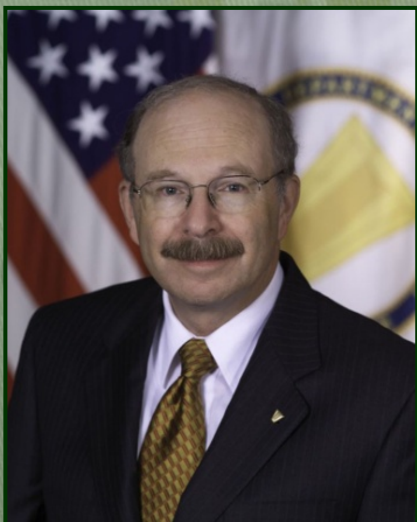
Spring / Summer 2007

MANPRINT Newsletter



Dr. Michael Drillings
Director for MANPRINT

Contents

The Director's Corner

As many of you know, the House Armed Services Committee (HASC) has taken a benign interest in Human Systems Integration (HSI) over the last few years. In addition to ordering several reports from the Office of the Secretary of Defense (OSD), they have also earmarked additional funds for HSI. All Services contributed to the newest report that will be forwarded to Congress after the approvals of the Services and the signature of Dr. Chu, the Undersecretary of Defense for Personnel and Readiness.

While they have been waiting for the report, the HASC has earmarked $12M for and ordered the creation of an OSD office for HSI, mostly for the further development of HSI tools. Of course, until the full Congress acts, it is not official, but it is encouraging. I anticipate that the duties of the OSD office will be combined within an existing office with the purpose coordinating HSI policy and ensuring that the money is well spent.

An important part of MANPRINT's success is to educate program managers' staffs, whose first exposure to MANPRINT often occurs when they attend or take courses through the Defense Acquisition University (DAU), which offers several courses that include HSI information. Taylor Jones, from my office, and Bob Beaton, from the Navy, are re-looking at HSI in DAU. Their job is complicated, because every acquisition specialty asks for more representation in the curriculum than they currently have. Consequently, obtaining more instructional time is a competitive process.

The last version of the Army's policy for MANPRINT, AR 602-2 was published in June 2001. It is time for an update, and we hope to accomplish that over the next few months. I would like to consider inputs from a variety of people and interests. If you have ideas for updating AR 602-2, please e-mail them to Teresa Hanson at teresa.hanson@hqda.army.mil.

In March, many of us attended the HSI Symposium in Annapolis, Maryland. It is always great to hear so many stimulating presentations and the views of the other Services and the contractor community. In my own presentation, I discussed the changes in HSI during the preceding few years. I believe that the changes in inter-Service cooperation have been huge. For reasons stated above, this cooperation is likely to improve and lead to an increased role for HSI. But we still face challenges. For example, there is a continuing movement to speed up acquisition. Some believe that assessment, in general, slows down the process. I have examined the acquisition process for several systems, and I have yet to see an instance of MANPRINT slowing down acquisition of a system that was not cancelled. I am pleased by how quickly we work, and we must resolve to keep up our fine record.

Michael Drillings,
Director for MANPRINT

A MANPRINT Success Story: The Modernized Target Acquisition Sight / Pilot Night Vision Sensor (MTADS / PNVS)

Daryl Llamas, Lockheed Martin
Dave Durbin, Army Research Laboratory, Human Research and Engineering Directorate
Al Lang, MTADS PNVS Program Office

Background

For the past 20 years, the AH-64 Apache helicopter, used in combat missions around the world, has been largely successful because of the Target Acquisition Designation Sight / Pilot Night Vision Sensor (TADS / PNVS), which provides targeting, designating, and pilotage capability during all weather conditions. The advanced infrared technology of the TADS / PNVS allows pilots to complete critical combat missions with increased levels of safety.

In 2000, the TADS / PNVS, renamed Modernized Target Acquisition Designation Sight (MTADS) / PNVS, was upgraded to include higher resolution infrared video, improved targeting capabilities, improved maintainability features, and increased reliability. A very active MANPRINT effort contributed to the successful development of the MTADS / PNVS system maintainability, reliability, and usability.

MANPRINT Team

The MANPRINT team conducted a series of early hands-on evaluations and design reviews of the MTADS / PNVS hardware prototype. As a result, the MANPRINT team documented 73 issues. Lockheed Martin addressed the 73 MANPRINT issues through engineering changes and production assembly procedures that resulted in significant design improvements, such as enhanced component accessibility and reliability. The MTADS / PNVS program management office funded the design improvements, and the MANPRINT team regularly evaluated them. Additionally, a MANPRINT Working Group (MWG) met every six months to formally present and discuss design solutions. By January 2005, after the MWG implemented and verified design solutions, all 73 issues were resolved. An analysis conducted by the Army Research Laboratory, Human Research and Engineering Directorate of the MANPRINT team's evaluation and design review process indicates that the resolution of the 73 MANPRINT issues has the potential to save several thousand maintenance man-hours during the lifecycle of the MTADS / PNVS.

MANPRINT is an Ongoing Process

The MANPRINT effort did not stop after the 73 issues were resolved. Since the first production systems were developed in January 2005, Lockheed Martin and the rest of the MANPRINT team have continually improved the MTADS / PNVS system design. They evaluate field failures and maintainability problems in the combat environment and determine corrective actions that reduce and eliminate future problems. The MANPRINT team will continue to assess the MTADS / PNVS and look for ways to improve performance during the system lifecycle.

Summary

The MTADS / PNVS program is an excellent example of a MANPRINT team working together to build a better system for soldiers. The MANPRINT program was funded by the MTADS / PNVS program management office and proactively supported by the contractor and government agencies. The result is a more reliable MTADS / PNVS system, fewer maintenance man-hours, reduced cost, and improved battlefield performance.

Participating agencies and companies include:

U.S. Army Aviation Logistics School

TRADOC System Manager, Reconnaissance Attack

Army Research Laboratory, Human Research, and Engineering Directorate

Lockheed Martin

Boeing

MTADS / PNVS Program Office.

New Maintenance Manpower Modeling Capabilities in IMPRINT

Susan Archer, Alion Science & Technology

As the Army transforms, so must the tools we use to influence system design for the benefit of the Soldier.

As the Army transforms, the tools available for MANPRINT practitioners must keep pace. This article describes a tool that is focused on helping MANPRINT practitioners assess the impact of new system maintenance concepts on Soldier tasks and operational readiness.

Over the last several years, the U.S. Army Research Laboratory, Human Research and Engineering Directorate (ARL HRED) developed a modeling and analysis tool to support the MANPRINT community. This tool, the Improved Performance Research Integration Tool (IMPRINT), grew out of common U.S. Air Force, Navy, and Army manpower, personnel, and training (MPT) concerns identified in the mid-1970s. It provides the means for estimating MPT and Human Factors Engineering (HFE) requirements and constraints for new weapon systems very early in the acquisition process. IMPRINT is government-owned software and consists of a set of automated aids to assist analysts in conducting MANPRINT assessments.

Recently, ARL HRED completed a release of a new version of IMPRINT, known as IMPRINT Pro.

Included in the many enhancements to IMPRINT Pro are significant improvements in the ability to predict operational readiness as a result of equipment reliability, maintainability, and operational requirements. The Define Equipment module of IMPRINT Pro is specifically designed for users that are interested in assessing the impact of new maintenance concepts (e.g., the increased use of operational crew performed maintenance and mobile contact teams) on operational readiness.

Many of the recent additions to IMPRINT Pro provide dramatic improvements to users and include changes to the interface, the visualization of the executing maintenance model, more useful reports and improved simulation performance. Many of the improvements are described below.

- Broader Task Set. The complete list of maintenance task types included in the Logistics System Analysis (LSA) standard consists of 33 separate task types. Each task is connected to attributes that describe the type of effort needed to perform the task—motor, visual, and cognitive. This improves the fidelity of capturing, modeling, and reporting maintenance task performance.
- Crew Chief Maintenance. The operational crews of the systems perform maintenance tasks, and it is important that this workload is considered as the system progresses through acquisition. These are not always simple remove and replace tasks, and can take significant amounts of time, skill, and spare parts. IMPRINT Pro can predict the impact on operational readiness of assigning maintenance tasks to the crew. Figure 1 shows the form on which users describe the maintenance tasks. Notice that at the bottom of the form, users can designate whether this task could be performed by the Crew Chief. This simple designation is used as the model runs to automatically queue some tasks for repair by the operational crew.
- Contact Team Repairs. Contact teams are mobile teams of maintainers that take parts, tools and skills to the system needing repair. This is an alternative to a more traditional maintenance unit that would wait for the system to return to the unit before needed repairs would begin. In IMPRINT Pro, users have greater flexibility in defining how these contact teams would be composed and used. As shown in Figure 2, users can provide the number of contact teams, the maximum number of repairs that can be waiting for the attention of each contact team, and the number of maintainers on each team. All of these variables impact the productivity of the contact teams, and ultimately, the operational readiness of the system.

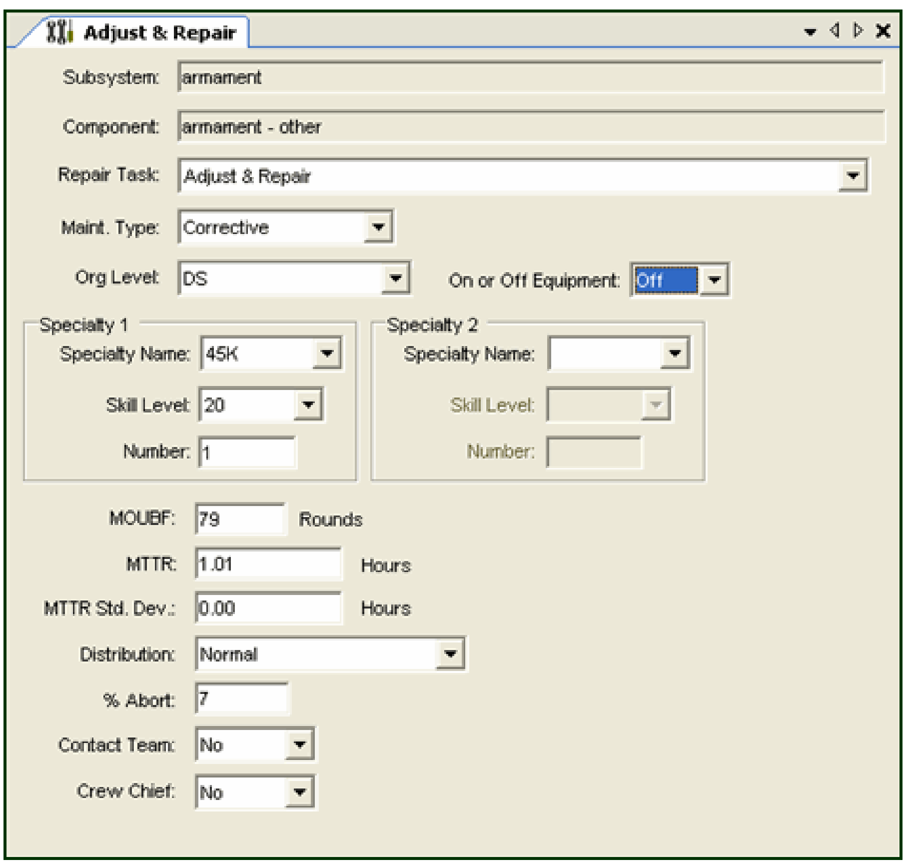


Figure 1. Maintenance Task Data Entry Form

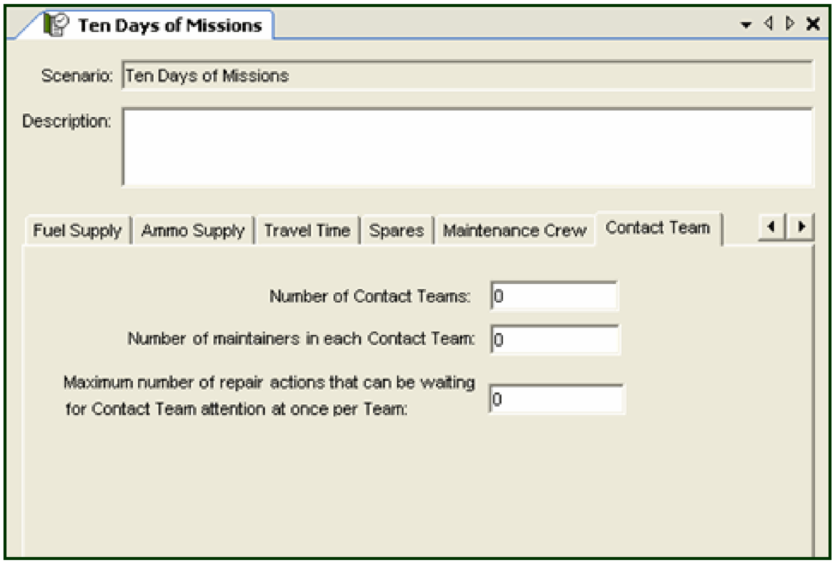


Figure 2. Defining How Contact Teams Will Be Used

- More Flexible Import Capabilities. Maintenance data often includes component level reliability and maintainability values. Data can be recorded in relational databases, spreadsheets, or text files. Translating data from an existing media to IMPRINT is an extensive process. To alleviate this work, MANPRINT has significantly broadened the formats that IMPRINT accepts into the maintenance database. Spreadsheet formats can be manipulated to fit each user's input data format, saving time for users and reducing potential for data translation errors.

- Faster Simulation Engine. MANPRINT is always looking for ways to improve the efficiency of the simulation engine that supports the maintenance modeling capability in IMPRINT. The most recent version of the simulation engine demonstrates a 10X improvement in speed. This enables users to conduct "what if" analysis much more efficiently than before.

- Visualization. Previous versions of the IMPRINT maintenance model ran in the background. Users were presented with a progress indicator, but were given no insight into how the maintenance organization was performing until the model completed and they could view the reports. Figure 3 is a screen print of the visualization capability now available as the model is executing. This screen enables users to see whether the maintenance queues are building, to examine whether the maintenance crew size is sufficient, and to assess operational readiness as the mission schedule progresses. Users will find it easier to identify and diagnose problems in the maintenance concept as they work toward meeting a target readiness rate.

- User Documentation. The IMPRINT user documentation has improved dramatically. "Quick start" flow charts help users understand how they could proceed through an analysis (see Figure 4). Upgraded help and user guides have been tested with new users to ensure that they are helpful and coherent.

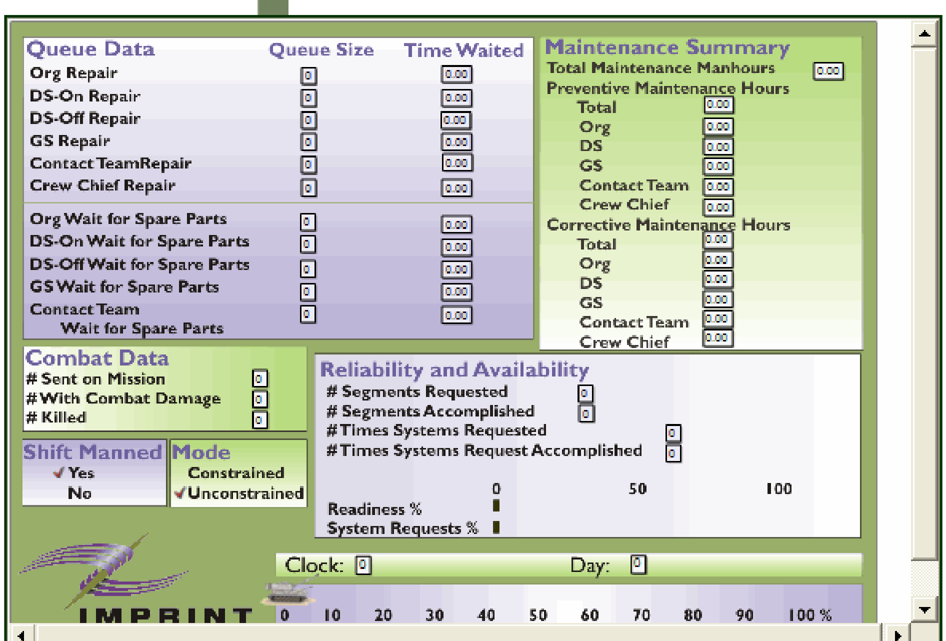


Figure 3. Maintenance Model Visualization

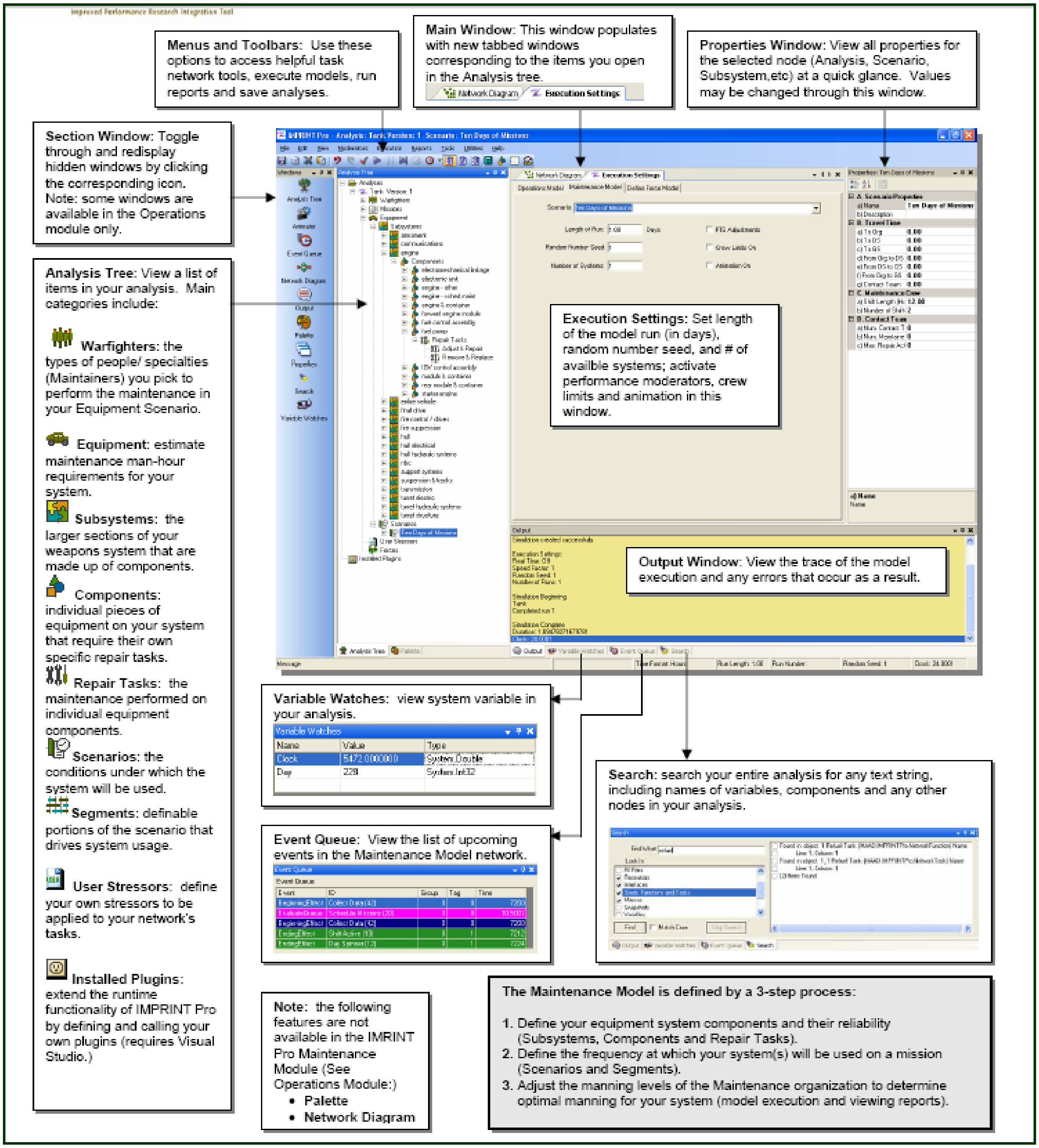


Figure 4. A Portion of the New Quick-Start Guide

The IMPRINT team is confident that users will be pleased with the new capabilities. Software development is a dynamic process, requiring continuous attention in order to take advantage of the gains in processing power, improvements in operating systems, and new supporting third party software capabilities, such as databases and user interface features. ARL HRED recognizes the importance of continuously improving the tools needed to support the MANPRINT Practitioner's ability to influence system design by improving system performance, reduce total operating cost, or improving Soldier safety and survivability.

For more information on IMPRINT or other available MANPRINT tools, please contact Charneta Samms at ARL HRED (csamms@arl.army.mil).

Thanks to Charneta Samms and John Lockett at ARL HRED for their contributions to this article.

IMPRINT
Improved Performance Research Integration Tool

Job Preparation for the 21st Century Warfighter: Lessons from Patriot after Operation Iraqi Freedom

John K. Hawley
U.S. Army Research Laboratory
Human Research and Engineering Directorate

the full article, including references, can be found at the MANPRINT Web site at www.manprint.army.mil.

During the combat operations phase of Operation Iraqi Freedom (OIF), Army Patriot units were involved in two fratricide incidents in which three flight crew members lost their lives. In the first, a British Tornado was misclassified as an anti-radiation missile (ARM) and subsequently engaged and destroyed. In the second, a Navy F/A-18 was misclassified as a tactical ballistic missile (TBM) and also engaged and destroyed. OIF involved 11 Patriot engagements by United States units. Out of the 11, nine resulted in successful TBM engagements; the remaining two were fratricides.

Patriot, which has been in the active force since the early 1980s, is the Army's first-line air and missile defense (AMD) system. Initially, Patriot was intended as a defense against conventional air-breathing threats (ABTs). However, since Operation Desert Storm (ODS) in the early 1990s, Patriot has been used primarily to defend against TBMs. Future scenarios envision the system as being used against a spectrum of air threats, including TBMs, conventional ABTs, cruise missiles, and various categories of unmanned aerial vehicles (UAVs). The range of potential air threats in the contemporary battlespace has significantly increased the complexity of the battle command problem for Patriot and other AMD systems.

What are the lessons learned from Patriot for preparing the 21st century warfighter? As Patriot has evolved over the past two decades, it has acquired characteristics more typical of systems the Army will employ in the future than those in the current inventory. Terms now used to describe Patriot include

(1) joint: Command and control (C2) for the Patriot system is joint—involving the Army and Air Force and sometimes the Navy;

(2) network-centric: Effective employment of system assets is dependent on a robust network;

(3) complex: The system as broadly defined is complex in that it consists of a large number of interacting components; and

(4) knowledge-intensive: Knowledge is required to characterize and comprehend the system. Patriot provides a glimpse into the future of human performance requirements and problems facing warfighters that is tangible and real, not abstract or hypothetical. The lessons discussed in this article are from combat operations and not based solely on the results of operational tests and simulated exercises. It has an Army focus, but the observations are general and apply to other classes of systems and to other services.

The Patriot Vigilance Project

Personnel from the U.S. Army Research Laboratory's Human Research and Engineering Directorate (ARL HRED) began looking into Patriot and AMD performance and training issues at the invitation of the then Ft. Bliss Commander, Major General (MG) Michael A. Vane. MG Vane was interested in operator vigilance and situation awareness (SA) as they relate to the performance of automated AMD battle command systems. SA is defined by Endsley, Bolte, and Jones (2003) as the *perception* of elements in the environment, the *comprehension* of their meaning, and the *projection* of their status in the near future. MG Vane was particularly concerned with a "lack of vigilance" on the part of Patriot operators and a "lack of cognizance" of what was being presented to them on situation displays, which resulted in "absolute trust in automation." His request for human factors support was prompted by the unacceptable rate of fratricidal engagements by Patriot units during OIF—two of eleven engagements, or 18%. MG Vane's reference to a lack of vigilance by Patriot operators led to the Patriot Vigilance project.

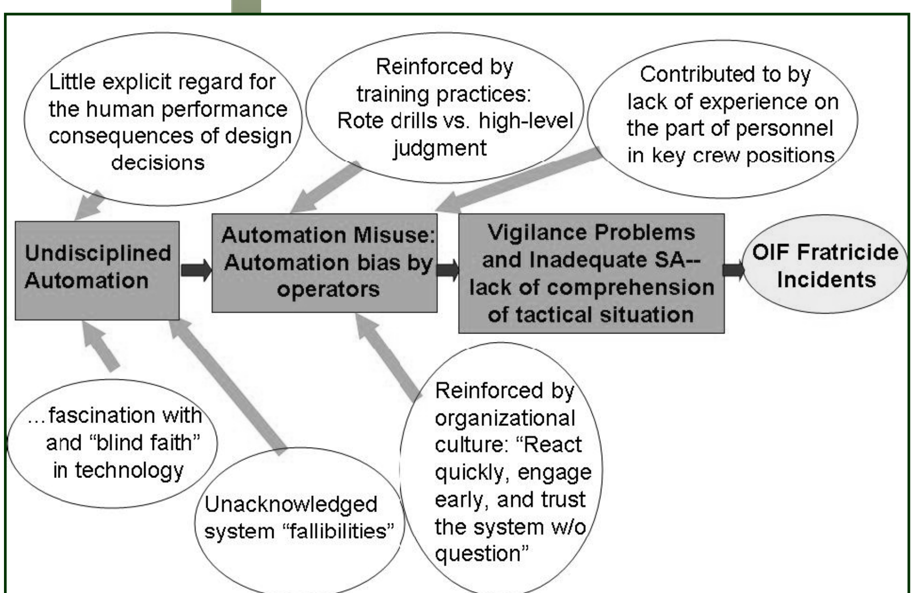


Figure 1. Patriot Vigilance Logic Model

Follow-On Work, Implementation, and Current Status

After reviewing initial project results, the Army Training and Doctrine Command (TRADOC) System Manager for Lower Tier AMD systems (TSM-LT), requested that the Patriot Vigilance project continue into a second phase. The TSM specifically requested that HRED's project staff expand on the material presented in Hawley, Mares, and Giammanco (2005) and prepare two more-detailed reports, one concerned with design for effective human supervisory control and a second addressing training for the emerging class of automated AMD battle command systems. In the TSM's words, the intent of these reports was to inform the AMD community on "what right looks like" in each of these topic areas. The results of the second phase of the effort were the technical reports, *Developing Effective Human Supervisory Control for Air and Missile Defense Systems* (Hawley & Mares, 2006) and *Training for Effective Human Supervisory Control of Air and Missile Defense Systems* (Hawley, Mares, & Giammanco, 2006). Both reports contain a summary and discussion of the technical state of the art in each of the topic areas. In addition, supporting informational briefings were developed for use across the AMD community. The project staff also worked with various elements in the AMD system development, training, and user communities on operationally defining and implementing Patriot Vigilance recommendations. Phase two formed the theoretical basis for what later were to be turned into actual design and training modifications.

What's Going On Here?

The underlying problem in OIF and observed in the PDB-6 test is that the new generation of information-dominant, network-centric systems exemplified by Patriot is complex and typically requires a high level of expertise for effective use. Moreover, many of these new systems are not systems in the traditional military use of the term—a single item of equipment. Rather, "the system" often is a capabilities increment brought about through changes in doctrine or tactics partly based in software, partly based in user procedures, and supported by various items of commercial or government off-the-shelf equipment—all networked together and linked with other similar systems. In a review of the evolution of operational warfare since World War II, Citino (2004) observes that success in the emerging warfighting environment is more a function of "soft" factors such as doctrine, procedures, and leadership than technology per se. Citino's observation speaks directly to the importance of viewing the system as a whole—hardware, software, people, organization, operational concepts (e.g., doctrine and tactics), and procedures—rather than just the hardware component by itself.

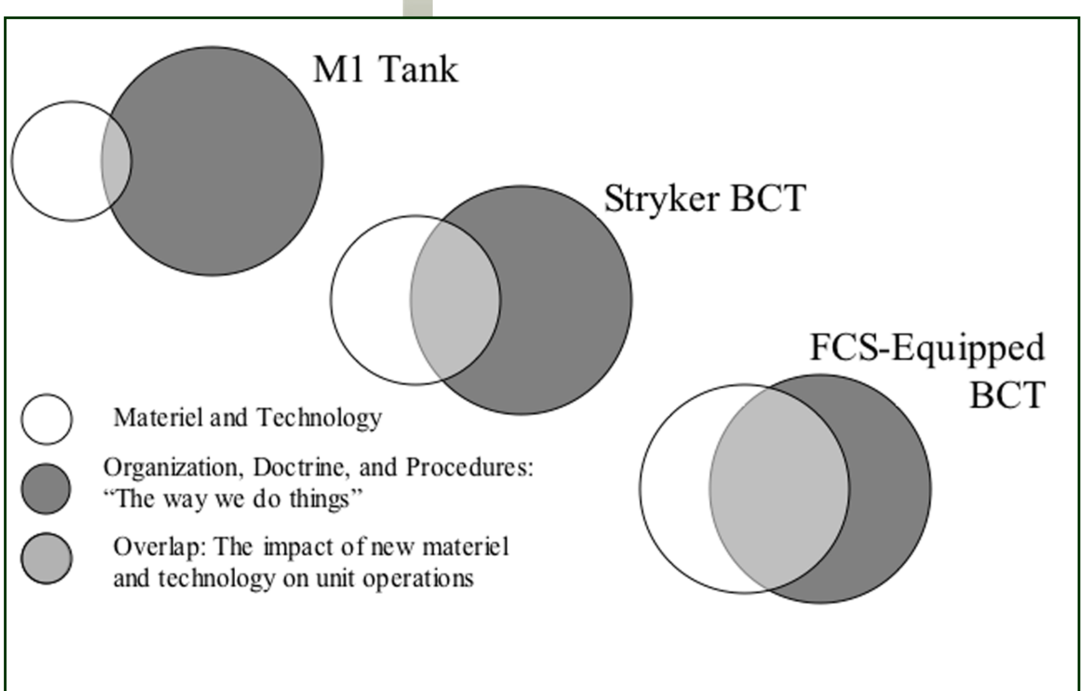


Figure 2. The Changing Nature of Systems Acquisition

What Has to Happen?

The discussion of solutions to the problem of developing effective and adaptive 21st century warfighters is organized into two sections. These are:

1. Job preparation
2. Personnel and staffing

Job Preparation

The primary lesson emerging from the Patriot experience during OIF and follow-on work through the PDB-6 operational test is that job preparation for knowledge-intensive systems must be quantitatively and qualitatively different from current practices. In present context, the term job preparation refers to all of the actions and activities that lead up to a soldier being assigned to an operational position. Job preparation consists of basic military training, advanced individual training, various phases of collective training, professional development, and on-the-job experience. It also includes the implicit job preparation that takes place by being in and around an operational unit—what Sternberg et al (2000) refer to as tacit knowledge. Used in this manner, the term job preparation is much broader than current Army concepts regarding training and job qualification.

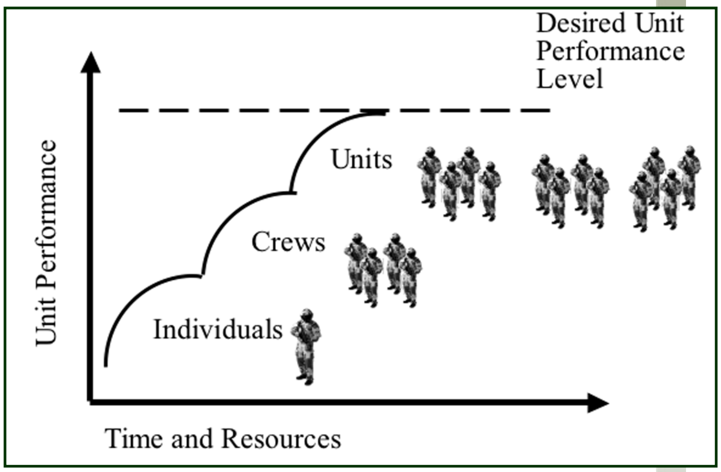


Figure 3. Developing Organizational Competence

Job preparation for knowledge-intensive systems must shift from a simple concern for task-related knowledge and skill to job-related expertise and adaptability. Expertise is a function of knowledge, skills, and job-relevant experience. Experience is essential to tuning the mental models that underlie performance adaptability. Extensive Army literature emphasizes that adaptive individuals and teams are necessary to cope with the uncertainty that is expected to characterize future operations. Individuals and teams must be able to make the necessary modifications to meet emergent challenges. Crews must expect to modify or replace plans. They must expect to improvise to meet changing operational contingencies.

As desirable and important as adaptive expertise might be, producing adaptive individuals and crews will not be a simple undertaking. Klein and Pierce (2001) caution that most teams can become adaptive, but most will not. Why not? At least three roadblocks stand in the way:

1. Time and job progression practices
2. Training quality
3. Trainee motivation.

First, achieving adaptive expertise will require more time for training than the Army has traditionally allocated for user job preparation. Simply put, there is no way to avoid the 5,000 hour rule that applies in other high-skill situations. Further, intra-unit job progression patterns will have to change. Operator trainees might have to spend an extended period in an apprentice status while they acquire the skills and experience necessary for effective job performance. Unit metrics regarding what constitutes qualified individuals and crews also will have to change, and it is not certain that current personnel management practices and concerns, such as career progression "gates," and up-or-out rules, can accommodate such requirements. The issue of personnel and staffing practices is addressed in more detail in the next section.

Second, many qualitative aspects of user training will have to change. To begin, training will have to be more rigorous and performance-oriented than at present. Training content and scenarios must reflect job requirements, and standards must be rigorously applied across the board. Introductory, baseline training will have to be followed by crew-oriented training that emphasizes active thinking and fluid decision-making within an adaptive network of roles (Kozlowski, 1998). This will require intact crews and—above all—time to form this collective expertise.

Third, trainees must be motivated to develop the deep expertise in technology, weapons systems, and operations necessary to inform the decision processes that characterize being adaptive. Trainees, commanders, and the general Army culture must accept that preparation for the emerging generation of knowledge-intensive military jobs involves no less professionalism than preparation for aviation or any other high-skill job in or out of the military. The topics and focus are different, but the preparatory requirements are similar.

Personnel and Staffing

The second major area where change must occur concerns personnel and staffing practices. Put bluntly, the Army's personnel management system must support the development of individual, crew, and unit competence rather than impede it. For example, a review of the battle rosters for missile crews and C2 teams participating in the PDB-6 test indicated that the unit was a very turbulent place with regard to personnel. Unit personnel turbulence resulted from transfers (both in and out), expirations of term of service, disciplinary problems, pregnancies, attendance at special schools, and the list of factors goes on. Consequently, only slightly more than half of the personnel participating in the test attended NET, and stable missile crews and C2 teams were the exception rather than the rule. When an inquiry was made regarding whether this situation was "normal," the unit's response indicated that this was the normal state of affairs for units in garrison. Turbulence at this level makes it virtually impossible to develop the competent individuals and crews required to effectively employ a knowledge-intensive system.

It can be argued that the jobs of the personnel who will employ the emerging generation of knowledge-intensive, non-aviation systems will be no less demanding than those of Army aviators, and job preparation and career progression for these personnel must be approached in a similar manner. The Army's personnel system manages to accommodate the requirement for aviation personnel to maintain their flying skills. Why cannot similar provisions be made for other job categories? An apparently workable model exists in the aviation community; and perhaps it needs to be generalized to non-aviation job categories. A good first start is to recognize the impact of the turbulence problem, identify what has to happen to address the problem, and then determine what changes in personnel practices are necessary to achieve those ends.

Conclusion

In the report, Training for Future Conflicts, the DSB asserts that the future will require that more people do new and more complicated things (DSB, 2003). The same report also remarks that meeting this challenge will require qualitative changes in the demands placed upon people that cannot be supported by traditional training practices. Decision makers must come to grips with issues of training time and the quality of training experiences. They also must recognize that the Army's "crew drill" mentality is a major part of the problem associated with preparing soldiers for knowledge-intensive jobs. The crew drill mentality discourages active thinking and almost guarantees a drift toward automatic, unthinking operating procedures of the kind that produced the OIF fratricides. In a 1987 report titled, Lessons Learned to Date, the Walter Reed Army Institute of Research (WRAIR as cited in Vandergriff, 2002, p. 268-269) remarked that the Army's training and personnel systems are "based on the fundamental concept of industrial mass production. Soldiers [are] defined as interchangeable parts in systems that require stereotyped behaviors ('by the numbers')." In essence, similar conclusions were reached by the post-OIF Patriot BOIs, HRED's incident assessment, and the DSB report on Patriot system performance. These points also reflect an implicit set of training and personnel practices that the Army must explicitly move away from.

The DSB's 2003 report concluded that training transformation to support warfare transformation will be a challenging undertaking. Old concepts and practices will have to change, but people often resist altering how change is implemented. It is too easy to beat the drums loudly for change but fall back into old, familiar behavior patterns—with the result that no significant change actually occurs. Real change requires sustained real changes. In The Path to Victory, Vandergriff (2002) advocates a "revolution in human affairs" (RHA) to parallel the so-called "revolution in military affairs" (RMA) made possible by advances in technology. This paper has lightly touched upon two components of RHA—training and personnel reform. Recall also the DSB's warning about an increasing risk of training failure negating technology promise. The converging trends discussed throughout this paper support the DSB's observation. An increasingly strong case can be made for the position that while technological opportunities might be the catalyst for an RMA, failure to address the parallel and equally important RHA has the potential to block that RMA's potential. Simply put, the performance promise of the emerging generation of technology-intensive systems will not be realized without significant changes in training and personnel practices. To remove these impediments, some parts of the Army are going to have to begin making the transition from the industrial age to the information age—from U.S. Steel to Microsoft, with all of the human resource challenges this analogy implies.

MANPRINT Training Schedule

MANPRINT ACTION OFFICER'S COURSE				
Class	**Start Date**	**End Date**	**Location**	**POC**
2007-002	06 Aug 2007	10 Aug 2007	ALMC, Fort Lee, VA	almc@lee.army.mil

MANPRINT TAILORED TRAINING (APPLICATIONS COURSE)				
Class	**Start Date**	**End Date**	**Location**	**POC**
2007-707	31 Jul 2007	02 Aug 2007	Warren, MI	almc@lee.army.mil
2007-708	18 Sep 2007	20 Sep 2007	Huntsville, AL	almc@lee.army.mil

MANPRINT INTRODUCTORY COURSE			
Start Date	**End Date**	**Location**	**POC**
26 Jul 2007	26 Jul 2007	ALION, Huntsville, AL	khopkins@alionscience.com

Meetings of Interest

Space and Missile Defense Conference

13-16 AUG 2007

Huntsville, AL

www.smdconf.org

AUSA Annual Meeting & Exposition

8-10 OCT 2007

Washington, DC

www.ausa.org

I/ITSEC - Interservice/Industry Training, Simulation & Education Conference

26-29 NOV 2007

Orlando, FL

www.iitsec.org

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MANPRINT Web Site: http://www.manprint.army.mil

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The MANPRINT Newsletter is an official bulletin of the Deputy Chief of Staff, G1, Department of the Army. The Manpower and Personnel Integration (MANPRINT) program (AR 602-2) is a comprehensive management and technical initiative to enhance human performance and reliability during weapons system and equipment design, development, and production. MANPRINT encompasses seven key domains: manpower, personnel, training, human factors engineering, system safety, health hazards, and soldier survivability. The focus of MANPRINT is to integrate technology, people, and force structure to meet mission objectives under all environmental conditions at the lowest possible life-cycle cost. Information contained in this bulletin covers policies, procedures, and other items of interest concerning the MANPRINT Program. Statements and opinions expressed are not necessarily those of the Department of the Army. This bulletin is prepared twice yearly under contract for the MANPRINT Directorate, G1, under the provisions of AR 25-30 as a functional bulletin.

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