

ARMY REGULATION

No. 602-1

HEADQUARTERS
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Personnel-Materiel Systems

HUMAN FACTORS ENGINEERING PROGRAM

Effective 15 July 1976

This revision implements the requirement to integrate Human Factors Engineering (HFE) throughout the materiel acquisition cycle. Policy for HFE during the conceptual phase, validation phase and during full scale development is specified to include procedures for conducting a detailed HFE analysis and documenting the scope of this analysis in the requirement document. Local limited supplementation of this regulation is authorized. If supplements are issued, major Army commands will furnish one copy to HQDA (DAPE-PBR), WASH DC 20310; other commands will furnish one copy to the next higher headquarters.

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1. Purpose. This regulation prescribes policies and procedures and assigns responsibilities for human factors engineering (HFE) in the Department of the Army. For the purpose of this regulation, HFE is defined as a comprehensive technical effort to integrate all personnel characteristics (skills, training implications, behavioral reactions, human performance, anthropometric data and biomedical factors) into Army doctrine and systems to assure operational effectiveness, safety, and freedom from health hazards. See appendix.

2. Scope. *a.* This regulation applies to Headquarters, Department of the Army, agencies and major field commands responsible for—

- (1) Development of organization and doctrine.
- (2) Materiel requirements.
- (3) Research, development, test, and evaluation of materiel.
- (4) Production and procurement of materiel.
- (5) Management of personnel resources.
- (6) Training or development of manpower.
- (7) Systems safety engineering.
- (8) Integrated logistic support.
- (9) System maintainability/availability/reliability engineering.

b. HFE includes—

- (1) That part of system analysis that deter-

mines the personnel role in a personnel-materiel system.

(2) Selecting, defining, and developing personnel-materiel interface characteristics, workspace layout, and work environment conducive to effective and efficient performance under expected use conditions. (The process of developing and defining such a work environment includes a detailed analysis of the impact of the proposed environment on the health and well-being of operator and maintenance personnel.)

(3) Coordination with other agencies in determining the needs for, and then developing and evaluating job procedures, performance aids, and training devices, aids, equipment, and technical publications.

(4) Providing basic personnel-materiel task sequence data used to describe, develop, and assess the feasibility of the soldier performance required in a personnel-materiel system.

(5) Developing equipment which permits effective personnel-materiel interaction under special limitations in the training time, aptitudes, skills, or physical standards.

(6) Determining number and kinds of military and civilian personnel needed in a personnel-materiel system to evaluate the relative effective-

*This regulation supersedes AR 602-1, 4 March 1968.

ness of design concepts and for subsequent personnel planning, and providing the data needed for modifying current MOS or establishing new MOS required by new equipment, doctrine, or organization.

(7) Assessing the training burden which competing materiel design concepts may impose on the Army.

(8) Developing the information needed for new or revised training plans, courses, or programs of instruction as required by new or modified materiel, doctrine, or organization.

(9) Confirming the effectiveness of HFE by evaluating the completed personnel-materiel combination.

(10) Conducting research required to resolve HFE problems encountered in materiel development programs, as disclosed through systems analyses (1) above).

c. This regulation does not apply to the Army National Guard or Army Reserve.

3. Objectives. The objectives of the HFE program are to—

a. Assure that Army materiel and concepts of its use conforms with the capabilities and limitations of the fully equipped soldier to operate, maintain, supply and transport the materiel in its operational environment; consistent with tactical requirements and logistic capabilities.

b. Insure that materiel is developed so that the personnel tasks involved in its operation, maintenance, supply and transport do not exceed the capabilities of the soldier.

c. Assist the Army trainer in achieving an effective, sufficient, necessary, and integrated Army training program.

d. Improve control of total life cycle costs of personnel-materiel systems by assuring consideration of the costs of personnel resources and training for alternative systems during the conceptual stages and for the selected system during subsequent stages.

e. Optimize the relationship between skill levels, training, and personnel required to operate and maintain materiel.

f. Assure that equipment designs are compatible with the capabilities and limitations of the personnel who must operate and maintain them through basic and applied studies and research in HFE, personnel-materiel system analysis and psychophysiology.

g. Develop data defining the existing range of human performance, comparing them against systems performance requirements, to identify new performance requirements, and provide for the timely development of the necessary trained personnel resources.

h. Insure that systems engineering considers safety and health standards.

i. Provide data for the development of technical manuals, training manuals, field manuals, and other technical publications and insure that the use of these publications does not require aptitudes, education, or training beyond that required to perform the tasks they describe.

j. Apply HFE concepts and current educational technology to design and development of training devices and aids.

4. Policy. *a. General.* During all phases of the life cycle for materiel systems, accepted principles of HFE will be used to integrate materiel development with personnel resources and will have an associate priority with all other systems characteristics. Personnel implications will be considered throughout all development activities. Human factors studies or behavioral research will be initiated when gaps in HFE data base exist and where novel human factors problems are identified in Army development programs. (See AR 70-8.) During all phases of systems development, the interactive effect of system concept, hardware design, software design, personnel performance requirements, and training requirements must be recognized. It is important that decisions regarding mission, doctrine, basis of issue, unit organization and manning, personnel selection and training, and technical or training publications all be made from a coordinated data base including human factors engineering. Task sequences developed originally for personnel-materiel task allocation and determination of personnel compatibility will be used to the maximum extent feasible in:

(1) The determination of personnel-materiel interface requirements (displays, controls, test points and maintenance tasks).

(2) The development of new or revised MOS or duty descriptions (AR 611-1);

(3) The development of training programs, training equipment and standards for training;

(4) The preparation of technical training and field manuals and other technical publications;

(5) The Product Improvement program; and

(6) The assessment of human performance reliability (MIL-STD-721B). The personnel data base will be brought up to date whenever affected by design or configuration changes. HFE will be applied to planning and making changes in missions, doctrine, organizations, and equipment to avoid personnel-materiel incompatibility.

b. HFE in the Conceptual Phase. HFE will be initiated in the conceptual phase of the system's life cycle. During the conceptual phase, HFE, personnel plans, and training considerations will be integrated into the technical and management plans. HFE data developed during the conceptual phase will be considered during this phase in determining projected personnel requirements and in planning development of personnel-support programs and training programs. In the case of materiel with a very strong human interface, it is critically important to develop HFE data in the conceptual phase (RDTE category 6.2 and 6.3a) sufficient to provide a basis for thorough design and evaluation during Systems Oriented Advanced Development (RDTE Category 6.3b).

c. HFE in the Validation Phase. Although HFE will be integrated throughout the materiel acquisition process during all phases of the RDTE Categories (6.1, 6.2, 6.3a, 6.3b, 6.4, 6.5, and 6.7) (fig. 2-1, AR 70-1) for materiel systems requiring a specific personnel materiel interface, Systems Oriented Advanced Development (RDT&E Category 6.3b) is the preferred stage of development for the completion of detailed HFE. At this stage, prototypes representing the first concrete expression of the concept are available for test and evaluation, yet the design has not been frozen. As a result, sufficient information concerning the proposed design is available to support a detailed HFE analysis while this design is still sufficiently flexible to accommodate any change resulting from the recommendations of this analysis. The requirement to initiate an HFE analysis as a part of 6.3b will be documented in the Letter of Agreement (LOA). It will include the designation of the agency with reorganized HFE expertise responsible for conducting and reviewing the HFE analysis. Results of the analysis will include:

(1) Tentative identification, allocation, and sequencing of operator and maintenance tasks to develop a concept of the training requirement for the soldier and the soldier's role in operating, using, or maintaining the materiel.

(2) Identification of human factors research required to support the training requirement and the operational concept. (In those cases where human factors research is required, the need for this research will be documented as a separate research and development requirement in a Human Research Need (HRN) under the provisions of AR 70-8. The HRN and any supporting documentation will be provided the agency, command or laboratory designated to provide such support.)

(3) Identification of HFE guidelines, standards, processes, or criteria and other documentation necessary to insure that operational performance objectives for the personnel-materiel system can be achieved by personnel available in the organization employing the system.

(4) Identification of training devices and aids, and special training requirements.

d. HFE in Full Scale Development Phase.

(1) *HFE in the Required Operational Capability (ROC), Letter of Requirement (LR), Training Device Requirement (TDR), or Training Device Letter Requirement (TDLR).* Human factors research or engineering will be continued to insure the timely consideration of human factors in materiel development established during materiel concept investigations, advanced development, and the preparation of a ROC, LR, TDR, or a TDLR. Human Factors research or engineering during Engineering Development and Low Rate Initial Production will include more detailed task analysis and further refinement of operator and maintenance task sequences as the materiel design is finalized. These task sequences will be used to determine skill requirements and training implications and their impact upon organizational structure. Special human engineering characteristics, and male and female personnel characteristics and training considerations, peculiar to the system and not covered in AR 702-3 will be specified in the ROC, LR, TDR, or TDLR and will reflect previous HFE analysis. ROC or LR format is specified in AR 71-9. TDR and TDLR format is specified in AR 71-7. Human engineering characteristics specified in the ROC, LR, TDR or TDLR should emphasize system effectiveness, human performance reliability, and personnel requirements. Human engineering standards which embody well-tested human factors principles or prescribe design standardization to minimize

cross-training or relearning problems are appropriate as guidelines for ROCs, LRs, TDRs, and TDLRs. These standards should not preclude design approaches which can lead to improved performance of the personnel-materiel system.

(2) *HFE in the Development Plan.*

(a) *General.* HFE will be applied to succeeding planning, designing, and development phases. HFE plans, personnel plans, training development plans and training device plans will be included as appropriate in the project Development Plan. Development of HFE plans requires a thorough systems engineering analysis of the system requirements combined with consideration of the state-of-the-art in HFE. Personnel plans will describe actions, decisions, and processes necessary to staff the organizations which employ or support the system, to include training support requirements. Training development plans will address all training support required for the specific system including personnel requirements, publications requirements, training aids and device requirements and the impact of the system on other training, if any. The project manager charter will indicate resources which will be used to accomplish HFE management, personnel planning and training development.

(b) *Integrated Logistics Support (ILS).* Throughout the development of new materiel systems, the HFE effort will be coordinated with the ILS Program (AR 700-127), culminating in the ILS plan documented in the Development Plan as specified below:

1. *Maintenance Plan.* HFE will be used to insure that the identified maintenance tasks can be accomplished by the personnel/equipment available to the maintaining organization, or, to identify the additional training requirements.

2. *Support and Test Equipment.* HFE will be used to insure that support and test equipment will interface efficiently and effectively with the operator/maintenance requirements.

3. *Supply Support.* HFE will be considered in the design of packaging and preservation materiel defined under supply support.

4. *Transportation and Handling.* HFE will be used in the development and evaluation of procedures for packing, crating, handling, and transporting the materiel system.

5. *Technical Data.* HFE will also be used in determining or evaluating the kind, quality,

format, and level of technical publications, technical training and field manual's for materiel developments.

6. *Facilities.* HFE will be considered in the design of all buildings, shelters, and similar facilities required to support a new materiel system.

7. *Personnel and Training.* Provisional qualitative and quantitative personnel requirements information will be based on:

a. Analysis of planned task sequences;

b. The skills or knowledge required by these tasks;

c. The personnel performance standards necessary to meet operational objectives; and

d. Special personnel implications identified during the preceding phases of the research and development cycle. Provisional qualitative and quantitative personnel requirements information and Army capability to man organizations to these requirements will be considered in determining and approving initial basis of issue and unit structure.

8. *Logistic Support Resource Funds.* Estimates of life cycle personnel costs, including training costs and projections of personnel availability, will be explicitly considered in cost effectiveness analysis. Cost effectiveness of training devices will be specifically addressed to determine savings occasioned by reduced wear and tear on operational equipment (with associated maintenance costs), reduction in fuel usage, training area requirement reductions, applicability for use by Reserve and National Guard forces.

9. *Logistic Support Management Information.* HFE information needs will be collected for integration into analysis supporting the development of logistic support plans.

(c) *Coordinated Test Program.* Plans for Development Testing/Operational Testing (DT/OT) will include an evaluation of HFE as described in AR 70-10. DT will include human factors testing to demonstrate an acceptable technical personnel (soldier) materiel (machine) interface and establish personnel performance reliability or confirm previous personnel performance reliability predictions. OT will operationally examine the personnel-materiel interface involving typically manned materiel in an operational environment.

5. Responsibilities. *a.* The Deputy Chief of Staff for Personnel (DCSPER) will—

(1) Review and monitor materiel objectives, requirements documents, development plans, and activities in materiel development which affect personnel or training to assure the appropriate application of HFE in the development of human performance requirements. He will coordinate actions with the Deputy Chief of Staff for Research, Development, and Acquisition, the Deputy Chief of Staff for Operations and Plans, the Deputy Chief of Staff for Logistics, and The Surgeon General.

(2) Provide nonmateriel behavioral sciences research support to insure a necessary scientific basis for HFE.

(3) Insure that HFE is coordinated with the Integrated Logistic Support Policy (AR 700-127).

(4) Provide for professional coordination among human factors specialists and behavioral scientists through the Research Development Advisory Group (RDAG) as described in AR 70-8.

b. The Deputy Chief of Staff for Logistics (DCSLOG) will—

(1) Insure that HFE requirements and design criteria are integrated into the development of logistics systems (e.g., packaging, handling, maintenance, identification, transportation, and disposal).

(2) Insure that Integrated Logistic Support Policy is implemented with consideration of the HFE program for developmental, nondevelopmental, and product improved materiel systems.

c. The Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA), in coordination with DCSPER, DCSLOG, and TSG will—

(1) Include RDTE funds for human factors in the annual submission of the Program 6 budget.

(2) Coordinate with DCSPER the structure and funding of the human factors RDTE portion of Program 6, to include proposed changes.

(3) Insure appropriate and systematic application of HFE throughout the materiel development cycle.

(4) Insure verification of the adequacy of HFE prior to the completion of the materiel production acceptance tests or direct procurement of materiel.

(5) Insure continuation of HFE in system modifications.

d. The Deputy Chief of Staff for Operations and Plans (DCSOPS), in coordination with the DCSPER and the DCSLOG, will—

(1) Insure the application of HFE in combat developments, during the preparation of requirement documents, and in the review of development objectives for total feasibility.

(2) Insure the inclusion of relevant HFE data in manpower allocation, in establishing requirements for training devices and aids, for new equipment training and unit training, and in developing tables of organization and equipment and tables of distribution and allowance.

(3) Insure the inclusion of HFE in the Operational Test (OT) Program.

e. TSG is responsible for health hazard assessment and will—

(1) Provide appropriate consultation and advice on the medical aspects of HFE to the Army staff and developing agencies, including a hazard analysis.

(2) Monitor the application of health standards to HFE throughout the materiel development cycle.

(3) Verify health safety of materiel before procurement of materiel.

(4) Perform the appropriate medical RDT&E tasks.

f. Responsibilities of developing agencies are as follows:

(1) The Commanding General, US Army Materiel Development and Readiness Command, will maintain a comprehensive HFE program to—

(a) Integrate HFE, including inputs from Army personnel, training, testing, medical, and research activities through the US Army Human Engineering Laboratory, into the materiel acquisition cycle.

(b) Develop, coordinate and implement HFE design and performance specifications, standards and procedures.

(c) Provide for orientation of system, project and product managers.

(d) Insure the inclusion of HFE in the DT program.

(e) Provide human factors specialists to materiel development programs.

(f) Improve the Army's capability for HFE management.

(g) Perform appropriate human factors RDTE tasks.

(h) Actively pursue efforts to insure the fullest coordination with Commander, US Army Training and Doctrine Command (TRADOC) and Commander, US Army Operational Test and Evaluation Agency (OTEA) relative to HFE in OT and during test integration working groups.

(2) Chiefs of other agencies assigned responsibility for development of materiel items, i.e., Commanding General, US Army Communications Command; Commanding General, US Army Security Agency; the Chief of Engineers; and The Surgeon General, will establish HFE programs which incorporate the above provisions as appropriate to their development responsibilities and as are compatible with the program of US Army Materiel Development and Readiness Command.

(3) To minimize potential for health hazards in materiel development, the review and concurrence of The Surgeon General will be sought at the concept stage and prior to prototype evaluation.

(4) It is required that developing agencies and each Major Command submit to The Surgeon General a written proposal for studies involving the use of volunteers, per AR 70-25. (The Surgeon General has final approval authority for all studies using volunteers except research with nuclear or chemical warfare agents, which are approved by the Secretary of the Army. Chemical warfare agents are restricted to type-classified and developmental lethal and incapacitating agents; The Surgeon General retains final approval authority

for experiments involving the use of simulant agents and standard riot control agents.)

g. The Commanding General, US Army Training and Doctrine Command, will—

(1) Insure that HFE is considered in doctrinal studies and in planning the future materiel development program.

(2) Insure that LOA, ROC, LR, TDR, and TDLR include adequate specification of HFE requirements (particularly desired personnel performance reliability) and that these requirements are realistic in terms of the state-of-the-art, doctrine, life cycle effectiveness, anticipated user requirements, and personnel capabilities and limitations.

(3) Insure that user input to HFE is provided to developing agencies.

(4) Participate in the development of HFE programs in support of materiel developments.

(5) Establish requirements for human performance information necessary for the development of training devices and aids and for training plans and programs.

(6) Evaluate these data in developing a command position for system evaluations.

(7) Recommend, when appropriate, to the DCSPER research and development projects in the field of education and training brought about by HFE considerations involving unusual skills or learning processes.

(8) Furnish training experience inputs and training advisors as needed to the HFE effort.

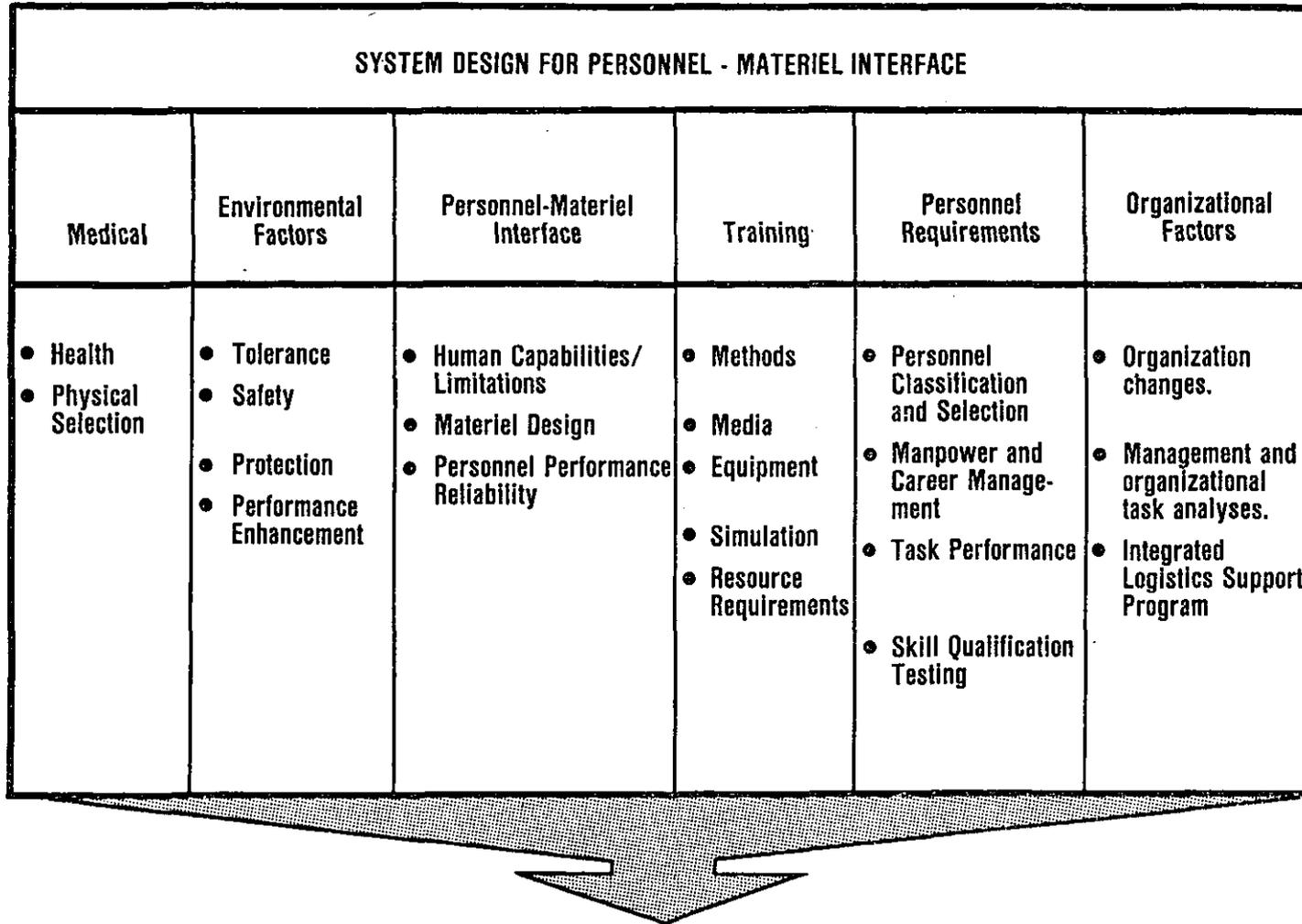
APPENDIX

PERSONNEL CONSIDERATIONS IN SYSTEM EFFECTIVENESS

The human factors approach takes a total system point of view directed at maximizing system effectiveness. Figure A-1 depicts the broad range of subjects which must be addressed for the soldier to be properly considered in material design. The figure focuses upon the Personnel-Materiel-Mission Performance in Systems Development and Operations. Personnel-Materiel-Mission R&D involves the development of Personnel-Materiel-Mission performance information for application in systems development and military operations. Although main distinctions of separate areas are useful in conducting the R&D, interactive, overlapping and integrated approaches between areas will exist. Operational studies and assessments of personnel-materiel systems must consider the applicable operational mode summary/mission profile of the item or system under evaluation. Human factors research and applications address human performance criteria for systems design and operations and are aimed at the human task components of: (1) equipment and subsystem (hardware and software) interfaces; (2) personnel-materiel, individual/team functions; (3) operator/maintenance procedures; (4) command and control information/decisionmaking; (5) operational tactics; (6) personnel-materiel system effectiveness and personnel performance reliability; (7) personnel-materiel design; (8) considerations of personnel skills and training; (9) models for personnel-materiel-mission performance technology; (10) interdependencies between systems design and training requirements; (11) environmental effects on personnel-materiel-mission performance; and (12) relative importance of human performance in system performance measures.

APPENDIX (continued)
**PERSONNEL CONSIDERATIONS IN
 SYSTEM EFFECTIVENESS**

AR 602-1



**PERSONNEL-MACHINE-MISSION PERFORMANCE
 IN
 SYSTEMS DEVELOPMENT AND OPERATIONS**

1 June 1976

Figure A-1

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The proponent agency of this regulation is the Office of the Deputy Chief of Staff for Personnel. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to HQDA (DAPE-PBR) WASH DC 20310.

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