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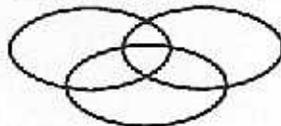


# MANPRINT BULLETIN

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Vol. IV No. 6

May/June 1990



## MANPRINT Methodologies:

### *Early Comparability Analysis and Hardware Versus Manpower Comparability Analysis*

Dianne L. Parrish

U.S. Army Personnel Integration Command

The articles in the November/December 1989 issue of the *MANPRINT Bulletin* focused on MANPRINT tools, models and methodologies. Missing, however, were two fully-developed, government-owned methodologies that are being used on a wide scale by the Army, specifically Early Comparability Analysis (ECA) and HARDware vs. MANpower (HARDMAN) Comparability Methodology (HCM). Though both methodologies are well established, improvements to these procedures are underway to better serve the system manager.

In 1982, the U.S. Army Personnel Integration Command (USAPIC), a major subordinate command of the U.S. Army Soldier Support Center, Fort Benjamin Harrison, Indiana, developed ECA as an easy-to-use, lessons-learned approach, task analysis that can be used early in the acquisition process to help managers produce an Operational and Organizational (O&O) Plan. While this methodology was originally designed to be conducted in-house (because it requires no specialized training), reduced manning at TRADOC proponents precipitated the need for contractor support. As a result, USAPIC has facilitated work on six contractor ECAs and one by the TRADOC Analysis Command—White

## MANPRINT Success Stories

MANPRINT success stories are coming in at a steady rate: the T700 engine; the Apache improvement program; methodologies such as FOOTPRINT, ECA, and HCM; a MANPRINT book; and even the spread of MANPRINT principles to the United Kingdom!

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Sands Missile Range. ECA was formally sanctioned as a MANPRINT methodology in February 1985; however, USAPIC—with assistance from the Army Research Institute (ARI) Field Office at Fort Benning—is currently developing product improvements

*Continued on page 2*

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**"Remember the Soldier"**

## Methodologies (continued from page 1)

to this methodology. Change 1 to TRADOC Pamphlet 602-1, Manpower and Personnel Integration (MANPRINT) Guide, is projected to include these changes.

HCM has and still is undergoing change. In 1984, USAPIC implemented this methodology, which was developed by ARI. Since that time, this command has facilitated the conduct of HCM applications on 29 systems approved by Headquarters TRADOC, Deputy Chief of Staff for Combat Developments (DCSCD), with 22 performed by contractors, and seven by the TRADOC Analysis Command. During its early stages of development, HCM was a manual labor-intensive methodology that had not been fine-tuned. Therefore, to provide more timely analytical results, ARI developed Man Integrated Systems Technology (MIST), a software package specifically designed for HCM. With the implementation of MIST, the methodology's name changed to HARDMAN II. Hence, after large-scale application of HARDMAN/HARDMAN II, users (to include implementors and contractors) identified minor flaws and omissions in the basic procedures. ARI then developed a product improvement version of the HCM procedures (HARDMAN II.1). More recently, USAPIC and ARI have joined forces to update the MIST software to reflect the improved procedures to the methodology (HARDMAN II.2). In 1989, these two parties signed a Memorandum of Agreement to establish points of contact and specific responsibilities for development, implementation, and sustainment of HARDMAN II.2.

Since 1984, USAPIC has maintained a contract to conduct HCM applications. In 1987, the contract was broadened to include the capability to perform any MANPRINT methodology. Since August 1987, system managers have contracted for over 4.8 million dollars in MANPRINT analyses. Any Army user may take advantage of this contracting service; in fact, although the current contract expires in August 1990, work can be delivered up to 30 months from the delivery order date.

In terms of regulatory information on MANPRINT methodologies, USAPIC—under the authority of the new AR 602-2, Manpower and Personnel Integration (MANPRINT) in the Materiel Acquisition Process that will be published in the near future—will provide propensity for manpower, personnel, and training (MPT) methodologies. This will include the responsibility for developing or approving methodology guidebooks, facilitating the conduct of analyses, operating

as a clearinghouse for emerging MPT analytical efforts, and serving as a one-stop information center on available methodologies and future initiatives.

The improvements to ECA and HCM will provide the MANPRINT community with more efficient and effective analytical tools for predicting MPT resource requirements in support of milestone decisions.

For more information, contact Art Pridemore or Jan Dykhuis, MANPRINT Methodologies Branch, Manning Integration Directorate, USAPIC, 200 Stovall Street, Alexandria, VA 22332-1365; (703) 325-2099.

## MANPRINT Hits the UK!

Nan B. Irick  
Automation Research Systems, Ltd.



The premier issue of *MANPRINT Mail*, the U.K. MANPRINT newsletter, recently made its way onto my desk. It was clear that the U.S. Army's MANPRINT program had clearly had an impact—not only in our own Army, but in a foreign service as well. I was excited about the opportunity for the sharing of information between our two countries, which can offer diverse points of view and new solutions to acquisition problems. What a great opportunity to learn from each other!

The opening editorial in *MANPRINT Mail* stressed the need for patience on the part of its acquisition community. The U.K. MANPRINT office has not yet established detailed procedures, which will be promulgated and monitored as MANPRINT issues become recognized features of the acquisition process. Though they have no dedicated financial resources yet, the British hope to eventually adapt the U.S. system and methods to incorporate what they learn from the pilot study now underway. Eventually, they intend to make MANPRINT mandatory. In the meantime, they have vowed to keep our MANPRINT slogan in mind: "Remember the Soldier!"

The *MANPRINT Mail* editor, Liz Wheatley, and I have arranged to share articles between the two publications. If you have anything that might be of interest to readers of either publication, contact the MANPRINT Office, HQDA (DAPE-MR), Washington, DC 20310-0300; AV 225-9213, COM (202) 695-9213.

## FOOTPRINT on the Decision Support Systems (DSS)



FOOTPRINT is an automated tool designed to support the assessment of the MPT-projected requirements associated with a new materiel system. FOOTPRINT utilizes existing databases to develop the MPT profile of a Military Occupational Specialty (MOS) for use in developing a Target Audience Description (TAD). The initial FOOTPRINT reports were available from U.S. Army Personnel Integration Command (USAPIC) in paper copy and are now available on either the HQDA or TRADOC Decision Support System (DSS). To request a report from DSS, follow these steps:

**Step 1:** Log onto DSS (HQDA or TRADOC). Then, type "FOOTPR" and press ENTER. You will be greeted by the FOOTPRINT welcome screen.

**Step 2:** Select the PF4 key (batch jobs). Then, on the first line of the Batch Job Selection screen, type "y" (yes) and press ENTER. Type your requested MOS and "y" for each report group (or all groups) of the MOS you desire. You can select up to three MOSs at a time. Press ENTER, and your request will be electronically sent to USAPIC for processing. The Batch Job Selection screen will echo, "FOOTPRINT job is submitted. Please check reader later." For urgent report requests, telephone USAPIC (AV 221-2092) to expedite processing. NOTE: This procedure may be repeated for additional MOSs.

**Step 3:** To print a FOOTPRINT report (after it has been sent back to you), press ENTER on the Batch Job Selection screen to select a printer. Type "S" for the appropriate printer and press ENTER.

USAPIC will mail printed FOOTPRINT reports to those unable to access DSS. Also, future enhancements to the FOOTPRINT report on the DSS will allow the user on-line (PF5 key from "Welcome to FOOTPRINT" screen) access when a relational data base is created. This enhancement is planned for this year. Should you have any additional questions about the FOOTPRINT report, contact Mr. Robinett at AV 221-2092 or SFC Dealy at AV 221-2095.

## MANPRINT Book Sales

*MANPRINT: An Approach to Systems Integration* (Edited by Harold R. Booher, Ph.D.) may be obtained at discount prices by ordering from Van Nostrand Reinhold, 115 5th Avenue, New York, NY 10003. Government purchases may be made under GSA Purchase Order GSO2F52100 (expiration date: 31 Jan 1992). Discounts are as indicated below. Contact Diane Kennedy at Van Nostrand Reinhold, (212)254-3232, if there are questions.

### Government Discount

1-199 copies = 20%  
200+ copies = 27%

### Corporate Discount

1-9 copies = none  
10-24 copies = 10%  
25-49 copies = 15%  
50-99 copies = 20%  
100-249 copies = 25%

Individual copies may be purchased for \$42.95 (publisher pays postage and handling) from Van Nostrand Reinhold, Mail Order Department, P.O. Box 668, Florence, KY 41022-0668. Credit card orders should call 1-800-926-2665.

## The RIATAS Methodology: A Long-Range Planning Guide

The Requirements Identification and Technology Assessment Summary (RIATAS) of the Special Operations mission area is a systematic process to identify and assess future war fighting capabilities to ensure human-centered concerns are addressed during weapon systems development.

Developed by the Air Force Human Systems Division's Development Planning Office, the RIATAS methodology involves researching higher level long-range planning documents to identify what weapon systems capabilities will be needed and how the human, as operator, maintainer, manager and supporter, will be affected by such developments.

*Requirements Identification and Technology Assessment Summary: Volume V. Special Operations Human Systems Analysis* is available from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, VA 22304-6045; AV 284-7633 or COM (202) 274-7633.

## NATIONAL SECURITY INDUSTRIAL ASSOCIATION Conference Notes

Hampton, Virginia was the site of the recent NSIA Conference on "Integrating People, Machines, and Organizations: The Winning Approach to Systems Acquisition." During this conference, MANPRINT and related programs demonstrated a higher level of maturity and institutionalization than ever before.

During the conference, the new MANPRINT book, *MANPRINT: An Approach to Systems Engineering*, was distributed to attendees and described by the book's editor, Dr. Harold R. Booher, Director for MANPRINT. Highlights included:

- Mr. Robert Hale, Associate Director for National Security, Congress Budget Office, addressed issues surrounding the major debates on the defense budget, including world events that reduce concern over the threat, the federal deficit, and defense vs. non-defense government outlays.
- BG Thomas Draude (USMC), Director, Defense Management Report (DMR) Implementation Coordination Office, OSD, reported on the DMR results, which include issues such as streamlining acquisition organizations, creating an Acquisition Corps, and streamlining the acquisition process.
- Mr. David J. Berteau, Principal Deputy Assistant Secretary for Production and Logistics, said in his remarks that a focus on the customer defines quality, that the barriers to the services moving together are breaking down, and that our focus must be on "value added" and broad concepts of system performance.
- MG R. E. Stephenson, Commander, OTEA, articulated his strong support of MANPRINT.
- COL Dave Matthews, Program Manager, Army Tactical Missile System (ATACMS), discussed how this program has addressed MANPRINT. He warned of the high risks and poor management of software and urged HFE to place greater focus on this area.
- Mr. George Daugherty, Front-End Analysis Task Leader, Martin Marietta, gave an analysis of the difficulties in doing MPTS. He addressed motivators for doing MANPRINT, the need to quantify sustainability trade-offs, and the use of sensitivity analysis of

configuration concepts to identify costs.

- Dr. Clayton Foushea, Science and Technology Advisor, FAA, stated that we may have reached a point of diminishing returns on investment in technology--and that it is time to invest in human performance. He addressed the opportunities for MANPRINT in civil aviation and explained the FAA's national plan to solve problems in aviation systems monitoring; the impact of the organizational climate; human performance measurement; data link technology and communication; controls, displays and workstation design; and training and selection of people.
- LTC James Feigley (USMC), Deputy Program Manager, Advance Assault Amphibious Vehicle (AAAV), and Dr. David Daly, AAAV HARDMAN Coordinator, U.S. Naval Training Systems Center, identified what caused the PM to realize MANPRINT's importance. They used OPNAV HARDMAN DIDs, a HARDMAN Assessment DID, an Economic Analysis Model, and verification indices to translate O&S problems into engineering design requirements.
- GEN Glenn K. Otis, (USA-Retired), Senior Vice-President, Atlantic Systems Research and Engineering International, Inc., told of the need for redefinition of tooth-to-tail ratios; combat/combat support concepts; targets for CFE reductions, to include weapon consumable stockpiles; and summarized by explaining how the Army is the least manpower-intensive service per combat and combat support system. GEN Otis also spoke of major changes needed in the selection of manpower (to focus on electronics), costs (especially O&S), embedded training on the front end of every system, pervasive user-friendliness, and deployment training.
- S.J. Deitchman, Science and Technology Division, Institute for Defense Analyses, discussed the results of his study, which revealed the value of training versus hardware investments and how our current investment in individual training equals our procurement budget.

The conference was meaningful and productive to the long-term incorporation of the human dimension in materiel systems.

# Independent MANPRINT MPT Assessment

MAJ Ted Barila  
U.S. Army Personnel Integration Command

The MANPRINT Assessment is a formal process that interprets MANPRINT input for the Army System Acquisition Review Council (ASARC) decision review. In compliance with guidance in the updated AR 602-2, Manpower and Personnel Integration (MANPRINT) in the Materiel Acquisition Process, major materiel systems must undergo a MANPRINT Assessment at each milestone decision review point throughout the acquisition process. This will ensure that MANPRINT issues and concerns are considered by decision makers before moving on to the next phase of the process. The assessment evaluates the strengths and weaknesses of the system in terms of the six MANPRINT domains (manpower, personnel, training, system safety, health hazards and human factors engineering) and determines whether the system has adequate documentation to support stated MANPRINT goals.

In March 1988, the Office of the Deputy Chief of Staff for Personnel (ODCSPER) provided new guidance on the MANPRINT Assessment—formerly called the Human Factors Engineering Analysis (HFEA). ODCSPER would henceforth consolidate input from the six domains and develop a MANPRINT Assessment for all major Army systems prior to the ASARC. This action would ensure an objective, non-biased review of the system from a MANPRINT perspective. It was felt that ODCSPER could more easily obtain the input necessary to fully evaluate a system, particularly in the areas where written MANPRINT evaluation had not been previously required.

ODCSPER tasks four agencies to prepare technical input for inclusion in the MANPRINT Assessment. The U.S. Army Personnel Integration Command (USAPIC) conducts this analysis for the MPT domains; the Surgeon General's Office, Army Safety Office, and the Human Engineering Laboratory prepare input for the remaining domains. Upon review, ODCSPER provides the ASARC with critical MANPRINT achievements, issues, and concerns.

USAPIC, in performing its mission to provide an Independent MANPRINT MPT Assessment, operates under a team concept. Each team normally consists

of four personnel, depending on the system's complexity and the availability of documentation. This team, which includes a leader and a system subject matter expert, operates without interference from internal or external agencies in order to ensure an impartial examination of the system.

Once the assessment suspense is determined by ODCSPER, a team composed of members of the Manning Integration Directorate, USAPIC, reviews all available program and requirements documents to identify important MANPRINT-related MPT achievements, issues and concerns. This effort focuses on disconnects between what is written and what is actually happening with the specific system. In 1989, USAPIC conducted nine independent assessments for ODCSPER; nine more are scheduled for 1990, including, among others, the *Longbow*-Apache, the *Line of Sight Forward-Heavy*, and the *Block III Tank*.

During the conduct of these Independent MANPRINT MPT assessments, USAPIC has identified some systemic problems. In the beginning of the analysis, there is normally a lack of data and available documentation to review. Also, data is inconsistent. Additionally, during the review, other MPT issues and concerns tend to surface. For example, in the manpower area, data routinely does not meet the required MPTS profile in accordance with DODD 5000.53, Manpower, Personnel, Training, and Safety (MPTS) in the Defense System Acquisition Process; in personnel, data reveals creeping increases in soldier quality requirements.

In short, the Independent MANPRINT MPT review of major system documentation provides the critical information on achievements, issues, and concerns that allows the ASARC to make informed decisions at milestone reviews. Without this impartial look at MANPRINT issues and concerns, the system's impact on the soldier and the Army personnel system might not be fully identified.

*For more information, contact MAJ Ted Barila, MANPRINT Evaluation Branch, Manning Integration Dir., USAPIC, Alex, VA 22332-1365. (202) 325-8779.*

# MANPRINT OUTTAKES

From the MANPRINT Program Office

■ **MANPRINT with Industry Executive Seminar.** MG Budge hosted the fourth MANPRINT with Industry Seminar on 20 March 1990. GEN Tuttle gave the keynote address. Fifty senior executives attended; attendance was evenly split between government and industry. The following topics were briefed: Individually Carried Record (Soldier Support Center [SSC]); Auxiliary Aviation Lighting Devices, Chemical and Biological Protected Shelters, Improved Meal, Ready-to-Eat (Troop Support Command); Line of Sight-Forward Heavy (Martin Marietta); and the Automated Target Handover System (Rockwell International). Demonstrations of HARDMAN III, the MANPRINT Data Base, and the automated Manufacturer's MANPRINT Management Plan-Expert System (MMMP-ES) were conducted.

■ **MANPRINT Activities at TRADOC Analysis Command-Monterey.** The MANPRINT Directorate and ODUSA-OR jointly sponsor a combat modeling program at TRADOC Analysis Command's (TRAC) Monterey, California field site, which is located on the campus of the Naval Postgraduate School (NPS). DCSPER sponsors the following studies at TRAC: The Development of a Light Infantry Platoon Combat Model that Considers Human Factors; The Impact of Human Factors on Decision Making in Combat; and Janus Human Factors, an analytical effort to modify the Janus combat model to more accurately reflect human factors.

■ **Armored Systems Modernization (ASM) ASARC Meeting.** The Army Systems Acquisition Review Council, reviewed the ASM (formerly Heavy Force Modernization [HFM]) program on 23 Feb 90. Major issues appear to be centered around the use of Advanced Technology Transition Demonstrators in lieu of prototypes and overall program funding. Some variants are sustaining heavy program cuts. MANPRINT assessment revealed numerous concerns in all of the domains but due to the early nature of the program (Milestone I), there should be adequate developmental time to resolve them, provided that the PEO/PM continue to stress/fund the MANPRINT effort. Individual variant milestones are

projected for the June time frame for the Block III tank and Combat Mobility Vehicle.

■ **Revision of DODD 5000.1/DODI 5000.2.** DOD Directive 5000.1, Policies Governing Major and Nonmajor Defense Acquisition Programs, and DOD Instruction 5000.2, Defense Acquisition Program Procedures, are currently being revised as a result of the Defense Management Review. Numerous DOD level directives will be eliminated by the implementation of this directive. The draft DODD 5000.1 recommends the cancellation of AR 70-1, Systems Acquisition Policy and Procedures, the primary Army acquisition regulation. The draft DODD 5000.2 does not yet articulate the critical need to adequately include the human dimension during the materiel design and development process, but is being addressed with that intent.

■ **Joint Surveillance and Target Acquisition Radar System (JSTARS).** Representatives from the MANPRINT Directorate recently visited the JSTARS Program Manager's Office (PMO). The PMO requested the visit in response to a memo soliciting lessons learned in the implementation of MANPRINT in the PM process. The PMO has enthusiastically embraced MANPRINT and has convinced the contractor (Motorola) to implement MANPRINT throughout the system design process. This has resulted in a vastly improved soldier-machine interface for the Ground Station Module, and has forced the contractor to institutionalize MANPRINT organizationally.

■ **MANPRINT at DSMC.** Representatives from the Defense Systems Management College (DSMC), the MANPRINT Directorate (ODCSPER), and the TRADOC MANPRINT training contractor (ARS) met on 24 April 1990 to review and discuss a proposed program of instruction for MANPRINT training at DSMC. The college will offer program managers and acquisition corps students a three-hour Army elective on MANPRINT concepts and procedures. Instruction is to begin in June or July FY90.

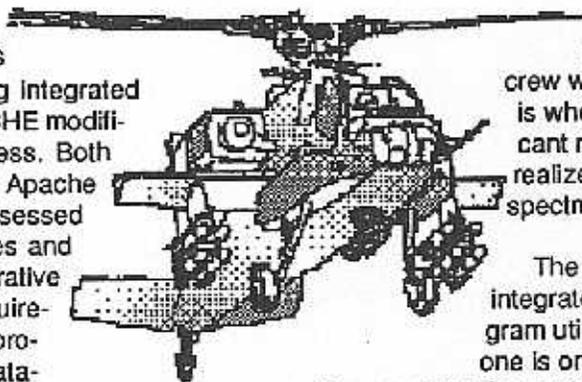
## In "Apache Country," MANPRINT Is A Must

Robert L. Grewe  
Apache Helicopters Program Office

The U.S. Army's MANPRINT program is being integrated into every aspect of the APACHE modification and improvement process. Both Longbow (LB) and Longbow Apache (LBA) enhancements are assessed for MANPRINT domain issues and concerns. Through an integrative approach, MANPRINT requirements for each enhancement program are tracked in a single database to ensure common areas affected by MANPRINT processes are identified and monitored. Because it pays high dividends, "MANPRINT is a must."

First, the improvements must be affordable. Within budget constraints, MANPRINT requirements are being calculated, analyzed, coordinated, validated and recorded in a MANPRINT database. As engineering change proposals and upgrades occur, MANPRINT requirements are incorporated into contract statements of work.

As the Apache is being upgraded to the Longbow configuration, MANPRINT requirements are being considered for the Maintainer, User, Supplier and Trainer. The "MUST" philosophy ensures that no soldier in the field is forgotten. The prime contractor and each of the subsystem contractors have implemented aggressive MANPRINT programs with this philosophy in mind and it is already paying off. While in the LBA upgrade design phase, numerous MANPRINT issues have been resolved. Contractors understand the importance of using technology to make the soldier's job easier while increasing capabilities. For example, the Apache cockpit is being MANPRINTed to rectify task saturation problems: with the addition of the Longbow came another targeting sensor to add to the Target Acquisition Designator System (TADS) with its Laser Spot Tracker, Day Television and Forward Looking Infrared (FLIR), the Pilots Night Vision System (PNVS) and the Helmet Mounted Sight. The new crew station envi-



ronment will have to reduce crew work load dramatically, and this is where MANPRINT plays a significant role. Similar benefits are being realized across the man-machine spectrum.

The MANPRINT program has been integrated throughout the Apache program utilizing existing resources. Everyone is on-board. MANPRINT considerations and requirements are integrated throughout the Apache Program Master Plan. As the Apache approaches Milestone II for Longbow and Milestone V for Longbow Apache, the total MANPRINT program is documented in the System MANPRINT Management Plan (SMMP). MANPRINT domains are documented in reports such as the Human Factors Engineering Analysis (HFEA), the Health Hazards Assessment Report (HHAR), the System Safety Program Plan (SSPP), and the Integrated Logistics Support Plan (ILSP), etc.

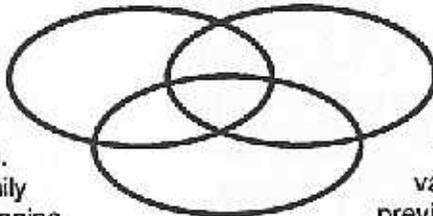
With the exception of a MANPRINT support contractor, the entire MANPRINT program is being accomplished with existing resources. We have worked to maximize the utility of existing groups and committees. The System Safety Working Group, for example, manages the Safety Program and also serves as the MANPRINT Joint Working Group's (MJWGs) Safety Panel. This dual utilization not only increases efficiency, but also solidifies the institutional memory on MANPRINT issues and concerns.

In short, MANPRINT is the principal dynamic in the development of efficient and highly effective upgrades to the Apache Weapon System in a way that considers all aspects of the man-machine interface.

*For more information, contact Robert L. Grewe, Chief, Product Assurance, ATTN: SFAE-AAH-PA, Army Aviation Systems Command, 4300 Goodfellow Blvd, St. Louis, MO 63120. (314) 263-3836.*

# Putting the MANPRINT On A Mature Program

Jack Hudak  
General Electric Aircraft Engines



The General Electric T700 engine is the powerplant for the U.S. Army's Blackhawk and Apache helicopters, as well as for the helicopters of other military services, both U.S. and foreign. Commercial engines of the T700 family are also in service worldwide. The engine has been in service since the late 1970s and has been chosen for multi-year procurement into the 1990s; it is to this multi-year procurement of a growth-version engine procurement that a tailored MANPRINT program has been applied.

The original design effort on the T700 was performed under a different set of ground rules than powerplants up to that time. Supportability factors such as maintainability and reliability were enforced as design criteria equally as important as weight and performance. With the high priority placed on supportability, all the areas now known as the domains of MANPRINT were actively on line during the engine's design phase. Unlike a MANPRINT program however, the domains acted as islands of expertise without formal unity. These islands of expertise, however, did have a positive effect on the engine design. The T700 family is able to boast a number of "firsts" for turbine engines.

Among the "firsts" introduced by the T700 were modular construction to allow replacement of major engine components at the lowest possible level of maintenance, and "on condition maintenance." Top-mounted accessories allowed ease of access while enhancing system survivability. "Broomstick clamps" replaced bolted electrical cable clamps, safety wire was eliminated, and wrench arc techniques were developed for fluid fittings, thereby eliminating torque wrench and tool requirements for those jobs. No trimming or rigging of controls or variable geometry linkages is required. These attributes, as well as a minimum variety of fasteners, allow the T700 to be field maintained with only ten common tools.

Concern for the soldier was present early in the

program. Maintenance times and trials were performed using Army mechanics (MOS 628B20) rather than factory experts. The original T700 has become a model of advanced maintainability compared with previous generation engines. It paved new ground and established a firm foundation for next generation engines to build upon.

## The T700-701C

The widely-fielded, mature T700 engine now faces new challenges. The Army T700-701C (and Navy T700-401C) growth engines are now being fielded. Fortunately, MANPRINT was available for these models. The islands of expertise were still active, but linked together and united. With a mature system already in place, the challenge to the T700 MANPRINT program was to ensure that this "drop in" growth-version retained a high degree of commonality. The demonstrated advantages of the design needed to be retained while "growing" the engine to 20% more power. Further improvements in supportability needed to be made rather than compromised while bringing the engine into the 1990s.

A MANPRINT program was put in place to work the design of the T700-701C. A MANPRINT Joint Working Group (MJWG) was established to enhance communication between the domains and design engineering. A MANPRINT review and sign-off is required for all engineering drawings. MANPRINT approval is also required at the Configuration Control Board (CCB) for design changes, and at the Publications Review Board (PRB), which approves all changes to technical publications.

In addition, MANPRINT training is continuous and expanding. Through the MJWG, all domains are receiving basic MANPRINT training. More broad-reaching MANPRINT training is a segment of a formal training course in supportability that is offered to all engineering personnel.

The MANPRINT program has had its effect, and its influence continues to be felt. The T700-701C is indeed a "drop-in" replacement. The old and new engines could even be mixed in the same airframe, under emergency conditions, to meet the demands of battle readiness. No changes to the existing maintenance plan have been required and the logistics pipeline is maintained. The effort to avoid the need for new tools has been successful, while the drive to minimize complexity continues.

### Manpower and Personnel

As MANPRINT does its job, the T700-701C continues to boast of "firsts" in the field. With the soldier remembered throughout system maturation, all domains continue to improve. The application of manpower and personnel is enhanced by the infusion of technology. New cooling materials in the engine hot section improve reliability and reduce maintenance problems, while improving power. A new digital electronic control replaces an analog electronic control with improvements in reliability. The task of engine diagnosis is made faster and easier with an engine diagnostic output, on existing cockpit gauges, after engine shutdown. A variety of engine health and history information is recorded and saved electronically. This data can be obtained on or off the aircraft, providing a powerful diagnostic tool to drive maintenance actions and avoid the shotgun method of troubleshooting.

### Training

The training domain benefits from commonality with the established system. All improved electronics are within the same envelope and employ similar harnesses and airframe interface. Changes to mechanical replacement procedures are minimized, and electrical connectors are specially keyed to avoid misassembly. This allows the attention of those in the training domain to focus on areas of improved capability. The operation of the new controls and displays are worked into the training even as the data is prepared for publication.

### Human Factors

Human factors disciplines are maintained by keeping maintenance actions simple and straightforward. In addition, there are human factors improvements for the pilot. A wider range of turbine speed can now be displayed. This allows the pilot to

observe an important parameter earlier during engine start up, minimizing the "blackout" of data early in the start cycle. The new control also eliminated torque spikes during start up and shut down, eliminating pilot distraction and annoyance.

### Safety

Safety is also enhanced in the engine system. The new control system can automatically identify failed input signals and resort to secondary signals to maintain engine control. This can often preclude the need for pilot action. A potential in-flight problem is reduced automatically to a ground maintenance task. The control even has the capability of automatically preventing hot starts, which could cause the need for unscheduled maintenance. This makes engine starting more automatic for the pilot.

### Health Hazard Assessment

Health hazard reduction has not been forgotten in bringing the engine into the 1990s. Asbestos cushion clamps, widely used in the 1970s, are being replaced with Kevlar or woven fiberglass. Qualification testing of the new materials is complete and introduction design changes are in process.

The T700 family of engines will continue to power Army aviation through the 1990s. A MANPRINT program will continue to keep the soldier in the loop of design improvements. A good engine was born among islands of expertise; this engine is growing better under the MANPRINT umbrella. A properly tailored MANPRINT program is a positive factor in the continual evolution and improvement of a mature system.

*For more information, contact Jack Hudak, General Electric Aircraft Engines, 1000 Western Avenue, MD 63NGB, Lynn, MA 01910; (617) 594-2950.*

### ARTICLES WANTED!

The *MANPRINT Bulletin* is in need of a few good articles! Success stories, new studies, methodologies, letters to the editor—anything that you feel will be of interest to our readers. Send your double-spaced typed draft (please, no longer than four pages) to: LTC Glen Hewitt, MANPRINT Directorate, HQDA (DAPE-MR), Washington, DC 20310-0300; AV 225-9213 or (202) 695-9213.