization; enough people must have aligned their mental models for meaningful action to result from this pattern recognition (see Figure 8).[14]

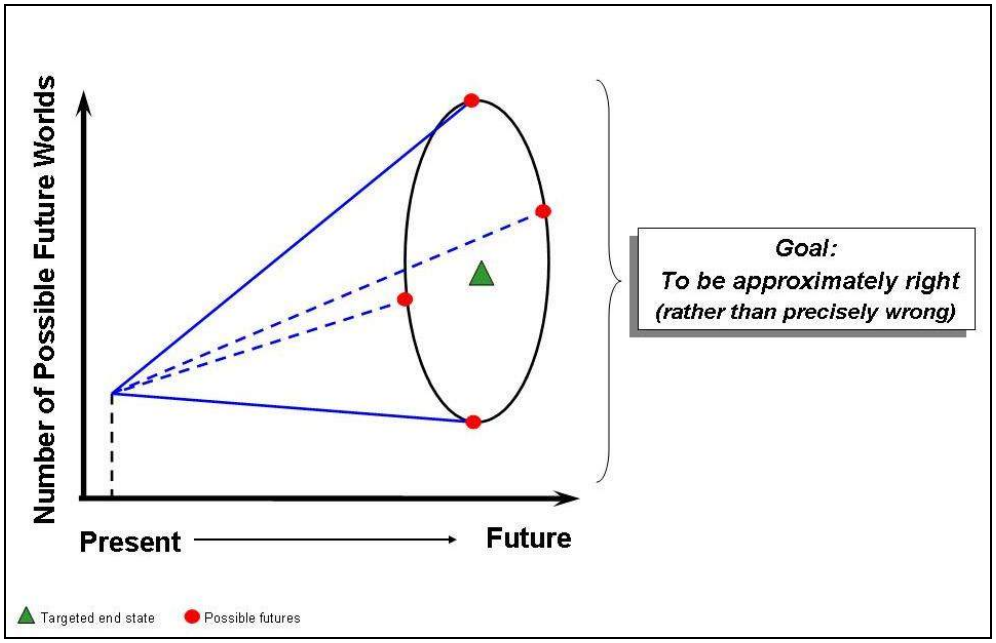

Figure 8 – Using Scenarios to expand Bounded Rationality[15]

Scenarios look further into the future the higher one moves up the organizational ladder. The appropriate time horizon depends on the reaction time of the system at different levels.[16] For example, a squad leader deals with scenarios about events that could happen during the next patrol. A company commander may use scenarios about actions taking place during one phase of an operation, while a battalion commander might choose scenarios covering the entire operation. The controlling idea on how far ahead to run the scenario is the reaction time of the organization – if something in the scenario actually occurs, could the organization actually react effectively, or would the time to act be too short?

Developing shared mental models and scenarios also bridges the gap between individual mental models and organizational learning. Scenarios can define perceptual cues, and such cues do not have to remain in the realm of a leader's decision criteria or confined to the domain of

experts.[17] Using scenarios based on a shared mental model of appropriate scale enables future learning by alerting the Marines of a unit to cues and weak signals emanating from the operating environment.

In a micro example, consider a fire team conducting a mission rehearsal for room clearing. (This rehearsal represents one form of scenario for a shared mental model called "room clearing.") Typically, training exhibits bounded rationality by presenting a choice between a room containing only enemy combatants and a room with combatants and non-combatants intermingled. Obvious choices to expand the mental model would include an empty room or a room containing only non-combatants. Less obvious choices that strive to step beyond bounded rationality would include a wall of the room collapsing as the team enters or having the room contain friendly forces. The actual mission may include some of these elements or combinations of the elements – the point of stepping beyond bounded rationality in the scenario (the rehearsal) is to increase the number of patterns available for recognition within the shared mental model (room clearing) for the Marines to assemble into a useable solution for the actual situation they confront.

Marines educated in organizational learning theory use environmental cues to evaluate the efficiency and effectiveness of their units. Explicitly understanding the difference between single- and double-loop learning aids them in determining whether they need to seek an increase in efficiency or if they need to change themselves in order to increase effectiveness. Provided they share a mental model, they share a common reference point for determination of whether they need to increase their efficiency in order to accomplish the mission, or if they must instead change their practices or organization to accomplish it.

Operating with Mental Models and Organizational Learning

Future Marines would put these principles into practice through a Design-Plan-Act cycle (See Figure 9). In this case, design refers to defining the problem confronting the unit. (Design is also analogous to the observe and orient steps in John Boyd's Observe-Orient-Decide-Act (OODA) loop.) Such problem definition centers on the shared mental model, answering the questions, "Who are we? What do we want to achieve? How will we organize to achieve this?" The shared mental model is central to the design because it determines how the Marines will plan and act, at both the individual and collective level. Thus, the design represents a major component of the shared mental model in relation to the operating environment.

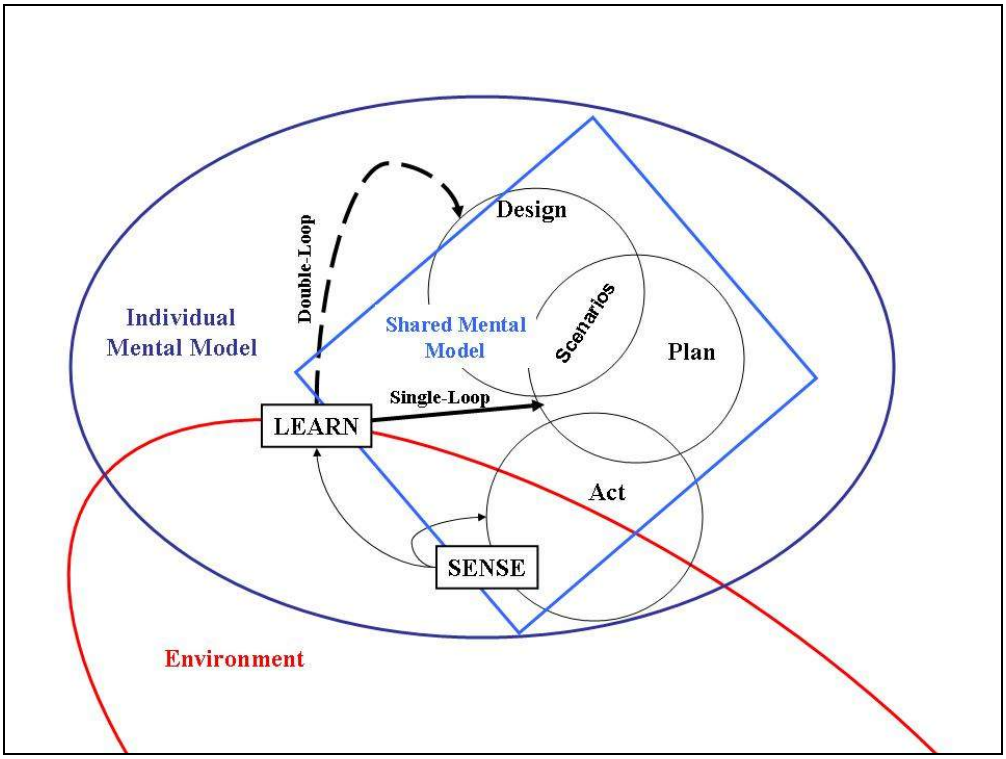

Figure 9 – Design-Plan-Act Cycle

As shown in Figure 9, designing, planning, and acting all belong firmly within the mental model, because the mental model determines how each will be performed. The outside environment – the real world – partially crosses into the mental model, but only partially because

no individual or shared mental model accurately captures the entire real world. Sense and act intersect within the environment, as interaction with the environment is how humans develop sensory input from it. Sense is also wholly contained within the mental model because it controls what it senses, too. Learning relies on input from sensing; single-loop learning occurs as adjustment of plans takes place in an effort to achieve greater efficiency along an already determined path. Double-loop learning occurs when the design, or shared mental model, is changed. In other words, double-loop learning changes the problem definition ("What do we want to achieve?") or fundamental composition and practices ("Who are we?") of an organization.

Understanding mental models leads to a better understanding of the adversary. Although no tool can provide complete knowledge of an enemy, mental models serve as a tool to synthesize a model of an enemy's possible future actions. A unit creates its own understanding of the experiences, assumptions, and cultural norms of their enemy. Necessarily imperfect, the aim of creating a model of an enemy mental framework is to identify the drivers behind their actions and what perceptual cues they will pull from the environment. These models are the starting point for constructing the scenarios that fall between design and planning in the cycle.

Toward the Future

The past provides insight into how to use the Design-Plan-Act Cycle in the future. If the Prussian generals prior to Jena had examined their shared mental model (or design) explicitly, they would have exposed the assumptions underlying their model. They could have produced a range of alternative futures for use in mental simulation, and with knowledge of bounded rationality, they reasonably may have produced sensitivity to cues telling them their adversary did not fight as they expected. Such knowledge would not in itself have prevented defeat at

Jena, but it would have given them valuable insight into such cues; instead, disruption occurred as their individual and shared mental models changed abruptly.

Complexity, diversity, lethality, and diffusion characterize today's complex warfighting environment. As with other eras, today's era witnesses the injection of new elements (decentralized media production, non-state actors, the internet, etc) into warfare.[18] Understanding why the Prussian generals failed at Jena and the expected trend toward increasing complexity in warfare's shape indicates why the Design-Plan-Act cycle is necessary for future success. Historical survey indicates the form of warfare continues to change between eras, and this comes as no surprise. Significant for the future is that the form of warfare continues to evolve at an accelerating rate. This will require Marines to continue to change their mental models about warfare in order to sustain their competitive advantage.

Marines potentially face numerous adversaries and so future warfare could take many forms. Wars of fire and maneuver, or "conventional" war, could erupt against an enemy such as North Korea. Insurgent enemies may appear in places such as Latin America, mimicking historical patterns. Alternatively, a future enemy could be a synthesized version, one that produces its own media broadcasts, provides basic services to a population, and possesses a quasi-conventional capability, such as Hezbollah or the Mahdi Army.[19] With such a spectrum to choose from, and the expectation that warfare's form will continue along the path toward more complexity, Marines cannot run the risk of adhering to a rigid mental framework.

John Boyd's opening quote spoke to how choosing just one doctrinal type constrains thinking and limits the production of creative solutions. Instead, he recommended reading multiple doctrines from many sources to provide numerous patterns to choose from when confronting a new operating environment.[20] This thought leads to recommendations for how

future Marines should structure their thinking about warfare. To sustain competitive advantage requires Marines to "open the system" when approaching a new operating environment.

"Opening the system" refers to Thomas Kuhn's observation, "Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change… [T]hese are the men who, being little committed by prior practice to the traditional rules… are particularly likely to see that those rules no longer define a playable game and to conceive another set that can replace them."[21] This observation, coupled with Boyd's point on exposure to multiple doctrines, leads to fundamental changes in the training and education of Marines, and particularly Marine officers.

In order to produce mental models by design instead of through drift or disruption, a broad understanding of mental models and organizational learning theory is necessary. Marines should discuss the composition of their mental models and how these models will control their perceptions and actions prior to entering an operating environment, not spend time learning about mental models or worse, reinforcing an existing, implicit model. Explicit knowledge of organizational learning will also guide intelligent thinking about the differences between increasing efficiency and increasing effectiveness. Lack of knowledge on the difference presents a mental trap – Marines influenced by the hidden structure of doctrine and training lack the mental tools necessary to break free.

Marine officers need a broader career education path to enable this opening of the system. In addition to including education about mental models and organizational learning at all levels of professional military education, the Marine Corps should offer electives spanning several disciplines (economics, languages, and philosophy for example) within each course of instruction. The Marine Corps should also invest in sending selected officers to civilian graduate

schools, both in the United States and abroad, to expand the intellectual capital available. The result for these recommendations sees an officer corps continuously educated in a wide spectrum of disciplines; this enables many different points of view to emerge during the construction of a shared mental model and an organizational learning plan for a new operating environment.

To comprehend and cope with their environment, humans destroy old mental patterns and create new ones to permit them to both shape and be shaped by the changing environment.[22] Understanding this concept leads to the realization that each level of education also needs increased exposure to a wider array of doctrines. Conducting a survey of published doctrines provides a larger number of patterns to choose from when facing a new situation. Additionally, study of how doctrines change and the driving forces behind such change would increase understanding of why these changes came about, and expand the pattern recognizing ability of Marines facing a fluid environment.

At the unit level, leaders perform three primary functions. The first function builds a shared understanding of the operating environment, in a manner similar to imaging techniques employed by professional athletes. This shared understanding should be as rich as possible to include pictures, sounds, and smells.[23] Leaders expose the unit to what they consider normal in the environment so they have a basis for discussion about abnormalities and what they might mean; this develops a common understanding for pattern recognition within the expected context. Since the context continually evolves toward increasing complexity and sophistication, leaders work with their unit on how to think through situations vice providing them discrete decision choices that might not fit with reality.

The leader's second function consists of the continual development and updating of subordinate leaders' mental models. Understanding that the mental model strongly influences

action and perception indicates why this is critical. Leaders are responsible for building organizations where people continually expand their capabilities to understand complexity, clarify vision, and improve shared mental models.[24] To do this, leaders exercise a continuous running dialogue with subordinates about the features of the shared model and how it corresponds to reality as it unfolds. Feedback from junior leaders informs and expands a leader's mental model as well. The dialogue runs through constant mental simulations, enabled by knowledge of bounded rationality to move beyond constrained choices and increase sensitivity to weak signals from the environment.

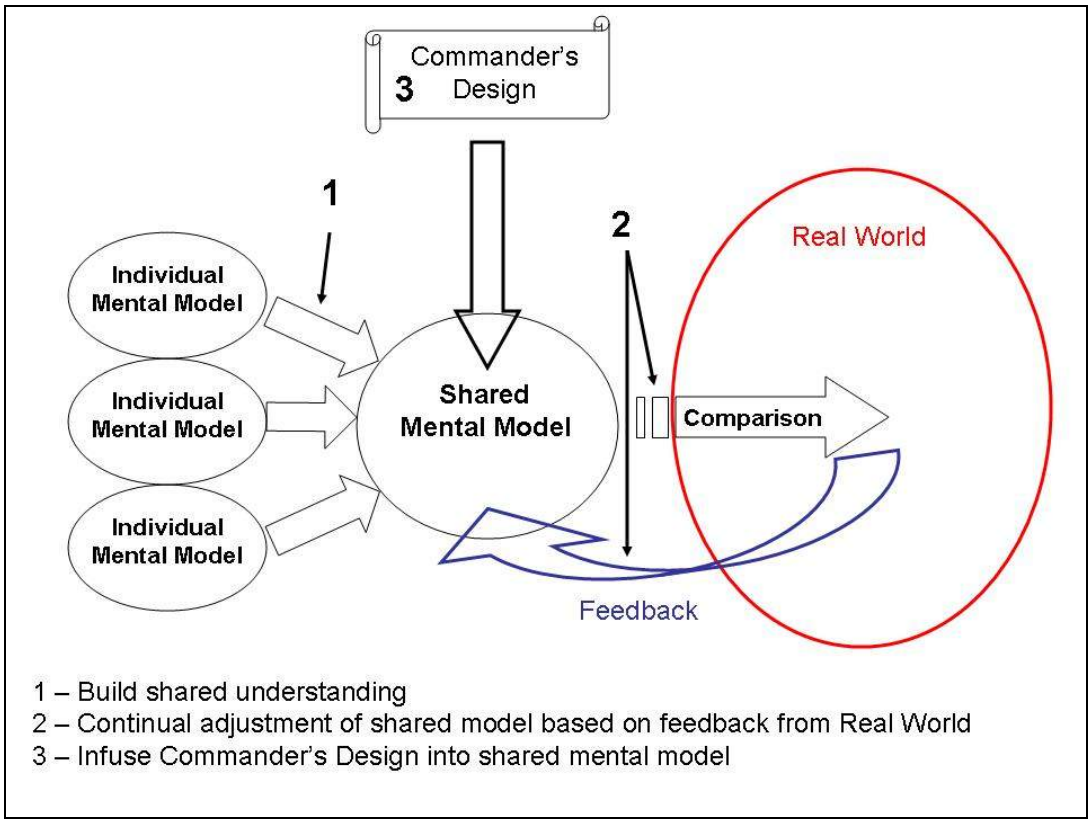

Figure 10 – Functions of future leaders employing mental models

The third function involves articulating the leader's design. Currently, the Marine Corps teaches commanders to issue their task and purpose in the mission statement and desired end state in the intent. This has proven a powerful formulation for units to train and operate with, yet

in the face of warfare's increasing complexity, additional elements are required to leverage mental models fully. Coupled with the task and purpose in the mission, future intent statements should include four elements in addition to the end state: the logic underlying the commander's design, the key decisions that may have to be made, antigoals (unwanted outcomes), and limitations that concern the leader.[25] These additional elements provide a richer understanding of the shared mental model (as the leader understands it) and enable subordinates to operate more effectively when faced with ambiguity.

The outcome from this changed emphasis for leadership produces an organization capable of unified purpose in the face of decentralized action. The shared mental model influences the actions taken by all who share it, with or without close supervision. It enables learning by providing a base line for how the organization views itself in relation to the environment. This becomes the starting point for expected adaptation. However, it also provides the necessary ingredients for determining whether to increase single-loop efficiency or double-loop effectiveness.

Looking Back to See Ahead

In Marine Corps history, one can draw lessons from two examples of shared mental model change leading to success on the battlefield. The first involves amphibious warfare, with the new paradigm (or design) produced by Major Earl H. "Pete" Ellis. His *Advanced Base Operations in Micronesia* provided the framework for experimentation and development of the amphibious doctrine with which the Marine Corps fought and won in World War II. The second involves Lieutenant General Lewis Walt and the Combined Action Platoon (CAP) program in Vietnam. General Walt's Marines produced "the best idea… seen in Vietnam, and it worked superbly."[26] In both cases, Marines expanded their shared mental models to produce original

designs, and then adjusted them through single- and double-loop learning after they placed them into action.

Marines initially produce their shared mental model through entry-level training and reinforcement of historical knowledge, building an ethos that guides future action on behalf of all Marines. Leveraging this time-tested strategy, Marines must now make explicit the formulation of mental models and their use in operations across the force. Marines can then use shared mental models built for operations as the basis for rapid action and as the reference for conducting organizational learning. Opening the system to new ideas and disciplines injects fresh thinking into the formulation of these models, making them adaptable and shock resistant.

The design-plan-act cycle points the way for future Marines to approach an operating environment. With design setting the problem and serving as the organizing principle within the shared mental model, Marines have a basis to run mental simulations to enable them to better deal with uncertainty and expand the shared model. Completion of design and simulation destroys old models and creates a new one tailored to the environment. This then becomes the driving force behind all planning and acting. Marines understanding the feedback loops of sense and learn are then empowered to focus explicitly on adapting, and further empowered to understand whether they need to increase efficiency or improve effectiveness, and how to achieve each.

Marines celebrate their history as part of their ethos, and they celebrate innovation as part of that history. In the next innovation, Marines move beyond implicit acceptance of this ethos and make explicit the understanding of the mental functions that drive planning and acting within individuals and among groups. Critical to performing effectively in warfare is accurately

perceiving what goes on in the environment. Since mental models control this perception, understanding them is essential for Marines.

Notes

[1] John R. Boyd, "Boyd Q and A Session." Streaming Video, < http://homepage.mac.com/ace354/Boyd / iMovieTheater39.html>, accessed 3 Dec 2006.
[2] Charles Edward White, *The Enlightened Soldier: Scharnhorst and the Militarische Gesellschaft in Berlin, 1801-1805*, New York: Praeger Publishers, 1989, xi.
[3] The Battle of Jena occurred 14 October 1806, pitting Napoleon's *Grand Armee* against the Prussian army. The Prussians remained wedded to the methodologies employed by Frederick the Great in the mid-18th century. Frederick's methodology included rigid discipline and strict obedience to orders, which emenated from a single mind. Frederick's desire to control all action inhibited independent action by scouts, either cavalry or infantry skirmishers. Columns of troops marched enmass with long baggage trains and were tied to depots and magazines, all of which limited Prussian freedom of movement and speed on the march. Napoleonic tactics featured combined arms corps marching separately and living off the countryside, with thick cavalry screens and infantry skirmishers. Each corps was expected to fight independently for at least 24 hours, until the rest of the army could concentrate. The Prussians made no substantive changes to their methods prior to 1806, despite several examples of Napoleonic victories based on the new methods. These new methods were extensively observed and reported on by numerous Prussian army observers in the decade preceeding Jena. In the actual clash of arms occurring at Jena, a Napoleonic corps held off the majority of the Prussian army while Napoleon concentrated and crushed the remainder. The ensuing Prussian retreat turned into a route under Napoleon's pursuit, forcing the Prussians to sue for peace and agree to terms favorable to Napoleon. Synopsis based on R.R. Palmer, "Frederick the Great, Guibert, Bulow: From Dynastic to National War," and Peter Paret, "Napoleon and the Revolution in War," in *Makers of Modern Strategy: from Machiavelli to the Nuclear Age*, ed. Peter Paret, Princeton: Princeton University Press, 1986, 91-119 and 123-142.
[4] Mitchell M. Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos*. New York: Simon and Schuster, 1992, 295-296.
[5] Dietrich Dorner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations*. trans. Rita and Robert Kimber, New York: Metropolitan Books, 1996, 42.
[6] Liane Anderson, "Argyris and Schön's Theory on Congruence and Learning," <http://www.scu.edu.au/schools /gcm/ar/arp/argyris.html>, accessed 2 Dec 2006.
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[12] Senge, 40.
[13] Richards J. Heuer, Jr., *Psychology of Intelligence Analysis*, Center for the Study of Intelligence Analysis, Central Intelligence Agency, 1999, 2-3. Available in .pdf format at <www.odci.gov/csi>
[14] Kees van der Heijden, *Scenarios: The Art of Strategic Conversation*, 2d Ed., Chichester, England: John Wiley & Sons, 2005, 6-7.
[15] Graph adapted from Scenario Planning presentation *Crossing the Growth Line*, John Deere Company, 26 Jan 2006.
[16] Gary Klein, *Sources of Power: How People Make Decisions*, Cambridge: The MIT Press, 1998, 156.
[17] Klein, 42-44.
[18] Chief of Army's Senior Advisory Committee (CASAC) [Australia], *Complex Warfighting*, endorsed 7 May 2004, 12.
[19] James A. Baker III and Lee H. Hamilton, co-chairs, *The Iraq Study Group Report*, New York: Vintage Books, 2006, 15.
[20] Boyd, "Boyd Q and A Session."
[21] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2d ed., Chicago: The University of Chicago Press, 1970, 90.
[22] John R. Boyd, *Destruction and Creation*, unpublished paper, 3 September 1976, 1.

[23] B. P. McCoy, interview with author, 23 August 2006. As of the writing of this paper, Col McCoy serves as G-3 (Operations), Training and Education Command, Marine Corps Combat Development Center, Quantico, Virginia. Col McCoy authored *The Passion of Command*, detailing his experiences as commander of 3d Battalion, 4th Marines, during Operation Iraqi Freedom (OIF) in 2003 and 2004. Prior to OIF, Col McCoy provided his Marines and sailors an understanding of the battlefield environment through imaging techniques. He attributes much of the success of the battalion to the use of these techniques. Additionally, Col McCoy leveraged his experiences with 3d Battalion, 4th Marines, in his current billet to develop training venues such as Mojave Viper at the Marine Air Ground Task Force Training Center, 29 Palms, California. As part of the training syllabus, Mojave Viper provides Marines and sailors a replica of Iraqi villages and role players that simulate expected conditions when deployed on OIF rotations.

[24] Senge, 340.

[25] Klein, 225. Klein recommends the following seven types of information important for describing intent: 1. The purpose of the task (the higher-level goals); 2. The objective of the task (an image of the desired outcome); 3. The sequence of steps in the plan; 4. The rationale for the plan; 5. The key decisions that may have to be made; 6. Antigoals (unwanted outcomes); 7. Constraints and other considerations. Types 1-3 are already contained in the purpose-method-end state formulation in use by the Marine Corps. Types 4-6 add a deeper understanding behind the intent and would help Marines pursue appropriate goals in ambiguous situations. Type 7 is addressed within the current Marine Corps planning process, but I have chosen to list it as limitations to capture both constraints and restraints, and to make it an explicit statement from the leader on what limitations concern him in pursuit of his end state.

[26] Sir Robert Thompson as quoted in Andrew F. Krepinevich, Jr., *The Army and Vietnam*, Baltimore: The Johns Hopkins University Press, 1986, 174.

Appendix A

Defining Mental Models

The following excerpts provide the sources for the synthesis of the definition for mental models used in this paper.

Reality Model – The totality of assumptions in an individual's mind, assumptions about the simple or complex links and the one-way or reciprocal influences between variables. A reality model can be explicit, always available to the individual in a conscious form, or it can be implicit, with the individual himself unaware that he is operating on a certain set of assumptions and unable to articulate what those assumptions are. An individual's reality model can be right or wrong, complete or incomplete. As a rule it will be both incomplete and wrong. People are most inclined to insist they are right when they are wrong and when they are beset by uncertainty. The ability to admit ignorance or mistaken assumptions is indeed a sign of wisdom, and most individuals in the thick of complex situations are not, or not yet, wise.
Dietrich Dorner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations*, trans. Rita and Robert Kimber, New York: Metropolitan Books, 1996, 41-42.

Mental Model – An explanation in someone's thought process for how something works in the real world. It is a kind of internal symbol or representation of external reality.
Wikipedia, <http://en.wikipedia.org/wiki/Mental_models>, accessed 1 Dec 2006.

Schema – In psychology and cognitive science, schema is a mental structure that represents some aspect of the world. People use schemata to organize current knowledge and provide a framework for future understanding. Examples of schemata include stereotypes, social roles, scripts, worldviews, and archetypes.
Wikipedia <http://en.wikipedia.org/wiki/Schema_(psychology)>, accessed 1 Dec 2006.

Mental Model – A mental model can be defined as a "mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states." In the area of cognitive psychology, researchers have suggested that mental models are important more generally to the understanding of how humans interact and cope with the world. [M]ental models allow people to predict and explain system behavior, and help them to understand the relationship between system components and events. [M]ental models provide a source of people's expectations… people "understand the world by constructing working models of it in their mind." Mental models enable people to draw inferences and make predictions, to understand phenomena, to decide what actions to take, to control system execution, and to experience events vicariously.
Janis A. Cannon-Bowers and Eduardo Salas, ed., *Making Decisions Under Stress: Implications for Individual and Team Training*, Washington: American Psychological Association, 1998, 27.

Mental Models – "Mental models" are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action. Very often, we are not consciously aware of our mental models or the effects they have on our behavior. (8)

Our "mental models" determine not only how we make sense of the world, but how we take action… what is most important to grasp is that mental models are *active* – they shape how we act… Why are mental models so powerful in affecting what we *do*? In part, because they affect what we *see*. Two people with different mental models can observe the same event and describe it differently, because they've looked at different details. (175)

Peter M. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*, New York: Currency Doubleday, 1990.

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