M A N P R I N T
An Approach To Systems Integration

The Problem

In the 60s, 70s and early 80s, the Army introduced hundreds of new weapons and equipment into the force. This force modernization program was designed to increase Army capability and readiness. The Army turned to technology to generate greater combat power.

In doing so, however, the Army encountered two persistent problems. First, when a new system was put into the hands of soldiers, actual field performance did not always meet the standards predicted during the system's development. For example, a system designed for a 90 percent chance of a first-round hit actually achieved only 30 to 50 percent when fired by soldiers. Second, the replacement of an existing system with a technologically complex system generated requirements for more highly skilled soldiers and a higher ratio of soldiers per system for operators, maintainers, and support personnel.

These systemic problems could only be solved by putting more systems in the field; recruiting more highly skilled soldiers; expanding training programs (as well as increasing training dollars); and increasing the size of the Army. This approach unfortunately led to additional problems. In the 1960s, Dr. John Weisz, Director of the U.S. Army Human Engineering Laboratory at Aberdeen Proving Ground, pointed out that we can no longer afford to develop equipment and merely hope that the necessary manpower can be found to operate and maintain it in a relatively short time. The cost of training and time available to conduct it on a mass basis may not permit this process under wartime conditions.

In 1980, Generals Walter T. Kerwin and George S. Blanchard surfaced their concerns about mobilization, readiness and sustainability brought on by increases in weapon complexity. They concluded that human performance assessments were often not integrated and made too late to influence the design stages of the system acquisition process. Supporting their conclusion, the General Accounting Office (GAO) published reports in 1981 and 1985 which attributed 50 percent of equipment failures to human error and stressed the need to integrate manpower, personnel and training (MPT) considerations into the system acquisition process.

The Solution—MANPRINT

In 1982, during his tenure as Army DCSPER, General Maxwell R. Thurman tasked the U.S. Army Research Institute (ARI) to look at the development process of several recently fielded weapon systems. He further directed ARI to tell him what the Army could have done differently to better integrate MPT issues. This initiative, known as the Reverse Engineering Project, showed that the integration of MPT considerations early in the design process could have made a difference. At this point, General Thurman directed that a manpower and personnel integration program be initiated. The term "MANPRINT" was actually coined in 1984 by General Richard H. Thompson, Commanding General of the U.S. Army Materiel Command and was used to identify this new program. Starting as a Special Assistant Office in 1986, it became an official Directorate in the Office of the Deputy Chief of Staff for Personnel (ODCSPER) in 1987.

In 1991, MANPRINT was expanded to include Automated Information Systems (AIS). This expansion came in response to numerous complaints that AIS were not being designed to maximize soldier-system performance.

The Program

MANPRINT is a comprehensive management and technical program designed to improve total system (leader, unit/soldier, and equipment) performance by focusing on the human requirements for optimal system performance. This is achieved by examination of optimal allocation of total system functions and tasks to man, machine, or a combination, and to the continuous integration of Personnel Capabilities, Manpower, Training, Human Factors Engineering, System Safety, Health Hazards and Soldier Survivability considerations throughout the system acquisition process. Each consideration is called a "domain." A brief explanation of each domain is given below:

- Personnel Capabilities: The cognitive and physical capabilities required to be able to train for, operate, maintain, and sustain materiel and information systems.
- Manpower: The number of military and civilian personnel required and potentially available to operate, maintain, sustain, and provide training for systems.
- Training: The instruction or education, and on-the-job or unit training required to provide personnel their essential job skills, knowledge, values and attitudes.
- Human Factors Engineering (HFE): The integration of human characteristics into system definition, design, development, and evaluation to optimize human-machine performance under operational conditions.
- System Safety (SS): The design features and operating characteristics of a system that serve to minimize the potential for human or machine errors or failures that cause injurious accidents.
- Health Hazards (HH): The design features and operating characteristics of a system that create significant risks of bodily injury or death; prominent sources of health hazards include: loud noise, chemical and biological substances, extreme temperatures, and radiation energy.
- Soldier Survivability (SSv): The characteristics of a system that can reduce fratricide, detectability, and probability of being attacked, as well as minimize system damage, soldier injury, and cognitive and physical fatigue.

An Additional Domain

In the wake of Operation Desert Storm, an important lesson learned was that incidents of attack from friendly units (fratricide) had to be reduced. It was also reaffirmed that increases in enemy detection and recognition capabilities, coupled with the expanding lethality and range of modern weaponry, could seriously limit the ability of the U.S. soldier to survive future battles. The then Chief of Staff of the Army, General Gordon R. Sullivan, stated that the Army could not accept casualties that could be prevented by proper Research,

Development and Acquisition (RDA). Thus, attention had to be focused on soldier survivability.

Many believed that soldier survivability (SSv) was a subset of system survivability. System survivability had been historically oriented toward hardware survivability; generally accepting the thought that if the system

survives, then the soldier survives, which is not always the case.

In 1992, the DCSPER, Lieutenant General Thomas P. Carney, proposed a way to resolve this issue. He suggested including SSv as a seventh domain in the Army's MANPRINT program. This approach provided written guidance and a means of assessing enhancements introduced into new materiel and soldier systems to increase chances of survival. In 1994, the U.S. Army Research Laboratory was given responsibility for SSv, and it was officially added as the seventh domain of MANPRINT.

Soldier Survivability Defined

Soldier survivability is more than vulnerability (a quantitative measure of a soldier's susceptibility to damage) and vulnerability reduction (measures to reduce or eliminate the effects of combat damage mechanisms). Soldier survivability is defined in terms of the soldier and system:

SOLDIER: Those system characteristics that enable soldiers to withstand (or avoid) adverse military action (both friend and foe) or the effects of natural phenomena (heat, cold, deep water, etc.) that could result in a loss of life or capability to continue effective performance of the prescribed mission.

SYSTEM: Those characteristics that promote reduced:

- fratricide;
- detectability of the system;
- probability of attack on the system, if detected;
- vulnerability, if attacked.

Benefit of MANPRINT

MANPRINT is a winning proposition for everyone involved. The Army wins with MANPRINT because emphasis on total system performance produces synergistic effects for people, equipment and organizations. Industry also wins through adherence to MANPRINT principles because products, whether designed for military or commercial application, are less costly to staff and train to operate and maintain. Above all, MANPRINT optimizes total system performance and at minimum cost.

Throughout the design and development phases, MANPRINT ensures that:

- system operation, maintenance, training, and support requirements are matched to personnel availability;
- systems become increasingly user-centered, trainable, reliable, and maintainable; and
- life cycle costs are reduced through minimizing or eliminating specialized skills and tools for user-level maintenance.
- total system performance is optimized at minimal life cycle costs by proper assignment of functions to man or machine.

In 1984, Allison and Garrett formed the Light Helicopter Turbine Engine Company (LHTEC), a partnership that won the Army's contract to develop an engine that would power the Comanche helicopter. The team approached MANPRINT integration principles with vigor and developed a program organization where communication, commitment, feedback and user influence prevailed on the designers.

This approach resulted in a capable and highly supportable engine, the T800, which surpassed all Army reliability and maintainability requirements. In contrast with predecessor engines, the T800 requires fewer personnel to perform flight-line maintenance. User training requirements are also significantly reduced. LHTEC's approach resulted in numerous innovative solutions to field maintenance and support challenges. For example, only six common handtools are needed to perform user-level maintenance, translating into a 76 percent reduction in depot tool inventories.

Human Systems Integration

The importance and success achieved by the Army's MANPRINT program has led the Office of the Secretary of Defense to adopt the concept for the entire Department of Defense. MANPRINT is included, under the descriptive name of Human Systems Integration, in DoD Regulation 5000.2-R, 1996.

Future

In addition to expanding MANPRINT's influence in the areas of soldier survivability and Automated Information Systems, future directions of the MANPRINT program include:

- MANPRINT assessments of the effect of multiple systems within a unit. This "unit assessment" would translate the gains MANPRINT has made at the single system level (tank, aircraft, radio) to the unit level (e.g., crew/squad, platoon, company, battalion, and brigade).
- Inclusion of MANPRINT principles at the very inception of a system--at the requirements level. The most efficient approach to this is to have MANPRINT influence the requirements generation process in the U.S. Amy's Training and Doctrine Command's (TRADOC's) Battle Labs.
- Incorporation and evaluation of MANPRINT considerations in the development and use of simulation and models before full scale field tryouts for prototype systems.

Conclusion

Since its inception, MANPRINT has done and continues to do much to improve total performance of Army systems. It enhances combat capabilities, reduces maintenance time, enhances supportability, and decreases operation and support costs over the life of the system. In sum, MANPRINT enables the Army to optimize total system effectiveness.

A MANPRINT Example

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