

# A Study on the Relationship of Human Factors Integration in the Defense

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**Abstract** : This work presents the relationship between the domains of Human Factors Integration(HFI) to develop the weapon systems through integrating human factors into the defense acquisition program. The HFI is a systematic process for identifying, tracking and resolving human related issues ensuring a balanced development of both technologies and human aspects of capability. In this point of view, this paper identifies and analyzes the HFI domains. Based on the results, this paper presents the relationships between the domains of the HFI.

**Key Words** : Human Factors Integration, Human Systems Integration, Human Factors Engineering

## 1. INTRODUCTION

These days, defense acquisition programs have focused on developing a system(human, hardware, software) including the human factors rather than just performance centered system development. When users operate a system with not being considered human factors, it will be restricted system performance and likely to easy redesign frequently.

For this reason, some commercial industry such as the cellular phone and craft manufacture have considered the psychology as well as physical states of human beings to enhance user's convenience. The developers in the defense acquisition area have also performed many activities to integrate human factor into systems. But, they focused on satisfaction of the

system performance rather than human factors to achieve the missions and functions during the system development. It is many difficulties in developing the systems due to limited design activities from insufficient consideration of human factors.

Thus, Human Factors Integration(HFI) to integrate human factors with weapon system in the defense acquisition programs is a systematic process for identifying, tracking and resolving human related issues ensuring a balanced development of both technologies and human aspects of capability[1]. HFI is also approach to enhance the safety and mission effectiveness through balanced considering system component(hardware, software, human) in the acquisition cycle.

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Most developed countries including The US, UK, Australia and Canada have made efforts to integrate human related factors into the acquisition program. HFI is a term used in the UK, most nation except the UK, however, have call it Human Systems Integration(HSI)[2].

In this point of view, this work analyzes the relationship between the domains of the HFI to develop the weapon systems through integrating human factors into the defense acquisition program. For this, this paper identifies and analyzes the consideration of HFI domains. Based on the results, the relationship between the domains of the HFI is presented.

## 2. HFI LITERATURE REVIEW

### 2.1 Benefits of HFI

The Benefits that can gain according to apply the HFI in the defense acquisition programs are as follows[3].

The HFI activities that identify and resolve people-related risks in the earlier stage of the acquisition program such as concept study may reduce costly surprises and re-designs later in the program. Also, they provide realistic trade-off study for the system analysis of alternative and estimation of the system acquisition cost. First of all, they are possible to avoid the death and injury of the system operator through advanced identification of the human related errors and to achieve given the missions and function.

HSI application in the defense acquisition program of US DoD has been mandatory since 2003. And, DoD Instruction 5000.02 revised in 2008 made mandatory to provide HSI plan in the phase of Material Solution Analysis(MSA). The UK Ministry of Defence(MoD) has also regulated to provide HFI plan coincided with System life cycle and apply it to defense acquis-

ition program since 2001.

### 2.2 HFI Domains

The US DoD has classified HSI domains into seven domains(manpower, personnel, training, human factors engineering, habitability, survivability, safety & occupational health) to identify and make trade off human related issues.

Manpower factors are used to determine the number and mix of military and DoD civilian manpower considering occupation task and operation environment. Personnel factors are used to develop the military occupational specialties considering human aptitudes(i.e., cognitive, physical, and sensory capabilities). The specific description of the HSI domains including training, Human Factors Engineering, habitability, safety & occupational health, survivability domain is presented in the Table 1. The UK MoD is similar to that of the US DoD with seven domains. The UK has, however, extended to concept of Network Enabled Capability(NEC) analogy to NCW. So, social and organizational domain is added.

Table 1. The US DoD HSI domains

Source: US DoD, Operation of the Defense Acquisition System(DoDI 5000.2), 2008, pp.60-61.

## 3. ANALYSIS OF RELATIONHSIP BETWEEN HFI DOMAINS

### 3.1 Identification of HFI domains considerations

It is necessary to apply the HFI domains characteristics to the defense acquisition program so that the systems effectively achieve given the mission. These HFI Activities are to identify issues related to the human factors and to make trade off the problems to happen between do-

Table 1. The US DoD HSI domains

Domains	Description
Manpower	Manpower factors are those job tasks, operation/maintenance rates, associated workload, and operational conditions(e.g., risk of hostile fire) that are used to determine the number and mix of military and DoD civilian manpower and contract support necessary to operate, maintain, support, and provide training for the system.
Personnel	Personnel factors are those human aptitudes(i.e., cognitive, physical, and sensory capabilities), knowledge, skills, abilities, and experience levels that are needed to properly perform job tasks. Personnel factors are used to develop the military occupational specialties (or equivalent DoD Component personnel system classifications) and civilian job series of system operators, maintainers, trainers, and support personnel.
Training	Training is the learning process by which personnel individually or collectively acquire or enhance predetermined job-relevant knowledge, skills, and abilities by developing their cognitive, physical, sensory, and team dynamic abilities. The "training/instructional system" integrates training concepts and strategies and elements of logistic support to satisfy personnel performance levels required to operate, maintain, and support the systems.
Human Factors Engineering	Human factors are the warfighter' 's cognitive, physical, sensory, and team dynamic abilities required to perform system operational, maintenance, and support job tasks. The human factors engineering community integrates the human characteristics of the user population into a system' 's definition, design, development, and evaluation processes to optimize human-machine performance for both operation and maintenance environments.
Habitability	Habitability factors are those living and working conditions that are necessary to sustain the morale, safety, health, and comfort of the warfighter. These factors directly contribute to personnel effectiveness and mission accomplishment, and often preclude recruitment and retention problems.
Safety & Occupational health	Human factors are the warfighter' 's cognitive, physical, sensory, and team dynamic abilities required to perform system operational, maintenance, and support job tasks. The human factors engineering community integrates the human characteristics of the user population into a system' 's definition, design, development, and evaluation processes to optimize human-machine performance for both operation and maintenance environments.
Survivability	Survivability factors consist of those system design features that reduce the risk of fratricide, detection, and the probability of being attacked; and that enable the system and warfighter to withstand man-made hostile environments without aborting the mission or suffering acute chronic illness, disability, or death.

Source: US DoD, Operation of the Defense Acquisition System(DoDI 5000.2), 2008, pp.60-61.

mains during the system life-cycle. The US DoD HSI seven domains are as follows[5].

Manpower factors include job tasks, operation and maintenance rates, associated workload, and operational conditions, which are used to determine the number and mix of military and DoD civilian manpower in order to operate, maintain, support, and provide training for the system. To decide manpower optimally, it should ensure the human resource demands of the system to operate, maintain, sustain systems. And, the human resource demands

should do not exceed the projected supply. It also needs to review whether the manpower requirements conflict with the others domains requirements or not.

Personnel factors are the human aptitudes (i.e., cognitive, physical, and sensory capabilities), knowledge, skills, abilities, and experience levels, which need to perform job tasks properly. And it aimed at developing the military occupational specialties to operate and maintain the system. It is to prevent increasing the life-cycle cost due to setting up the level

beyond required human aptitudes and skills. And, availability of personnel, their Knowledge, Skills, and Abilities(KSAs) related to the system operations should be identified in the earlier stage of the acquisition program. It provides specific thresholds during the system development. It should also review whether the personnel requirements and effects conflict with the other domains requirements and a cost, schedule, and performance of the program or not.

Training is a learning process by which personnel individually or collectively acquire or enhance predetermined personnel performance levels to operate, maintain, and support the systems effectively. It is necessary that the concepts of the training and education systems are reflected in the logistics support strategy to reduce related manpower.

Habitability factors include living and working conditions that are necessary to sustain a morale, safety, health, and comfort of the warfighters. They consist of those characteristics of systems, facilities(temporary and permanent), and services necessary to satisfy personnel needs. It needs to evaluate the results of the system habitability study to ensure the habitability impacts will enhance system and warfighter's capabilities. Also, It is required to review projected habitability requirements, and the effects on the applicable domains and a cost, schedule, and performance of the program.

Human Factors Engineering(HFE) performs the trade off analysis to reflect the requirements of the other domains into the defense acquisition program. This is to optimize human-machine performance for both operations and supports environment. Accordingly, HFE domain accomplishes analysis of functional interfaces including functions, tasks, and alloca-

tion for human performance or automation. It also performs the analysis of environment interfaces including natural and artificial environment, environmental controls, and facility design. In addition, it accomplishes the analysis of informational interfaces, co-operational interfaces, and operational interfaces. It should also review whether the HFE requirements and effects conflict with other domains requirements and a cost, schedule, and performance of the program or not.

Safety and occupational health domain aims at minimizing and eliminating a series of accidents during operations and supports. Safety considerations should be considered in the earlier stage of the system acquisition to reduce mishap probability and severity to personnel, system loss or damage, and mission failure. It needs to evaluate a system safety compliance and mishap reduction strategy, methodologies, and analyses to ensure that safety impacts will enhance system and warfighter's capabilities.

Survivability factors consist of the system design features that reduce the risk of detection, and the probability of being attacked, and that enable the system and warfighters to withstand man-made hostile environment without aborting the mission or suffering acute chronic illness, disability, or death. Survivability considerations include the activities to reduce detectability, probability of attack and minimize damage if attacked. And, it should evaluate the results of the system survivability studies to ensure the survivability impacts will enhance system and warfighter capabilities. It is necessary to review projected survivability requirements and the effects on the applicable domains and a cost, schedule, and performance of the program or not.

So far, the considerations of the seven domains are identified to integrate human factors

into the defense acquisition program. Human factors integration applies integrated requirements of the domains through the trade off analysis into the defense acquisition program rather than independent each domain requirement. For example, if the level of the operations and supports personnel is established higher than a planned level, the cost of manpower and training might be increased in order to accomplish given the mission through the enhancement of person's required capabilities. Thus, analysis of the relationship between HFI domains is required to apply human factor into the defense acquisition program efficiently.

### 3.2 Analysis of relationship between HFI domains

The purpose of HFI activities is to define a safety and interfaces between a system or equipment and the people who train , operate and support it. An analysis of relationship between HFI domains is required to integrate HFI domains requirements into the defense acquisition program systematically.

As earlier explained, it is necessary to compromise requirements between manpower (number of personnel) and personnel(required level of capability). The level of the training requirements also is adjusted upward, if the level of the personnel domain requirements(ie., knowledge, skills and ability) is highly adjusted than a planned level. HFE domain plays a key role in reflecting the trade-off analysis between the requirements of the other domains in the defense acquisition program.

HFE domain receives manpower data as a input to operate and support the system from manpower domain, and required capability level from personnel domain. It takes job task description, operator scenario, task analysis data

from training, and mishap analysis results and available space to operate the system from safety and occupational health domain. Thus, HFE domain receives the other domains requirements and performs trade-off analysis for the requirements between HFI domains, then reflects the results trade-off analysis into the defense acquisition program.

As shown Fig.1, manpower domain gets the system, job and user interface design, person levels per mission and ergonomic criteria from HFE domain, and personnel receives the task analysis data to set up the required capability level. Training also takes the user interface design support and task and workload analysis data to achieve the required capability from HFE domain. Safety and occupational health receives the personnel hazards, human error analysis, design and performance criteria and the inputs to hazard analysis to minimize and eliminate the hazards.

Thus, the relationship between HFE domain and others should be performed from the earlier stage of acquisition such as concept study, then each requirement of HFI domains is specifically refined according as acquisition phase is proceeded. As it is explained above, the relationship between HFI seven domains may be represented in the Fig.1.

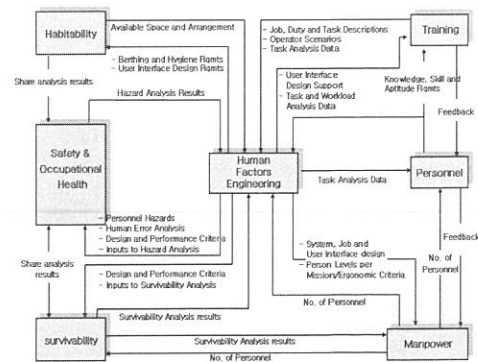


Fig 1. The relationships between HFI seven domains

## CONCLUSIONS

This paper analyzed the relationship between HFI domains to integrate the human factors into the defense acquisition program. This work identified the considerations of HFI domains. Based on the results, it presented the relationship between the domains of HFI to develop the weapon systems through integrating human factors into the defense acquisition program.. The presented relationship will be a good idea to derive a HFI framework in the further work.

## REFERENCES

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