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Pre-Standard

First edition
2007-06

Guidance on human factors engineering for system life cycle applications

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GUIDANCE ON HUMAN FACTORS ENGINEERING FOR SYSTEM LIFE CYCLE APPLICATIONS

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IEC-PAS 62508 has been processed by technical committee 56: Dependability.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
56/1163/PAS	56/1184/RVN

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of three years starting from 2007-06. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

This PAS provides technical information on human factors (HF) for engineering and implementation of systems. It fills the urgent need for an HF standard currently not available among the ISO or IEC standards.

HF is one of the key system elements that have significant influence on the system design to achieve dependability performance and service quality. This PAS provides guidance and criteria to facilitate the incorporation of HF requirements in system development and operation. It permits practical HF applications and design trade-offs with other key system hardware and software elements for cost-effective implementation. The technical contents of this PAS are based on human engineering standards and guidelines established by the FAA and NASA. Technical approaches and HF methods are adopted from industry best practices suitable for systems engineering applications.

The HF and human reliability knowledge base covers a broad scope of technical and scientific work. This PAS focuses on the engineering aspects for HF applications in the system life-cycle process. It does not address the human reliability issues involving the study of human anatomy, anthropometry, biomechanics, physiology, and psychology affecting system design and operation with human interactions.

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GUIDANCE ON HUMAN FACTORS ENGINEERING FOR SYSTEM LIFE CYCLE APPLICATIONS

1 Scope

This PAS describes the process on human factors (HF) influencing system dependability design and provides HF methods and practices applicable to system life-cycle implementation to achieve dependability performance.

2 Normative references

The following referenced documents are applicable to this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60300-1, *Dependability management – Part 1: Dependability management systems*

IEC 60300-2, *Dependability management – Part 2: Guidelines for dependability management*

IEC 60300-3-15, *Dependability management – Part 3-15: Guidance to engineering of system dependability*[1]

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
human factors (HF)
knowledge on human abilities, limitations, and other human characteristics that are relevant to the design and application of products affecting human-system performance

3.2
human factors engineering
application of human factors knowledge to the design of tools, machines, systems, tasks, jobs, and environment for safe, comfortable, and effective human use

3.3
human reliability
study of human performance in terms of probability that a person will correctly perform some system-required activity during a given time period (if time is a limiting factor) without performing any extraneous activity that can degrade the system

NOTE The application of human reliability knowledge is often referred to as human reliability engineering, human engineering, or human system engineering. It is sometimes used interchangeably as human factors engineering and the scope of application may vary for each application.

3.4
ergonomics
study of scientific information concerning humans to the design of objects, systems and environment for human use incorporating elements from many subjects including human anatomy, physiology, and psychology in the design

NOTE Ergonomics is sometimes used interchangeably as human factors engineering. There are minor differences in approach.

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[1] To be published.

4 HF and its influence

4.1 Understanding the HF relationships

The term “HF” is mainly used in North America. The term “ergonomics” is used in Europe and other parts of the world. HF involves working to make the environment function natural to human use. Ergonomics is matching the task and product to the human user. Ergonomics and HF engineering are often used interchangeably in the work environment. Both describe the interaction between the human user and the task demands, and the human-machine relationships. The difference between them is that ergonomics focuses on how the task affects the user, and HF engineering emphasizes the design to reduce the potential of human error in system operation. It is the HF engineering aspects influencing dependability performance that needs to be addressed in system dependability standards.

The relationship of HF to system is that humans are often deployed and used in system functions. The linkage of HF to dependability is that human functions affect the influencing characteristics of reliability, maintainability and maintenance support in system performance.

Human reliability is related to the field of HF engineering. It refers to the study of reliability of humans in various fields such as information processing, manufacturing, transportation, medicine and service operation. Human performance can be affected by many factors such as age, circadian rhythms, state of mind, physical health, attitude, emotions, propensity for certain common mistakes such as errors and cognitive biases.

The broader issues concerning the study of human reliability are directly linked to the possible adverse consequences of human errors or oversights, especially when the human is engaged in a crucial part of a complex system for safety, security or mission critical applications involving human machine and human system interactions. HF engineering utilizes the human reliability knowledge base for application in user-centric and error-tolerant designs by adapting appropriate technologies to enhance human-system operation.

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4.2 Human machine comparison

The following presents an overview of human versus machine abilities for comparison. Although rapid advances in technologies have significantly increased the machine abilities, this overview presents a classical observation that remains valid in the HF field.

Humans surpass machines in

- ability to detect small amount of visual and acoustic energy;
- ability to perceive patterns of light or sound;
- ability to improvise and use flexible procedures;
- ability to store very large amounts of information for long periods and to recall relevant facts at the appropriate time;
- ability to reason inductively;
- ability to exercise judgement.

Machines surpass humans in

- ability to respond quickly to control signals and to apply great force smoothly and precisely;
- ability to perform repetitive and routine tasks;
- ability to store information briefly and then to erase it completely;
- ability to reason deductively, including computational ability;
- ability to handle highly complex operations;

- ability to do many different things at once.

The major differences between humans and machines are as follows.

- Machines can be modified, redesigned, and retrofit whereas humans cannot. Humans are born with innate, genetically determined differences that are shaped by the environment. Innate aptitudes or abilities are developed through education and training.
- Machines can be manufactured to be identical to provide exact output and duplicate precise operation. Humans are not identical and vary across all sensory, cognitive, physical and performance characteristics. Specific aspects of human performance can be made more equal through education and training.

4.3 HF engineering process

HF engineering involves the process of engineering the human into systems. The inclusion of humans in systems has the advantage of the human's intuitive reaction, flexibility to adapt to situations, and the capability of performing many functions and tasks. However, human has limitations in cognitive and physical capabilities for task performance. The inherent qualities in the human element as a system attribute can be exploited for design trade-offs with interacting hardware and software elements contributing in a holistic manner to enhance system performance. The aim is to maximize the overall system capabilities in performance operation.

Involvement of HF engineering at early design stages has extensive influence to maximizing the return on investments and optimizing the system capabilities in performance operation. The critical impact areas for HF engineering participation in system design and operation include

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- early identification of critical system functions that are considered suitable and advantageous for human interaction by analysis of system operating scenario;
- user-oriented task designs for timing and operating task sequence through HF engineering activity in system decomposition and functional analysis for ease and expediency in human-machine operation;
- consideration of human capabilities and limitations when making function allocation decisions for cost-effective application and training needs;
- integrating the human requirements into the system design process for optimizing the system performance compatibility of human-machine interface and interoperability;
- the process of engineering human into systems includes task analyses of the systems engineering process and the HF engineering process. The relevant tasks, decisions, and information common between the two processes can be used as basis to identify areas of interactions between the human and the system.

Annex A provides additional information on the HF engineering process concerning task analyses for human system interactions.

4.4 HF in system life cycle

HF as a technical discipline is closely associated with systems engineering and system life-cycle process. The system life cycle concept adopted from IEC 60300-3-15 is shown in Figure 1 to identify the key HF influence in the system life cycle. The system life-cycle stages are briefly described as follows.

The concept/definition stage is to identify the market needs, define/identify the operational use environment/timeline, define preliminary system requirements and confirm feasible design solutions by producing technical specifications for the system design.

The design/development stage is to plan and execute selected engineering design solutions for realization of system functions.

Realization/implementation stage is to execute make-buy decisions for acquisition and deployment of subsystem elements.

The operation/maintenance stage is used to deploy the system for delivery of service and to support system operational capability by means of maintenance.

The enhancement stage is to improve system performance with added features to meet growing user demands on the system.

The retirement/decommissioning stage is to end the existence of the system entity.

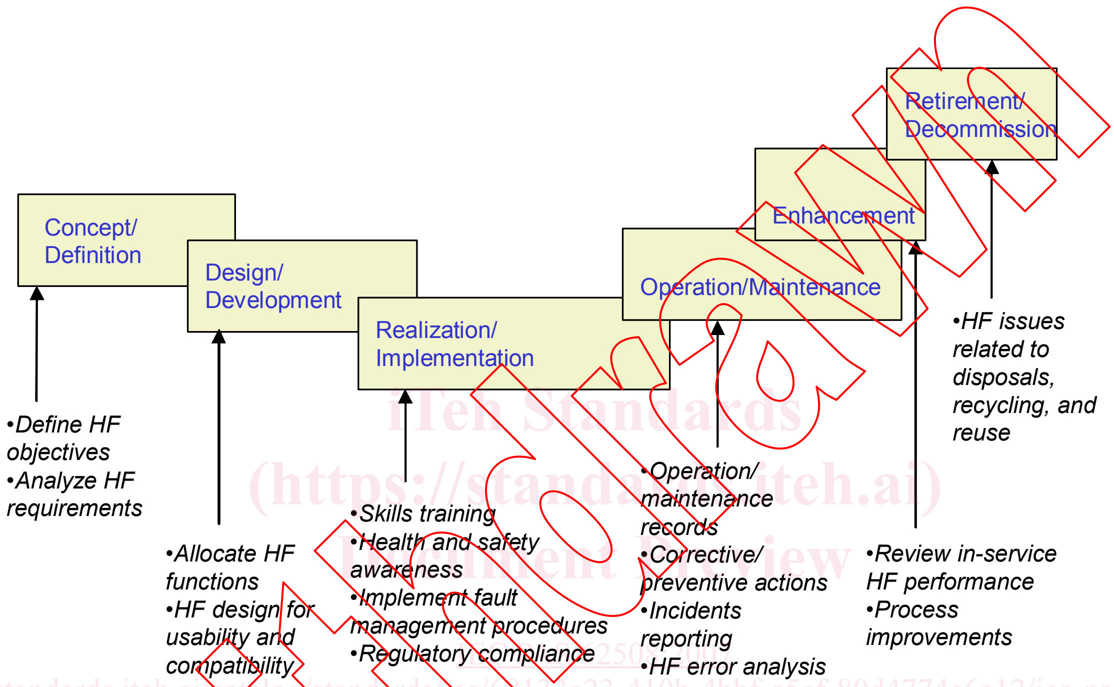

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Figure 1 – Human factors influence in the system life-cycle process

4.5 The importance of HF designs

The HF activities complement the dependability projects and work programmes. Dependability is the ability of a system to perform as and when required to meet specific objectives. Dependability describes the availability performance of a system influenced by its performance characteristics of reliability, maintainability and maintenance support. The principles of dependability management are presented in IEC 60300-1. The applications of dependability management techniques are described in IEC 60300-2.

HF activities have significant impact on system dependability design and performance operation. The HF issues when identified and applied early in the system life-cycle design process would

- increase productivity, improve performance, and gain greater user satisfaction;
- reduce errors in design and operation;
- simplify system operation and maintenance procedures;
- reduce time in user support;
- reduce the need for special skills training;
- reduce risks of serious accidents;