MANPRINT BULLETIN

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An Effective NDI MANPRINT Program: FAAD Line-of-Sight-Forward-Heavy (LOS-F-H)

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Martin Marietta Missile Systems (MMMS) is currently under contract to the U.S. Army to produce the Line-of-Sight-Forward-Heavy (LOS-F-H) component of the Forward Area Air Defense System (FAADS). LOS-F-H is being procured as a nondevelopmental item (NDI) system with a phased acquisition from an initial candidate evaluation system to the final production system. The system has successfully completed most of the technical and operational tests structured in a test-fix-test format. The Initial Operational Test (IOT) force-on-force trials were completed in May 1990.

The LOS-F-H (see Figure 1 on page 2) is a highly mobile and survivable manned missile air defense weapon system. It consists of a fire unit composed of a weapon subsystem that includes eight ready-to-fire missile rounds and associated fire control; a common subsystem to provide command, communication, control and intelligence (C3I); and a vehicle subsystem based on the Bradley M3 vehicle. The fire unit is supported by the required training and maintenance equipment.

Martin Marietta recognizes that for LOS-F-H to successfully complete its battery of tests, MANPRINT must be a key element in overall system effectiveness. Therefore, the MANPRINT initiative must influence any design modifications related to the soldier/system interface. To achieve this, Martin Marietta established a formal LOS-F-H MANPRINT group. This article describes Martin Marietta's MANPRINT approach to meet the U.S. Army's LOS-F-H MANPRINT needs.

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MANPRINT *Momentum*

The MANPRINT Program continues to move forward as 1990 wears on. This issue highlights the momentum as we take a look at the LOS-F-H program, MANPRINT's foothold in the UK, this year's MANPRINT Practitioner's Workshop, Dr. Booher's MANPRINT book, and MANPRINT success stories from TROSCOM.

LOS-F-H *(continued from page 1)*

MANPRINT Program

The LOS-F-H MANPRINT program strategy effectively integrates and coordinates the MANPRINT domains (human factors engineering, manpower, personnel, training, system safety, and health hazards) into the production system maturation and subsequent preplanned product improvements (P3I). This strategy was implemented by providing the MANPRINT program visibility within the program management structure and giving it specific responsibility to review and track system changes for MANPRINT impacts. The MANPRINT group functions within both the Product Support and Engineering chains of command (see Figure 2 , page 3).

The MANPRINT organization establishes direct ties from all MANPRINT domains to Integrated Logistics Support (ILS), system engineering, and design engineering disciplines.

The LOS-F-H MANPRINT group has developed and successfully implemented a unique "closed loop" approach by which to identify, track, and obtain resolution of MANPRINT problems, failures, and deficiencies reported from tests, design reviews, and other program activities. Participation in the LOS-F-H MANPRINT Joint Working Group ensures that Martin Marietta's efforts are integrated with the LOS-F-H Program Manager's Office efforts and other appropriate government agencies. This process is based on a comprehensive, formal document review cycle in tandem with a dedicated MANPRINT Corrective Action Board.

Document Review Cycle

The MANPRINT group plays an integral part in hardware and procedural decisions made during the system's life. MANPRINT representatives, by reviewing test plans, system specifications, drawings, technical manuals and test procedures, ensure compliance with all MANPRINT domain requirements. When design reviews involve man-machine interaction during any phase of the equipment's life cycle, MANPRINT representation is mandatory. Review findings and recommendations are recorded in memoranda distributed to appropriate program personnel and used as input by System Safety for drawing and document sign-off. The memoranda are recorded in the Systems/Systems Test file (a LOS-F-H program archive) and, when warranted, released through the Martin Marietta Engineering Data File (a company-wide data repository). This provides both a comprehensive audit trail and a data source for LOS-F-H and other Martin Marietta programmatic decisions.

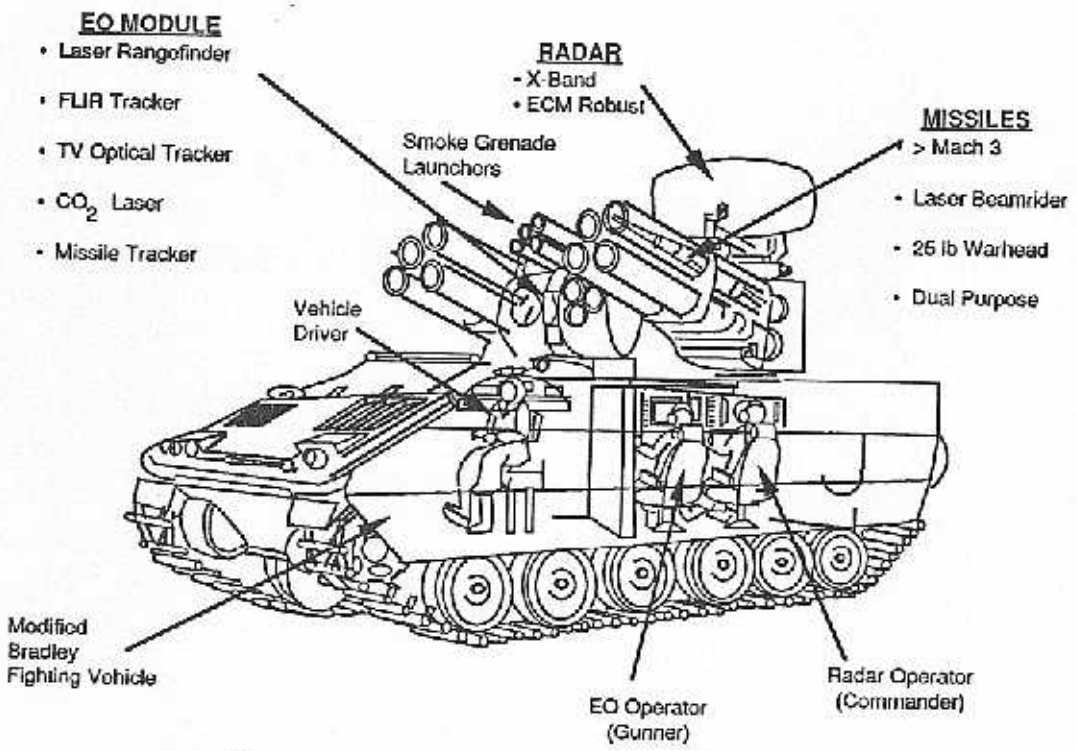

Figure 1. The Line of Sight-Forward-Heavy (LOS-F-H)

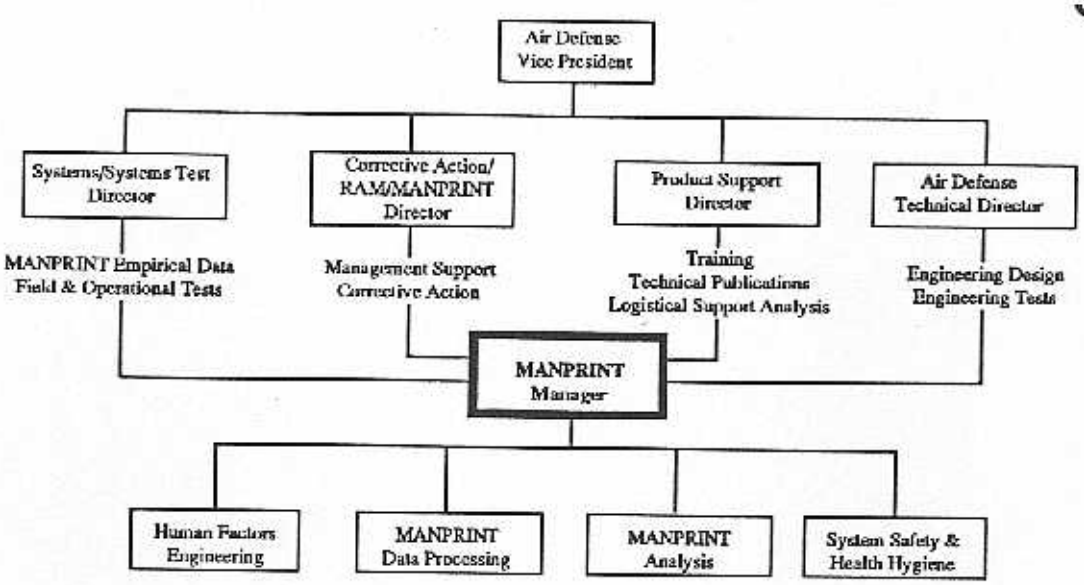

Figure 2. The MANPRINT Organization

MANPRINT Corrective Action Board

In addition to the document review, another mechanism that aids in ensuring that MANPRINT requirements are met is the MANPRINT Corrective Action Board. LOS-F-H field tests results led to design refinements during the transition from preproduction to production hardware. As MANPRINT issues and problems are identified in the field, the data must be transmitted to in-plant MANPRINT personnel. Recognizing this need for accurate and timely feedback early in the program, Martin Marietta assigned MANPRINT personnel directly to the field team. This enables the quick response appropriate to the test-fix-test environment by allowing immediate investigations and timely corrective action for identified problems. The MANPRINT Corrective Action Board meets weekly to review potential MANPRINT problems, determine corrective action, and formulate implementation plans and associated items which impact program activities. This board is convened for emergency situations requiring immediate action, when necessary.

The MANPRINT Corrective Action Board, chaired by the MANPRINT manager, includes representatives from Technical Publications, Training, Systems Engineering, Corrective Action (a Quality Engineering function), Systems Test, Reliability, and Maintainability. Engineering subsystem managers for the hardware being addressed attend on an as-required basis.

Problem reports include government test Incident reports (TIRs), test reports, and Martin Marietta internally-generated documents. Once a problem is determined to fall within the scope of the MANPRINT Corrective Action Board, a formal automated audit trail is established. Each MANPRINT corrective action problem is recorded in summary form by Quality Engineering and entered into the program corrective action database (this database includes all hardware subsystems). The Board determines the appropriate corrective action, if any (e.g., change the design, improve training, modify procedures, change technical publications). To ensure timely follow-up, the status of all open corrective action items is updated at the weekly MANPRINT Corrective Action Board meeting.

If a problem has critical safety implications, the Board requires that Systems Test Engineering generate a Field Alert to be transmitted to the field. If the problem has no critical safety implications, but does warrant interim procedures to revise the Preliminary Draft Equipment Publications (PDEPs), Product Support (Technical Publications) issues an All-Sites Bulletin (ASB) to facilitate hardware or software interim solutions, or to inform field personnel of issues concerning fielded hardware. If the issue is a valid immediate concern but impacts neither safety nor PDEPs (e.g., test-peculiar operations), Systems Test Engineering issues a Field Directive. The use of the three distinct forms--TIRs, the test reports, and internally-generated documents--ensures that the criticality of the subject matter is immediately apparent to the recipient.

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Display Formatting of Tactical Information

Mary E. Dominessy
U.S. Army Human Engineering Laboratory

The U.S. Army Human Engineering Laboratory (HEL), located at Aberdeen Proving Ground, MD, is the Army's lead research laboratory for human factors engineering. Results from research conducted by HEL are incorporated into the data acquisition cycle. This provides Army materiel developers with information necessary to ensure that the design of military equipment will enhance the quality of soldier-machine integration (SMI). Human factors research also directly supports the objectives of the MANPRINT program. Recently, research aimed at improving SMI was conducted by members of the Aviation and Air Defense Division (AADD) and the Behavioral Research Division (BRD) at HEL.

Using pilots from the Maryland and Delaware National Guards as test participants, this research compared three computer-generated display formats for presenting tactical information to pilots to aid them while engaging specific airborne targets presented on a situation display. Pilots were presented the information in one of the following formats: symbolic, alphanumeric, or numeric. Following the presentation of this information, pilots were required to search the situation display for the designated target. The pilots performed this search task either by itself (i.e., copilot status) or while simultaneously flying a helicopter simulator. Reaction time (the time taken to touch the designated target on the situation display) was used as a measure of performance for the search task; the ability to maintain altitude and airspeed was used as the measure of flight performance. Pilots also rated the workload imposed by the various test conditions.

Two important findings emerged from this study. First, both the search task and the piloting task performance deteriorated dramatically when they were performed simultaneously as compared to when each task was performed alone. This may have resulted from the two tasks competing for the same human resources. The continuous motor task of flying was periodically interrupted by a discrete motor search task, forcing the pilot to switch his attention and resources back and forth between the two tasks. Secondly, of the formats tested, the alphanumeric format required the longest time to acknowledge and was perceived as the most difficult to use. Performance of the search task with the numeric and symbolic formats showed no significant difference. When copiloting, however, the test participants reported that the symbolic format was the easiest to use. Further research is required to firmly establish which of these two formats is a better alternative.

The findings from this research will be added to the human factors engineering technology data base, thus providing system designers with necessary information about a user's ability to perform required missions based on crew station display design and information formatting.

For more information, contact Mary E. Dominessy, US Army LABCOM, Human Engineering Laboratory, Aberdeen Proving Ground, MD 21005-5001; (301) 278-5851 or DSN 298-5851.

LOS-F-H *(continued from page 3)*

Summary

The efforts of the Martin Marietta MANPRINT group have been fully integrated within program events, and the impact on the soldier-machine interface has been continuously assessed prior to all change decision points. These efforts during the transition of the NDI LOS-F-H system to production, coupled with an operational assessment phase consisting of both technical and operational tests, has resulted in changes for performance, safety, reliability and training.

For more information, contact Mark Housman or Betty Mohs, Martin Marietta Missile Systems, PO Box 555837 MP-715 Orlando, FL 32855-5837; (407) 356-2055.

MANPRINT NOTES

From the MANPRINT Program Office

■ **URGENT!!!** We are in the process of "cleaning up" the *MANPRINT Bulletin* and POC mailing list. The *MANPRINT Bulletin* and *POC List* will continue to be sent ONLY to those who respond. Please use the renewal form on page 11 to send us correct mailing information. The form may also be used to indicate your desire to be listed as a POC for your organization. We ask that you mail or FAX this form to the MANPRINT Directorate using the address or FAX number located on the form. Alternately, you may call Ms. Carolyn Johnson (ARS) at (703) 824-5314 with the information. We appreciate your prompt attention to this matter!

■ **TRADOC Analysis Study.** HQ TRADOC has initiated efforts to conduct a study of Manpower, Personnel, and Training (MPT) in MANPRINT analyses. With a purview up to and including Milestone I, this study will identify key agencies conducting MPT analyses for the Army, to evaluate analysis deliverables, and to assess and enhance the tools used for conducting MPT analyses. It will identify obstacles to meaningful use of those study efforts (to include timing problems, certification procedures, etc.) and recommend a systemic remedy to the difficulties found in the course of the study. Current MPT analysis tools, as well as enhancements effected by the study, will be consolidated into a MANPRINT Analysis Aid.

■ **First TRADOC MANPRINT Video Conference Held.** HQ TRADOC held its first MANPRINT video conference on 10 May 90. While TRADOC schools and centers linked into the TRADOC Video net, Directorate for MANPRINT, HQ AMC, and USAPIC representatives participated from a Pentagon video conference facility. Topics covered include: Integration of MANPRINT-related deliverables, potential changes to the materiel acquisition program, TRADOC of the future, and MANPRINT training. The availability of the book *MANPRINT - An Approach to Systems Integration*, edited by Dr. Harold R. Booher, was announced.

■ **Publication of *MANPRINT - An Approach to Systems Integration.*** *MANPRINT - An Approach to Systems Integration* was published in May 1990 by Van Nostrand Reinhold Publishers. Dr. Harold R. Booher, Director for MANPRINT at ODCSPER, is the editor of this text, which was compiled by subject matter experts from government, industry, and universities. The book addresses the technical and managerial aspects of MANPRINT and will be utilized by MANPRINT managers, practitioners, and researchers. The book:

—provides practical solutions to the little-understood managerial problems of integrating people and technology
—helps readers locate and evaluate sources of user-centered technology
—covers current advances in macro and micro ergonomic techniques, computer-aided ergonomics, life-cycle costing, and engineering error reduction
—identifies research and development issues uncovered by MANPRINT.

Copies of the book 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 GS02F52100 (expiration date: 31 Jan 1992). Contact Diane Kennedy at Van Nostrand Reinhold if there are questions at (212) 254-3232. Discounts are as indicated below:

<u>Government Discount</u>

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

<u>Corporate Discount</u>

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

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. For credit card orders, call 1(800) 926-2665.

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Notes (continued from page 5)

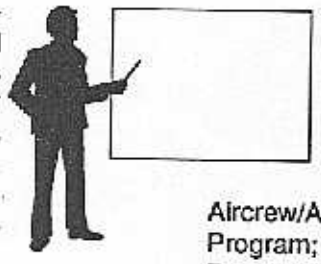
■ **Revised AR602-2 Published.** Effective 18 May 1990, the MANPRINT community has a totally revised regulation. This revision clarifies the relationship between the MANPRINT program and the MANPRINT domains; assigns responsibilities to Program Executive Officers and Project/Product Managers; redefines HQDA responsibilities to reflect the organization of the DA Staff; adds MANPRINT in the Source Selection Process; redefines the Human Factors Engineering Assessment; establishes the MANPRINT Assessment and the MANPRINT Review; and adds policy and procedures for an abbreviated System MANPRINT Management Plan.

■ **MANPRINT Addressed at French/U.S. Army Staff Talks.** At the request of the French delegation, HQ TRADOC presented a briefing entitled "Human Factors in Materiel Development" at the French/U.S. Army Staff Talks, held 31 May 1990 at Ft. Sill. TRADOC emphasized to the French delegation that MANPRINT must be implemented early in the acquisition cycle. The role of the six MANPRINT domains and cooperation with industry were also stressed as essential to the program's success. The French Army delegation was especially interested in MANPRINT's interface with industry, and proposed a 1991 MANPRINT meeting between French and U.S. ergonomics experts. HQ TRADOC will coordinate with the International Army Program Directorate for follow-on actions.

■ **New MANPRINT Office Arrival.** LTC Gary Shaw is the latest member to join the ODCSPER MANPRINT Directorate, arriving in May from duties as a Personnel Staff Officer. He has assumed responsibilities for MANPRINT Training and Education, and has initiated efforts to address MANPRINT in the acquisition of information systems.

■ **An Finally--Our Apologies!** The May/June issue of the *MANPRINT Bulletin* was mailed out late due to difficulties at the printer. We apologize to our readers, and plan to be back on track with this issue!

MANPRINT Practitioner's Workshop Held



Seventy-five MANPRINT practitioners representing TRADOC, AMC, and other government agencies, and industry participated in the MANPRINT Practitioner's Workshop held 19-20 June 1990 in Alexandria, Virginia. The keynote speaker for the annual event was Dr. Harold R. Booher, Director for MANPRINT.

Attendees received update presentations on the MANPRINT Enhancement Study; MANPRINT assessment requirements for developing systems; the development of an automated Manufacturer's MANPRINT Management Plan (MMMP); the newly released MANPRINT book; the revised AR 602-2; the revision of the *MANPRINT Handbook for RFP Development*; the Air Force IDEF Study results; HARDMAN (I, II, and III); and the Computer-aided Acquisition and Logistics Support system (CALS).

Other topics addressed include the career development needs for MANPRINT professionals; the MANPRINT relationship with Total Quality Management (TQM); MANPRINT guides and handbooks; MANPRINT analytic techniques; lessons learned in the JSTARS MANPRINT program; advice on incentives from Martin Marietta; the Army-NASA Aircrew/Aircraft Integration Program; the DoD MPTS Program; and changes to the acquisition guidance in DoDD 5000.1 and DoDI 5000.2.

Key areas requiring continued practitioner's attention were identified. These included those areas related to the impact of acquisition process changes; training needs; improving the SMMP; reporting MANPRINT successes; retaining MANPRINT resources during down-sizing of the force structure; and supporting the program manager's MANPRINT requirements for developing systems.

For more information, contact LTC Glen Hewitt, HQDA (DAPE-MR), Washington, D.C. 20310; AV 225-9213 or (202) 695-9213.

Notes from Dr. Booher: United Kingdom Visit

MANPRINT is receiving considerable interest in the U.K., as was determined from visits to the Ministry of Defense (MOD) in London, Army Personnel Research Establishment (APRE) at Farnborough, The Royal Military College of Science at Shrivenham, The Medical Research Council Applied Psychology Unit (APU) in Cambridge, and British Aerospace in Bristol.

The British Army has made a commitment to MANPRINT, but is wrestling with the specifics of implementation. One of their problems results from trying to bring in several new initiatives (Integrated Logistics Support, for example) as well as MANPRINT, to affect the acquisition process, and they too are facing cutbacks in staff. They wish to build on U.S. MANPRINT experience as much as possible.

The British have an opportunity to implement MANPRINT across all branches of service since their policy for MANPRINT is at Ministry of Defence level. Their Navy has as much interest in MANPRINT as does the Army. The Navy has set up a Human Factors Steering Group (chaired by Assistant Director of Policy & Programs in the Director of Operational Requirements (SEA) to insure human factors considerations become more central in their "specification, design, procurement and support of ships and equipment." This steering group is acting to highlight the relevance to the Navy of the Army's efforts to formalize MANPRINT. The approach is broad, including "research, writing of Staff Targets and Requirements, industry, project support and investment appraisal techniques."

There is considerable interest in having a U.K. "MANPRINT with Industry Day" Conference modeled on the U.S. conferences. The MOD Policy Office, USARDSG (UK), APRE, The Royal Academy of Science, and British Aerospace all expressed a desire to participate in such a conference.

Although smaller than either the Systems Research Laboratory (Army Research Institute) or the Human Engineering Laboratory, APRE has under one roof the capabilities to do all the MANPRINT domains, including health hazards. It is a natural organization to conduct MANPRINT reseach and provide direct expert assistance to program managers of systems being planned or procured. It is unique even in the United Kingdom. British Army research is just beginning to investigate manpower, personnel and training models with intended applications like the ARI HARDMAN.

The Royal Military College of Science (RMCS) is a world leading academic institution for Military Science and Technology. It provides both undergraduate and graduate courses in Science, Engineering, and Management. It also provides a wide range of short courses. Courses are available to both military and civilian students. They expressed interest in providing MANPRINT courses at the College as well as hosting MANPRINT Conferences with Industry.

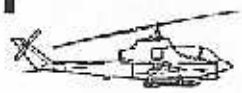
Research conducted at the Applied Psychology Unit in Cambridge is most similar to our basic research (6.1) performed primarily at universities and is valuable for better understanding human behavior. Topics like human memory, human-computer interaction, and effects of stress on human performance are some of their current research interests. Most of the reports provide useful information which adds to overall knowledge of human performance capabilities and limitations.

Major defense industries, like British Aerospace, have heard of MANPRINT because of competitive efforts for U.S. procurements. The industry appears quite ready to respond favorably for MANPRINT requirements on future U.S. and European procurements. It was noted that even smaller countries (Singapore, e.g.) are now starting to have MANPRINT requirements.

The Royal Army, through its MANPRINT Office, has the lead to demonstrate application, but the Ministry and sister services have all made encouraging steps. The MANPRINT program is being received everywhere with great enthusiasm. We will continue to support their efforts with Army experience, and I believe we can learn some things from them as well.

Army-NASA Aircrew/Aircraft Integration Program

James Hartzell
NASA



The Army-NASA Aircrew/ Aircraft Integration (A3I) program is a joint Army and NASA exploratory development effort to produce a Human Factors-Computer Aided Engineering (HF-CAE) system called MIDAS (Man-Machine Integration Design and Analysis System). The program's goal aims to assist design engineers in the conceptual phase of rotorcraft crewstation development and anticipate crew training requirements. The system provides interactive symbolic, analytic and graphical components which permit early integration and visualization of human engineering principles. Hosted on a number of networked Symbolics and Silicon Graphics workstations, MIDAS serves as the framework in which other research findings and models, developed by or sponsored through the Computational Human Engineering Research Office, are based.

Seventy to eighty percent of the life-cycle cost of an aircraft is determined in the conceptual design phase. After hardware is built, mistakes are hard to correct and concepts are difficult to modify. Currently, engineers responsible for developing crew training simulators and instructional systems begin work after the cockpit is built--too late to impact its design. MIDAS gives designers an opportunity to "see it before they build it," to ask "what if" questions about all aspects of crew performance, including training, and to correct problems early. The system is focused on helicopters, but is generic and permits generalization to other vehicles.

MIDAS is conceptually similar to computational tools such as finite element analysis and computational fluid dynamics, which are used to improve designs and reduce costs. Results of the computational analysis are presented visually. The HF-CAE workstation uses human performance models and a computational simulation of "manned flight" to evaluate the cockpit design. The results are presented graphically and visually to design engineers, often as a computer animation of manned flight.

The major elements of MIDAS currently are: (1) symbolic methods to represent and decompose the operator tasks; (2) simulation support workbench, including aircraft dynamics and guidance models, human behavior/performance models, system function models, and workload models; (3) training requirements models; (4) 3-D CAD utilities for prototyping cockpit instrumentation and controls; (5) an anthropometric pilot model (graphic mannequin); and (6) analysis displays to observe aspects of task performance, resource use, and load versus time.

The program began in the Fall of 1984 and has completed three major phases of development toward a 1994 target date for a full prototype system. The current phase focuses on the expansion of several elements of the system demonstrated during May 1990, along with the addition of a dynamic, opportunistic scheduling model and two new applied vision models currently undergoing integration.

For more information, contact E. James Hartzell, Chief, Computational Human Engineering Research Office, NASA, Ames Research Center, Moffett Field, CA 94035; (415) 604-5743.

? DID YOU KNOW?

• The Human Factors Society has recently released *Selected Readings in Human Factors.* HFS members may purchase copies for $20.00 each; nonmembers, for $25.00 each. For more information about the book, contact the HFS Publications Department at (213) 394-9793 or FAX (213) 394-2410.

• The average Japanese employee submits 24 suggestions per year for improvements in his or her company, compared to 0.14 by U.S. workers. Furthermore, 77% of Japanese suggestions are implemented, while only 26% of the U.S. suggestions are used.

MANPRINT
TROSCOM Success Stories

■ Auxiliary Aviation Lighting Devices

Army helicopter pilots identified a critical need for auxiliary lighting for missions where maintaining night vision is essential for success. Natick was tasked to evaluate existing devices, which were being used by air crewmen as an interim solution. One such device is attached to the finger and can be pointed in any direction in the cockpit. The other device (lip light) is attached to the microphone boom and thus leaves the user's hands free.

Early in the program, the project engineer enlisted the assistance of personnel from the MANPRINT Office and the Operational Forces Interface Group to conduct extensive evaluations of the interim devices with actual users, Army helicopter pilots. As a result, several design suggestions were made to the project engineer. For example, it was suggested that the lighting devices use push on/push off switches, that the finger strap be made longer to accommodate a thick glove, and that the user should have the option for both the finger light and the lip light. These and other suggestions have been incorporated into the Requests for Proposal (RFP) and the requirements documents for these items. These auxiliary lighting devices will enable Army air crewmen to maintain their night vision and therefore decrease the chance of an accident during night operations. This program was accomplished on an accelerated basis and shows the importance of early involvement of MANPRINT and user feedback in achieving the optimal product for the soldier.

■ Chemically and Biologically Protected Shelter (CBPS)

The CBPS is a lightweight, quickly erectable, inflatable tent with integrated components which provide a temperature controlled, biological and chemical agent-free environment. It is designed to replace the M-51 Battalion Aid Station.

MANPRINT personnel conducted an appraisal of the CBPS to determine the demands placed on human users to perform all required functions while wearing protective (cold/wet) garments. This appraisal resulted in numerous design recommendations. Among the suggestions were to develop the smaller (300 square feet) tent, which is easier to erect and strike. It was also suggested that designers continue to develop the raised litter airlock, incorporating modifications to make it easier to handle and decontaminate, and to use the vehicle's engine as the system's source of power because it is easier to set up and makes the system more "self sufficient."

Each of these, and other recommendations, have been included in the design of the current version of the CPBS. These design changes are expected to result in enhanced ease of use, and lessen the expenditure of energy needed to accomplish medical missions.

■ Improved Meal Ready-to-Eat (MRE)

A 1983 field test of an early version of the MRE IV revealed that the ration was not consumed in sufficient quantity, causing troops to lose weight. Data revealed dissatisfaction with some of the entrees, a desire for larger portions of certain entrees, and a desire for fruit-flavored beverages, breakfast items and hot sauce to be included in the ration. These suggestions were phased into subsequent procurements of the MRE. In 1986, a preproduction version of MRE VIII, which incorporated all these requests, was compared to MRE IV and MRE VII in a field test. The results from this test indicated that troops consuming this new version of the MRE ate more food, drank more water, and found components of the ration to be more acceptable than troops consuming consuming MRE IV or VII. These data served as the basis for a GO IPR decision to procure this new MRE version.

Continuing user feedback on the improved rations remains very positive and highlights the kind of success that can be achieved when the user is involved in product design and improvement.

For more information, contact Col. John Sosnowski, Deputy Commander for Procurement and Readiness, HQ TROSCOM, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798.