MANPRINT Quarterly

PEOPLE TECHNOLOGY ORGANIZATION

Vol. IV, No. 2 Spring 1996

The Director's Corner

THE PENDULUM SWINGS

There is the perspective of youth and the related (generally lost) cultural optimism of our country that "things will work out for the better." Then there is the balanced judgment of middle age that there are "good days and bad ones" and things may or may not get any better. And then there is the outlook of old age and the related pessimism of European societies that there are no fundamental changes in human nature, science, or politics that warrant any expectations for future improvements in the relations among men and nations.

The Department of Defense (DoD), acting in the finest traditions of American optimism over the government's ability to improve behavior—in this specific instance, the Defense Acquisition System—has now issued a revised Directive (5000.1) and Regulation (5000.2-R). The 5000 series documents had over time accreted cumbersome requirements and had become "unwieldy and too complex." The essence of the new guidance follows from recognition that smart Project Managers can do a better job, in terms of buying higher quality, cheaper, and faster, if empowered to rely on judgment instead of being forced to follow rigid regulations.

Thus, the pendulum has swung from over-regulation based on essential mistrust of the acquisition community to minimal regulation with a high degree of trust. It should be a goal of the MANPRINT community to keep the pendulum where it has now swung.

Jack H. Hiller
Director for MANPRINT

contents

DCSPER Presents MANPRINT Practitioner of the Year Awards for 1995

LTG Theodore G. Stroup, Jr., awarded the MANPRINT Practitioner of the Year Awards on February 1, 1996 at the Pentagon. Individuals recognized as winners were: Mrs. Elizabeth Redden, Chief, HRED Field Element, US Army Infantry Center, Ft. Benning in the Combat Developer Category; Mr. Richard McMahon, HRED-ARL, Aberdeen Proving Ground in the Materiel Developer Category; and Major Alfred A. Coppola, Jr., Crusader Project Office, in the Military Category. Also

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Manpower and Personnel Integration (MANPRINT) in Force XX

Breaking the Paradigm

LTC David Watkins and LTC Mitchell Howell
MANPRINT Directorate

Force XXI initiatives, plus acquisition streamlining, horizontal technology integration, smaller budgets, and increasingly complex requirements, are all placing tremendous pressures on materiel development process managers to rethink how we routinely do business. The Manpower and Personnel Integration (MANPRINT) community is the combat and materiel developers' ally in their efforts to respond to these complex mission requirements.

MANPRINT casts the soldier/user as the framework for system acquisition. It seeks to leverage current and future technologies to best utilize human resources to produce a more effective warfighting capability for the nation's defense. Although digitization of the battlefield may produce a quantum leap forward in the ability of the U.S. Army to conduct Information Warfare, to do so effectively will require the total integration of soldiers, units, and leaders with the digitized systems.

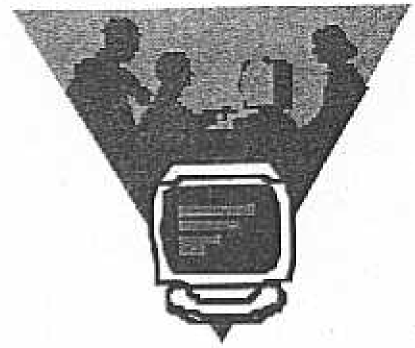
MANPRINT analyses performed early in the development process can identify potential conflicts between initial materiel system designs and the abilities of humans as operators/maintainers, unit members, and leaders. For example: (a) developers can identify solutions to issues and concerns dealing with mental and physical fatigue, task overload, and task allocation; (b) effective collective training techniques and operator/maintainer training device requirements can be identified early; (c) the target audience can be structured to be best supported by the training and recruiting base; (d) reserve component concerns and requirements can be identified and considered; and (e) safety, soldier survivability, human factors engineering, and health hazard concerns can be raised and addressed within the envelope of program design instead of worked as unfunded requirements after testing shows problems.

Traditionally, MANPRINT and its associate methodologies have been applied too late to the sy tem design process or not at all. To reap the full be efits of MANPRINT, we must break this paradig and apply the MANPRINT process whenever we a considering soldier impact on life cycle costs.

One recent example of a non-traditional utiliz tion of MANPRINT methodology involved a revie related to Depot Maintenance Plant Equipme (DMPE) for the Longbow Apache and Comanc programs. The analysis identified a significant cheaper process for the conduct of depot repair f these aircraft. The MANPRINT community did n generate these particular cost avoidances; howev MANPRINT methodology was successfully appli to discover where savings could be achieved.

MANPRINT methodologies can be applied Force XXI as the former Chief of Staff's initiati unfolds: force projection, mobilization requiremen task allocation, installation and battlefield inform tion management, casualty reduction and mana ment, identification of training requirements (in tutional, embedded, individual, leader, and coll tive), reduction of life cycle operations and supp costs, and identification of future personnel syste in support of the Total Army. Recruiting, equipp and maintaining the Army of the 21st Century v require a break with tradition, using the MANPRI process to examine total organization design throu out the force. The MANPRINT process need not limited to an acquisition cycle process driven f ward by an impending milestone decision review, can function as a force multiplier and managem tool for effective and efficient utilization of our m important resource, our personnel—soldiers and le ers.

Automated Tool for Soldier Survivability Assessments



Donald B. Headley
Human Research and Engineering Directorate
U.S. Army Research Laboratory

Richard Zigler
Survivability/Lethality Analysis Directorate
U.S. Army Research Laboratory

The Spring 1995 issue of the MANPRINT Quarterly discussed methodology for performing soldier survivability (SSv) assessments (pp. 4-5). The key tool outlined in the article is the parameter assessment list (PAL), a hierarchy of some 170 issues pertaining to the six components of SSv.

The PAL is now automated. This Windows-based product is called the parameter assessment list—MANPRINT automated tool edition, or PAL-MATE. Although an assessor will have the option of using either the original PAL format or this new version, the PAL-MATE has many features that mitigate the occasional burdensome nature of the paper-and-pencil PAL. PAL-MATE is also a convenient means for Program Manager offices and contractor personnel to quickly view what is assessed under the SSv domain.

The Interface

PAL-MATE is a customized modification of a product called Human System Interface Design Review Guideline which was developed for the U.S. Nuclear Regulatory Commission by Brookhaven National Laboratory and Micro Analysis and Design, Inc. Researchers at the Army Research Laboratory's Human Research and Engineering Directorate re-designed parts of the interface to make it more usable for SSv applications.

On the main assessment screen (see Figure 1), one section displays the issue and its associated hierarchical

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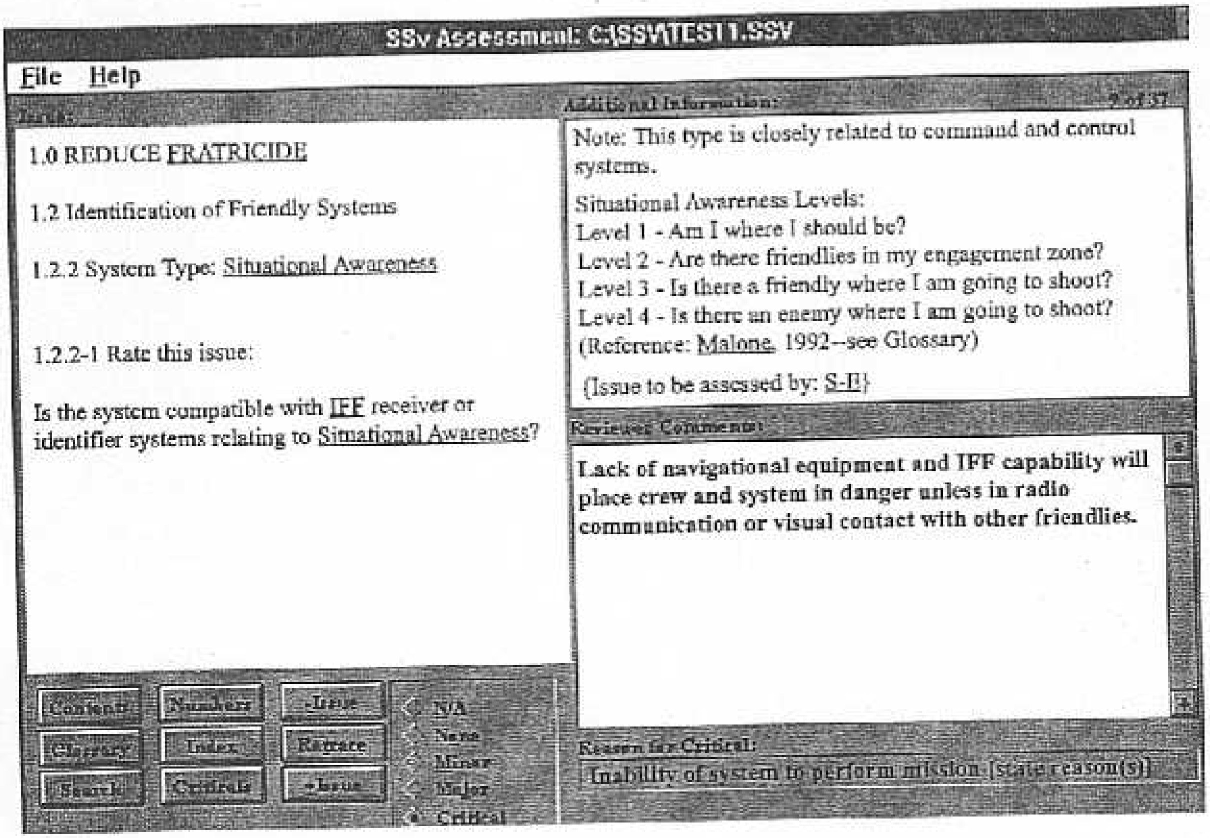

Figure 1. Sample SSv Assessment Screen

Determination of Crew Heat Stress Exposure in Ground Combat Vehicles: A MANPRINT Concern

Ajoy Muralidhar, MANPRINT Engineer
United Defense L. P., Ground Systems Division, York, PA 17405-1512

This article is the second of a two part overview of thermal stress concerns in Ground Combat Vehicles (GCVs). This installment looks at possible ways of minimizing the risk of heat stress by monitoring crews' metabolic activity with respect to the prevailing thermal environment.

Most current scenarios for global conflicts indicate a major role for the United States involving the deployment of troops either as active participants or as a moderating influence. Since the end of the Cold War, the most likely site for future engagements is probably the Middle East - Persian Gulf region. The climatic conditions of this part of the world pose some challenges to ensuring the safety and well being of personnel during operations and maintenance and, as such, should be of prime importance to the MANPRINT practitioner.

Hardware design improvements and strict military specifications have increased the reliability and ruggedness of GCVs such that they can be expected to perform with a high degree of confidence over a wide range of environments, from Arctic cold to extreme desert conditions. However, the same cannot be said for the crews of these vehicles. Human beings cannot function in extreme environments without adequate provisions being made to maintain comfortable working temperatures. Although with repeated exposure, a certain degree of 'conditioning' or acclimatization takes place, extreme thermal environments pose a constant danger to the well-being of personnel.

GCV crew members in the field are expected to be able to man their vehicles at all times. This means an availability requirement of 100% for crews, irrespective of the fact that the GCV itself may not be available for operations, due to equipment failure, maintenance requirements, etc. As the same set of crew members has to carry out combat, diagnostic and maintenance tasks in the field, the crew faces prolonged exposure to the degraded environment.

Continuous operations in hot conditions result in thermal stress on combat vehicle crews, leadin heat induced fatigue, exhaustion, and in extre cases, heat stroke and death. Where the expec duration of operations in such conditions is expec to be prolonged, it is necessary for the mission pl ning authorities to take extra precautions to red the risk of heat stroke. This can be done by admi trative measures to ensure as little exposure as p sible by initiating a carefully planned regimen controlled exposure leading to acclimatization, equate and readily available supplies of fluids, minimization of work in enclosed spaces and in permeable, encapsulating whole body protection s tems.

Recognition of heat stress conditions and the tual measurement of thermal stress induced ph ological distress is not easy, as no single factor be pin-pointed as the causative agent. Thermal str occurs from a combination of conditions that n exist simultaneously - air temperature, radiat sources, air movement, physical work perform humidity, age, gender and physical condition of exposed crew members, use of prescription and n prescription drugs, and any pre-existing medical c ditions. When these conditions are known to present, extra precautions must be taken.

Due to the enclosed nature of most combat hicles and the insulation of the crew compartm work conditions in 'button down' conditions beco rapidly unbearable. If the crew has to carry out m erate to heavy activities, the risk of heat strok heightened. The ventilation system of the com vehicle may be designed to circulate a suffici amount of air within the crew compartment, but i possible for the microclimates induced within crew members clothing system to increase core b temperature to dangerous levels, without the cre knowledge, until it is too late, and collapse occu

When there is a risk of thermal stress conditi occurring, exposure times must be carefully mo tored and regulated. In industrial applications, h stress indices are used to predict the level of thermal stress experienced by workers as a way of regulating shift duration, and to provide adequate recovery periods. Similarly, heat stress indices may be used in evaluating the thermal stress in the interiors of GCVs.

There are two indices that can be used for the evaluation - the Wet Bulb Globe Temperature (WBGT) Index and the Belding-Hatch Heat Stress Index (HSI). The WBGT index determination requires the MANPRINT practitioner to measure the wet bulb temperature, the dry bulb air temperature and the globe temperature. Depending on indoor or outdoor exposure measurement, the dry bulb air temperature is factored into the WBGT equation. The Belding-Hatch HSI requires that the dry bulb air temperature, wet bulb temperature, globe temperature, the air velocity, and the metabolic energy expenditure all be known for the determination of the HSI.

Historically, the WBGT has been popular with industry and the military because of its ease of determination, and is endorsed by the National Institute for Occupational Safety and Health as well as the American Conference of Governmental Industrial Hygienists (ACGIH). However, due to the specialized nature of the conditions within the crew compartments of GCVs, the use of Belding-Hatch HSI may be more appropriate during the system development and design phases because it considers the air velocity and energy expenditure, and thus gives a better idea of the actual environmental conditions. One drawback of the HSI is that it assumes the skin temperature to be constant at 35° C, causing possible overestimation of thermal stress. The MANPRINT practitioner utilizing this index during design and testing should pay attention to this possibility while assessing the heat stress.

In order to determine the thermal stress risk to crew members during operation and field maintenance of GCVs, it is necessary to review the operational requirements of the fielded system in detail, and to prepare a comprehensive task analysis. This analysis can be used to determine the metabolic energy expenditure demand of the tasks on each crew member. The heat stress index (WBGT), task metabolic demands and time of exposure can be used to determine the Threshold Limit Value (TLV) for exposure to thermal stress. Once the TLV is determined, the duration of exposure can be regulated by the introduction of recovery periods between tasks, or where that is not possible, shortening of exposure time of the crew by dividing the manning period into several intervals interspersed by rest periods in a 'cooling zone' outside the crew compartment where

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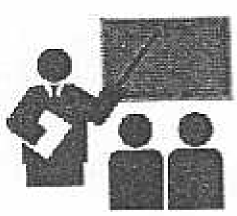
MANPRINT Training Schedule

MANPRINT Action Officer Courses

Class	Date	Location
96-001	15-25 Apr 96	USALMC, Fort Lee, VA
96-705	14-23 May 96	Fort Hood, TX
96-706	30 Jul - 8 Aug 96	Fort Monmouth, NJ
96-002	9-19 Sep 96	USALMC, Fort Lee, VA

MANPRINT Workshops

Class	Date	Location
96-708	30 Apr - 2 May 96	TACOM, Warren, MI
96-709	7-9 May 96	Redstone Arsenal, AL
96-710	4-6 Jun 96	Fort Bliss, TX
96-713	20-22 Aug 96	Redstone Arsenal, AL



MAISRC

Class	Date	Location
96-714	10-12 Sep 96	Fort Belvoir, VA
96-715	24-27 Sep 96	Fort Huachuca, AZ

MANPRINT Training POC: SFC Irvin Raveneau, (703) 325-8422/3200 or DSN 221-8422/3200

Determination of Crew Heat Stress Exposure
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possible, or by providing a relief crew.

Such a solution will work very well for an industrial setting, but is almost impossible to comply with in the battlefield—crew members cannot be reasonably expected to leave the GCV or to take rest breaks in hostile territory. Also, the provision of a rotating crew is logistically very difficult, as combat mobility requirements would mean that the relief crew would have to be transported along with the GCV wherever it moved. The problems which can be foreseen in maintaining combat continuity during crew transition preclude the use of crew rotation.

Current design philosophy calls for optimization of the ventilation and cooling, or for GCV specific solutions applicable across all variants of a platform. These solutions are not universally applicable, as there are wide variations in the size and configuration of crew compartments, depending upon the internal geometry and placement of equipment and stowage racks. These variations in different GCV crew compartments affect the air circulation and cooling. Stowage of equipment is usually a low priority in the early stages of the system design, and is often done as an afterthought, with equipment accommodated in every available space. In addition to this, further variations can be expected due to improper replacement of equipment after use and due to individual crew space usage.

It is known that for any given set of environmental conditions (the measured WBGT) and metabolic load on crew members, the safe exposure period as a percentage of total working time can be determined. For a particular WBGT, if the crew is engaged in tasks that impose low metabolic loads, the permissible exposure periods are much longer than for tasks that impose high metabolic loads. For example, a task imposing a metabolic load of 200-350 kcal/hour (moderate work) could be performed continuously at a WBGT of 26.7° C, but at a WBGT of 29.4° C, *the same work would require a work-rest division of 50 percent work and 50 percent rest each hour.*

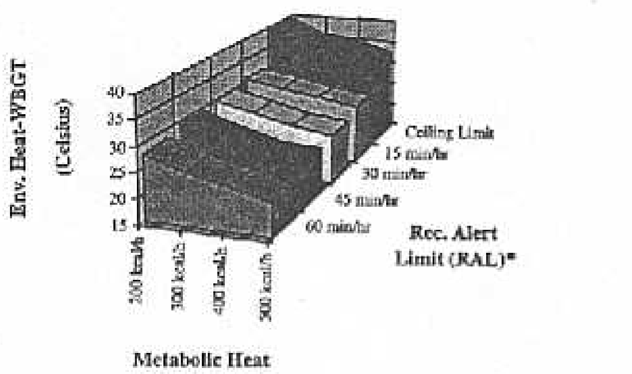
The marked difference that a WBGT temperature variance of a few degrees makes is even more pronounced when the metabolic loads are heavy, in case of operational requirements such as loading and firing. If crews continue to operate under such conditions, ignoring 'minor' changes in the crew compartment environment and increased physical activity, the body core temperatures may increase to dangerous levels, resulting in heat stroke. Crew members should be instructed in the hazards of thermal stress, and trained to recognize high risk conditions. Crew commanders in particular should be aware of this limitation on the continuous availability of their crews so that recovery periods can be incorporated into the planned activities. If possible, all non-combat, metabolically demanding activities should be planned for cooler hours of the day, such as the early morning or late evening.

As these conditions are faced during operations, it may become necessary to determine the heat stress index in the field. The tasks performed by the GCV crew members can be classified into four categories by the MANPRINT practitioner, depending on their estimated energy expenditures—Light (up to 200 kcal/hour), Moderate (200 - 350 kcal/hour) and Heavy (350 - 500 kcal/hour) and Very Heavy (>500 kcal/hour). Using this as a guideline, the unit medical staff (or the crew members themselves) can be trained to compute the heat stress index in the field. For field computation, the WBGT may be used for its simplicity, as a very acceptable approximation of heat stress index (WBGT) can be determined from the relation:

WBGT = WGT(Wet Globe Temperature) + 2° C

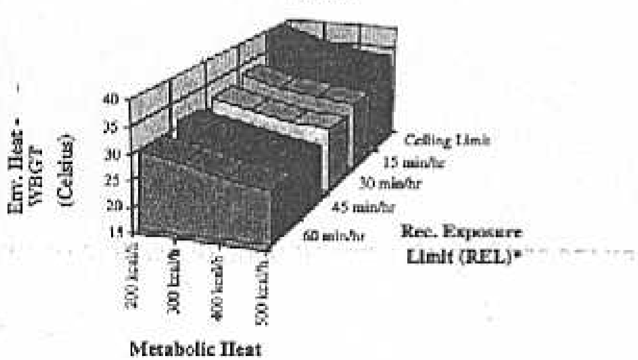
The Wet Globe Thermometer is simple to use, and easy to read. It combines the thermal exchange by conduction, convection, evaporation and radiation into one reading that can be read off a dial that is provided at the end of the stem. A medical corpsman can be easily trained to measure the WGT and add 2° C to compute the heat stress index. The permissible exposure is determined from Figure 1 (for unacclimatized personnel) and Figure 2 (for acclimatized personnel).

Figure 1 - Heat Stress Alert Limits For Unacclimatized Personnel



** For "standard worker" of 70 kgs. (154 lb.) and 1.8m² (19.2 ft²) body surface. Data Source: Reference 1*

Figure 2 - Heat Stress Exposure Limits For Acclimatized Workers



** For "standard worker" of 70 kgs. (154 lb.) and 1.8m² (19.2 ft²) body surface. Data Source: Reference 1*

The energy expenditure for various tasks may be used to calculate the metabolic workload of any crew member, and should be used as a guideline for allocating tasks in the GCV. The energy expenditure per minute for various tasks are given in Table 1.

Table 1 - Energy Expenditure

Task Type/Activity	Energy Expenditure
Basal Metabolism	1.0 kcal/min.
Sitting	0.3 kcal/min.
Standing	0.6 kcal/min.
Walking	2.0 - 3.0 kcal/min.
Hand Work -Light	0.4 kcal/min.
Hand Work - Heavy	0.9 kcal/min.
One Arm Work - Light	1.0 kcal/min.
One Arm Work - Heavy	1.8 kcal/min.
Two Arm Work - Light	1.5 kcal/min.
Two Arm Work -Heavy	2.5 kcal/min.
Whole Body - Light	3.5 kcal/min.
Whole Body - Moderate	5.0 kcal/min.
Whole Body - Heavy	7.0 kcal/min.
Whole Body - V. Heavy	9.0 kcal/min.

Using this table as a guide, the metabolic load can be calculated approximately as follows:

Sample Task: Loading Ammunition

Whole Body Work, Moderate:	*5.0 kcal/min.*
Standing:	*0.6 kcal/min.*
Basal Metabolism:	*1.0 kcal/min.*
Total:	*6.6 kcal/min. or 396 kcal/hour*

At 26°C WBGT, Metabolic Work at 400 kcal/hour can be performed at 60 min./hour, but at 27.5°C WBGT is limited to 45 min./hour (for Acclimatized Personnel).

As new systems are fielded, the MANPRINT practitioner should ensure that the risk of heat stroke conditions occurring is reduced by the careful design of crew tasks, and by the elimination of tasks that impose a high metabolic load on the crew. For example, the increased use of autoloaders in future GCVs would relieve the combat personnel of the physically demanding tasks of lifting and loading heavy munitions and reduce the need to move about in the crew compartment. Task allocation between the crew members should be carefully planned so that excessive stress on any crew member is thereby avoided. Commanders should be advised to keep thermal stress risks in mind when fielding the units under their command and plan accordingly, so that operational requirements are not affected if several units are withdrawn periodically to provide recovery periods for the crews.

References

1. NIOSH. *Occupational Exposure to Hot Environments*, Revised Criteria (1986), US GPO, Washington DC.

2. Grandjean, E. *Fitting The Task to The Man - An Ergonomic Approach* (1980), Taylor and Francis Ltd., London.

3. Plog, B. A., Benjamin, G. S., and Kerwin, M. A. *Fundamentals of Industrial Hygiene, 3rd Edition* (1988), National Safety Council.

4. Oborne, D. J. *Ergonomics at Work, 2nd Edition* (1989), John Wiley & Sons, Chichester.

USACHPPM Designated as Health Hazard Assessment Program Executive Agent

The Army's Health Hazard Assessment (HHA) Program office located at the U.S. Army Center for Health Promotion and Preventive Medicine (formerly the Army Environmental Hygiene Agency or AEHA) was recently designated as the Executive Agent for the HHA Program by the Office of The Surgeon General. Consequently, correspondence addressing HHA Program issues and concerns should be submitted to: Commander, USACHPPM, ATTN: MCHB-DC-OHH, Aberdeen Proving Ground, MD 21010-5422. Telephone numbers are available in the MANPRINT Domain POCs listing in this Quarterly.

Health Hazard Assessment reviews of acquisition program documents and MANPRINT Joint Working Group (MJWG) assistance are provided by the U.S. Army Medical Department Center and School (USAMEDDC&S). Requests for document reviews and MJWG support should be submitted to: Commander, USAMEDDC&S, ATTN: MCCS-FCM, 1400 E. Grayson Street, Fort Sam Houston, TX 78234-6175. Telephone inquiries should be directed to Mr. Ben Gibson at DSN 471-1827 or commercial 210-221-1827.

Requests for HHA reports should continue to be submitted through the Army Materiel Command (AMC) Surgeon's Office to USACHPPM. The address at AMC is: Commander, USAAMC, ATTN: AMCSG-H, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001. Telephone inquiries should be directed to MAJ Mike Leggieri at DSN 667-0241 or commercial 703-617-0241.

MANPRINT Practitioners Symposium

Plans for the 1996 MANPRINT Symposium are taking shape. We are aiming for the latter part of October, in the Washington, D.C. area; start making plans now to attend. The program theme this year will center on the revised DoD Directive 5000.1 and DoD Regulation 5000.2-R and the opportunities and challenges they present to MANPRINT. See you there.

Health Hazard Assessment Program on the Internet

Information on the Army's Health Hazard Assessment (HHA) Program is now available on the Internet at:
http://chppm-www.apgea.army.mil/hha
or
http://131.92.88.201/hha/

The information includes overall program information, current status of acquisition programs being assessed, an electronic mail HHA request form, and related Army Medical Department and materiel acquisition World Wide Web sites.

Practitioners of the Year Awards

(continued from page 1)

recognized at the ceremony was Mr. Richard Zigler, SLAD-ARL, Aberdeen Proving Ground as the runner-up in the Materiel Category. Mr. Dennis Lipscomb of the Directorate for Combat Developments, US Army Armor Center, Ft. Knox was recognized as the runner-up in the Combat Developer Category but was not available for the ceremony.

Nominations were sought by the MANPRINT Directorate from throughout the acquisition community, Army Materiel Command, TRADOC, and other offices associated with MANPRINT and system acquisition. Winners were presented with a DCSPER Letter of Commendation, a framed DCSPER Certificate, and an engraved plaque. Runners-up were awarded a DCSPER Letter of Commendation and a framed DCSPER Certificate.

Winners were selected by a board of seven General Officers and Senior Executive Service officials who have an interest in or direct affiliation with MANPRINT and system acquisition. Winners were evaluated in the areas of: MANPRINT Innovations, Overall Program Complexity, Personal Qualities, Personal Involvement, and Meeting or Exceeding Agreed Upon Program MANPRINT Objectives.

Nomination procedures for 1996 will be made by memorandum from the MANPRINT Directorate in the June-July time frame, with presentation scheduled for the MANPRINT Symposium in the fall.

Automated Tool for Soldier Survivability Assessments (continued from page 3)

information (i.e., subcomponent & component). Another section contains key information about the issue. All cursor movement takes place near the bottom portion of the screen. Buttons that select support features (e.g., search, glossary) are conveniently arranged at the lower left. The lower center contains the rating area (critical, major, minor, etc.). Once the assessor chooses a rating, the applicable rating button is clicked to tag that issue. A "reviewer comments" section allows notes to be typed directly on the screen and stored with the given issue.

Features

- On-line
  - — Glossary of terms
  - — Help
  - — Tutorial
- Search Functions
- Navigational aids
- Report generator (screen & paper) which sorts issues by rating category and allows reviewer notes to be printed
- Context index look-up of key words appearing in issues
- Selection of specific components, subcomponents, or issues for evaluation, with capability for later modification
- Screens for additional issues
- Screens for subcomponent and component roll-ups
- File sharing of evaluations
- Lap-top compatible

Additionally, a paper user's guide and a fold-out quick reference guide are available as part of the PAL-MATE package.

System Requirements and Installation

PAL-MATE requires Windows Version 3.1 or higher and at least 4 megabytes of RAM. A minimum of 5 megabytes of free hard disk drive space is recommended (4 MB for PAL-MATE plus room for storing system application files).

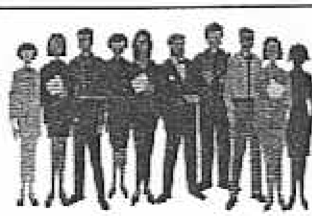
The program comes complete on one 3.5 inch disk and has an auto-install feature. Installation is achieved in less than 5 minutes.

Availability and Distribution

PAL-MATE will be ready for distribution to government and contractor personnel by mid-April 1996. The PAL-MATE disk and accompanying materials can be obtained by contacting Mr. Richard Zigler at

- Director, U.S. Army Research Laboratory
  ATTN: AMSRL-SL-I (Mr. Zigler)
  Aberdeen Proving Ground, MD 21005-5068
- rzigler@arl.mil
- Office: 410-278-8625 (DSN 298)
  Fax: 410-278-7254

Meeting of Interest



The Department of Defense Human Factors Engineering Technical Advisory Group Meeting # 36

May 6-9, 1996
Nassau Bay Hilton and Marina
Houston, TX

POC: Dr. James Geddie
ARL Field Element, HQ, TEXCOM
ATTN: AMSRL-HR-MV
Fort Hood, TX 76544-5065

Commercial: 817-288-9572
DSN: 738-9572

MANPRINT Directory Update

We are starting to update the MANPRINT Directory for 1996. If you want to be included in this year's directory or make a change to information in the 1995 directory, please let us know. Just use the form on page 11 of this MANPRINT Quarterly and indicate "MANPRINT Directory entry." We want to make the 1996 directory as complete and accurate as possible. Thanks for your help.