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Approaches to Managing Future Training

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February 2006

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U.S. Army Research Institute
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This report explores issues related to managing adaptable training in the future, when Future Combat Systems (FCS), embedded training (ET) capabilities, and a full range of personnel management tools are the norm for daily operations. The report first discusses the issues associated with management of future training and related current and emerging Army initiatives, FCS documentation, and previous research findings. The five principal issues concern the vision and expectation for future training; the tools and information that would be needed; how the tools and information could be provided using automated channels; what level of automation users will accept; and the nature of near-term solutions. The concept for a future training management system, is described through use cases that detail the use of specific tools and information. Based on analysis of the use cases, technology needs are described in five areas: massive database systems, bi-directional reach (both accessing and sending needed information), sophisticated self-learning search engines, performance support systems and computer-generated simulations powered by artificial intelligence, and super-broad bandwidth. We then present a set of detailed recommendations, including priorities, interim solutions for near-term development, and directions for further research and development in both training and technology realms.

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APPROACHES TO MANAGING FUTURE TRAINING

EXECUTIVE SUMMARY

Research Requirement:

As the U.S. Army transformation to the Future Force equipped with the Future Combat Systems (FCS) moves forward, system design and development decisions are made daily. In parallel, there are training design and development decisions that support the delivery of realistic and targeted training, anywhere and anytime, by means of *embedded training* (ET). Unit members will be participating in training while they are seated in their vehicles or at their workstations, using the system controls and interfaces just as they would operationally, and the training content will be presented through those interfaces.

Because the system capabilities are being designed now, those who are working on managing future training need to address the issues surrounding efficient and effective use of embedded training capabilities. The intent of this research of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), was to identify the issues associated with the management of collective training for Future Force Soldiers, leaders, and units, and to design a detailed approach for that training management. Of particular interest was the way that future embedded training could be adaptable—amenable to changes in response to training needs, with minimal programming or laborious administrative effort.

Procedure:

Initial project activities consisted of identifying and obtaining materials relevant to the project objectives. Information on current initiatives within U.S. Department of Defense (DoD) was gleaned from conversations with experts and from documentation available on the internet. The vast majority of information on FCS capabilities is still evolving, so many of the materials examined were draft and preliminary copies. The information was reviewed and analyzed by a shifting group of experts, including individuals from ARI, the FCS team focused on collective training, and other military and training experts. This analysis consisted of categorizing information, identifying consistencies and inconsistencies, and establishing linkages and shared capabilities. The information was used to formulate and explore five issues related to future training management:

- Expectations for future training development and delivery, based on FCS network services planning and training roles.

- Types of information and tools that users will need for planning and conducting collective training.

- Methods for providing the information and tools, based on current and emerging Army database initiatives and status of computer-generated forces (CGF) and artificial intelligence (AI) technologies.

- Expectations of the kind of tools (i.e., how much automation) users will accept, acknowledging commanders' need to insert their own expertise and expectations into exercises rather than allow an automated system to make decisions and act as the expert.

- Assessment of successful near-term development of the anticipated tools and capabilities and description of the nature of near-term solutions.

The issues were further explicated by means of informal use cases for future training development and execution. Use cases focused on units and unit commanders were used to formulate secondary use cases targeting the conceptual future training management system, which were decomposed to identify the specific capabilities that would be required. By linking the needed capabilities and their purposes to plans and expectations for FCS capabilities and then determining the likelihood of technology maturity within the next 10 years, the project team delineated specific recommendations concerning training management possibilities and needs for further research and development.

Findings:

The concept for future training management provides a detailed description of how collective training exercises can be developed and delivered, given a suite of technologically sophisticated services including massive database systems, bi-directional reach (both accessing and sending needed information), sophisticated self-learning search engines, performance support systems, CGF simulations powered by AI, and super-broad bandwidth. A more realistic near-term approach is also described, along with discussion of research and development recommendations focused on how the needed information and tools can be provided. The findings have necessarily been edited to avoid specific information about FCS decisions that are not yet final.

Utilization and Dissemination of Findings:

The results of this project can benefit those involved in further definition and development of the training management capabilities for the transformation to the Future Force equipped with FCS. In addition, the research and development issues provide direction for future work that will assist the Army in achieving its stated goals for the Future Force.

APPROACHES TO MANAGING FUTURE TRAINING

CONTENTS

Page

Introduction 1

Issues Associated with Future Training Management 2

What Will Future Training Development and Delivery Be Like? 4

Requirements Analysis for FCS Training Common Components 4

Battle Command Software Services 5

Human and Automated Training Roles 5

What Kind of Information and Tools Will Users Need? 6

How Will the Information and Tools be Provided? 7

Combined Arms Training Strategy 8

Digital Training Management System 9

Army Training Information System 9

Defense Integrated Military Human Resources System 10

Computer-Generated Forces and Artificial Intelligence 11

What Kind of Tools Will Training Managers Accept? 13

What are the Near-Term Solutions? 14

Non–Issues 14

The Future Training Management System (Concept) 15

Method 15

Findings—Primary Use Cases 17

Findings—Secondary Use Cases 20

The Issues and the TMS(C) 27

Database Systems 29

Bi–Directional Reach 30

Search Engines 30

Performance Support Systems, Computer-Generated Forces Simulation, and Artificial Intelligence 31

Improved Bandwidth Capabilities 33

Summary and Recommendations 33

Page

References.....37
Appendix A Acronyms and Abbreviations..... A-1

List of Tables

Table 1. Use Case 1 Information Needs and Sources 22
Table 2. Use Case 1 Information Provided to User.....23
Table 3. Summary of Capability Needs and Research and Development Needs.....28

List of Figures

Figure 1. Use Case 1, showing activities of the commander or training manager in preparing for a collective training exercise 18
Figure 2. Use Case 2, showing activities of the commander and other unit members during conduct of a collective training exercise.....19
Figure 3. Secondary Use Case 1, showing information flow between the user and Training Management System (Concept) during development of an exercise 21
Figure 4. Secondary Use Case 2, showing Training Management System (Concept) activity during conduct of an exercise.....25

APPROACHES TO MANAGING FUTURE TRAINING

Introduction

As the U.S. Army transformation to the Future Force equipped with the Future Combat Systems (FCS)[1] moves forward, system design and development decisions are made daily. Myriad engineers, programmers, and modeling and simulation experts have joined forces with military experts to create and integrate the components of the envisioned FCS: a fully-networked system of systems, enabling rapid and complete sharing of information across echelons, leaders, and systems—throughout the full battlespace. The heart of the information-sharing capability will be the system of systems common operating environment (SOSCOE), supporting multiple applications that serve a wide array of information demands.[2]

With these system decisions come training design and development decisions addressing the delivery of realistic and targeted training, anywhere and anytime. Again, the SOSCOE is at the heart of the capability. The integrated information-sharing environment will make it possible to meet all training needs, from individual Soldier training to large scale collective exercises, while participants are seated in their vehicles or a tactical command post (TACP), or in high fidelity networked training venues known as networked reconfigurable full task trainers (NRFTT). This training capability will take advantage of technologies such as massive database systems, bi-directional reach (both accessing and sending needed information), sophisticated self-learning search engines, performance support systems, computer-generated forces (CGF)–simulated conditions and participants powered by artificial intelligence (AI), and super-broad bandwidth, to allow Soldiers and leaders to get the training they need at the exact moment that they need it.

The capability to provide this type of training is referred to as an *embedded training capability*. Unit members will be participating in training while they are seated in the vehicles or at the workstations in the TACP, and they will be using the system controls and interfaces while they are in training, just as they would operationally, and the training content will be presented through those interfaces. That method of delivery and point of participation is what makes the training *embedded*. The capability is so critical within the FCS development plan that it has been designated as a Key Performance Parameter (KPP) for acquisition of the FCS family of systems.

That, at least, is the plan and the vision. It is more than a little ambitious, depending as it does on the use of technologies that are not yet mature or even, in some cases, much beyond the drawing boards. For individual training, the delivery will closely resemble computer-based instruction or web-mediated instruction. For collective training, where unit members may be located on opposite sides of the country or the globe, delivery of exercises presents a much more complex picture. Yet, with designation as a KPP, the embedded training capability has become non-negotiable: it *will* be realized. In one form or another (yet to be fully comprehended),

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[1] Appendix A contains a list of the acronyms and abbreviations used in this report.

[2] Think of it as Windows® on steroids, where you can pull and push products from all of the applications—Microsoft® (MS) Word, MS Excel, Adobe PhotoShop, and so on—with no apparent translation machinations and complete reliability and accuracy. Then multiply that by about a hundred. That is a pale imitation of the envisioned SOSCOE capability.

training will be delivered to unit members in their vehicles or TACP workstations, through the normal user interface, as they use system controls. In some fashion, all training will be available anytime, anywhere, and that includes on the vehicles.

This reality (or vision foreshadowing reality) gives rise to a training management imperative: The issues associated with management of future training must be identified, examined, and addressed in parallel with the design and development of the systems that will provide future training. The system capabilities are being designed now, and the recognition of issues and formulation of approaches for the efficient and effective use of embedded training capabilities is essential. This will be a continuing task for integrated teams of training design experts, engineers, programmers, modelers, and military experts. The unique role for the training designers and researchers is to clearly identify the issues and apply relevant research and development (R&D) experience to defining resolutions from the training management perspective.

To that end, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) sponsored research to identify the issues associated with the management of collective training for Future Force Soldiers, leaders, and units, and to design a detailed approach for that training management. Of particular interest was the way that future embedded training could be adaptable—amenable to changes in response to training needs, with minimal programming or laborious administrative effort. In the course of that research, a host of other issues surfaced related to training management, issues that recognize the way in which training is a part of the larger system of Army and Department of Defense (DoD) operational requirements and human resource management.

This report is the product of the research. Its purpose is to describe issues and recommendations related first to providing adaptable training, and then also to management of training in the future, when FCS, embedded training (ET) capabilities, and a full range of personnel management tools are the norm for daily operations. The report also discusses research issues and procedural questions that will need to be addressed in order to provide effective and efficient training for the Future Force.

The report first discusses the issues associated with management of future training (as well as some of the non–issues) and related current and emerging Army initiatives, FCS documentation, and previous ARI research findings. The concept for a future training management system is then described through use cases. We then present a set of detailed recommendations, including priorities, “fall-back” solutions for near– and long–term development, and directions for further research and development in both training and technology realms.

Issues Associated with Future Training Management

For about the past 10 years, large-scale collective training events have come to be closely associated with (and even confused with) the training support packages (TSPs) that make conduct of those exercises possible. In general, the term “training support package,” or TSP, refers to all of the information and products that would allow a structured, scenario-based

exercise to be conducted with some degree of standardization. The U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 350-70-1 (Department of the Army [DA], Headquarters, 2004) defines a TSP as, "a complete, task-based, exportable package integrating training products, materials, and information necessary to train one or more critical tasks" (p. 65). Scrupulous use of a well-constructed TSP ensures that realistic and doctrinally correct situations are presented, training objectives are addressed, appropriate observations and assessments are made, and targeted feedback is given to the participants (Campbell, Campbell, Flynn, Sanders, & Myers, 1995; Gossman, Graves, Mauzy, & Clagg, 2001). When we refer to TSPs in this report, we do *not* mean the training event itself, or a broad program of unit training—we mean the package of material that enables conduct of the training, whether packaged in digital text and graphics files, on paper, or in some futuristic automated system.

Ten years ago, TSPs were almost entirely packaged as printed text on paper. As embedded training capabilities loom, however, there is widespread recognition that that approach must change. In a recent report that synthesizes much of ARI's research on TSPs for collective training, Burnside and Throne (2004) identified five distinct capabilities that embedded training systems must provide. These include:

- rapid tailoring or modification of training events based on the users' needs, performance, and choice;
- bi-directional reach to and from remote knowledge centers to obtain updates or to access and exchange additional products;
- a simulated operating environment that has the capability to address all aspects of the training environment that are not physically present (e.g., terrain, enemy, other friendly units, unit personnel), and must therefore be represented synthetically;
- semi-automated performance measurement for assessment and feedback; and
- pretests or selection criteria for entry into a training event, based on identified individual and collective performance weaknesses.

The capabilities described by Burnside and Throne (2004) cannot be incorporated as features of individual self-contained TSPs that support defined training events, even if the TSPs migrate from paper to electrons. They will only be achieved through the framework of a training management system that integrates the tools and allows them to operate in concert with the individual TSPs. The five capabilities are intertwined and thus will require a powerful training management system that draws on information resources outside the separate TSPs to adapt training events, access information in various repositories, simulate various combination of conditions, measure and assess performance, and evaluate training readiness and achievement.

In formulating a conceptual description of the future training management system, we began by listing out the issues. Our initial set was eventually reduced to a critical set of five:

1. What will future training development and delivery be like, given the technologies and mandates?

2. What kind of information and tools will training managers and exercise controllers need?

3. How will the information and tools be provided (or obtained, or produced)?

4. What kind of tools (i.e., how much automation) will the training managers accept?

5. For tools and capabilities that are far off in the future, what are the near-term solutions?

These five topics form the organizing construct for this report. This section presents a summary of our understanding of the five issues, as well as a short discussion of topics (referred to as non–issues) that have already been recognized and addressed and should no longer be issues of major concern.

What Will Future Training Development and Delivery Be Like?

Without a crystal ball, we can still construct a somewhat cloudy vision of the training development and delivery of the future. A primary source of information is the documentation that emerges from the FCS design efforts, and particularly from the FCS Training Systems Integration Integrated Product Team (IPT). The premise for future training, described in the Training IPT's *Training Management Plan,* is that collective training must be available on demand and will be delivered by means of embedded training capabilities.[3] Our understanding of the functioning of future training was shaped by examination of the Training IPT work and other products from FCS teams who are working on training issues. The subsections below provide short reviews of several areas of FCS R&D:

- Requirements analysis for FCS Training Common Components (TCC).

- Software services supporting FCS battle command.

- Training roles, both human and automated.

Requirements Analysis for FCS Training Common Components. The Training IPT is working with the Program Executive Office for Simulation, Training, and Instrumentation (PEOSTRI) to define the basic software components that will support embedded individual and collective training. The initial baseline in creation of these TCCs was derived from software capabilities developed through Army-sponsored programs. In an analysis of requirements for

[3] The *Training Management Plan* (FCS Training Systems Integration IPT, 2005) is classified by Boeing and SAIC, the FCS Lead Systems Integrator (LSI), as Distribution D - Distribution authorized to the Department of Defense and U.S. DoD contractors (Administrator or Operational Use). Those wishing to view the plan should contact the LSI. Additionally, a more detailed version of this report, which would also be classified as Distribution D, was prepared for ARI.

software components that will support training, a number of tools and functions are described.[4] The definitions and the longer descriptions conjure up a rich descriptive picture of embedded training capabilities. However, they are at this stage very general and largely from the point of view of the system, not the human user.

Battle Command Software Services. Additional FCS design information is found in descriptions of the Battle Command Software Services (BCSS).[5] Like the TCCs, these services are applications that are available through the SOSCOE. The descriptions of the services and subservices (the features and capabilities of each) are not constrained by considerations of what is possible today. Neither are they yet very specific in how these services will be provided. However, as noted by Mauzy, Flynn, Dannemiller, and Gossman (2003), services and systems that support performance during operations should also be incorporated in training. This is more than a matter of "train as you fight." In fact, such performance support services can also be useful in designing training events and constructing TSPs as well as in conducting the *training*.

Human and Automated Training Roles. In addition to descriptions of software services and components, the human role in future training is being defined. The definition of training roles is seen as essential for FCS software developers to understand the needed features and capabilities of the embedded training systems, as well as the demands that will be placed on the SOSCOE. A role is not a duty position, nor is it inextricably linked to any particular duty position. Rather, on any given day, one of any number of individuals, from platoon leaders to battalion commanders and staff, could be designated to perform the role. In general, the functions currently performed by humans that will require assignments in the future include:

- a training manager, who makes decisions about what training will be conducted;
- an exercise controller, who actually monitors and directs a training exercise; and
- a CGF operator, who controls the behaviors of entities in simulation.[6]

The still-evolving working definitions contain considerable detail on the specific actions that would need to be performed. A notable feature is that, at this point in time, the roles are fully anthropomorphic, that is, expressed as though performed by humans. Given the rapid advances being made in the use of broadband networks, complex databases, intelligent agents, and collaborative tools, many of the activities that are at present assigned to humans should eventually be relegated to automated systems. This is not a startling insight, nor inconsistent with expectations of the Training IPT; it merely reflects the difference between realistic near-term planning (for the 2012-2016 timeframe) and more fantastic long term aspirations.

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[4] The *Requirements Analysis for FCS Training Common Components* (FCS Training Common Component Technical Integrator, 2004), describes the planned software assets. The Requirements Analysis has not been designated for open distribution. Those wishing to view the analysis should contact the LSI.

[5] Descriptions of the Battle Command Support Services are still under development and have not been designated for open distribution. Those wishing to view descriptions should contact the LSI.

[6] Definitions of the roles and their specific responsibilities are still under development and have not been designated for open distribution. Those wishing to view descriptions should contact the LSI.

The FCS Training IPT has made impressive progress in translating the FCS Operational Requirements Document ([ORD] Unit of Action Maneuver Battle Laboratory, 2002) into increasingly detailed descriptions of services and human roles, so that engineers, programmers, military experts, and training experts can have a common understanding of the necessary design and development products. The FCS documentation is convergent overall, with only minor inconsistencies that are likely an artifact of semantics rather than internal conflicts or gaps in planning. Although the design and development, and the documentation itself, are still works in progress, the degree of convergence suggests that the information is reliable and sufficiently mature to serve as the basis for further analysis.

Armed with those descriptions of the FCS operational and training system requirements, technology services, and roles of humans interacting with services, we formulated informal use cases that portray the training development/delivery/management system in operation. As the Training IPT continues its efforts, we expect that they will further explicate the descriptions into specific elements by means of detailed, formal use cases. Our initial version of these products is contained in the next major section, following discussion of the other issues.

What Kind of Information and Tools Will Users Need?

Among the users and uses that were culled from review of the various products and think pieces, the following (broad but not particularly deep) descriptions of users and uses emerged:

- For individual Soldiers (including everyone from the Private to the Command Sergeant Major, from the Second Lieutenant to the General Officer) who are interested in their own training—the capability to see what training they have completed, what training they could do next, and what opportunities are available for those requirements; a way to sign up for or schedule individual training; options for additional non-required individual training.

- For unit leaders and their staffs—the capability to view data on individual and unit readiness and plan further training by reviewing training completed, progression specified in their Combined Arms Training Strategy (CATS), and opportunities are available for training; tools to modify their CATS as their missions change; a way to sign up for or schedule unit training; options for additional non-required training.

- For training facility managers—tools for monitoring use of live training areas, constructive/virtual simulation facilities, and NRFTT sites, reviewing and adjusting schedules with unit leaders, scheduling routine or situation-driven maintenance of their facilities.

- For organizations engaged in training and doctrine development—the capability to monitor currency and quality of training materials and training support packages, make any necessary updates with very short turnaround time, provide rubrics on skill decay, prepare and incorporate optimal schedules for refresher training, construct baseline tables of organization and equipment (TO&E) training strategies (e.g., CATS) and formulate options within those strategies.

- For personnel managers—the ability to monitor individual training opportunities and availability by means of both regular and on-demand reports of fill rates, seats available, requirements for training; the capability to forecast training availability through "what if" simulations; tools to optimize personnel assignments based on proficiency; tools to monitor completion of required training and professional development for promotion purposes.

The first three of those users and uses concern planning and scheduling of training. The fourth one, referring to the process for making prepared training modules and TSPs available for users, clearly belongs under training management as a sort of planning function, although it is decidedly different from the first three. The last one addresses use of archived training data for non-training purposes, and is only tangentially a training management concern. Although these requirements address a number of uses and users, they should be seen as parts of a single multipurpose system: all of the functions described above are intertwined and will need to share information.

Conspicuously missing in those discussions and plans is a description of how the training of the future can be provided anytime, anywhere, and how to make it readily adaptable by Soldiers and units, as described in various ARI research products (e.g., Campbell & Holden, 2001; Gossman, Flynn, & Breidenbach, 2004; Throne & Burnside, 2003). Thus, another use was noted:

- Additionally, for individuals, small groups, and units—a means for on-demand delivery of training, over the (future) network, as interactive multimedia instruction, small group instructor-led instruction (synchronous or asynchronous), small group multiplayer exercises, or unit collective simulation-based exercises; facility for producing tailored exercises and accompanying TSPs to target specific tasks, scenarios, and participating individuals or units; capability to modify existing exercises quickly (even "on the fly"); support for conducting training with less than full unit participation; automated data archiving; facility for leaders to modify training events and annotate archived data for unit needs.

All of these users and uses have a vested interest in the training management of the future. However, our primary focus in this effort is on collective training—development, delivery, feedback, and data archiving. Thus, the uses and users of interest are the unit leaders planning collective training and the units participating in adaptable collective training. The use cases described in the next major section were based on these initial descriptions.

How Will the Information and Tools be Provided?

The emerging FCS documentation, some of which was described above, gives a general overview of what software services are being planned to support training development, delivery, and management. The description begs the question of where the information that those services use will come from. Several prime sources are likely candidates, including the Army Training Information Architecture (ATIA), the Common Training Instrumentation Architecture (CTIA), and the Unit Training Management Component (UTMC; sometimes referred to as the Unit

Training Management Configuration). These are large, complex database systems that contain doctrinal information about individual and collective tasks; unit information such as their CATS and Mission Essential Task List (METL); individual and unit training history; linkages to other databases that permit scheduling and resource planning; and semi-automated tools to assist training personnel in managing the information for their own training needs. Clearly, one expectation is that the extensive research and development that has already been focused on tools for training management should not be scrapped.

The resources that we examined yielded descriptions of a core set of databases that may serve as the source for future training management. Most of the effort is focused on immediate and near-term solutions, designed to address the frustrations experienced today with the technologies available today. Nonetheless, four database systems seem likely to be useful for Future Force training, as they are now (or should be in the near future) for Current Forces. They are described briefly below. As concerns tools, some of those are integral to the database systems. Others, though, will make use of highly realistic AI and CGF. A brief summary of the current and emerging developments on AI and CGF is also presented below. The ensuing discussions address:

- the CATS program.
- the Digital Training Management System.
- the Army Training Information System.
- the Defense Integrated Military Human Resources System.
- advances in CGF and AI.

Combined Arms Training Strategy. One such initiative is the CATS program, the Army's overarching strategy for current and future training of the force. Its basis is a series of branch-proponent unit and institutional strategies describing training events, event frequencies, and resources required to train to standard. These strategies describe how the Army will train the total force to standard through self-development, institutional training, and in units. They also document the quality of and justification for all training resources required to execute the training. The automated CATS module (currently a part of the Automated Systems Approach to Training [ASAT]) allows training developers to produce individualized training strategies using automated tools. It identifies training events using a crawl–walk–run training methodology; provides a conceptual training calendar that lays out the training events under perfect training conditions; and outlines the recommended number of times tasks should be trained during one training year based on an interval that considers key personnel turbulence, skill decay, mission changes, and task complexity. For every training event, there are details that outline the purpose, outcome, recommended training audience, means (including training aids, devices, simulators, and simulations, or TADSS), estimated event duration, critical training gates (i.e., prerequisite training or readiness criteria), and execution guidance.

Digital Training Management System[7]. A promising tool that builds on the information found in the CATS is the Digital Training Management System (DTMS). The DTMS is a customized commercial-off-the-shelf (COTS) product provided by nFocus Software®. An Information Paper describes the system as "…a user-friendly web-based unit training management system for units at all levels to track and manage their unit training … [It is] optimized to support unit training management from company to brigade level" (Collective Training Directorate, 2005a). Through the DTMS, unit leaders and trainers can detail the unit's METL, personnel, and modified tables of organization and equipment (MTO&E); view CATS and schedule training; review training assessments and after action reviews (AARs); and both examine and add to a library of references. According to the DTMS training site (Collective Training Directorate, 2005b), it is (or is going to be) linked in real time to a host of other databases, including:

- Personnel systems (e.g., EMilpo–Electronic Military Personnel Office, ITAPdB–Integrated Total Army Personnel Database, SIDPERS–Standard Installation/Division Personnel System),

- Training facility and resource systems (e.g., RFMSS–Range Facility Management Support System, ATRRS–Army Training Requirements and Resources System, TAMIS-R–Training Ammunition Management Information System-Redesign, TESS–Tactical Engagement Simulation System), and

- Task and training information systems (e.g., CALL–Center for Army Lessons Learned, ATIS–Army Training Information System, ITRS–Individual Training Readiness System).

Army Training Information System. As it turns out, the DTMS is subsumed under one of the systems that are shown as a supporting database: the ATIS, which is overseen by TRADOC's Army Training Support Center (ATSC). The ATIS is "…a system of systems that brings together myriad functions in one comprehensive Army training system. [The] ATIS uses the [World-Wide Web] to access an all inclusive digital library and data repository through a suite of software applications including: training development; individual training management; unit training management; and common core services available to all through the Soldier Training Homepage" (Total Army Distance Learning Program [TADLP], 2005). Functions and information currently found in ASAT, such as task analysis products, are to be migrated to ATIS (TADLP, 2005).

The key software applications of the system are (or will be):

- Training and Doctrine Development Tool (TDDT)—used by the training development community to create and develop the source doctrine and training materials required to develop training products.

[7] The "Digital Training Management System" (DTMS) is a database product that satisfies most, if not all, of the requirements for the UTMC.

- Army Learning Management System (ALMS)—delivers standardized individual training to Soldiers, providing a fully automated, seamless and web-accessible training and education network; provides users a common "tabbed" start page from which they can access the other configurations, materials in the Reimer Digital Library and Common Core Services of the data repository.

- The UTMC—provides the functionality to analyze, manage, plan, conduct, evaluate, and provide feedback on unit training and is, in fact, the defining requirement for the DTMS.

Defense Integrated Military Human Resources System. To round out the picture, there is an even more overarching system: The Defense Integrated Military Human Resources System (DIMHRS). The DIMHRS is a congressionally-mandated program which crosses all military services. It consists of three functional areas, named Personnel and Pay, Manpower, and Training. Its origins are in a realization that each military service (Army, Navy, and Air Force) has had separate systems, which comprise over 160 documented redundant systems, databases, and interfaces—and that was only for personnel and pay functions. This resulted in significant gaps in personnel management, including the inability to track active and reserve status changes, account for personnel in theater, maintain consistent service records, and ensure adequate security of personal information. As envisioned, DIMHRS will provide real-time accurate information to Soldiers, human resources professionals, and commanders from non-redundant databases.

The personnel and pay functions have been captured in the subsystem of DIMHRS known as the Enterprise Human Resources System, which is now in initial fielding beginning with the Army and to be followed by the Navy and Air Force. Attention has turned to the manpower function, and the training function will follow. Examination and needs/gap analysis of CATS, DTMS, ATIS, and all of the systems and interfaces to which those programs are linked should prove to be an interesting and informative exercise. At this point, there is little information available about the purpose or goals of the training subsystem.

It is apparent that training management systems are on the minds and drawing boards of many Army and DoD decision-makers. Yet these are not the visionary designs that will push technology development to address future needs. Advocates of CATS, DTMS, and TDDT will point out, accurately, that users can construct programs of instruction and exercises, using the tools provided. This is not the same as obtaining training support on-demand—that is, with a minimum of training developer manipulation of database information. This point will be discussed more fully in the next section. As of today, ATIS is probably the prime candidate for addressing the needs for training management. It may someday be absorbed into DIMHRS, but at this point it has at least some functionality, while the training component of DIMHRS has not entered the analysis phase. According to the ATIS proponent, the ATSC, ATIS will provide the architecture to allow personnel, resource, training and doctrine development, and other applications to be able to cross-reference and interact with one another (TADLP, 2005). It is intended to be the overarching tool for integrated training management.

Computer-Generated Forces and Artificial Intelligence. Two related aspects are involved in considering CGF progress: the visual representation and the behavioral representation. The visual representation, as the name suggests, refers to the apparent realism of objects in simulation, which is conveyed by physical details, shadows, and perspective that change to correspond with the point of view of the person viewing the simulation. Behavioral representation refers to how objects move and react to movements of other objects. For humans, for example, it includes walking and running, moving around obstacles, turning around to look at or listen to things, falling when hit with a killing projectile (e.g., a bullet). For vehicles, the behavioral representations include speed of movement over various terrain types, blowing up when hit by a missile, and blowing up differently when an improvised explosive device (IED) goes off. Buildings and other terrain features don't move, but they do show different effects when damaged in different ways. It is in consideration of behavioral representation that AI enters the discussion, as a way to more accurately and quickly portray the behaviors.

The areas of CGF and AI (and a related area, human behavioral representation) are not new. However, despite unrelenting theorizing and developments, they continue to be important topics for researchers. Conference schedules for gamers, military system developers, and medical training experts (among others) are heavy with papers and presentations on faster and more realistic techniques, processes, and applications. Review of the topics of recent CGF-related research and presentations, all of which allude to the use of some form of AI, demonstrates the relevance of ongoing CGF and AI R&D to ET delivery. A sampling of those topics includes:

- Use of Performance Measurement Objects (PMO), which represent actors, behavioral data, and measurement methods and support the real-time requirements of intelligent agents, human observer/instructors, and distributed performance assessment processors (Stacy, Freeman, Lackey, & Merket, 2004).

- Standardizing CGF behaviors so that composite behavior developed for one simulation can be reused in another, by having the composite behavior make reference to primitive behaviors that are functionally equivalent in the two simulations (Gerber & Lacey, 2004).

- Formalized behavior models for CGF entities that allow quick creation of new behaviors and multiple variants and easy modification of existing behaviors (Stottler, Lackey, & Kirby, 2004).

- Integrating physics-based damage effects in real-time urban simulations to represent the visual aspects of damage and permit calculation of the extent of damage and personnel casualties (Mann, York, & Shankle, 2004).

- Use of dynamic procedural tactics, wherein AI tailors tactics to the situation and terrain at hand using on-the-fly algorithms and dynamic inputs (Straatman, van der Steeren, & Beij, 2005).

- Methods for determining line-of-sight in complex simulated environments (University of North Carolina at Chapel Hill, 2005).

Visual representation is already very good, especially for objects (as opposed to people), and continues to improve. Behavioral representation also continues to improve with respect to every aspect of a virtual simulation—natural and man-made terrain features, vehicles, humans and animals, and munitions. In trying to extend virtual simulations to distributed training, the implementation of realistic behavioral representations is frequently brought up short by considerations of bandwidth.

In practice, AI is more distinct from CGF than CGF is from AI—that is, there tend to be more scientific papers and presentations that address AI apart from CGF than the converse. Still there exists some confusion regarding the definition of AI. According to the "Artificial Intelligence Frequently Asked Questions (FAQ)" website (Crabbe, Dubey, & Kantrowitz, 2004), the phrase is so broad that people have found it useful to divide AI into two classes: strong AI and weak AI. Strong AI makes the bold claim that computers can be made to think on a level (at least) equal to humans and possibly even be conscious of themselves. Weak AI simply states that some "thinking-like" features can be added to computers to make them more useful tools (e.g., expert systems, drive-by-wire cars, speech recognition software) Subtopics within the realm of AI include both problems and solutions:

- Automatic programming—the task of describing what a program should do and having the AI system 'write' the program.

- Bayesian networks—a technique of structuring and inferencing with probabilistic information (part of the "machine learning" problem).

- Knowledge engineering/representation—turning what we know about a particular domain into a form in which a computer can understand it.

- Machine learning—programs that learn from experience or data.

- Natural language processing (NLP)—Processing and (perhaps) understanding human ("natural") language. Also known as computational linguistics.

- Neutral networks (NN)—The study of programs that function in a manner similar to how animal or human brains do.

- Planning—given a set of actions, a goal state, and a present state, decide which actions must be taken so that the present state is turned into the goal state.

- Speech recognition—Conversion of speech into text.

- Visual pattern recognition—The ability to reproduce the human sense of sight on a machine.

These are the very capabilities and technologies that will be needed to support simulation-based training, as will be shown later. The technologies are not just theoretical; they are being used broadly today for such developments as:

- Financial software, which is used by banks to scan credit card transactions for unusual patterns that might signal fraud.
- Applications of expert systems/case-based reasoning to create a computerized leukemia diagnosis system that does a better job checking for blood disorders than human experts.
- Machine translation software, developed in the 1970s, that translated natural language weather forecasts between English and French.
- Deep Blue, the first computer to beat the human chess Grandmaster.
- Physical design analysis programs, such as for buildings and highways.
- Fuzzy controllers in dishwashers, clothes dryers, and other common appliances.

Even with a very shallow understanding of CGF and AI, it is obvious that much has been accomplished and much remains to be done. However, the possibilities are directly relevant to the planning for adaptive training management.

This information on current and near-term-future database systems and CGF/AI was used in formulating the use case analyses described in the next major section.

What Kind of Tools Will Training Managers Accept?

The FCS documentation and database initiatives described above present a curious mix of automated tools and human intervention. While the FCS technologies will likely be able to take over much of the time-consuming effort of planning training events and preparing TSPs, most of the documentation still indicates that the Training Manager or Exercise Controller will prepare tactical materials for the TSP, make decisions about scenario events, determine initiating conditions for the exercise, control enemy and other friendly forces during the exercise, and prepare and deliver the AAR. The capability for systems to do the work for individuals may not mean that individuals—especially commanders—will be willing to relinquish control of their training events. This is more than a matter of job protection or mistrust of systems' abilities to do as well as humans (although there may be some of that). It is at least partially the very proper responsibility that the commanders feel for the training of their units and unit members, and the accountability for readiness to their higher-ups. It may also be a lingering reluctance to lose hands-on control—and this is the same danger that commanders encounter in all of their networked operations: they have the capability to micromanage, and the appropriate balance between knowing and controlling continues to be an issue.

In the next major section, where the use cases are expounded, we have chosen the route on which the commander trusts the system completely to make many of the decisions in planning, preparing, and delivering the training, but also has considerable freedom to tweak the parameters of a training event.

What are the Near-Term Solutions?

This is the crux of the matter. Given the current status of work on FCS, the timeline for FCS development and production, the current and emerging initiatives, and the pace of technology development, it will be important to forecast the likelihood of actually realizing the plans for collective training using ET capabilities. This issue and some possible answers will be discussed and presented in a later section, titled "Issues and Recommendations."

Non–Issues

We also identified a number of decision and planning points that have either already been addressed or that are, in the long run, relatively unimportant in determining the scope and structure of future training management. However, because they contribute to our understanding of the issues by helping to restrict the scope, we describe them briefly here. They include:

- What will the different kinds of training be? All of the FCS documentation refers to simulation–based training, individual interactive courseware (ICW) or interactive multimedia instruction (IMI), and interactive electronic technical manuals (IETMs). Our specific concern here is collective training—that is, simulation–based. The simulations are more specifically characterized as live, virtual, or constructive, or some combination. With embedded training capabilities, distinctions between live, virtual, and constructive will blur even more than they do today, and all exercises will necessarily be a combination. The more pertinent question concerns whether the training be conducted on the FCS platforms completely in training mode (stationary) or somewhere else? The "somewhere else," which may include the NRFTT or moving (live) FCS vehicles, requires additional resources that the embedded training system cannot itself supply, which requires some additional coordination.

- How will the training products be adapted from embedded training versions to run on NRFTT or other means of delivery? They won't. Everything will be constructed in such a way that the various systems are entirely compatible. The embedded training system that works for the FCS platform will work in exactly the same way for NRFTT, desktops, personal digital assistants (PDAs), and other devices, at least as far as the transmission of electrons is concerned.

- Who will be the human training manager (HTM)? As described earlier, the training manager role will be assumed by different people, including unit commanders or members of their staffs, for different training events. While that decision may be reversed someday, it is a reasonable course of action, given the fact that commanders are in fact responsible for unit performance. The two other roles—exercise controller

and CGF operator—should eventually be very minor roles as the automated training management takes over those functions.

- How will the HTM have time and expertise to build the training event and the TSP? Given the projected sophistication of the FCS software services and other performance support systems, the HTM would need very little in the way of formal knowledge of how to construct the training, but would need to understand the unit's training needs and have a normal complement of tactical and operational expertise.[8]

- How will the HTM know what to train? Currently, task information is found in ASAT and decisions on what to train are based on the unit METL and estimates of readiness. In essence, that process will continue, although automated tools should make the information on optimal training schedules and current unit proficiency more available and more accurate. The task information will have been upgraded and migrated to ATIS.

- How will the HTM get the latest training information and content onto FCS platforms? The SOSCOE, with networked links back to databases and repositories and the Home–Station Operations Center (HSOC), will access the information when needed. Separate versions will not be resident on individual FCS platforms.

The Future Training Management System (Concept)

The vision for future management of training is for the most part being painted with a fairly broad brush. In order to develop a concept for future training management, we brought together the preliminary findings on FCS training designs, information and automation needs, available tools and databases, and commander preferences, and used the assembled information to paint the more detailed picture. We focused on collective training, following it through the full process of analysis, design, development, delivery, and evaluation, as defined by the Army's *Systems Approach to Training* in TRADOC Regulation 350-70 (DA, 1995).

Our process is described below, followed by a description of the interim and final conclusions.

Method

We began with a use case approach to identifying training management issues and describing the training management system of the future. Our assumptions concerning the available technologies were very optimistic (and were stated earlier): massive database systems, bi-directional reach, sophisticated self-learning search engines, performance support systems, CGF–simulation of conditions and participants powered by AI, and super-broad bandwidth. Not all of these are likely to be ready for use by the time the FCS is fielded (around 2016-2020). Nonetheless, we posited these capabilities.

[8] We would say "a *full* complement of tactical and operational expertise" except that that would obviate some of the need for training.

Using the information gathered and reviewed, we prepared informal use cases for two of the major aspects of training management described above: (1) planning and scheduling of collective training events, and (2) conduct of collective training (including data archiving). These two use cases included the activities described for the three FCS training roles (training manager, exercise controller, and CGF operator) although the correspondence was not specifically delineated. In all cases, the principal figure (the actor) was the human, and the supporting actor was the training management system and interface. By focusing first on the human user, we explored capabilities and features in a user–centric, rather than system–centric, mode.

A note on use cases: We followed the guidance from Larman (2002) in developing these use cases. He describes what he refers to as casual-style "black box" use cases; they do not describe the inner workings of the system, but rather define system responsibilities in relation to user needs. He also suggests a presentation comprising the primary path, with extensions to describe branching or alternate activities. In our use cases, the extensions are shown in brief style, which includes even less detail than casual style.

We then analyzed those use cases to prepare secondary use cases, where the principal actor was the training management system and interface. This had the effect of focusing attention on what actions the training management system should be able to perform and how it will be able to perform those actions, in support of the user. These elaborated use cases are closer to the "fully dressed" format (Larman, 2002).

From secondary use cases, we extracted training management system actions, and organized them according to type of action (e.g., database look-up, report preparation). The product of this activity was a definition of training management system requirements in terms of types of capabilities and features, as well as specific capabilities and features. We then worked backwards to identify critical "what–if" situations, possible workarounds, priorities for development that consider both criticality and realistic development pace, and recommendations.

To make the discussion easier to follow, we will henceforth refer to the future training management system as the *TMS(C)*, which stands for training management system (concept).[9] The principal user of the TMS(C) is the training manager (the unit commander or his designated representative) during planning and development of the training event, and the unit itself during conduct of the exercise. We will use the pronoun "he" when referring to the user, with full understanding that current and future users may be either male or female.

All of the interactions between the user and the TMS(C) will be mediated through the Warrior Machine Interface (WMI), which the user employs habitually to send and receive information. The WMI is the portal for links to a vast array of databases via the SOSCOE. The TMS(C) will have numerous integrated routines to allow it to access, analyze, compile, report, and archive data, and all of this will be completely transparent to the user. The TMS(C) will rarely print anything, although individuals can. Instead, most presentation of information will occur via the user's WMI.

[9] We are reluctant to propose a catchy name and acronym, for fear it will stick and the conceptual description will be thought of as an actual system and begin to take on a life of its own.

Findings—Primary Use Cases

The first use case, covering activities in preparing for a collective exercise (including analysis of training needs, design of the training event, and development of the TSP) is diagrammed in Figure 1. The actual conduct of the training event (including both implementation and evaluation) is captured in the second use case, depicted in Figure 2.

Constructing the two use cases enabled us to identify a number of facts and assumptions about the user and the TMS(C). Those concerning the TMS(C) required further analysis by means of the secondary use cases mentioned earlier. Those concerning the user—commander, training manager, or unit members—were primarily concerned with the decisions that he must make or would want to make, and were entirely derived from Use Case 1 (preparation). These included:

- Type of training—collective exercise (unit or small group) or individual training. (Note: For the remaining considerations concerning the user of the TMS(C), we will follow the thread of collective exercises, not individual training.)

- Training venue—on stationary FCS platforms, in NRFTT, on moving FCS systems using augmented reality, or using other common devices (desktops, Notebooks, PDAs, etc.)

- Level of participation—full or with specified participants absent.

- Preparation activities—conducting prerequisite individual or collective training.

- Thumbprint—multiple opportunities to provide commander's input to tailor the training conditions and AAR, and to annotate the archived data, concerning any aspect of the tactical situation, exercise intensity, scenario events and timeline, discussion points and priorities, analysis of performance data, readiness assessment, etc.

- Level of assistance desired during the exercise—multiple selections including remediate poorly performing Soldiers one-on-one, provide unobtrusive in-stream coaching, perform pause-and-coach, and make in-stream adjustment to exercise conditions to reflect unit proficiency (as opposed to a straight run-through of the exercise with no assistance other than what the FCS BCSS would provide during actual operations).

- Other human support—whether or not to have a live Observer/Controller (O/C) for coaching and feedback.

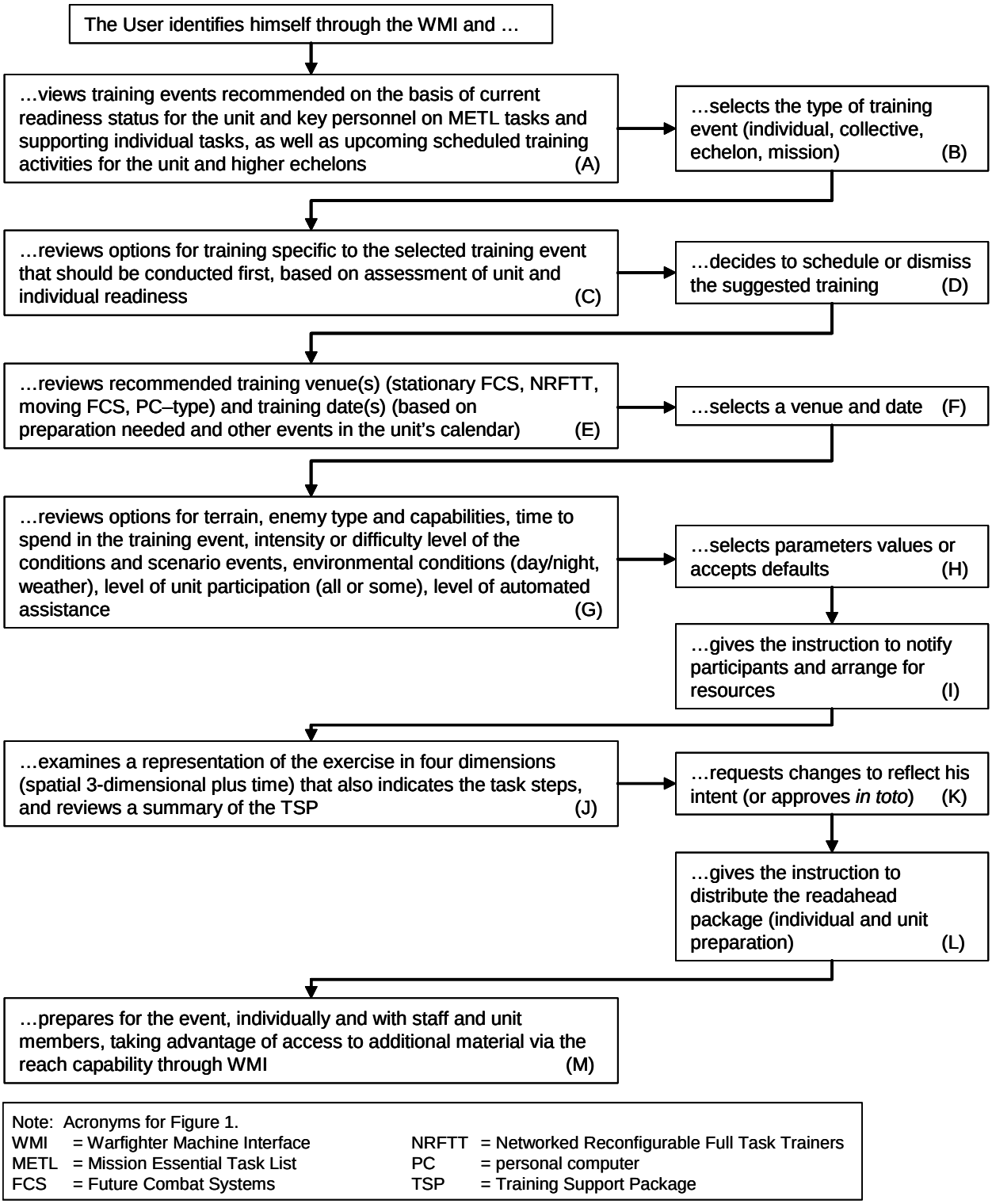


Figure 1. Use Case 1, showing activities of the commander or training manager in preparing for a collective training exercise.

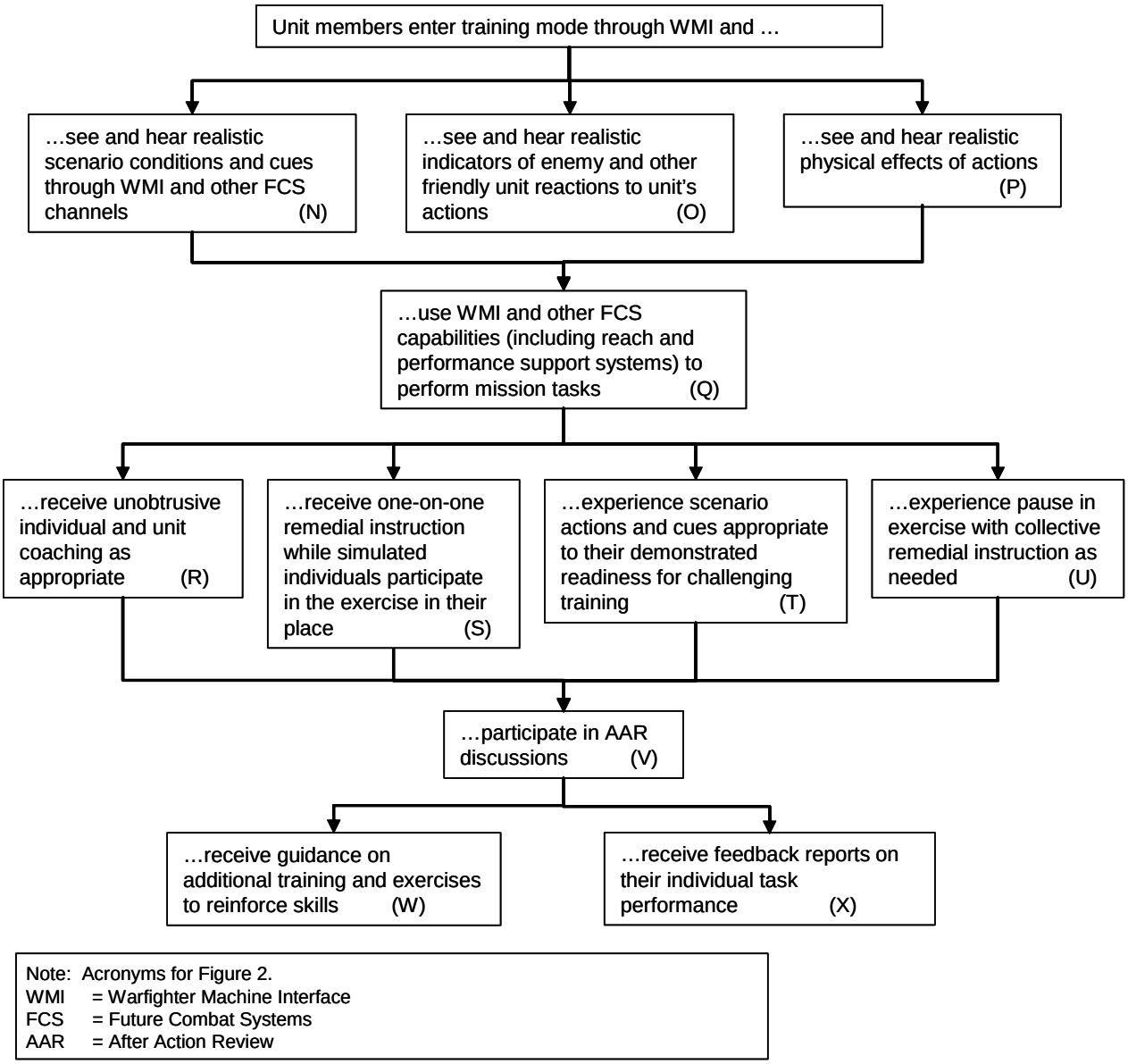


Figure 2. Use Case 2, showing activities of the commander and other unit members during conduct of a collective training exercise.

For each of these decision points, further analysis was needed to determine how the user would make those decisions—what information would be available, what options would be offered, and which decisions could have meaningful defaults. Additionally, the use case glosses over such necessary activities as scheduling, obtaining resources, notifying and assisting participants, and constructing the TSP. The secondary use case was intended to explicate those activities in terms of the performer—the TMS(C) or a human exercise controller.

Interestingly, what Use Case 2 showed us was that the unit members' actions during the exercise were completely focused on reacting to scenario conditions and events and performing their tasks. The description of their activities reads very like a description of actual combat

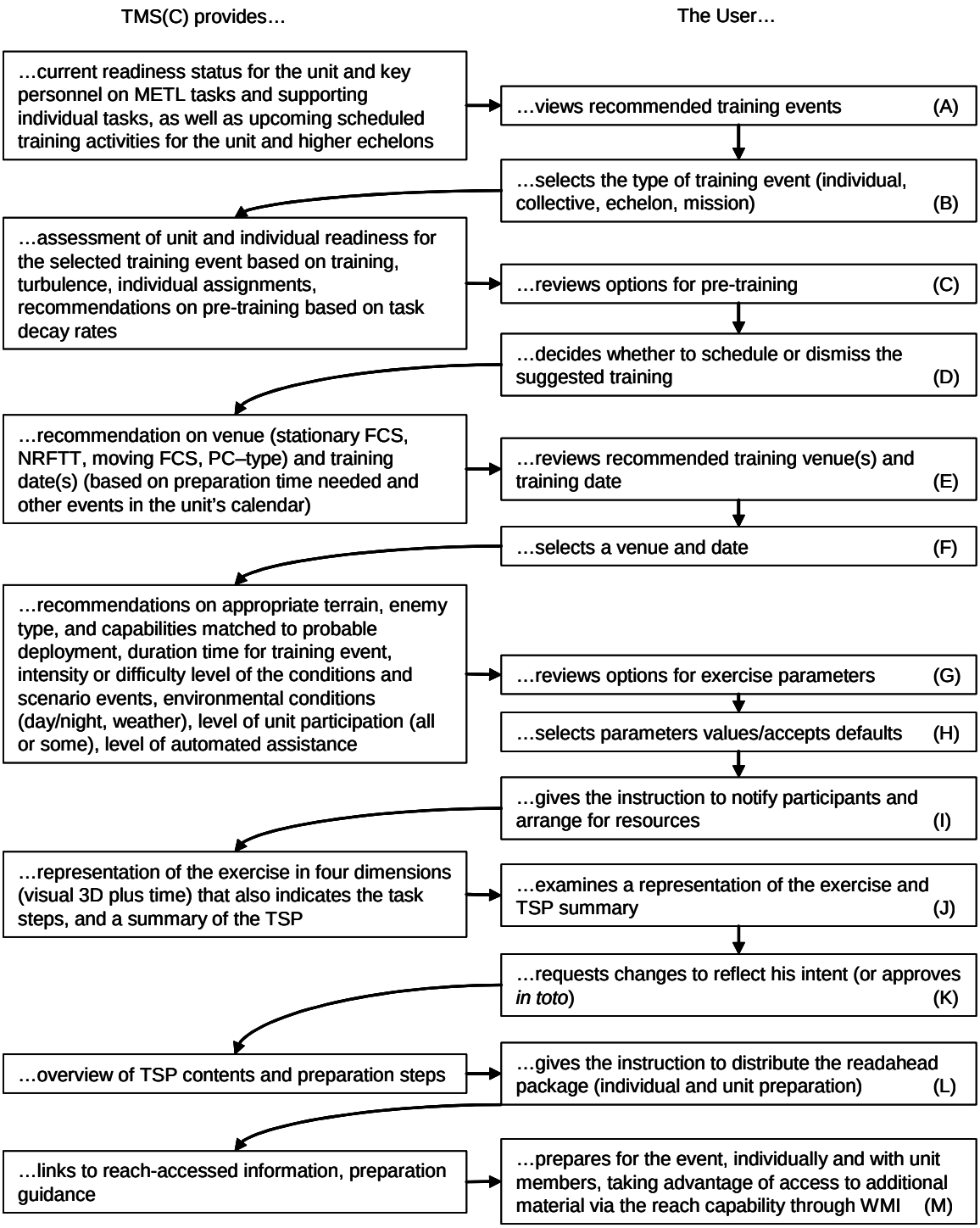
operations. Having all of the scenario conditions and enemy and other friendly unit actions provided from outside the unit is the norm in large–scale exercises. In today's collective exercises, the commander might be consulted on whether to adjust the exercise in mid-stream in response to the unit's ability to benefit from the experience, but this is not usually the case. For Use Case 2, further analysis was needed to determine whether the control exerted from outside the unit would, or should, come from a human exercise controller, CGF operator, or O/C, or whether, alternatively, it would come from the TMS(C).

Findings—Secondary Use Cases

Extending the process used to explicate the primary use cases, we prepared secondary use cases that focused on the person(s) or system(s) that support the commander, training manager, or unit. To the extent that the support comes from humans, there will be a need for tertiary use cases that expand on what those humans need from the TMS(C). As will be shown below, there was rarely a need for human participation, given the mature technologies described earlier. The only real exceptions occurred if, for whatever reason, the commander were to elect to have a live O/C, and in the case of live FCS exercises, where an exercise controller would direct the activities of live roleplayers.

Figure 3 shows the secondary analysis for Use Case 1, development of and preparation for the training event. In the diagrams, the strand on the right represents actions of the user, which is essentially the same as what was presented in Figure 1. The left strand shows what the TMS(C) provides to cue the user or to accept the user's response.

In Use Case 1, much of the support for the user is in the form of data that have been analyzed and formatted to satisfy the user's need for information to support decision-making. In describing where those data come from, we make reference to information available from *the database*. In fact, *the database* will be a number of databases, such as those described earlier, that are linked—that is, able to share information using integrated routines. It will comprise multiple data tables or datasets, elegantly structured so as to minimize redundancy and optimize processing speed. To the user, however, it will truly appear to be one massive set of data. We made the assumption that, because the WMI, the TMS(C), and a host of other interfaces and databases will be completely networked, each of these will be able to export and import data from the others, seamlessly, using integrated routines that provide usable, readable reports or data tables. The interfaces, wizards, and help functions in those systems will be sufficiently well-developed that specialized technicians will not be required to manipulate bits and bytes to enable viewing of usable information.



Note: Acronyms for Figure 3.

TMS(C)	= Training Management System (Concept)	PC	= personal computer
METL	= Mission Essential Task List	TSP	= Training Support Package
FCS	= Future Combat Systems	WMI	= Warfighter Machine Interface
NRFTT	= Networked Reconfigurable Full Task Trainers		

Figure 3. Secondary Use Case 1, showing information flow between the user and Training Management System (Concept) during development of an exercise.

The specific data needs derived from Use Case 1 are shown in Table 1, along with a generic indication of the specific type of database (or segment of a larger database) where the data would be found. In Table 1, the information needs are listed in order by source, so that the type of data from each source is obvious. All of the information needs and types of databases already exist (e.g., CATS, ATIS) except for the scenario repository. In the envisioned repository, the various components of TSPs will be stored as *objects* that can be searched, acquired, modified, and assembled into a logical and coherent TSP with no inconsistencies or loose ends. The TSP components will include those listed in TRADOC Regulation 350-70 (DA, 1995) for collective TSPs, and the specific objects stored in each component table will be derived primarily from user-produced TSPs. Each object will have metatags or hooks that define the ways in which objects can be combined. For example, it would not be logical to have a platoon exercise in which the platoon is expected to engage the entire army of the enemy country, nor to have a brigade-size element sent out to take down a single sniper.

Table 1

Use Case 1 Information Needs and Sources

Information Needed	Source
• Individual training plan, assignments and training history, and current readiness status for commander, staff, subordinate unit commanders	Personnel database
• Individual and staff readiness (task proficiency) for tasks in exercise	Personnel database
• Unit-specific Combined Arms Training Strategy (CATS), Mission Essential Task List (METL), point in life cycle, unit proficiency from previous exercises, unit's scheduled deployments, unit's personnel turbulence history	Unit database
• Scheduled training from unit training calendar	Unit database
• Available window(s) in training calendar with sufficient time for preparation	Unit database
• Geographic location of next likely deployment	Unit database
• Intensity level appropriate to current proficiency	Unit database
• Unit naming conventions and call signs	Unit database
• Recommended training frequency for each unit METL task	Task database
• Prerequisite individual and collective tasks for each task in exercise	Task database
• Recommended venue(s) for tasks in exercise	Task database
• Time required to train to proficiency from current level	Task database
• Exercise specifications for initialization	Task database
• Task performance measures, standards, and steps for after action review (AAR) template	Task database
• Scenario events that will cue task performance or allow for task observation; include in AAR template	Task database
• Training resources by venue	Venue database
• Options for environmental conditions for venue	Venue database
• Mission appropriate to unit type and selected tasks	Scenario repository
• Exercise components that match exercise specifications	Scenario repository
• Segment of selected terrain appropriate for mission	Scenario repository

In every case, the accessed information would be packaged so that it is presented to the user in a form that he can use. In some cases, that packaging will use pre–formatted report or table templates, supported by analytic routines that compare or combine different bits of information. For example, in determining the unit's readiness for an exercise, the information on individual proficiency would be estimated (calculated using a developed algorithm) from records of previous training and recent assignments; the results would be used to look up appropriate training opportunities to satisfy the need; the information on all key staff and subordinate unit commanders would be packaged using a table template; and the table would be presented to the user to show critical training prerequisites by individual.

In other cases, the presentation will be in the form of pick-lists, which will show options for the commander to select. For example, the commander will be asked to decide on the terrain for the exercise, and will have the option of selecting the one most appropriate to his upcoming deployment, or one that allows him to have the unit practice those skills that he deems critical.

The template and option pick list needs identified by means of the secondary analysis of Use Case 1 are shown in Table 2. Review of the items in the list makes it fairly obvious that presenting the information will not be especially difficult—even a COTS product like MS® Access® has tools for reporting database information. Rather, creating the algorithms and analytic routines to transform the raw data items shown in Table 1 and the selected options in Table 2 into information for the reports will be the challenge.

Table 2

Use Case 1 Information Provided to User

Information to be Provided	Form
• Recommended options for unit training, in terms of mission, tasks, terrain, intensity	Option list
• Recommended scheduling and venue(s) options, with description of preparation strategy and resource requirements for venue(s)	Option list
• Options for environmental conditions for venue	Option list
• Options for participation (subordinate units, commanders, and staff); level of coaching (unobtrusive, one-on-one, pause and coach); live Observer/Controller (O/C) or automated observation, feedback, and after action review (AAR); and adjustment of exercise intensity based on unit performance	Option list
• Report on individual and unit training status, readiness to participate in exercise, prerequisite training needs, criticality of each prerequisite, and recommended training strategy	Template
• AAR plan showing training objectives, standards, and general discussion points	Template
• Exercise overview comprising situation summary, training objectives and standards, overview of exercise events, terrain sketch, and control measures	Template
• Observation and AAR guidance for live O/C (as needed)	Template
• Exercise specifications for networked reconfigurable full task trainers (NRFTT) facility manager (as needed)	Template

Finally, for the commander's review of the constructed exercise, the information will be packaged and shown in the form of a 4–dimensional representation (space plus time) that will be labeled with reference to the tasks that are targeted in the exercise. This presentation will have options for the commander to freeze the action, point to particular features, and request changes.

For example, in a platoon exercise, the tools that construct the TSP may have placed a concertina obstacle on a road, and the commander would rather the platoon encounter a suspected IED.

In addition to the needs to find data and present information, there will also be a need to send information directly to other users or systems: exercise dates to the unit training calendar, resource requests to appropriate suppliers, and facility reservations (e.g., NRFTT) to the facility calendar or manager. These are functions that are already available in existing training management systems, such as DTMS. It should be noted that there is no need to send initialization data for the exercise to another system, as the development of those data and the use of the data are both functions of the TMS(C).

The nature of the interaction between the TMS(C) and the unit members during conduct of the exercise, as shown in Figure 4, is quite different from what occurs during development (Figure 3). The TMS(C) will present almost nothing in the form of reports or option lists. During the exercise, much of the information will be in the form of simulated activity to represent the behaviors of enemy and other friendly units, physical effects on battlefield objects, environmental conditions, and the like (shown as Activities N–Q in Figure 4). This will be the case whether the exercise unfolds in accordance with the developed TSP, or whether the TMS(C) adjusts it based on the unit's demonstrated proficiency and need for more (or less) challenging conditions (Activity T). It will also be the case when the TMS(C) needs to simulate the activity of any missing participants, whether that need was identified during development (Figure 3, Activity G) or occurs because an individual is pulled off-line for remediation (Activity S).

The simulated activity will be presented by means of dynamic, physics-based modeling of the entities in the simulated environment. Physics-based modeling allows developers to define the structure and behavioral characteristics of entities (e.g., vehicles, units, physical objects, nonparticipating unit members), in terms of how they move or act and how they react. In the case of physical entities, other modeling will include how they blow apart or collapse when destroyed, how vulnerable they are to different hits (which are also modeled with characteristics), and so on. For the characteristics of human simulations, the modeling will be focused on how they perform their tasks in reaction to a variety of stimuli that, together, appear to define unpredictable situations. These behavioral rule sets will also have defined levels of stochastic reactions to allow for the imperfections in modeling. This will permit the TMS(C) to control the scenario events at a fairly high level, by releasing general guidance concerning events and timing and allowing the entities to operate according to their rule sets within that guidance.

Adjusting the difficulty level of the exercise will be done in one of two ways. As the TMS(C) compares unit performance to standards and determines that the unit needs more (or less) of a challenge, it will search the scenario repository for appropriate TSP components to present the appropriate change. If the TMS(C) locates likely TSP components, it will test them for realism and consistency with the portions of the exercise already completed, modify as needed to match the difficulty level, conditions, and objectives for the exercise, and swap them into its operating plan to replace the existing components. If appropriate TSP components do not exist in the scenario repository from previous training events (see the final TMS(C) activity in Figure 4), the TMS(C) will construct those components from an underlying physics-based model of TSP component elements.

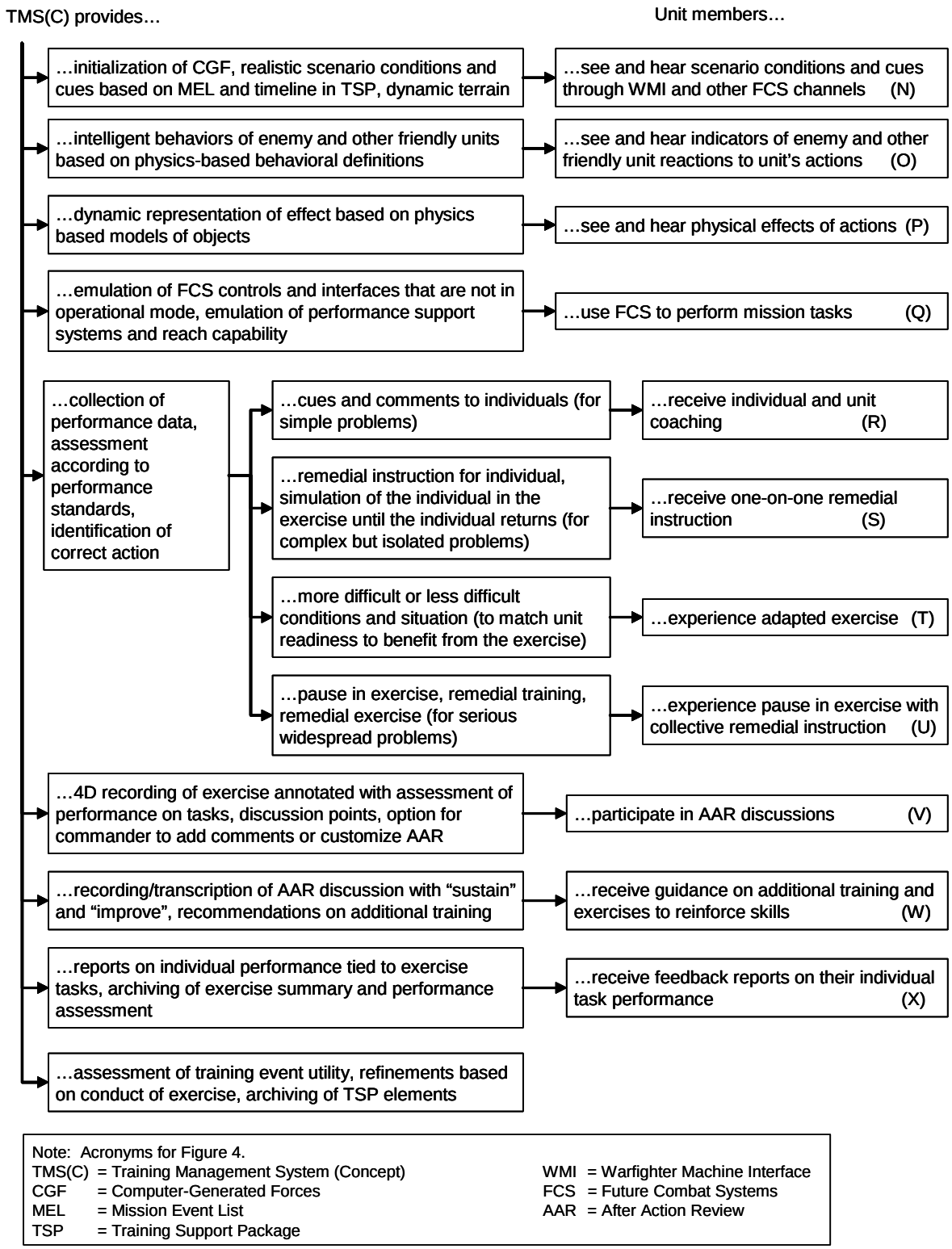


Figure 4. Secondary Use Case 2, showing Training Management System (Concept) activity during conduct of an exercise.

When there is a need for unobtrusive coaching, the nature of the interaction will shift slightly as the TMS(C) presents leading questions or probes that cue the individual unit member to consider particular information or perform particular actions (Activity R). Providing more direct remediation to individuals (Activity S) or activating a pause with directive instruction (Activity U) will put the TMS(C) in the anthropomorphic role of a trainer, giving information and asking questions rather than presenting cues. The AAR will also be conducted by the TMS(C), which will play selected segments of the recorded exercise in 4-dimensional format (3-dimensional space plus time), present discussion points, probe for additional analysis, and capture information on identified strengths and weaknesses.

As with development and preparation for the exercise (Use Case 1), there will be relatively little need for live trainers or controllers. If there is to be a live O/C (selected by the user during development in Activity G), the TMS(C) will provide preparation guidance and in-process guidance for coaching and feedback, and will support the O/C's situational awareness by allowing him to view the exercise from any vantage point and to access collected data about the unit's performance. It will also assist the O/C in preparing the AAR, conducting the AAR discussion, capturing the outcomes, and preparing the report. Discussions of O/C location, either with the unit or remote, will be moot: the capability for distributed training will apply not only to the unit members but also to any observers.

Similarly, even in the case of "live" FCS-based training, where the users are moving their vehicles across real terrain and viewing a combination of real objects (terrain features and each other) and virtual objects (enemy and other friendly vehicles, weapons effects) by means of augmented reality, there will be only a minimal need for a human exercise controller. The TMS(C) will be able to track activities of the live FCS vehicles, and control the reactions and appearance of simulated objects. Whether or not we will entrust safety considerations and control to the TMS(C), or require the vigilance of a live exercise controller, remains to be seen. If there is a human controller, which there would be if live roleplayers were used (for civilians or enemy troops, for example), the TMS(C) will provide streaming guidance to the human controller on directing their activities. This could even be done when the TMS(C) adjusts the exercise intensity.

There are two archiving activities shown in Figure 4, both of which will occur at the conclusion of the exercise. The first concerns recording the exercise outcomes. The TMS(C) will communicate directly with the unit database to record information on unit task proficiency, identified strengths and weaknesses, and recommended next training. Information on individual task proficiency will be derived from the exercise records by use of algorithmic routines, and recorded in the personnel database. These results will then be available to the user when he next plans a training event. Note that no roll-up reports that use the separate data points will need to be stored, as integrated routines can compile the reports as needed. (This relates to the issue of database normalcy.)

The other type of archiving concerns preservation of the TSP for future use. After an exercise is completed, the TMS(C) will make an assessment of the utility of the training event, based on unit performance improvement, robustness of AAR discussions, and general coherence of the TSP components. The commander or training manager will also be asked if the training

event was useful for the unit. For training that is judged as effective and efficient, the TMS(C) will parse the TSP back into its component pieces, update the metadata for pieces that were modified, and archive the new, revised, and unrevised components to the scenario repository.

The Issues and the TMS(C)

The expanded analysis of the two use cases, together with examination of the work already being done on training management for current and Future Forces, allowed us to identify and isolate a number of needs that are already being addressed, as well as some that are not. Recall the five issues and the main discussion points:

- What will future training development and delivery be like? Discussion of FCS planning for software services and training roles was presented.

- What kind of information and tools will the user need? Discussion focused on two situations—unit leaders planning collective training and the units participating in adaptable collective training.

- How will the information and tools be provided (or obtained, or produced)? Four current and emerging Army database initiatives were discussed, as well as a brief review of CGF and AI technologies.

- What kind of tools (i.e., how much automation) will training managers accept? The need for commanders to place a personal imprint on exercises rather than allow a TMS(C) to make decisions and act as the expert was discussed.

- What are the near-term solutions? Discussion pertaining to this issue was deferred to this section.

The picture of future training development and delivery in the use cases is, we think, comprehensible and consistent. However, that picture and the TMS(C) it describes rely heavily on future technology capabilities for the information and tools that the user will need: a complex database system, bi-directional reach, sophisticated self-learning search engines, performance support systems, CGF–simulation of conditions and participants powered by AI, and an upgraded bandwidth.

The future in which that picture can be a reality is a long way off, probably beyond the 2016-2020 timeframe when the first units will be fully equipped with FCS. Fortunately, while the capabilities are critical for the use cases' picture, they are not the *sine qua non* for good training to be available to Future Forces by 2016.

This brings us squarely to the third issue: How will the information and tools be provided? If the TMS(C) depends on technologies that will not be available, then the picture of future training changes. Using the use case explications and our best estimate of the maturity of those capabilities, we formulated interim solutions, as follows (and as summarized in Table 3).

Table 3

Summary of Capability Needs and Research and Development Needs

Capability	Need	Reality	Research and Development Needs
Databases – personnel, unit, task, venue	Easily accessible, with standards and specifications for interfacing with each other; integrated reports and other tools that will make them easy to use.	Already underway (Army Training Information System [ATIS], Defense Integrated Military Human Resources System [DIMHRS]).	Research on data needs, report needs, ways of compiling and analyzing data to produce usable results.
Scenario repository and registry	Tools for developing and archiving multiple versions of each training support package (TSP) component, finding versions of the components with specific characteristics, and combining selected versions of the components to build a TSP; capability to modify components, have modifications cascade through the assembled TSP and effect related modifications, and check the finished TSP product for internal consistency.	Possibility that TSP modification tools can be developed. Unlikely that automated TSP construction tools will be developed.	Repositories and registration of whole TSPs or large–granularity TSP components that can be modified as needed, based on the six Future Combat Systems (FCS) scenarios. Identification of TSP components and possible combinatory rules.
Bi-directional reach	Overarching network that will connect all FCS to each other and to their home-station operations center (HSOC), to support direct point-to-point contact; provide access to databases and repositories, remote observer/controllers (O/Cs), additional information about tactical conditions, and additional TSPs.	Highly likely; network is at the heart of FCS.	Delineation of specific information requirements.
Search engines	Capability that indexes available content and performs intelligent searches; able to "learn" and replicate quickest paths and most usable content.	Likely; still evolving with no end in sight.	Investigation of most useful search engine capabilities and display modes.
Performance support systems, future computer-generated forces (CGF) and AI	Multiple tools (e.g., automated cognitive decision and planning aids, communication and service support aids, collaborative problem solving aids, and tools for terrain and automated pattern analysis).	Unlikely; processes will resemble the current processes, with human training managers, exercise controllers, and CGF operators; performance support systems without CGF and AI are likely.	Automated network-enabled tools to support training manager, exercise controller, and CGF operator.
Bandwidth	Increased bandwidth for real-time presentation of synchronous simulations to multiple distributed participants, with ongoing data collection and performance evaluation, options for observation, and dynamic automated adjustments; reliable security measures and multiple redundancies.	Highly likely; network is essential for FCS, making bandwidth solutions a central requirement.	Research compression techniques and effect on data transmitted; develop techniques and best practices for workarounds.

Database Systems

Given the progress that has already been made with CATS and with early versions of DTMS and ATIS, it is likely that another 10 years will be sufficient to mature the TDDT and DIMHRS. Our guess is that the databases listed in Table 1 for personnel, unit, task, and venue information will be accessible and will have standards and specifications for interfacing with each other. Furthermore, they will have integrated reports and other tools that will make them easy to use for normal people (e.g., commanders, training managers). From a technology and human effort point of view, there is no reason that the databases should not be operational. Considerations of data security are integral to personnel database development and use, and are expected to continue to be addressed. At the same time, it will be important to provide similar safeguards on any systems that use those databases, such as a future training management system.

The scenario repository referred to in Table 1 and Use Case 1 is another matter, somewhat further from maturity. It is, in fact, more than a repository. The need is for a way to develop and archive multiple versions of each TSP component, find versions of the components with specific characteristics, and combine selected versions of the components to build a TSP. Furthermore, it must be possible for an intelligent system such as the TMS(C) to modify components, to have those modifications cascade through the assembled TSP and effect related modifications, and to check the finished TSP product for internal consistency (more on the required intelligence below).

If anyone has identified ways to define the specifications for TSP component objects, constructed the objects, or built a repository and registry for those objects, they are being fairly secretive about it. Repositories and registration of TSP component objects may be the bridge too far for 2016. If we can't have the capabilities for TSP component objects, then the next best thing would be repositories and registration of whole TSPs that can be modified as needed. (The modification capability, related to the AI requirement, is described below.) The scenarios and tactical situations around which the first base set of TSPs should be constructed can be derived from the six scenarios that are widely used in the current FCS analytic work (Unit of Action Maneuver Battle Laboratory [UAMBL], 2004).

This may be a realistic goal for 2016. Work being done on the Content Object Repository Data Registration Architecture (CORDRA) is exploring ways to register learning content developed according to Shareable Content Object Reference Model (SCORM) specifications, and to parse larger sets of content into separate objects by means of the object metadata (Dodds, 2004). Additionally, the Institute of Electrical & Electronics Engineers (IEEE) Learning Technology Standards Committee has formed a standards study group to examine the possibilities for interfacing instructional systems and simulation systems (G. Franks, personal communication). These two initiatives may form the foundation for work on constructing a collective exercise version of the SCORM work. Given current and recent efforts, we would anticipate that some versions of such a system of repository and registry, the specifications and standards, and the TSP content to populate the system may be operational by 2016. In fact, once the repository and registry are created, the content may be registered by parsing constructed TSPs into component objects at a fairly high level of granularity, as is done with SCORM–

conformant content under the CORDRA specifications. It seems likely that the technology would allow a working system, if individuals and agencies are inclined to work on it.

Bi–Directional Reach

This is such an integral requirement for the FCS that we have every confidence (tempered by pessimism born of experience with technology initiatives) that the necessary capabilities will be available. The overarching network that will connect all FCS systems, not only to each other but also to their HSOC, will support direct point-to-point contact, eliminating relays of information. For training management specifically, commanders will have access to the databases and repositories described above, to remote O/Cs, to additional information about the tactical conditions underlying the exercise, and to individual and small group training that can be used in preparation for the exercise.

It seems unnecessary to describe an interim solution for 2016. If the capability is not operational, it will likely be a problem with interfaces among databases and repositories, adaptable search engines, or bandwidth (described below), rather than any inherent difficulty in enabling communications.

Search Engines

Powerful search engines are needed to support both the reach capability and the TSP-building process. The user cannot be expected to sift through all of the available information that contains his chosen keyword. Additionally, trying to organize information so that the user can look through all available information will be impossible, given the multiple users and their multiple needs. Rather, the need is for a powerful Google-like search capability (sort of a Googleplex) that indexes available content and performs intelligent searches. Each time a search is performed, the system "learns" the quickest path and most usable content. Wall, Elms, Biggers, and Sticha (2004) developed a prototype knowledge network that looked at ways to organize information, find the most relevant information for a user's request, authenticate the information, and allow users to add information to the network. This type of system will be needed to facilitate the reach capability.

The Defense Advanced Research Projects Agency (DARPA), which invented the internet, is moving far beyond Google in the development of advanced search engines. For example, a not-so-recent DARPA-sponsored project at Insightful Corporation led to the development of a product known as InFact, based on linguistic normalization and making use of sophisticated technology for modeling the morphology, semantics, and syntax of languages (DARPA, 2003). It captures a larger amount of information than other search engines and can "read" documents while retaining the information content of every sentence.

Rather than retrieving information by keywords, as did early search engines, or by concepts and patterns, as did the next generation, the third generation of search engines will retrieve facts. The emerging technologies use language models that examine morphology for the analysis of word form, syntax for the analysis of keyword relationships, and semantics for the analysis of overall linguistic meaning. Morphological and semantic analyses are not new to

search and retrieval, but it is the inclusion of the syntactic model that will allow search engines to understand meanings and duplicate the process of lexical comprehension in humans. Furthermore, many of the next generation search engines have unique ways of grouping and displaying results (e.g., concept maps, concept spaces, semantic webs and visualization, and semantic indexing) that make it easier to find relevant information. They also have the ability to use contextual and positional operators, query by example, query expansion using related words and concepts, improved faceting, and data mining technologies to improve search and retrieval results (S. Shadrick, personal communication).

In the very near-term, Google already exists. Further developing the process and turning the 'bots loose on the developed databases and repositories should not be an obstacle. If nothing else, we will have more primitive ways of searching and accessing information, which means things will take longer, users will be discouraged by the laborious routines involved in finding what they need, and they will stop searching. This capability has both a high likelihood of success and a dearth of interim solutions.

Performance Support Systems, Computer-Generated Forces Simulation, and Artificial Intelligence

This discussion combines the topics of performance support systems with considerations of future CGF and AI because of the nature of those future performance systems, as described in FCS documents. Many of the most useful of the planned systems for FCS will be enabled by powerful CGF and AI, so that the technologies and products are inextricably linked.

The FCS program developers have a strong commitment to performance support systems—that is, ways of presenting the appropriate information, at the appropriate time and level of specificity, using techniques appropriate to the user's ability and needs. Plans for FCS capabilities are rife with references to various software services. The need for leaders and their staffs, as well as system operators, to use the same tools during training that they use in operations is indisputable. These same tools, however, are also needed for the TMS(C) features.[10]

The distinction between training support systems and performance support systems is moot. If the performance support systems are available via the SOSCOE in the platforms, and embedded training is available in the platforms via the SOSCOE, then there is no reason that they should not take advantage of the same technology—it would be foolish to do otherwise.

The tools and software services are of limited utility without AI, and many also require CGF. As described earlier, the related fields of CGF simulation and AI have a long way to go, but also have devoted researchers. The adaptive training system requires both CGF and AI for complete development of the performance support systems, in order to dynamically present conditions reactive to unit actions, evaluate unit member performance against competency definitions and determine needs for coaching and remediation, present space and time models for

[10] Descriptions of the specific software services has not been designated for open distribution. Interested readers should contact the LSI for more information.

scenario development and AARs, construct internally consistent training events and TSPs, lead AAR discussions and recording results, and so on.

Engineers and programmers are already at work on those systems and technologies, but the probability of success by 2016 is moderate at best (in our opinion), despite some very dedicated efforts. Even if the technologies are sufficiently matured to permit the tools to be deployed, there is a distinct possibility that they will not be assembled into the training support tools posited for the TMS(C).

If the various performance support tools are not operational (with their supporting CGF and AI capabilities), then processes for training development and execution will resemble the current processes, where individual training managers, exercise controllers, and CGF operators make decisions and carry them out with live roleplaying participants and only the barest of automated tools.[11] All three of the training management roles will need to be filled by humans, rather than by computerized services. Roleplayers and O/Cs will require training and their own performance support, just as they do today. The TSPs may not need to be predominantly paper, but they will need human translation to the simulator devices, while an instantiated TMS(C) would actually serve as the TSP for many purposes currently performed by humans with paper- or computer-delivered guidance (e.g., providing standardized controlled conditions, providing support for feedback).

If the mechanisms for automatic and intelligent construction of training events and TSPs are not developed—then users should at the very least have semi–automated tools such as the Commander's Integrated Training Tool (CITT), developed by ARI for the Close Combat Tactical Trainer (CCTT; Flynn et al., 2001). That tool set led the user through a process to identify an appropriate training event and download the matching TSP. The user could then modify the TSP to adjust starting positions and unit names and call signs, and produce an exercise initialization file for CCTT, as well as the other paper-based materials that would be used to guide unit preparation, O/C activities, control of CGF during the exercise (by humans), and AARs. If no TSP was found that was close to the identified training need, then the user was instructed in how to develop the exercise specifications and the TSP.

More recent work at ARI is examining rapid scenario generation (A. Cianciolo, personal communication), although the prototype tools are still only semi–automated, largely requiring human development. The Joint Advanced Distributed Learning (JADL) Collaborative Laboratory (CoLab) is also pursuing the development of tools to assist with development of training support materials (JADL CoLab, 2005). Thus, there is some small flurry of interest in making the tools available. With continued interest and effort at the current pace, it should be possible to achieve the goal of developing the scenario repository and the tools that will support at least a CITT–like capability.

[11] These "barely automated" tools include, of course, semi-automated forces, simulated plan view and out-the-window displays, templated reports and support materials, exercise initialization capabilities, and other technology advances that were state-of-the-art only 10 years ago.

Improved Bandwidth Capabilities

The real-time presentation of synchronous simulations to multiple distributed participants, with ongoing data collection and performance evaluation, options for observation, and dynamic automated adjustments, will put a severe strain on a network with conventional bandwidth. The requirements are not only for increased bandwidth, but also for reliable security measures and multiple redundancies.

These are not new thoughts—FCS developers and other researchers in and around DoD are well aware that they will need improvements just for operational purposes—but may increase the scope of the requirement. A presentation at a recent DARPA Tech (Saleh, 2005), described some of the ongoing DARPA research and plans concerning bandwidth issues. The DoD Global Information Grid (GIG) operates on the backbone of the Global DoD Enterprise Network, consisting of satellite-based networks, optical core and edge networks, and land-based fixed wireless networks, all with strong connectivity to tactical wireless networks.

Currently, the optical core of the DoD Enterprise Network is the GIG Bandwidth Expansion (GIG-BE), now managed by the Defense Information Systems Agency (DISA). It is a state-of-the-art, fiber-optic network with the impressive projected aggregate capacity of 10 terabits per second. However, to enable powerful network centric warfare applications, DARPA projects that the next-generation optical core network must have at least 10 times the capacity of GIG-BE (or an aggregate capacity of at least 100 terabits per second). According to DARPA, simply scaling up today's technology to meet these enormously great demands is not a viable answer. If we actually try to do this, the mostly switching and routing nodes will become too expensive, too big, too power hungry, and far too hot. The solutions being explored by DARPA focus in part on creating the technologies for all-optical networking, dense wavelength-division multiplexing, and aggressive optoelectronic integration.

For network-centric operations as envisioned in the FCS ORD, the next-generation GIG must be not only fast, but incredibly reliable, self-healing, and secure. If those requirements and the 100 terabits per second are achieved, and if training management features can share some of the future GIG capability, then it is likely that bandwidth will no longer be an issue.

Based on description of efforts by DARPA (among others), we are cautiously optimistic that, in the next 10 years, the bandwidth capabilities will be orders of magnitude greater than they are today, at least for operations if not for training. The entire FCS concept is predicated on the notion of completely networked systems. Without the fully capable network, FCS itself is in peril, and embedded training in FCS is moot.

Summary and Recommendations

Our recommendations are based on a balance between what is most critical for future adaptive training, and what is most achievable by the 2016-2020 timeframe. They focus on the technologies and the ensuing capabilities (as opposed to the surrounding work involved in making them useful, described below), and target the efforts required of psychologists, military

experts, and instructional designers working in close collaboration with engineers and programmers.

The work on the databases should include training experts who will be able to define and describe the variables of interest, and to delineate the connections among those variables. Separate databases or segments (tables) within databases should not contain redundant information or information that can be computed from existing data (again, the consideration of normalcy). Training experts should be able to generate the complete list of personnel, unit, task, and venue characteristics that are needed, draw the linkages and relationships, and tell why they are needed and how they will be used in clear and concise sentences. Then, working with database designers and engineers, the team will be able to design the structure of compatible databases that will share information with each other and with users. They will also be able to build the tools that will allow users to access appropriate reports and enable performance data archiving. This should be an effort accorded some high priority, primarily because the very promising ATIS and DIMHRS initiatives are already underway and should not be ignored.

Additionally, work on scenario repositories and registries should expand to include definition of the scenario and TSP components, the ways in which they are related and can be defined as compatible or incompatible, interfaces and decision points for human input, and methods for relegating the compatibility decisions to an intelligent agent. Work should begin on codifying the process for translating the TSP components into coherent TSPs with information for human users and data bits used by the services of the embedded training TCCs. The scope of work on the scenario repository is very broad, and needs to be coordinated with work on the TCCs and BCSSs. We would also consider this to be a fairly high priority, not so much because of any urgency for quick solutions, but simply because it's going to take some time.

The bi-directional reach feature in support of both training and operations is already on the radar for FCS developers and engineers. The use of search engines to facilitate construction of training events, preparation for training, and obtaining information during training (as during operations) is going to take some thought. There are significant bodies of research literature on knowledge management, and the corpus expands daily. The role for training experts here is to maintain a watching brief on knowledge management within the military community and to be alert for ways to exploit emerging developments. With the passage of time, as decisions are made, training experts should become even more active in the process to ensure that those decisions are reflected in training management system developments. The priority to monitor the process is high, but the effort is of relatively low intensity.

Continuing development of the FCS performance support systems, on the other hand, is going to be a fascinating area for research. It is still relatively embryonic, as a vast array of capabilities in CGF and AI are folded into the mix. The use of performance support systems should be largely human–centric, as opposed to technology–centric, designed to support human needs rather than to deliver every possible service. The involvement of experts in training, military requirements, human factors, and cognitive behaviors is essential to influence both the type of support provided and the ways in which it is provided. This area is considered as a high priority, both monitoring developments and participation in design and decision-making.

The likelihood for success by 2016 is not assured. It would be wise for training experts to continue to work on the interim solutions: less intelligent performance support systems for human training managers, exercise controllers, O/Cs, and CGF operators; CITT-like tools to facilitate construction of training events and TSPs from a core set based on the six scenarios (UAMBL, 2004); and templates that can be used with minimal human input supplementing database input to provide reports on training needs and accomplishment. The development of tools to permit rapid building of training events and TSPs is already being studied (ARI, 2005). The performance support systems for human training roles are of particular interest, and should be a fruitful area for research to determine the specific needs for each role, the ways of delivering the support, and the appropriate levels of automation.

The work on bandwidth issues, including security and redundancy, is in the hands of engineers. Our only participation in these developments is to stay informed on the capabilities so that the proposed solutions do not render the training management system inoperable. For example, network security measures that prevented exchange of information between platforms during training would be counterproductive. Bandwidth allocation that did not permit distributed data collection, analysis, and AARs would seriously impede conduct of distributed exercises.

There are other requirements for making the technologies and capabilities useful, such as populating the databases with personnel and unit training and experience information, documenting collective and leader task analyses, devising and recording the baseline CATS, creating the starter set for the scenario repository and registry, analyzing the expert, collective, and structural behaviors that CGF and AI will portray, preparing task standards that are measurable by intelligent systems, creating the individual training that can be used for remediation, among others. All of these will need attention, and findings will need to be integrated to permit exploitation.

One issue stated earlier has been left hanging: What kind of tools (i.e., how much automation) will people accept? This is a field for research all by itself, and should probably get underway before all the tools are built. The early days of battlefield digitization were characterized by a tendency among leaders to revert to voice communications when stressed. The CITT, despite the obvious advantages it afforded in saving time and ensuring completeness, is not widely used today. In fact, a recent study of CCTT utility found that company commanders and platoon leaders who use CCTT are generally unaware that TSPs are even available (Mastaglio, Peterson, & Williams, 2004). Research might include reviews of the literature on automation acceptance, interviews among military leaders, and even experimental investigation of how trust and acceptance are formed.

This set of recommendations will be well served by collaborative teams of training developers, psychologists, and military experts, similar to the groups that comprise the Training IPT. Work on the recommended courses of action will support a future training management that does not require all of the promised technologies to be delivered, and simultaneously advances our current understanding of and designs for future training management. These initiatives will help us to identify avenues of research that are promising, as well as those that will be pointless to explore. The interim solutions are not the stop-gap workarounds that are

independent of the envisioned goal. Rather, they are stepping stones on the path toward the eventual high-end solutions.

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Appendix A
Acronyms and Abbreviations

AAR	After Action Review
AI	Artificial Intelligence
ALMS	Army Learning Management System
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ASAT	Automated Systems Approach to Training
ATIA	Army Training Information Architecture
ATIS	Army Training Information System
ATRRS	Army Training Requirements and Resources System
ATSC	Army Training Support Center
BCSS	Battle Command Software Services
CALL	Center for Army Lessons Learned
CATS	Combined Arms Training Strategy
CCTT	Close Combat Tactical Trainer
CGF	Computer-Generated Forces
CITT	Commander's Integrated Training Tool
CoLab	Collaborative Laboratory
CORDRA	Content Object Repository Data Registration Architecture
COTS	Commercial-Off-the-Shelf
CTIA	Common Training Instrumentation Architecture
DA	Department of the Army
DARPA	Defense Advanced Research Projects Agency
DIMHRS	Defense Integrated Military Human Resources System
DISA	Defense Information Systems Agency
DoD	Department of Defense
DTMS	Digital Training Management System
EMilpo	Electronic Military Personnel Office
ET	Embedded Training
FAQ	Frequently Asked Questions
FCS	Future Combat Systems
GIG	Global Information Grid
GIG-BE	Global Information Grid Bandwidth Expansion
HSOC	Home-Station Operations Center
HTM	Human Training Manager
ICW	Individual Interactive Courseware
IED	Improvised Explosive Device

IEEE	Institute of Electrical & Electronics Engineers
IETM	Interactive Electronic Technical Manual
IMI	Interactive Multimedia Instruction
IPT	Integrated Product Team
ITAPdB	Integrated Total Army Personnel Database
ITRS	Individual Training Readiness System
JADL	Joint Advanced Distributed Learning
KPP	Key Performance Parameter
LSI	Lead Systems Integrator
METL	Mission Essential Task List
MS	Microsoft
MTO&E	Modified Tables of Organization and Equipment
NLP	Natural Language Processing
NN	Neutral Networks
NRFTT	Networked Reconfigurable Full Task Trainers
O/C	Observer/Controller
ORD	Operational Requirements Document
PDA	Personal Digital Assistant
PEOSTRI	Program Executive Office for Simulation, Training, and Instrumentation
PMO	Performance Measurement Objects
R&D	Research and Development
RFMSS	Range Facility Management Support System
SCORM	Shareable Content Object Reference Model
SIDPERS	Standard Installation/Division Personnel System
SOSCOE	System of Systems Common Operating Environment
TACP	Tactical Command Post
TADLP	Total Army Distance Learning Program
TADSS	Training Aids, Devices, Simulators, and Simulations
TAMIS-R	Training Ammunition Management Information System-Redesign
TCC	Training Common Components
TDDT	Training and Doctrine Development Tool
TESS	Tactical Engagement Simulation System
TMS(C)	Training Management System (Concept)
TO&E	Tables of Organization and Equipment
TRADOC	U.S. Army Training and Doctrine Command
TSP	Training Support Package

UAMBL	Unit of Action Maneuver Battle Laboratory
UTMC	Unit Training Management Component, *also* Unit Training Management Configuration
WMI	Warrior Machine Interface