Proceedings of the 1998 Winter Simulation Conference
D.J. Medeiros, E.F. Watson, J.S. Carson and M.S. Manivannan, eds.

MILITARY SIMULATION WORLDS AND ORGANIZATIONAL LEARNING

Michael D. Proctor

Industrial Engineering and Management Systems Department
University of Central Florida
Orlando, Florida 32816 - 2450, U.S.A.

Justin C. Gubler

G3 Exercises
III Corps
U.S. Army
Ft. Hood, Tx 76544, U.S.A.

ABSTRACT

The operational benefits of having a learning organization include at the very minimum increased organizational competitiveness and responsiveness in a given realm of competition. Military simulation worlds have served and continue to serve as practice fields for organizational learning. Organizational learning mechanisms like the simulation debriefing session have been linked to organizational learning through a taxonomy for rare events. This research provides both descriptive and prescriptive findings for military interactive simulation and debriefing systems. Some suggestions for simulation system design are made based on the research.

1 INTRODUCTION

Failure to learn from the lessons of previous wars or anticipate the organizational change necessary to succeed has lead to defeat of military forces throughout this century. The often cited French disasters in early World War I and World War II stand as testimony of the failure to achieve organizational adaptive and generative learning. WWI French red trouser and kepis infantry lines assaulting in perfect order just to be slaughtered by Germans machine guns (Stokesbury, 1981) or WWII French Maginot Line fortifications being nullified by a German armored flanking maneuver through the Ardennes are perhaps the most easily remembered failures. With the Cold War well behind us, the U.S. military is striving in the words of General Sullivan (1994) "to project ourselves into the future. Simulators and simulations -- we are reading everything we can about the world in the 21st century. And then we are trying to create the worlds of the 21st century and force ourselves into the 21st century." Creating in simulation the future worlds where the military might fight is a challenge being undertaken across all branches of the military.

While the tools exist to design the systems of the future, the organizations that use them in the future must evolve from the organizations of today. One need simply look at the World War II example cited earlier to understand the importance of successful change. On the eve of the war, both the Germans and the French had the new tools of war - - large tank armies and air forces. The difference between the forces stemmed from what the organizations learned over time. Based on their actions, the French military organization did not show that they had learned the true potential for these new weapons systems whereas the German military organization demonstrated that they had.

1.1 Issues

In the context of today's military modernization and organizational change efforts, the present is set off from the past by the current heavy reliance on simulation for analysis. This reliance includes a huge spectrum of simulation systems and applications (Piplani et al. 1994). From a learning perspective, military simulation is highly regarded as a means to achieve effective training for individuals and teams. But when learning goes beyond individuals and teams to the organization, a degree of uncertainty surfaces.

Philosophically can military simulation be extended to facilitate organizational learning? If it can, then we may even see more use of simulation in areas that our heavily dominated by expert judgment combined with trial and error experience in actual military operations.

If military simulation be extended to facilitate organizational learning, what is the nature of potential organizational learning created through actual interactive simulation experiences? This question may require extensive and prolong research to answer. The research discussed below seeks to begin to baseline the general nature of the learning created. The research does not attempt to address novel environments, various organization sizes or types, nor judge the quality of the learning created.

How can simulation designers promote the type of learning of interest in future simulation systems? Insight into this question hopes to promote focus on simulation engineering development.

1.2 Organizational Learning & Interactive Simulation

When considering whether or not the military simulation paradigm is extensible to address the concepts of organizational learning, little discussion relating military simulation to organizational learning can be found in the literature. As organizational learning has its roots in organizational psychology, academic research in the parallel realm of business practices may yield insights into how simulation is related to organizational learning.

International competitiveness drives businesses to find new advantages over competition. Stalk (1988) while listing such traditional advantages as cost, quality and inventory indicates that time is on the cutting edge of industrial competitiveness. But in order to gain a time advantage, organizations must generate new governing variables or adapt their current actions quickly to new ideas and concepts that create a unique advantage. From a long term perspective, a generative business posture would be preferable to an adaptive one as a generative posture infers first to market while an adaptive posture infers reaction to market change. Given that adaptive learning as the minimum standard, failure to adapt infers loss of market share or even business collapse. On the other hand, rapid adaptation infers less loss, stability or even gains in market share. Generative change infers potential strategic advantage. When viewed in the context of a competitor or adversary, more rapid adaptation or generative change to the environment infers a competitive advantage.

To successfully implement change, learning must occur throughout the organization of the procedures, routines or systems related to that which is new. De Geus (1988) refers to a cycle of "hearing, digestion, confirmation, action" involved in "institutional change." De Geus goes on to boldly assert that "the only competitive advantage the company of the future will have is its managers' abilities to learn faster than their competitors."

Complete organizational learning requires “detecting and correcting error” in actual business operations (Argyris, 1977). Probst and Buchel (1997) define organizational learning as "the ability of the institution as a whole to discover errors and correct them, and to change the organization's knowledge base and values so as to generate new problem-solving skills and new capacity for action." Argyris (1977) identifies single and double loop learning feedback mechanisms within an organization in order to accomplish change. Senge (1990) indicates two levels of organizational learning which roughly parallel these feedback loops. The first level refers to learning about adaptiveness or coping within an environment. The second level focuses on generative learning and addressing systemic sources of problems.

Since learning requires change, the search for confirmation that a suggested change would have the result desired has lead to scenario building, modeling of the situation and demonstrating the effects of the change through simulation (De Geus, 1988). Business management teams consider changes of organizational operations through interactive experiences with these simulations (Senge, 1990). The interactive nature of the simulations allows the participates to input change to the simulations while the simulations are active. Hence the organizations members become integral parts of the simulation. Keys, Fulmer and Stumpf (1996) indicate that such interactive simulation experiences serve business corporations and government agencies as practice fields for the organizations intent on learning new problem-solving skills and capacities for action.

Simulation also provide participates an environment that Schein (1993) indicates is necessary for organizational learning like a “safe” place for learning and “opportunity to try out new things without fear of punishment.” Keys, et al (1996) indicate that “research suggests that managers learn poorly from experience if there is no feedback or coaching." Hence simulation experience also require feedback or coaching to the participates for organizational learning to occur. He goes on to say that "debriefings must be extensive and performed by experts in the simulation, in the subject matter, and in group processes.”

1.3 Interactive Simulation & the Military

Braddock and Thurman (1993) identify various forms of interactivity for simulation systems with associated after-action-review systems used throughout the military. The extent of the integration of interactive simulation systems with after-action-review systems as well as the standardization of these systems is reported by Meliza (1996). The objective of military simulation after-action-review systems are to provide “feedback” to “participants” in a “diagnostic” manner “to increase and reinforce learning” (Department of the Army, 1990). Gibson (1995) discusses the design and functional capabilities of military interactive simulation-based debriefings or after-action-review systems where all of the above techniques can be brought together.

The nature of interactivity between the simulation system and participates may vary, yet interactive simulation may constitute both a strategy and a structure to accomplish organizational learning. Likewise, though the form of the simulation system itself may also vary, both business and military organizations use interactive simulation systems with debriefing or after-action-review systems in order to increase understanding, train individuals and teams, and attempt to increase actual learning amongst participates.

2 ACTION RESEARCH

In order to determine the nature of potential organizational learning created through actual interactive simulation experiences, the research approach needed to emphasize a real setting. Action research describes a spectrum of activities that focus on research, planning, theorizing, learning, and development that focus on studying problems that are relevant in real settings (Cunningham, 1993). An action research approach was selected since it is desired to identify the nature of potential organization learning in real settings.

2.1 Research Limitations

A limiting factor on simulation and hence this research is that merely increasing understanding amongst participates is not organizational learning. According to Argyris (1992) organizational learning occurs under two conditions: (1) "when an organization achieves what is intended" and (2) "when a mismatch between intentions and outcomes is identified and it is corrected." Organizational learning also assumes that new actions are demonstrated in actual operations. Whether or not the potential for organizational learning was realized by actually "correcting" operational "error" was beyond the financial scope of this research.

A theoretical organizational learning cycle may be considered wherein observations are first made of organizational activities. Subsequently, observations may precipitate or engage organization members and/or decision makers in the development of new or revised abstract concepts. These concepts may result in specific actions by the organization and/or modification of the variables governing the organization. New organizational experiences result. New observations can then be made. The cycle may then repeat itself.

Research into the relationship between organizational learning and simulation is also limited by the fact that simulation by definition is not actual operations. The military captures this perspective in the phrase "everything is simulation except war" (Braddock and Thurman, 1993). Simulation does enable organizations to behave as they might in a real situation.

2.2 Research Variables

Essential to understanding the effects of simulation on organizational learning potential is determination of the variables active both in organizational learning, interactive simulation and debriefing sessions. A complete interactive simulation system with debriefing system may be considered an organizational learning mechanisms as it may facilitate both observation and development of abstract concepts by the organization. As organizational learning mechanisms, these systems enable study of a portion of the organizational learning concept as a “actual phenomenon, rather than as an anthropomorphism or a metaphor” (Lipshitz, Popper and Oz, 1996).

In order to capture the contribution of organizational learning from rare events, Carley and Harrald (1997) have expanded the organizational learning cycle into a taxonomy beginning with a rare event and ending with a problem solution. Interactive simulation experiences are seldom a daily experience for any one organization. The frequency of such events may be considered rare depending on the perspective of the organization and the degree of market change and internal turnover. The Carley and Harrald taxonomy for organizational learning contain components that could serve as variables applicable to interactive simulation and debriefing systems. Of particular interest are problem identification, solutions sought and solution found steps of the Carley and Harrald taxonomy.

Essential to any learning is identification of organizational problems. Some interactive simulation experiences and debriefing sessions may be more productive in terms of identifying problems. The number of Problems Identified within a debriefing session provide a basis for that potency. To insure that the problems identified are relevant to the organization mission, Problems Identified are defined as operational issues identified by the unit members or by the debriefing session leaders during the debriefing session.

As with any organizational problem, solutions may be sought but only some may be found. Solutions Sought are defined as problems where at least one task to rectify the problem was identified during the debriefing session by either the unit or the debriefing session leaders.

To be a proposed Solution Found an organization must develop standards and conditions for tasks specified for resolving the identified problems. Solutions found have the greatest potential for organizational learning. Like adaptive and generative learning, some solutions found focus on adapting to the immediate problem with its associated tasks, conditions and standards. Generative learning capture tasks, conditions and standards but also focus on more systemic or root concerns that under lie the deficiency. Thus two types of Solutions Found exist.

To differentiate between the two, solutions found that had only tasks, conditions and standards identified to rectify an operational issue are labeled Developed Solutions Found. Developed Solutions are more indicative of adaptive learning.

The remaining solutions found were referred to as Planned Solutions Found. Planned solutions are considered representative of generative learning. Planned solutions consider governing variables such as how to train at home station prior to training at a national simulation site. Training at home station governs a large part of unit actions at a national simulation site.

2.3 Field Observations

As mentioned earlier, the nature of interactivity as well as the training simulations systems themselves varies widely within the military. Yet the basic structure of a interactive simulation experience followed by a debriefing session involving the participates is common to the military simulations being considered. As such the nature of the interactivity is not essential to establish whether or not simulation can be extended to facilitate organizational learning or to determine its nature.

Live simulation is but one form of interactivity where participates operate "real equipment" in a field environment (Braddock and Thurman, 1993). In live simulation selected interactions and phenomenon are simulated between real players. This interactivity type insures a high level of involvement by participates. Observation data from actual field trials eliminates effects created from experiments conducted in a laboratory setting (Argyris, 1992; Cunningham, 1993).

Consequently, observation data was gathered from the National Training Center and the Joint Readiness Training Center simulation sites. These sites offer a fairly uniform, high quality simulation experience considered by the military as being unparalleled in the world. Seventeen available recorded live simulation debriefing sessions for company and platoon size units were examined for three organizational learning variables identified above. All the debriefing sessions involved similar subject material. All sessions had similar personnel in terms of position in the organization, years involved with the organization and authority within the organization. All of the debriefing leaders had similar experience levels in terms of the simulation and the subject matter as well as conducted the debriefing session in accordance with the same established written guidelines. All debriefings were allotted a similar amount of time.

3 RESULTS AND ANALYSIS

Results and analysis addressed both the potential for organizational learning as well as implications for simulation system design.

3.1 Potential for Organizational Learning

Descriptive data from the investigation revealed in part the potential military simulation worlds and associated debriefing sessions create for subsequent organizational learning. Across all seventeen debriefing sessions conducted, 401 operational problems were identified. Of the 401 Problems Identified, 220 Solutions were Sought. Of the 220 problems where solutions were sought, 36 Solutions Found were developed and 4 Solutions Found were planned. See Table 1 below.

Table 1: Observed occurrence of the variables across all debriefing sessions

Pro blems Identified	Solutions Sought	Solu tions Found	Developed Solutions	Planned Solutions
401	220	40	36	4

Based on articulated Solutions Found within the debriefing sessions the ratio of potential for adaptive to generative organizational learning is 9 to 1. See Table 2 below.

Table 2: Ratio of Organizational Learning Potential

Ratio of Potential for Adaptive to Generative Learning	9 to 1

While this data is descriptive of the interactive simulation experiences and subsequent debriefing sessions being considered, it is not necessarily descriptive of all military interactive simulation experiences and subsequent debriefing sessions. For example, in this field study each unit that participated in the interactive simulation is considered professional at the mission it had to perform. Operational considerations such as personnel, tactical doctrine, equipment, missions, scenarios and environments were familiar to the unit. Had any of these operational considerations been more novel to the unit such as might occur in future operations, one might hope for more generative learning.

Another significant finding is that generative learning occurred in only three of the seventeen observed units. This occurred despite stated goals for units to consider systemic issues such as home station training. This may infer a dominate effect due to the unit leader or the debriefing session leader.

3.2 Inferences to Simulation System Design

From a prescriptive perspective, one may wonder if any relationships might be drawn from this data that might direct simulation system designers and engineers in a way that might promote more adaptive and generative learning.

Related research has examined the effects independent variables such as selected debriefing session techniques or session phenomenon have on individual learning (Department of the Army, 1993; Downs, et. al., 1987; Joint Readiness Training Center, 1993; National Training Center, 1994; SHERIKON, 1996; Word, 1987). This research took a number of those session techniques and phenomenon and looked at the relationship of the techniques used and the type of organizational learning observed in the simulation debriefing session. In pursuit of this, a Pearson two tailed correlation test at .01 was performed on the observed number of occurrences of specified session techniques and phenomenon with the manifestations of adaptive and generative organizational learning.

Two session phenomenon and one session technique demonstrated the strongest correlation with generative and adaptive learning. Questions Asked by Unit (.818 for generative learning and .824 for adaptive learning), Discussion Amongst Unit (.668 and .652) and Unit Leader Aided Discussion (.648 and .642) were statistically significant for both categories of learning (Table 3). While having Unit Leader Aided Discussion is a prerogative of the session leadership, Questions Asked By Unit and Discussion Amongst Unit are session phenomenon.

Further analysis of the two session phenomenon revealed correlation with some session techniques that session leadership may use to stimulate Discussion Amongst Unit and Questions Asked by unit. Again at a .01 statistical significance, correlation was found between Questions Asked by Unit and Provide Participative Feedback (.899), Focused Open Questions (.658) and Unit Leader Aided Discussion (.606).

Table 3: Pearson two-tailed correlation between Session Phenomenon and Potential Organizational Learning

Session Phenomenon and Leader Prerogative	Potential Generative Learning	Potential Adaptive Learning
Questions Asked by Unit	.818	.824
Discussion Amongst Unit	.668	.652
Unit Leader Aided Discussion	.648	.642

Further analysis of the two session phenomenon revealed correlation with some session techniques that session leadership may use to stimulate Discussion Amongst Unit and Questions Asked by unit. Again at a .01 statistical significance, correlation was found between Questions Asked by Unit and Provide Participative Feedback (.899), Focused Open Questions (.658) and Unit Leader Aided Discussion (.606).

Based on correlation, Unit Leader Aided Discussion appears to be a very influential technique. It had a direct and significant correlation with both adaptive and generative learning. Additionally, it was also positively and significantly correlated with Questions Asked by Units.

The importance of debriefing session leader or unit leader in promoting learning stands out. Sharing discussion leadership with Unit leadership was one successful technique that can be implemented by debriefing session leaders to encourage learning and discussion. For session leaders to provide participative feedback and focused open questions requires some advanced skills as a group session leader.

These findings should be considered in design of simulation systems and debriefing or after-action review systems. Of particular interest is aiding session leaders to do their part in providing participative feedback and focused open questions. This is not interpreted to be a list of things for session leaders to do or not do. Long lists of recommended steps already exist in writing. Rather attention should be to aid leaders in generating focused open questions and providing participative feedback as part of the automated after-action-review system.

A typical military simulation system that focuses on after-action-review contains sub systems that perform data collection, storage, system & network management, analyst work and presentation (Gibson, 1995). While session leaders are expected to be "experts in the simulation, in the subject matter, and in group processes," expertise in all those areas is not always present in one individual. Assuming subject matter expertise, approaches to aiding a session leader in group processes include technical aides such as audio, text, shared work space and video devices. Aides available to the session leader for help with the simulation system have typically relied on site technical experts or some simulation help menus.

Not often considered in simulation design are embedding intelligent tutorial aids in conducting group sessions. Session leaders are typically chosen based on their subject matter expertise rather then their group session leader skills. This makes sense since military expertise is costly to duplicate. Ragusa (1998) indicates difficulties and high costs associated with embedding intelligent computer-aided instruction systems in general.

Simulation systems designed to aid session leaders in generating focused open questions and providing participative feedback appear to promise large returns in creating the conditions necessary for generative and adaptive learning. The complexity of such an intelligent system is far smaller then attempting to embed military, subject matter expertise in the debriefing session sub system. To reduce the scale and cost of embedding intelligent computer-aided instruction systems into a after-action-review system, it would appear that an emphasis should be on aiding session leaders in stimulating group processes.

These findings may be applicable to other interactive simulation systems with debriefing systems. Such simulations include not only the "live" simulations considered here but virtual systems such as the Close Combat Tactical Trainer.

4 FUTURE EFFORTS

This research examined single repetitions of the simulation system by each given unit. The inability of units to conduct multiple repetitions in the simulation systems is driven by the cost of live simulation. With development of virtual simulation systems capable of supporting organizations, the cost of conducting repetitive simulation by the same unit drop significantly. Repetitive simulation experiences would enable the unit to apply the actions that they identified during a previous simulation run. Unit performance toward established standards or expectations could be tracked. Additionally it would give insight into the change in organizational learning over time. Currently work is on going that examines the relationship of both adaptive and generative learning within and applicable to repeated use of selected simulation world contexts.

For individuals and units alike the speed at which they learn effects when they are available for operational missions and the state of readiness they are in when deployed. Due to operational and personnel turnover, military organizations continuously face the potential for organization turmoil. Degradation of unit readiness can be as great as 25% in a three month period due to skill decay and personnel turnover (Gorman, 1990). The ups and downs of unit readiness for normal operational missions is only part of the issue organizational learning begins to address.

Organizational learning also encompasses a far more recent phenomenon. Deployment of units into novel operations such as Bosnia, Operation Sea Signal in Cuba and other novel environments creates unique and significant organizational learning challenges for simulation systems. Additional work is proceeding that examines the relationship of organizational learning and experiential learning mechanisms as it relates to adaptation of simulation system design and unit operations to these novel environments.

REFERENCES

Argyris, C. 1977. Double Loop Learning in Organizations. *Harvard Business Review*, September-October.

Argyris, C. 1992. *On Organizational Learning*. Cambridge, Mass: Blackwell Publishing Inc.

Argyris, C. and D. A. Schon. 1996. *Organizational Learning II*. Reading , Mass: Addison-Wesley Publishing Company,.

Braddock, J. V. and M. R Thurman. 1993. Impact of Advanced Distributed Simulation on Readiness, Training and Prototyping. *Report of the Defense Science Board Task Force on Simulation, Readiness and Prototyping.* Washington, D. C: Office of the Under Secretary of Defense for Acquisition,.

Carley, K. M. and J. R. Harrald. 1997. Organizational Learning Under Fire. *American Behavioral Scientist*. Vol. 40, No. 3.

Cunningham, J. B. 1993. *Action Research and Organizational Development.* Westport, Connecticut: Praeger.

De Geus, A. 1988. Planning as Learning. *Harvard Business Review*. March-April, Vol. 66:2 70-4.

Department of the Army. 1988. *GTS 25-6-6: After Action Review (AAR) pocket reference guide.* US Army Training and Audiovisual Support Centers.

Department of the Army. 1990. *FM 25-101: Battle focused training.* Fort Leavenworth, KS: US Army Combined Arms Center.

Department of the Army. 1993. *TC 25-20: A leader's guide to after-action reviews.* Fort Leavenworth, KS: US Army Combined Arms Center.

Downs, C. W., K. M. Johnson, and J. J. Fallesen. 1987. Analysis of feedback in after action reviews. *Technical Report 745*. Ft. Leavenworth, KS: Research Institute for the Behavioral and Social Sciences, ARI Field Unit.

Edmondson, A. C. 1996. Three Faces of Eden: The Persistence of Competing Theories and Multiple Diagnoses in Organizational Intervention Research. *Human Relations*, Vol. 49, No. 5.

Garvin, D. A. 1993. Building a Learning Organization. *Harvard Business Review.* July-August.

Gibson, J. W. 1995. After Action Review System (AARS) Design and Functional Capabilities. *Proceedings of the 1995 Winter Simulation Conference*, Ed: Alexopoulos, C., Kang, K., Lilegdon, W.R., and Goldsman, D.

Gorman, Paul. 1990. *The Military Value of Training.* (Institute for Defense Analysis, Institute for Defense Analysis -Paper P-2515). Alexandria, VA.

Joint Readiness Training Center. 1993. Preparing the AAR. *BDM*. (Available from Commander, Operations Group, JRTC, Fort Polk, LA)

Keys, J. B., R. M Fulmer,. and S. A. Stumpf. 1996. Microworlds and Simuworlds: Practice Fields for the Learning Organization. *Organizational Dynamics*, Spring.

Lipshitz, R., M. Popper and S. Oz. 1996. Building Learning Organizations: The Design and Implementation of Organizational Learning Mechanisms. *Journal of Applied Behavioral Science,* Vol. 32, No. 3.

National Training Center. 1992. Platoon/company AAR. *BDM*. (Available from Commander, Operations Group, NTC Observation Division, Attention: ATXY-CTL-N, Fort Irwin, CA)

Piplani, L. K., J. G Mercer, and Roop, R. O. 1994. *Models and Simulations*, Fort Belvoir, Virginia: Defense Systems Management College Press.

Probst, G., J.B Bettina and S.T. Buchel. 1997. *Organizational learning : the competitive advantage of the future*, London ; New York : Prentice Hall.

Schein, E. H. 1993. How Can Organizations Learn Faster? The Challenge of Entering the Green Room. *Sloan Management Review.* Winter.

Senge, P. 1990. The Leader's New Work: Building Learning Organizations. *Sloan Management Review*, Vol. 32, No. 1.

SHERIKON, Inc. 1996. *Analysis of AVCATT after action review requirements.* Orlando, Fl.

Sullivan, Gordon R. 1994. Focusing on the Future. Video Presentation, Force XXI, U. S. Army, Washington, D. C.

Stalk, George 1988. Time -- The Next Source of Competitive Advantage. *Harvard Business Review,* July - August, Vol. 66:4, 41-51.

Stokesbury, James L. 1981. *A Short History of World War I*, New York: William Morrow and Company.

AUTHOR BIOGRAPHIES

MICHAEL D. PROCTOR is an Assistant Professor in the Department of Industrial Engineering and Management Systems at the University of Central Florida. His research interests include interactive military simulation, simulation interoperability, modeling and analysis, intelligent simulation, intelligent tutoring systems, information management and distant learning systems. He holds a BS from the United States Military Academy, a MSCS from Monmouth University, MSOR from Florida Institute Technology and a Ph.D. from North Carolina State.

JUSTIN CHASE GUBLER is a Major in the United States Army stationed at Fort Hood Texas. His research interests include military simulation, human cognition, learning theory, inquiry theory and learning reinforcement. He holds a BS from the United States Military Academy and a MS from the University of Central Florida.