Advanced Distributed Learning in Support of Future Joint Operations

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ABSTRACT

The security environment facing the U.S. and its allies is complex. The variety of threats, their asymmetries and asynchronies are well documented elsewhere. Equally well documented are the shrinking military resources the U.S., and its allies, bring to bear against the threats. This paper asks, "How do decreasing numbers of people deal with the increasing, and increasingly complex, threat environment?"

The answer proposed is that Advanced Distributed Learning (ADL) technologies and acculturation are necessary to the point of being an imperative if U.S. and allied forces are to be successful. ADL, comprised of education, training, and performance support[1], plays the critical role because it enables military personnel effectiveness. As has been documented, "Inadequate & poorly timed training will negate the technical superiority of our hardware."[2]

This paper will identify and discuss ADL technologies and services, the acculturation necessary for successful implementation of these technologies and services, and the role ADL will play in enabling future Joint Operations.

- The necessary technologies and services are increasingly well documented in both military, e.g. The Defense Science Board Task Force on Training Superiority and Surprise, and industry, e.g. American Society for Training and Development, publications. Capabilities such as learner-centric training utilizing embedded training devices, intelligent tutoring agents, and collaborative mentoring will seek to attain the two-sigma increase in performance that maximizes the training benefit realized for time spent. Learning delivered when and where needed minimizes training decay and time wasted in travel. Performance assessment ensures the learner attains the required proficiency both effectively and efficiently. Collaboration, knowledge-management, modeling and simulation; the list of requisite technologies and services goes on.
- Often overlooked, "acculturation" deserves elaboration. Selecting one ADL technology, collaboration, and paraphrasing a collaboration authority, "There are three challenges to successful implementation of collaboration. Of these, the infrastructure is the easiest and the security is slightly more challenging, but by far the most difficult is fostering a collaborative culture in which the 'economies of trust' enable increased productivity." Acculturation, then, is the process by which the use of ADL technologies and services reach their full effectiveness.
- The implementation and integration of these technologies into future Joint Operations is the task facing the United States Joint Forces Command (USJFCOM) J-9, Joint Experimentation (JE). Using limited objective experiments (LOEs), and larger bi-annual experiments, ADL technologies and services will be evaluated for their effectiveness when used by Joint forces participating in a programmed series of Joint exercises sponsored by USJFCOM. Lessons learned from these experiments then yield recommendations for U.S. Doctrine, Organization, Training, Materiel, Leadership, Personnel and Facilities (DOTMLPF) changes. The paper will propose a role for ADL in enabling future Joint Operations.

[1] U.S. DoD Implementation Plan for ADL
[2] The Defense Science Board Task Force on Training Superiority and Surprise

Introduction

In response to the April 2000 U.S. Defense Planning Guidance (DPG) tasking for "…new joint warfighting concepts and capabilities…"[1], United States Joint Forces Command (USJFCOM) J-9, Joint Experimentation (JE), is developing a concept called Rapid Decisive Operations (RDO). RDO "provides a construct for future joint operations and a framework for future USJFCOM experimentation to develop a set of recommendations for doctrine, organization, training, materiel, leadership, personnel and facilities (DOTMLPF), as well as policy implications."[2] This paper focuses on one of these categories, training, proposing an initial set of promising technologies and services that will improve training. In doing so, it also proposes an experimentation path towards meeting the current DPG tasking to USJFCOM to assist in developing "a plan to transform military training to better enable Joint Forces operations."[3] The recommended path seeks to evolve training by asserting that learning is the key to successful future Joint Force operations.

Learning, defined as "the acquisition of knowledge, skills, behaviors, and attitudes (through the integration of education, training, and performance support),"[4] is the key to enabling RDO. Learning focuses on what the student or trainee knows as the result of the intervention rather than the time allotted to learning, the number of trainees present, incident of attendance, or other common, but irrelevant, metrics. Advanced Distributed Learning (ADL) leverages the use of technology to ensure learning is available when and where needed. ADL will enable Joint Force operations and RDO in four areas:

1. ADL technologies and services are necessary to train, educate and support Joint Force conduct of RDO.
2. ADL technologies and services can support and advance knowledge management (KM) initiatives necessary for the success of RDO.
3. ADL performance support tools should serve a dual purpose, or at least be integrated, with decision aids used for RDO functions.
4. ADL strategies should be used to engender innovative thinking since innovation is a conspicuous attribute in the RDO documentation.

This paper will start by briefly introducing RDO concepts. I will then identify and discuss ADL technologies and services and the areas in which they might lend support to ADL. Finally, I will address the acculturation necessary for successful implementation of these technologies and services.

Rapid Decisive Operations

RDO is a concept for conducting future joint operations. It focuses on the adversary, identifying his "critical capabilities" in order to bring the appropriate measure to bear "to achieve the desired political/military effect."[5] RDO recognizes and leverages the military's role as one instrument of national power, considering a broader range of actions by a broader range of agencies than those available to just the military. Thus,

> "at the national and theater strategic level, the United States will attempt to influence and deter an adversary by using diplomatic, economic, and information operations, supported by relevant military flexible deterrent options. If deterrence fails, RDO provides the capability to rapidly and decisively coerce, compel, or defeat the enemy in order to accomplish our strategic objectives…"[6]

In order to accomplish our objectives, and "the desired political/military effect," RDO integrates "knowledge, command and control, and effects based operations…"[7] Each of these play a pivotal role in RDO.

The Joint Force envisioned by the document has knowledge of the enemy's weakness. It has knowledge of its own capabilities so that the appropriate capability can be utilized to attack that weakness. It has knowledge of the operational environment in which the force will act. RDO's "knowledge-centric" operations rely on the supporting concepts and technologies of:

- Operational Net Assessment (ONA)
- Common Relevant Operational Picture (CROP)
- Joint Intelligence, Surveillance, & Reconnaissance (JISR)

The Joint Force will rely on improved Command and Control (C2) measures and technologies to synchronize actions among military forces, agencies, and multinational organizations. Habitual, collaborative rela-

tionships, enabled by persistent C2 networks, promote rapid planning and execution. C2 supporting concepts and technologies are:

- Adaptive Joint Command and Control (AJC2)
- Joint Interactive Planning (JIP)
- Interagency Operations
- Multinational Operations

The Joint Force will use Effects Based Operations (EBO) to achieve "the desired political/military effect." EBO recognize the adversary as complex, multidimensional, and adaptive. EBO allows consideration of non-traditional means of attacking an adversary in order to accomplish strategic objectives. EBO supporting concepts and technologies are:

- Dominant Maneuver
- Precision Engagement
- Information Operations

RDO is "the USJFCOM vehicle for transformation and operationalizing Joint Vision 2020 (JV2020)…[and is] based on JV2020 operational capabilities…"[8] Quite naturally RDO literature concentrates on the development of the RDO concept. It does, however, mention training in several places, acknowledging its importance without describing how future Joint Force members will be trained. It should address training. According to the Defense Science Board (DSB) Task Force on Training Superiority and Training Surprise, "[JV] -2010/ 20 warfare will require more training, not less."[9]

RDO and its co-evolving functional and supporting concepts are being developed and evaluated by USJFCOM J9 during Limited Objective Experiments (LOEs) and larger bi-annual experiments. The LOEs, bi-annual experiments, and RDO literature do not now include or consider experimenting with methods of training. How then will J9 make DOTMLPF "training" recommendations?

Advanced Distributed Learning

ADL is "an evolution of distributed learning that emphasizes collaboration on standards-based versions of reusable objects, networks, and learning management systems...."[10] In addition to the obvious match between the networked collaborative training required for RDO C2 concepts and the definition of ADL, ADL promises other technologies for RDO concept support and pedagogic support for RDO knowledge requirements. The following services and technologies will be discussed in this paper, together with suggested application to RDO concepts: learner-centric learning (LCL), intelligent tutoring, embedded training devices, collaborative learning, distributed simulation, and performance assessment. In practice these are not distinct techniques and often overlap or are used concurrently to enhance learning. For example, one practitioner[11] defined intelligent tutors as

- Educational technology that mimics the best known way of teaching: 1-on-1 tutorial.
- Simulations that enable automated directed, active learning of complex skills.
- Knowledge-based systems that automate teaching strategies and/or exemplary task performance.
- Adaptive instructional systems that can change behavior dynamically to the meet the needs of individual students.

What is the goal of LCL? Studies have shown that learning interventions focused on decreasing the "learning gap," the difference between the learning objective and the learner's current state of knowledge, by targeted instruction to address that gap, speed student learning. Moreover, as the DSB noted, "what amounts to individual tutoring…does more than reduce the time to learn. It greatly increases the level of knowledge or skill in the student."[12] In particular, the "2-sigma" difference, shown in figure 1, refers to studies showing that tutored students perform two standard deviations better than their classroom counterparts.

Figure 1

Organization Wide Learning (OWL) is an example of a LCL system. OWL uses the learner's own actions over a period of time to determine the learner's current level of knowledge. As indicated in figure 2, the average user knows only a portion of the knowledge of the peer group and a fraction of the total possible application functions.[13]

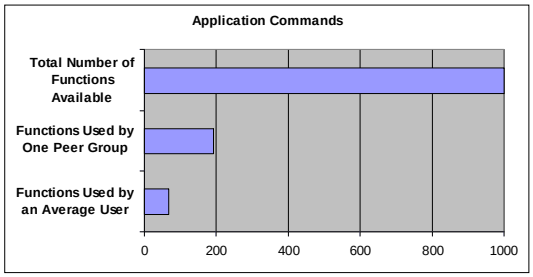

Figure 2

OWL bases learning objectives on the pooled knowledge of members in the organization doing similar work. OWL identifies "individualized instructional topics … by comparing an individual's knowledge to the pooled knowledge of her peers."[14] Having identified the topics that comprise the learning gap, OWL recommends these topics to the user to narrow the gap between current and objective learning. OWL, and other LCL systems, can support RDO in each of the first three of the four areas identified for ADL support. That is, LCL systems can enable learning of RDO concepts, advance KM initiatives, and should be integrated with decision aids used for RDO functions such as AJC2 and JIP. In particular, a "recommender" system would seem to be applicable since, over time, the pooled knowledge of users of C2 systems or decision aids would grow as users addressed similar planning and execution problems. New or infrequent users of these systems would benefit from the pooled knowledge of those that had gone before. This would be of significant benefit since a current training problem is that "training must be applied over and over again as the composition of the units and joint forces changes and as skills erode over time."[15]

Intelligent tutors. Individual tutoring need not be done by; automated or intelligent tutoring agents can enable learning gains similar to those possible with human tutors.[16] PROPA is an example of an intelligent tutor. PROPA uses a reasoning process, "argumentation," to teach basic explanatory analysis skills to satellite activity analysts (SAAs). SAAs are responsible for interpreting behavior of earth-orbiting satellites. PROPA provides the student SAA with data-access tools used by SAAs and a "special *argument palette* on which students construct arguments for and against alternative explanations of reported satellite activity events."[17] PROPA teaches argumentation by requiring students to select one or more candidate explanations, evidence statements, inference rules linking explanation and evidence, and supporting data. PROPA records the resulting network so that, if the student asks for a hint, it can suggest one or more correct steps. PROPA knows the correct solution(s) to the problem so at any point during the instruction it can compare the student's solution with the correct solution and give a hint in one or more areas. Intelligent tutors can support RDO by enabling learning of RDO concepts for a new Joint Force member and should be integrated with decision aids used for RDO functions such as AJC2 and JIP. Since the desired capabilities for both AJC2 and JIP include advanced planning and decision support tools, an intelligent tutor should be included to provide training for new users and routine training to avoid training decay for infrequent users.

Embedded training (ET) devices. The principal advantage of ET devices is that they are embedded in systems, C2 systems for example, that users need to perform their duties. So use of an ET device helps to minimize issues associated with training transfer, the application of the learning intervention in the workplace. One example of an ET system is shown in figure 3. The general case, in black text, shows a learner interacting with an application and being assisted by the ET device.

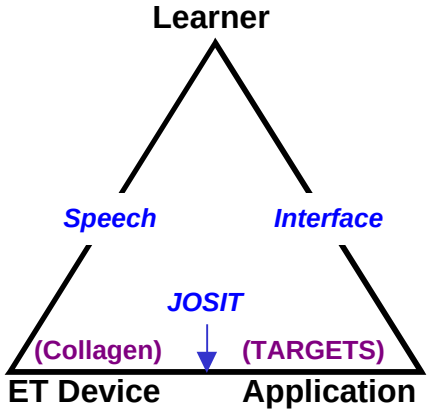

Figure 3

In this specific example, the application is the Terminal Area Route Generation, Evaluation and Traffic Simulation (TARGETS). TARGETS is a flight simulation used to plan and simulate flight approaches and departures from airfields. The ET device, a tutoring agent called Collagen, was developed by the Mitsubishi Electric Research Lab. The specific application and tutoring agent are shown in purple parenthesis. Interface mechanisms are shown in blue italics. The learner uses TARGETS interface to interact with TARGET. The Java Observation, Simulation & Inspection Tool (JOSIT) instruments TARGETS' computing environment in order to identify user actions. Learners interact, using spoken language, with Collagen. The system is used to research both coaching/mentoring and guiding/directing instructional strategies.[18] Such devices would benefit RDO in the first and third of the four areas identified for ADL support. They would help to enable learning of RDO concepts and should be integrated with AJC2 and JIP decision aids.

Collaborative Learning. As previously mentioned, collaborative learning appears in both RDO C2 concepts and in the definition of ADL, so there are clearly opportunities to leverage work done by one program in the other. One example of a technology that promotes collaborative learning does so by recording the work done by a collaborative team so that individual team members can replay it either because they are participating asynchronously or because they wish to review the work. Also because the work is recorded, team members can explore branches and sequels. These are also captured so that they can, in turn, be edited or replayed.[19] RDO can benefit the first, second and fourth areas identified for ADL support using collaboration tools and collaborative learning. Clearly collaborative learning can help to enable learning of RDO concepts. Recorded collaborative work supports KM initiatives. Finally, collaborative teams foster innovation as diverse views widen the solution space.

Distributed simulation (DS). DS, already used for Joint, Service, and Multinational Force training, can support the first and third areas identified for ADL support. Actually, DS is already used to support C2 training. For example, the U.S. Army is using DS to train its C2 systems, components of the Army Battle Command System, over wide area networks.[20] This technique provides the training when and where needed, reducing travel costs and personnel absence. More importantly, providing the training when needed helps to redress the problem of skill decay. As the DSB found, "if complex skills are not constantly exercised, proficiency will decay substantially in times as short as a few months."[21] The J9 will have a more varied training audience to support and thus must expand the nature of scenarios currently presented via DS to include situations amenable to solution, or at least consideration, by the agencies and/or multinational organizations with which J9 seeks to form habitual relationships.

Performance assessment is the key to LCL, and the first three of the four ADL support areas, because you "can't know there is a training problem until you have ways to measure proficiency."[22] Performance assessment of some learning domains is easier than other learning domains. For example, "information technology skills have the advantage of being observable …[whereas] primarily mental activities…can only be inferred."[23] One effort that seeks to better support the assessment of mental activities is developing technology that supports observer/trainer (OT) observations, analysis and feedback. This effort capitalizes on information that is already known in a simulation-supported exercise environment. Training objectives, the scenario, and the timing events prescribed by the exercise control group combine to dictate, to a large degree, actions and decision points by the training audience. The OT, supported by a digital device that helps him to both anticipate the actions and decision points, and capture activities as they occur, is better able to reconstruct the decision process after the fact.[24]

ADL literature summarizes some of the technologies and services addressed thus far under the rubric Intelligent Computer-Aided Instruction (ICAI). As documented in ADL literature, ICAI focus areas include[25]

- empirical foundation for how individuals and team develop expertise
- selection of instructional alternatives
- learning assessment
- selection of follow-on or remedial instruction
- system improvement.

The importance and relevance of the first focus area is underscored by the recommendations of the DSB. The DSB recommended Dr. R. Sternberg's work on intelligence types, using "repeatable and well-defined measures of these traits" to "permit better coupling of training to the individual."[26] In particular, Dr. Sternberg's metrics for creative intelligence should be applicable to selecting personnel for ONA since innovation and creativity are sought in developing ways and means to resolve crises.

Dr. Sternberg's work, and other empirical work on developing team expertise, should also be leveraged to provide pedagogic support for fostering knowledge development and management. J9 should experiment with learning techniques because knowledge-centric operations are a key tenet of RDO and because knowledge is inextricably linked to learning. What is the relationship between knowledge and learning? "Workers generate their knowledge through learning…"[27] has significant implications for knowledge creation. The RDO documentation suggests a hierarchy[28] similar to that shown in table 1 absent the top-level, intelligence.[29] Table 1, a representation from the Intelligence, Surveillance, Reconnaissance (ISR) domain, contains notional entries. The author's point, however, is the same as that

	Present	Mid-Term	Future
Intelligence	**0.2**	**1.0**	**6.0**
Knowledge	**0.8**	**3.0**	**3.0**
Information	**3.0**	**3.0**	**0.8**
Data	**6.0**	**3.0**	**0.2**

Table 1

raised in the RDO documentation. Both recognize that we currently have far more data than information or knowledge. Both acknowledge the importance of reversing this situation. Both suggest a better capability to do so in the future than currently exists. I argue that the method to do so is learning. Those who separate knowledge from learning risk encountering the "inert knowledge" problem. "The ability to store and recall facts out of context is not the same as the ability to use knowledge as part of skilled performance. Learning while performing a version of the realistic end task has been shown to reduce the chance of acquiring "inert" knowledge."[30] The DSB summarized the importance of learning by recommending that DoD "Institute a program of learning research for DoD-specific training."[31]

Acculturation

I have thus far argued that Joint Force conduct of RDO is dependent on individual and group learning and that ADL technologies and services can foster that learning. It is additionally important to acknowledge that acculturation will also affect the success of RDO and its supporting concepts. I address acculturation in order to avoid the "fundamental flaw in most innovators' strategies is that they focus on their innovation, on what they are trying to do – rather than on understanding how the larger culture, structures, and norms will react to their efforts."[32] Clearly J9 is considering some of these "larger" issues; AJC2 is a new organizational structure whose design and function will help to ameliorate the changes that RDO portends. As Joint Force personnel learn and execute RDO, however, it is worth considering some areas in which acculturation may be an issue and take action to ensure that change progresses in these areas. What follows is an incomplete list; cultural issues associated with collaboration and KM are presented only to provide concrete examples of the phenomena.

Collaboration, and collaborative learning, is one such area. Paraphrasing a collaboration authority, "There are three challenges to successful implementation of collaboration. Of these, the infrastructure is the easiest and the security is slightly more challenging, but by far the most difficult is fostering a collaborative culture in which the 'economies of trust' enable increased productivity."[33] The underlying issue stems from most people being raised to "do your own work." Those that are comfortable doing their own work are less likely to share their ideas or to work in harmony with others to build a group product. Moreover, many organizations recognize and reward individuals with promotion, salary, etc. on the basis of individual effort. While increased use of integrated product teams, action learning groups, and other group efforts, have made group recognition and awards more common, we

should understand that some may be unused to collaborative environments. For individuals such as these, continued participation in collaborative efforts and organizational recognition for group products will help to alleviate the problem. Collaboration is itself a learning process!

Knowledge Management (KM) literature also references cultural issues. Knowledge sharing, one aspect of KM, is by nature "opposed to the traditional power driven culture that is associated with 'knowledge is power'"[34] Morey and Frangioso describe the "pseudo market for knowledge [which] already exists today in any organization."[35] They argue that most knowledge sharing occurs in cases in which either a "trust relationship" exists or the sharer anticipates a reciprocal sharing sometime in the future.[36] Knowledge capture, an aspect of KM defining the process of documenting knowledge assets, would logically be even more difficult in such an environment since no opportunity for establishing trust relationships exists. Morey and Frangioso recommend several approaches for KM acculturation, principally establishing a system allowing the organization to monitor and reward knowledge sharing and knowledge capture.

Summary

Advance Distributed Learning has much to offer J9. ADL technologies and services will support Joint Force learning and use of RDO concepts. Learning is linked to knowledge creation and knowledge sharing; key components of knowledge-centric operations. Finally, acculturation is a necessary consideration in implementing innovative technologies, services, and concepts in order to achieve full effectiveness.

About the Author

Andy Bowers is a Senior Modeling and Simulation Engineer at MITRE Corporation's Joint Warfighting Center site. A retired U.S. Army officer, Mr. Bowers co-authored the draft Mission Needs Statement for the Joint Advanced Distributed Learning Network and co-developed the Advanced Distributed Learning – Joint Interoperability Training Advanced Concept Technology Demonstration. Mr. Bowers holds a Bachelor's degree from the United States Military Academy and a MS in Operations Research and a MS in Civil Engineering from Stanford University.

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[6] RDO p.8
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