MANPRINT BULLETIN

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A Comparison of Manpower, Personnel and Training (MPT) in the Services

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In each of the services, the acquisition process is a complex undertaking that involves developmental, validation, and approval phases. Of prime importance, beyond the total cost of developing the system, is the cost of operating, maintaining and supporting the system throughout its operational life. Dramatic increases in manpower, personnel, and training (MPT) support costs have made it necessary to pay careful attention to these factors early on in the acquisition process. Over the past decade, each of the services has been forced to reevaluate the role of MPT during weapon system design and development.

Each service independently acquires, operates, and maintains its weapon systems. Although each reviews the other's requirement documents to determine joint applicability, lessons learned during acquisition are only partly shared. Also, each service's acquisition organization is large and subdivided into functional areas of responsibility. In the past, changes that have occurred during weapon system development often affected more than one element, but individual planners did not thoroughly communicate and coordinate their efforts. Performance (along with cost and schedule) was given primary consideration in weapon system acquisition at the expense of supportability. Because of this, system inefficiencies sometimes plagued the equipment after fielding. Further, the need to use fewer people with a greater range of skills in order to limit the total number required to operate and maintain weapon systems is now evident. Each of the services is aware of these problems and has initiated programs to address the "people factors" during weapon system acquisition.

DOD Directive (DODD) 5000.53," Manpower, Personnel, Training and Safety [MPTS] in the Defense System Acquisition Process," requires all of the services to demonstrate MPTS planning. Along with service-level planning and guidance, increased use of analytical methologies to assess/project MPT resources is critical to more thorough resource planning.

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The Army's Approach

The Army's MANPRINT (Manpower and Personnel Integration) program, developed in the early 1980s, is a centrally managed and structured program to ensure that an acquisition meets operational, organizational, and technical requirements. New equipment must be designed with the soldier in mind. With the MANPRINT initiative, the Army made the decision to "equip the man" rather than "man the equipment."

MANPRINT is an all-encompassing institutional strategy and mechanism for ensuring that adequate attention is paid to manpower, personnel, training, human factors, safety, and health hazards considerations early in the acquisition process. All Army acquisitions must be "MANPRINTed," and contractors are getting the word through the Request for Proposals (RFP). The program aims to:

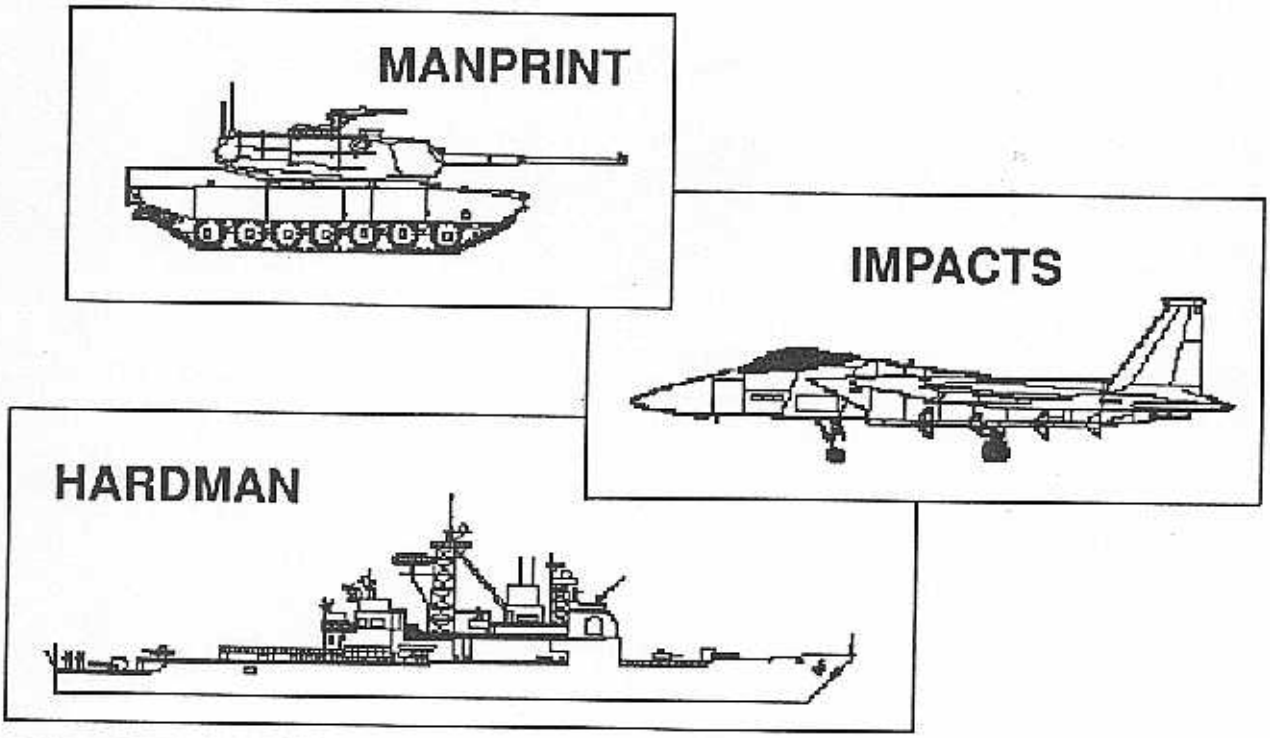
- get "people issues" considered earlier, more coherently, and more thoroughly during weapon system design and development
- relate human performance to total system performance as a function of alternative designs, alternative performance contexts, and mission requirements
- better plan and budget Army MPT resource requirements for all new equipment
- focus Army R&D efforts on human factors, man-machine design, and MPT resource definition relevant to acquisition.

MANPRINT policy, procedures, and responsibilities are discussed in Army Regulation 602-2, " Manpower and Personnel Integration (MANPRINT) in the Materiel Acquisition Process." AR 602-2 requires that MANPRINT " be accorded equal priority with all other system characteristics to assure effective soldier-machine interface." MANPRINT responsibilities extend to all Army Commands and agencies involved in systems acquisition. Primary staff responsibility rests with the Office of the Deputy Chief of Staff for Personnel (ODCSPER). The Soldier Support Center-National Capital Region (SSC-NCR) is responsible for MANPRINT training.

The Navy's Approach

The HARDMAN (HARDware/MANpower Integration) program, approved in 1985, is headed by the HARDMAN Development Office in the Chief of Naval Operations (now OP-123F) Office with a small support staff at this level. OPNAVIST 5311.7 mandates that HARDMAN will be applied to all new Navy acquisitions.

The Navy's approach is similar to that of the Army's. HARDMAN involves a set of procedures, analytical techniques, and models to be used during



system development to assess the human resources impacts of alternative designs in order to identify MPT constraints. These analyses are done early enough to allow trade-off or design alternatives to be consciously and deliberately performed. Also, through HARDMAN, MPT requirements that emerge from the design process can be tracked, aggregated, and budgeted for while providing a clear audit trail for future analysis.

HARDMAN is used during the earliest phases as a comparability analysis of the developmental weapon system and the system being replaced. Historical data on the predecessor is used as a baseline to estimate the likely performance of the new system after technology improvements and context changes have been taken into account.

HARDMAN also helps to identify MPT requirements from program initiation through development (or modification) and deployment by way of a more rigorous, detailed analysis. As the opportunity to influence design through comparability data wanes after the concept development phase, HARDMAN becomes an MPT requirements tracking tool.

HARDMAN methodology encompasses three separate types of analysis that correspond to three primary types of Navy acquisitions: Equipment/ System/Subsystem (E/S/S); Total Aviation Squadron; and Total Ship. Each of these methods involves the same five basic steps:

1. Collect Preliminary Data/Conduct System Analysis.
2. Conduct Comparability Analysis.
3. Develop an MPT Concept.
4. Develop MPT Resource Requirements.
5. Develop Program Documentation Input.

HARDMAN is enhanced by the HARDMAN Information System (HIS), a computer-based data bank containing the identity and deployment of new systems, manpower and training requirements for each acquisition program, and aggregate MPT requirements Navy-wide. It is used for planning and budgeting as well as for early trade-off analyses and design supportability assessment.

As soon as HARDMAN program data are available, a Supportability Analysis Methodology (SAM) is conducted on the new acquisition program to determine whether the introduction of the new system will create any significant Navy-wide manpower or personnel supportability problems. HARDMAN also uses the Force Analysis Simulation Technique (FAST) to apply projected gains and losses data to the current personnel inventory.

HARDMAN Guides, a series of training guides, and a program manager's guide have been published. Because there is little in-house capability, the Navy has normally contracted for HARDMAN analyses.

The Air Force's Approach

While the Air Force led the development of advanced analytic tools and data systems for assisting in MPT integration into weapon systems, it has not consistently applied available tools and data systems within a coherent framework. Numerous conferences, studies, and reports have led to an increasing awareness and determination to improve coordinated MPT system-support planning.

Since the sixties, the Air Force has sought to use human factors engineering to increase aircraft compatibility with human operators. Less attention has been given, however, to optimizing the maintenance and supportability factors that are also an integral part of weapon systems in a combat environment. Programs and analytical tools have been developed by the Air Force to aid in integrated MPTS planning related to developmental weapon systems, and have helped the Air Force in a piecemeal fashion. Some of these have been adapted by the other services to unify their MPT planning and analysis.

In 1986, the Air Staff, Air Force Systems Command, and the Air Training Command jointly initiated a model MPT organization at Wright-Patterson Air Force Base in the Aeronautical Systems Division (ASD/ALH) to integrate MPT planning earlier in the acquisition process. (Safety [S] was added to the Air Force MPT effort later. Since safety is handled separately in the Air Force, it was not added to the ASD/ALH charter.) ASD/ALH aims to quantify MPT impacts on individual developmental weapon systems and elucidate MPT concepts and design options and their influence on total force effectiveness. This multi-disciplinary group has already influenced several future weapon systems designs, and has led the way to greater emphasis of MPT planning and integration at ASD.

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MPT in the Services (continued from page 3)

The Air Force, realizing the need to give early MPTS planning the required emphasis throughout the Air Force, recently launched the IMPACTS (Integrated Manpower, Personnel and Comprehensive Training and Safety)program. The program will emphasize MPTS integration in order to better plan, design, and build weapon systems that are operable and supportable with the people resources that will be available in the coming decades.

IMPACTS will benefit from existing tools to help in MPT planning and analysis. These include the Advanced Training System (ATS), the Computer Supported Network Analysis System (CSNAS), CROSSWALK, FOOTPRINT, R&M 2000, RIVET WORKFORCE, RIVET Train Training Analysis Support Computer System (TASCS), and the Logistics Composite Model (LCOM).

Policy Comparison

The Army

The Army has developed one source for policy guidance: AR 602-2 , "MANPRINT in the Materiel Acquisition Process (July,1986)," requires use of MANPRINT for all Army acquisition programs.

The Navy

The Navy has developed one source to guide MPT planning: OPNAVINST 5311.7, "Determining MPT Requirements for Navy Acquisitions (August 1985)," mandates the use of HARDMAN for all acquisition programs.

The Air Force

Regulations and guidance sources include: AFR 57-1, "Operational Needs," requires identification of manpower constraints prior to new program initiation; AFR 800-8 , "ILS Program," requires evaluation of alternative concept implications on support resources, including MPT, prior to program initiation, and MPT analysis throughout WSAP; AFR 50-8, "Policy and Guidance for ISD," requires development of training systems and training resource requirements from program initiation throughout the life of a weapon system; AFR 800-16, "USAF System Safety Programs," requires safety consideration during operational need determination and throughout the WSAP.

Approximately 40 other regulations relate to MPTS activity in the weapon system acquisition process. The Air Force is currently working on a draft regulation to tie together the MPT requirements for acquisition planning. Under USAF Acquisition Regulation Streamlining, IMPACTS program direction will soon be found largely in AFR 800-3.

Organizational Comparison

The Army

The DCSPER MANPRINT Office develops Army policy relating to MPT. Combat developers and materiel developers apply MANPRINT to new programs. MANPRINT methods and tools are developed by the Army Research Institute, while the Army Materiel Command maintains MANPRINT data bases. The Army Health Services Command prepares health hazard assessments for new systems, and the Army Human Engineering Laboratory assesses HFE requirements. The Training and Doctrine Command develops and conducts MANPRINT training.

The Navy

OP-111C implements and manages the HARDMAN program, develops HARDMAN procedures, and performs HARDMAN training. OP-11G maintains the HARDMAN Information System. Navy Systems Command, through the MPT offices, applies HARDMAN methodologies to new programs. Participating commands act as members of the MPT Advisory Board to support program managers.

The Air Force

HQ USAF/Requirements and Organizations Division of the Directorate of Manpower and Organization (PRME) has recently assumed responsibility for implementing the IMPACTS program. A Colonel-level steering committee, made up of representatives from various concerned organizations, lends guidance to the program. The ASD/ALH prototype organization supports MPTS planning and analysis for one of the Systems Command product divisions. The Air Force Human Resources Laboratory (AFHRL) is responsible for development of MPTS tools and analytical techniques. The Air Force Inspection and Safety Center (AFISC) advises the program managers on safety matters.

Procedures and Guides

The Army

The Army has published the "HARDMAN Comparability Methodology (HCM) Guide" and "Manpower Requirement Criteria (MARC) and Staffing Standards," along with various HFE and system safety regulations. The Army also has a series of training courses to provide MANPRINT background information to decisionmakers, mid-level managers, and MANPRINT analyses.

The Navy

The Navy has published the "HARDMAN Methodology Guide;" the "HARDMAN Document Review Guide;" the Program Manager's Guide to Early MPT Planning;" the "Supportability Assessment Methodology;" an "MPT Data Source Directory;" and OPNAVINST 1500.8M, "Navy Training Planning Process in Support of New Developments." The Navy also has Manning Document Preparation guides and a HARDMAN Training Workshop.

The Air Force

The Air Force has a myriad of analytical techniques and models. The Air Force also has programs to institutionalize reliability and maintainability advances (R&M 2000) to orient industry engineers to operational and maintenance problems in the actual environment (Blue Two visits) and others, some of which we have described earlier.

Summary

The Army

- The Army considers manpower, personnel, training, system safety, health hazards, and human factors engineering under one program.
- The Army starts with requirements and available manpower, followed by technology available, and engineered to put the human element first.
- Supportability is addressed by MPT analysts during system analysis.
- Policy issue and technical requirements are the responsibility of separate commands.
- System is fairly complex, requiring high level of effort, produces various reports, and an audit trail.

The Navy

- The Navy considers MPT only as part of HARDMAN. Safety and HFE are managed as part of the design process.
- The Navy starts with requirements, followed by technical solutions adjusted for manpower supportability (man the equipment).
- Supportability is assessed on a Navy-wide context by the OPNAV staff.
- Policy issues along with technical requirements are managed by one office.
- HARDMAN is straightforward, systematic, producing standardized products and a complete audit trail.

The Air Force

- The Air Force considers MPTS under one program. HFE is managed as part of the design process.
- The Air Force starts with requirements, followed by technical solutions adjusted for manpower supportability. Crew and operator human factors engineering seems to have much higher priority than maintenance and support people factors.
- IMPACTS program elements and protocol are under development.

The Army and Navy have completed the centralized structure of their MPT programs and are currently working to fill in the structure with analytical techniques, manager and analyst training, and operating memorandums to sharpen the focus of mid-level policy execution. The MANPRINT and HARDMAN programs are now well publicized throughout the services and industry. Though the Air Force still leads in terms of analytical techniques, human factors integration for operators, and lower-level structure, it has yet to complete a top-level structure to provide central guidance and direction to an overall, integrated IMPACTS program.

In a way, MPT integration is a mindset. It is the belief that by working together, and by upgrading and developing the necessary analytical tools, data bases and networks, government and industry can reduce the life-cycle costs of U.S. weapon systems while enhancing mission accomplishment. If we all pull together, it will happen.

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Integrating Soldier/User Concerns and the Needs and Constraints of the Tactical Battlefield

Theodore Marton, Ph.D.
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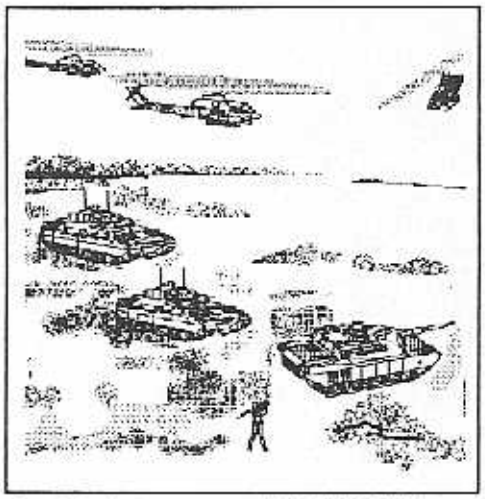
There are numerous critical issues that should be considered during the development of manned military equipment destined for deployment to tactical battlefields. Included are those associated with the accommodation of the man-related requirements and constraints imposed on the developing design by the environmental and operational characteristics projected for the modern tactical battlefield. These characteristics might include:



- the human and equipment-related stressors present in current and future **combat scenarios** within which the weapon or support system must function
- the anticipated impacts of the physical and man-made **operational environments** normal to modern tactical combat
- the physical and emotionally disruptive effects of exposure to the **threat elements and tactics** typically used by the opponent forces **on both the hardware and its manned component**.

There have been enormous advances in the range, lethality, speed, mobility, variety, and accuracy of offensive and defensive weapon systems, as well as increased capabilities in surveillance, intelligence processing, and communications. Thus, future tactical battlefields will involve intensive, fast-moving, wide-ranging and deep actions that will continue around the clock and under almost all weather conditions.

The modern tactical battlefield will no longer be limited to a narrow operational area of combat twenty or so miles deep. Instead, it will involve a zone of vulnerability that can extend two or three hundred miles behind the "line of engagement," where men, equipment and stores are both in jeopardy and capable of initiating or supporting direct strikes against the enemy force. The implications (both positive and negative) of these new battlefield characteristics on the man-related concerns of military systems require the integrated and comprehensive consideration and accommodation provided by the MANPRINT process. Although each of the six MANPRINT domains (Manpower, Personnel, Training, Human Factors, Health Hazards, and System Safety) must give specific consideration to the types of concerns generated by modern tactical battlefield scenarios, inputs from the human factors and training domains are of particular importance.

Human Factors Considerations

Human factors specialists are responsible for detecting, identifying, describing, and, as appropriate, quantifying the types and magnitudes of significant man-related stressors anticipated in the modern tactical battlefield in which the developing item is expected to function. A description is then developed of these stressors' ability to modify the performances of the user, his equipment, or the critical man-machine interfaces needed to sustain mission-critical functions at acceptable levels.

Human factors specialists are further charged with the responsibility for providing man-related conceptual and quantitative design and operational guidance, standards, and criteria needed to achieve and sustain the required functional capabilities of the

manned system. At the same time, the human factors specialist must work to eliminate or minimize avoidable threats to the user's safety or well-being, while making the best possible use of military personnel and other limited resources. In addition, the human factors specialist must gauge the total system's ability to survive and function at acceptable levels during routine, degraded, and emergency situations that are likely to occur in the projected battlefield scenario.

The preceding information must be provided to design teams as early as possible during the development process to maximize the probability of its integration in the developing design and to ensure that all six MANPRINT domains are using the same man-related standards and other design drivers. Such early or initial information will of course be based on the best data available at the time. Unfortunately, such "best data" is structured on educated guesses and conjecture driven by tentative, conceptual versions of the proposed system. As a result, all participants must be aware of, and allow for, the iterative nature of early human factors (and other) outputs which must be continuously updated to reflect the evolving hardware, software, operational, tactical and scenario requirements of the maturing design.

Finally, the proponents for the human factors domain are required to design, implement, analyze, and apply the results of test programs. These test programs are intended to verify that the tested system or item can effectively and safely carry out its assigned mission objectives in the anticipated wartime scenarios. If the test results are negative, the findings should help identify and describe the modifications needed to achieve the desired results.

Training Considerations

To paraphrase a widely quoted homily (whose author I have not established):

> *"Although the tactical battlefield in wartime is the ultimate test of a manned military system, it should not, and must not, be the ultimate school."*

MANPRINT training specialists must structure and focus all facets of original, sustaining, or updating training development to ensure that the user is trained to effectively and safely implement mission responsibilities under the projected real world wartime operational conditions and scenarios. In addition, training schedules must be structured to ensure that the user will have all necessary knowledge and skills needed for safe and effective application of the system well before deployment.

The knowledge and skills developed in standard classroom instruction are not usually sufficiently transposable to ensure effective performance in the atypical, unsupportive, and threatening settings frequently associated with tactical or other wartime operational settings. It is seldom safe, feasible, or necessary to replicate all of the degraded or unsupportable conditions, hazards and other stressors of the wartime tactical battlefield for effective new system training. What is essential, however, is the inclusion of selected key learning and testing opportunities needed to safely and effectively operate and maintain the system under wartime field conditions.

Trainers must make every effort to maximize their understanding of the major performance modifiers that are expected in the system's wartime environment (especially the tactical battlefield). With this understanding, the unique impacts and training implications can be considered and accommodated within the constraints imposed by available resources, schedules, and safety considerations.

Trainers must use their knowledge of the system's projected operational scenarios and the characteristics of the modern tactical battlefield to establish the types, frequencies, and probabilities of man-related casualties that can be expected during wartime conditions. This information is essential in order to accurately estimate and accommodate training pipeline needs, cross-training requirements, personnel skill allocations, etc., for wartime deployments.

In summary, all MANPRINT proponents involved in a manned military systems acquisition (especially those in human factors and training) must consider and accommodate the implications placed on their particular domain by the degrading influences imposed on men and equipment by factors in the tactical battlefield.

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Danger Inside the Cockpit

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Editor's Note: This article is a shortened version of an article that appeared in the May/June 1989 issue of MILITARY FORUM.

June 19, 1988 is a day many U.S. Air Force officials in Europe would just as soon forget. On that day, three of their front line F-16 fighters crashed within their borders. Even for fighter pilots aware of the constant risk, being dealt three in one day at a single command was ominous.

In all, NATO lost more than 100 jet fighters in crashes during a 12-month period ending last October. The U.S. Air Force accounted for 40 of those losses. Air Force officials estimate that roughly two-thirds of those accidents were caused by pilot error.

Unofficially, Air Force and Navy officials say one form of pilot error—"controlled flight into terrain"—now accounts for a greater percentage of crashes than ever before. "Controlled flight into terrain" is the aircraft equivalent of a one-car accident on a deserted highway. A pilot, perhaps disoriented by the unprecedented gravity-pulling power of his modern fighter or distracted by its overwhelming complexity, drives a perfectly sound aircraft into the ground. "This type of crash is probably the best indication," says Capt. Robert Hughes of the Naval Air Systems Command, "[that] a pilot has lost sight of his first task, which is to maintain where he is in relation to the ground."

If a significant number of fighter pilots are flying their aircraft into the ground, how many are disoriented enough to prove ineffective in combat? Even the most experienced pilots admit that they turn off the aircraft's warning and information systems in stressful situations to avoid becoming hopelessly confused. Yet some of those very systems are the foundation upon which Navy and Air Force officials base their prediction that our pilots will be able to fight and win at fairly good odds.

Ergonomic experts say the cockpits are the problem, a culmination of a thirst for high-technology sophistication and performance that was rarely tempered by human factors concerns, such as pilot workload. Yet, the trend toward more complex, single-seat, multimission military aircraft continues unabated. The combat pilot's job promises to become harder still.

Nor have inflight training hours kept pace with the rapid change in aircraft design and capability. With pilots already showing signs of reaching physiological and mental saturation, critics question the wisdom of a strategy that continually stretches the flight envelope with little regard for human boundaries. Says Charles Meyers, former director of air warfare for the Department of Defense (DOD), "You give a pilot so much information that he can't absorb it, so he shuts the system off." Meyers claims that as we've continued to broaden the mission capability of our airplanes, the amount of flying time we give pilots has not been enough to keep them proficient at any one mission, much less all of them.

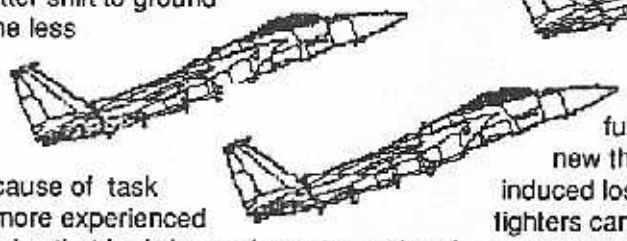
Aside from pilots who have seen actual combat, perhaps no group better understands the subtle dynamic that separates a decisive edge in combat capability from potentially debilitating overload than the pilots who prowl eight million acres of arid, highly restricted Nevada desert at Nellis Air Force Base.

Nellis' Red Flag exercises constitute the largest peacetime force-on-force engagements of combat aircraft in the world. For the first time many pilots see their entire attack package assembled and in the air. Pilots in ground support A-10s must coordinate strike routes and mid-air refueling schedules with deep interdiction squadrons, both of which rely on air-superiority fighters, such as F-15s and F-16s, and the directions of command and control aircraft. "Enemy" ground threats and targets are equally well represented, with the 64th and 65th Aggressor Squadrons acting as Soviet-style sparring partners. These pilots fly small F-5s with smokeless engines painted to approximate the similarly maneuverable and hard-to-spot Soviet MiG-21.

Air Force studies indicate that during the Vietnam War, it took a pilot ten combat missions before he was experienced enough to rate a good chance of survival. Given advances in the lethality of modern

aircraft and the numbers that would be involved in an all-out air war over Europe, many experts say U.S. pilots will not have the luxury of getting ten missions to become acquainted with mind-numbing complexity of combat.

This realization was the impetus behind Red Flag. Recognizing that task saturation is a way of life for modern pilots, Red Flag officials take pilots to the limits of their workload and capability, hoping to stretch their personal "envelope." They look for signs that the pilot is adjusting his priorities to reflect a changing combat environment. A fighter pilot flying at 1,500 feet, for instance, may be looking over his shoulder for enemy fighters. If he takes his fighter down to 250 feet or less, however, his attention had better shift to ground avoidance. The less experienced pilot fails to adjust his priorities appropriately because of task saturation; a more experienced pilot will recognize that he is becoming saturated and will begin to ignore certain systems and threats. His survival depends on it.

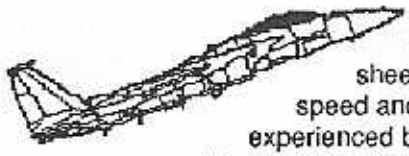


Red Flag officials tell the story about the pilot who became so wrapped up in avoiding an aggressor on his tail that he literally skipped his jet off the desert floor. He was one of the lucky ones. A 1984 tally of Red Flag casualties found that since its inception in 1975, 34 aircraft were destroyed and 33 aircrew members killed in Red Flag exercises. Of those deaths, more than two-thirds were "controlled flight into terrain."

While many of the new systems that are continually added to U.S. fighters are designed to increase the pilot's critical "situational awareness," cockpits have reached a stage of complexity where the warnings may have exactly the opposite effect.

The myriad information systems and warning indicators in the modern cockpit sprang up in reaction to various revolutions in air combat. Today, air borne command planes direct fully integrated and fluid strike teams in far more effective yet complex attack plans. That in turn has led to an emphasis on communications jamming and the era of electronic countermeasures. Look-down, shoot-down radars and beyond-visual-range missiles have meanwhile greatly expanded the lethal zone of battle that pilots must constantly monitor.

But even as advancements in air warfare have put far more capable and complex offensive and defensive systems at the fingertips of combat pilots, they have also greatly reduced the time pilots have in which to react to their increasingly lethal environment. The result, says one expert, has been to make the job of combat pilot "the most difficult in the world in terms of complexity, lethality and stress."



Underscoring that claim is the sheer increase in speed and gravity (G) force experienced by pilots in modern fighters. Only in the early 1980s did Air Force and Navy officials begin to fully realize that their pilots faced a deadly new threat from within, known as GLOC, for G-induced loss of consciousness. Today's front-line fighters can pull up to nine Gs and more before risking structural damage. At those pressures, however, the blood vessels in a pilot's arms pop, his head slams into his chest, and temporary blindness sets in as the blood drains from his brain. If he does not ease off on the stick, he will probably black out.

Yet in combat—even simulated combat—the temptation to stay on the stick can prove overwhelming. Turning tighter than your enemy can make a difference between getting waxed or making a clean getaway, between overshooting your prey or making a clean kill. Since 1982, the Air Force attributes 14 class-A mishaps (its worst category of aircraft accident) strictly to GLOC.

The problem is not so much the unprecented level of G-forces, but rather the speed at which aircraft like the F-16 and F-18 can reach those critical forces. An F-16 can go from zero to nine Gs in less than three seconds. With the high G-onset rate of today's fighters, pilots can lapse into unconsciousness before experiencing any physiological symptoms.

But even short of causing an actual blackout, the G-forces regularly produced by today's modern combat maneuvers may have a debilitating effect on pilot performance. Researchers are only now beginning to understand some of the implications this

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Danger (continued from page 9)

added form of physiological stress has in the area of pilot workload and potential task saturation. Studies have drawn a strong correlation beween sustained acceleration and significant increases in a pilot's mental workload. Another study found that a pilot's performance in the cockpit deteriorates measurably as G-forces increase. Perhaps most significantly, researchers suspect G-forces play a part in what they call "spatial disorientation," the single most common cause of mishaps and crashes attributed to operator error in the Air Force.

Since the 1960s, the percentage of mishaps attributed to spatial disorientation has almost quadrupled. The primary causes are the increased maneuverability of modern aircraft, as well as increased mission demands on pilots. In addition, much of the instrument panel of modern aircraft today is devoted to things that have nothing to do with a pilot's primary flight reference displays. He can easily lose sight of his number one task of controlling the aircraft.

Experts concede that while both the aircraft's and the combat pilot's jobs have become more complex, cockpit design has remained fundamentally unchanged. In the cockpit of the F-15 fighter, for example, there are 11 switches on the control stick and an additional nine on the throttle. The pilot has to know which critical function and bit of information is represented by each of the 300 switches and 75 different displays in the cockpit. Says Wayne Martin, chief of visual display systems at the Air Force's Armstrong Aerospace Medical Research Laboratory, "As more and more systems were integrated into the airframe, little thought was given on how best to display that information to the pilot." According to Martin, analyses based on pilot interviews have indicate that as much as 80 percent of the information displayed in a combat aircraft's cockpit has little to do with keeping the pilot alive in combat, and "in the end they frequently don't believe [all] the information, or they just turn the information off." Or they try to juggle each new bit of information until a critical mass is reached, and the entire juggling act comes tumbling down along with the aircraft. Researchers have found that when people have to switch from one task to another without completing the first job, they are more likely to make errors. At a certain point, performance starts to break down "catastrophically."

Designers have managed to update modern cockpits to help pilots avoid crossing into the red while skirting the thin line between optimum performance and task saturation. Head-up displays that project information at eye level help keep the pilot's eyes "outside" the cockpit, and multifunction displays reduce the number of separate gauges a pilot must scan. One audio warning system has been designed that will alert a pilot when he has reached "bingo" fuel, or just enough fuel to return to base or ship.

This device could be expanded from monitoring on-board systems to vocally listing outside threats in a coherant hierarchy beginning with the most urgent. But researchers concede that the integration algorithms are a nightmare, and that pilots are reluctant to delegate what is in effect a judgement call in a fluid combat environment. Overcoming such skepticism will require a system whose software can be constantly upgraded.

Researchers are currently developing the user-friendly cockpit of the future. The problem of overload, however, will prove difficult to address in the current crop of combat aircraft. Human factors experts are forced to react to problems that were locked into aircraft hardware years before, when human factors engineering was in its relative infancy.

Given the growing seriousness of the task-saturation problem, Air Force and Navy officials probably have little choice but to try to relieve pilots of as many noncritical responsibilities as technology and advances in artificial intelligence allow. Even so, certain developments in aircraft design, such as the military's growing preference for single-seat combat aircraft, for example, promise to make the job of combat pilot more treacherous still.

"Technology has allowed us to go to a single-seat combat aircraft, but the drivers were purely economical," says Red Flag's Martin. Even as technology is harnessed to address some of the failings of older cockpits, aircraft designers are continually adding new capabilities and mission demands. This has pushed training demands higher. Some pilots are unable to log the minimum hours per month flying time their mission demands.

Training is the real limitation to all this new technology, says one Air Force pilot. Training is key to limiting pilot overload, yet the Air Force has been forced to scale back its Red Flag rotations from four to three a year. Pilots use Red Flag as the culmina-

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MANPRINT Training for Industry

Army MANPRINT training is available to industry. The current MANPRINT Staff Officer Course (MSOC), MANPRINT Senior Training Course (MSTC), and MANPRINT General Officer/Senior Executive Service Seminar (GO/SES) have openings for students from industry. The purpose of the MANPRINT course is to train military and civilian personnel to integrate manpower, personnel, training, human factors engineering, health hazards, and system safety considerations throughout the materiel development and acquisition process. The three-week MSOC is directed toward action officers. The one-week MSTC is directed toward individuals who manage the acquisition process, and the one-day GO/SES seminar (Day 1 of the MSTC) is directed toward senior managers.

In order to facilitate registration in the MANPRINT training courses, request the government contracting office responsible for your contract review the current contract to determine whether a training fee is reimbursable under the government contract. If the fee is reimbursable, there is no charge for registration.

A letter from the government contracting officer stating that the fee is chargeable to your contract eliminates the fee requirements. The letter must be presented to the SSC-NCR course manager at registration.

There is a registration fee required for all MANPRINT course attendees who are not affiliated with the Department of Defense (DOD) and do not qualify for relief of fees as stated above. DOD military and civilian personnel will continue to attend all MANPRINT courses without cost. Registration fee for industry personnel is as follows:

One day GO/SES Seminar - $240.00
One-week MSTC - $600.00;
Three-week MSOC- $1550.00.

Method of payment is Certified Check, payable to: TREASURY, UNITED STATES, and brought to the course training site for collection on the first day.

The FY89 and FY90 schedule of courses is shown below. The GO/SES course is always Day 1 of the MSTC.

MANPRINT Senior Training Course (MSTC)

25 Sep - 29 Sep 89
27 Nov - 29 Nov 89
08 Jan - 12 Jan 90
12 Feb - 16 Feb 90
19 Mar - 23 Mar 90
16 Apr - 20 Apr 90
14 May - 18 May 90
18 Jun - 22 Jun 90
23 Jul - 27 Jul 90
20 Aug - 24 Aug 90
24 Sep - 28 Sep 90

MANPRINT Staff Officers Course (MSOC)

11 Sep - 29 Sep 89
16 Oct - 03 Nov 89
27 Nov - 15 Dec 89
22 Jan - 09 Feb 90
05 Mar - 23 Mar 90
02 Apr - 20 Apr 90
30 Apr - 18 May 90
04 Jun - 22 Jun 90
09 Jul - 27 Jul 90
06 Aug - 24 Aug 90
10 Sep - 28 Sep 90

For additional information, please contact Mr. Ashley or Dr. Engler at AV 221-3707/3709 or COM (202) 325-3707/3709.

Successful MANPRINT Practitioner's Conference Held in June

A MANPRINT Practitioner's Conference was held June 20-21,1989 in Alexandria, Virginia. Sponsored by the ODCSPER MANPRINT Directorate, the conference aimed to bring representatives from throughout the MANPRINT community together to discuss the direction of the MANPRINT program—what is needed, and where it is headed. Attendees included personnel from AMC, TRADOC, HEL, ARI, MRSA, TACOM, and SSC-NCR.

Presentations included: Simulation in Determining MANPRINT Concerns (ARI/Ft. Knox); CROSSWALK/FOOTPRINT (Training and Performance Data Center); the MRSA MANPRINT Database (MRSA); DOD Directive 5000.53, AR 602-2 Update, MANPRINT Survey, and MANPRINT in Source Selection (MANPRINT Directorate), a Logistics Planning and Requirements Simplification System (LOGPARS) Demo (MRSA), Insertion of MANPRINT in RFPs: Heavy Force Modernization (TACOM), a MANPRINT Methodology Demo (ARI) and Idea Presentation (HEL), and MANPRINT Industry Seminar Feedback (Automation Research Systems, Limited [ARS]).

The conference agenda was designed to stimulate ideas and discussion by balancing presentations with panel discussions. Each of the panels was assigned a leader who facilitated the discussion and then outbriefed the results on the afternoon of the second day. Panel discussions included: Target Audience Description, MANPRINT Reviews and Assessments, Future MANPRINT Needs, The SMMP Process, MANPRINT Effectiveness, MANPRINT in Non-Major Systems, and DOD Directive 5000.53 Implementation. Panel outbriefs are summarized below:

Panel 1: Target Audience Description

Issues:

- Determine what industry wants included in the TAD.
- TAD is not a requirements document, and thus does not have the same clout as the O&O and ROC.
- TAD language and system diagram language do not complement one another.
- The TAD should orient on soldier task performance, and not just list tasks.
- ARI "Project A" data needs to be shared with those outside ARI as reference for cognitive requirements.
- Can other data sources (i.e., MRSA database) be used to refine the TAD?

Conclusions:

- Redo Industry Survey - next iteration.
- Continue SSC-NCR Working Group.
- Link up with ARI TAD Enhancement Study.
- Refine TAD to eliminate "boilerplating."
- Educate industry on purpose of TAD and its role with the SMMP.

Panel 2: MANPRINT Reviews and Assessments

Issues:

- Availability of information prior to Milestone I
- Resourcing
- Timing of assessments
- IPR process
- Lessons Learned.

Recommendations:

- Not all issues need a General Officer review.
- Applicable documentation, tests results, research efforts, MANPRINT/HARDMAN discussions and CEP should be used.
- SARDA is responsible for funding; MACOMS have to budget. Program sponsor must allocate funds. There is a systemic problem with top Army leadership recognizing resourcing issues.
- Program sponsor should determine when domain assessments are due.
- Tasking authority should be given for domain assessment (AMC/TRADOC issue).
- Enforce or change AR 70-1 to reflect implementing instructions in the IPR process. Include format for MANPRINT review.
- Add verbage to MANPRINT Assessment focusing on "issue impacts on other domains" (Integration).
- Coordinate findings with the proper agencies. Identify and forward only priority issues for review.

• Develop a "crosswalk" of MANPRINT in acquisition documents.

Panel 3: Future MANPRINT Needs

• Training.
- Tailor to specific agency.
- Intermediate course needed for mid-level managers (less than 3 weeks).
- Self-paced modules needed for specific topics.
- Case study oriented on problem solving.
• Career Concerns.
- Define career/training criteria for MANPRINT DA civilians.
- Progression and recognition needed through performance evaluation.
- Top-level AMC/TRADOC endorsement needed.
• Process.
- Optimum utilization of existing products.
- Conduct Trade-Off Analysis in each domain.
- Process Issues: Tracking, Criteria, Cost, Time, Responsibility for Solution, Receiver.
• DID: Tighten the RFP.
• Identify and reschedule funding for manpower products.
• Develop estimating techniques for MANPRINT costs.
• Develop evaluations, measures and methods.

Panel 4: SMMP

Issues:
• Guidance needed for developing and staffing the SMMP.
• Responsibility for updating the SMMP throughout the life cycle of a system is unclear.
• SMMP/O&O sequence.
• Abbreviated SMMP.
• Staffing SMMP with Industry.

Recommendations:
• Publish guidance in AR 602-2 and TRADOC supplement to AR 602-2.
• SMMP responsibility remains at TRADOC throughout life cycle. PM/TSM should be MJWG member.
• Input for SMMP should be extracted from the initial O&O draft plan.
• Study concept of abbreviated SMMP to determine usefulness.
• Staffing SMMP with industry provides MANPRINT concerns and heightens their interest in MANPRINT.

Panel 5: MANPRINT Effectiveness

Issues:
• Measuring MANPRINT Effectiveness
• Enhancing MANPRINT Effectiveness
• Challenges
- Use MANPRINT to reduce design problems; not after-the-fact identification.
- Document and solve problems in the MANPRINT process.
- Identify the quantitative MANPRINT problems early enough for impact.
- Establish measures of effectiveness (MOE).
- Measure successful system results vis-a-vis the success of the MANPRINT process.
- Maintain audit trail on design changes, i.e., establishing documentation.
- Train engineers, technical personnel and action officers.
- Transfer responsibility among commands to ensure continuity and responsibility.
- Identify and communicate lessons learned.
- Establish and maintain top-level commitment.
- Use horizontal integration in developing and fielding systems.
- MANPRINT the MAP.

Recommendations:
• Measure the program through effective use of the process; ability to identify/analyze/key issues; quantification of objectives; and results (MANPRINT successes).
• Enhance Effectiveness:
- Quantify objectives and criteria early.
- Strengthen the negotiation process/compromises.
- Include training in DSMC.
- Train technicians and engineers.
- Increase attention to up-front analyses.
- Put MANPRINT in TOA/D, BTA, COEA, etc.
- Concentrate on bigger payoffs.
• System performance must be more measurable than process effectiveness.
• Realize that there is an inseparable link between process and objectives.
• Increase focus on the relatively neglected domains of manpower and personnel.
• Army-needs convergence: can this soldier...can this system...
• Realize that reliable subjective measures are better than unreliable objective measures of performance.

Continued on page 14

Conference (continued from page 13)

Panel 6: MANPRINT In Non-Major Systems

Issues:
- Non-major systems comprise 90% of the systems in RDT&E, but receive only 40% of funds.
- All non-major systems cannot be addressed; abbreviated SMMP could facilitate the process.
- Identification of issues: How many and where?
- SMMP Approval/Schedule: Who approves?
- SSEB Criteria.
- Manpower and Personnel Assessment Format/ Approach.
- Manpower and Personnel Literature: "How to" guidance.

Recommendations:
- Full SMMP prioritized by resources (dollars), domain concerns, MACOM concerns. Excluded are those systems past "impact" stage of development and NDI systems where "buy-decision has been made."
- DA and AMC are addressing issues identification.
- SMMP approval by DCD (at TRADOC); PM/PO (at AMC) CG (at School); General Officer (at AMC).
- Schedule approval date should be established in acquisition cycle.
- Non major systems should be compatible with major systems. AR 602-2 should address these issues; AMC Commander should provide direction.
- Manpower and Personnel Assessment format and approach should be same as major/DAP.
- "How to" guidance: publish TRADOC Pam 602-2, DA Pam 602-XX, and AMC Pam 602-xx.

Panel 7: Implement DOD Directive 5000.53, "Manpower, Personnel, Training and Safety in the Defense System Acquisition Process."

DOD Directive 5000.53 creates no requirements that are not addressed by AR 602-2 and on-going standardization activities.

Issues:
- Standardize databases, documents, and programs.

Recommendations:
- Account for contractor labor category in Manpower Estimate Report (MER).
- Establish need for implementing guidance for 5000.53 other than AR 602-2.
- Establish standardized format for MPTS collection.
- Establish MPTS data elements IAW DODD 5000.53-- not yet done.
- Presently, databases are not combined via a common network.

For more information, contact LTC Rudy Laine, HQDA (DAPE-MR), Washington DC 20310. AV 224225-9213 or COM (202) 695-9213.

Danger (continued from page 10)

tion of all their training in individual skills. It is useless and potentially dangerous to force a young pilot to try and get back into sync with his attack package if he has not had enough time to perfect mid-air refueling on his own. Nor does it make sense to test his bombing skills under pressure if his ground attack skills are still marginal.

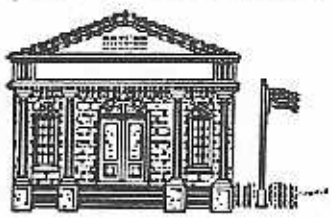
Scaling back Red Flag rotations raises another question. Does it make sense to keep stacking new capability and complexity onto the backs of pilots who are already straining from the load? While the pilot will initially overload quickly, continual exposure to the intense training will bring him progressively deeper into the mission before he becomes saturated. "As long as technology keeps leaping forward you need to bring the pilots along as well with this type of training."

Many thanks to Mr. Kitfield and MILITARY FORUM for allowing us to use this excellent article. MILITARY FORUM is published by National Journal, Inc., 1730 M St., N.W., 11th Floor, Washington, D.C. 20036 (202) 857-1400.

? DID YOU KNOW ...

. . . that an executive-level MANPRINT Industry Seminar to be held September 20, 1989 in Alexandria, Virginia? Watch for a report of this seminar in an upcoming issue of the MANPRINT Bulletin...

. . . that the four components of Apple's new computer, the Macintosh IICX, are held together with just one tiny screw? This allows for easy servicing and upgrading. How's that for efficient design?



Schedule of Upcoming MANPRINT Courses

MANPRINT Senior Training Course

25-29 Sep 89 (Ft. Eustis, VA)
27-29 Nov 89 (AMC, Alexandria, VA)
08 Jan-12 Jan 90 (Ft. Leonard Wood, MO)

MANPRINT Staff Officers Course*

11-29 Sep 89
16 Oct- 3 Nov 89
27 Nov-15 Dec 89

*All courses will be held at Ft. Belvoir, VA.

MANPRINT INFORMATION

POLICY - MANPRINT Directorate, HQDA (DAPE-MR). Washington, DC 20310-0300. AV 225-9213, COM (202) 695-9213.

MANPRINT TRAINING - Soldier Support Center-National Capital Region, ATTN: ATNC-NM, 200 Stovall St., Alexandria, VA 22332-0400. AV 221-3706, COM (703) 325-3706.

PROCUREMENT & ACQUISITION - US Army Materiel Command, ATTN: AMCDE-PQ, 5001 Eisenhower Ave., Alexandria, VA 22333-0001. AV 284 5696, COM (202) 274 5696.

HUMAN FACTORS ENGINEERING STANDARDS AND APPLICATIONS - Human Engineering Laboratory - MICOM Detachment, ATTN: SLCHE-MI, Redstone Arsenal, AL 35898 7290. AV 746-2048, COM (205) 876-2048

MANPOWER, PERSONNEL AND TRAINING RESEARCH - Army Research Institute, ATTN: PERI SM, Alexandria, VA 22333-5600. AV 284-9420, COM (202) 274-9420.

16-20 October 1989

33rd Annual Meeting of the Human Factors Society. Denver, CO. Contact: The Human Factors Society, Box 1369, Santa Monica, CA 90406. (213) 394-1811/9793.

6-10 November 1989

31st Annual Conference of the Military Testing Association . San Antonio,TX. Contact: USAFOMC (ATTN: MTA) Randolph AFB, TX 78150-5000. AV 487-6623 or COM (512) 652-6623.

13-16 November 1989

Interservice/Industry Training Systems Conference: "Training Through Teamwork - Meeting the User's Needs." Ft. Worth, TX. Sponsored by the American Defense Preparedness Association. Contact: Capt. Jackson or Ms. Amy Enwright, ADPA, TMAS, Rosslyn Center, 1700 N. Moore St. Arlington, VA 22209. (703) 522-1820.

GENERAL INFORMATION

Proposed articles, comments, and suggestions are welcomed, and should be mailed to: MANPRINT Bulletin, ATTN: HQDA (DAPE-MR), Washington, DC 20310-0300. Telephone: AV 225-9213, COM (202) 695-9213.

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