

H U M A N S Y S T E M S
Incorporated

Humansystems

111 Farquhar Street

Guelph, Ontario

N1H 3N4

Tel: (519) 836-5911

Fax: (519) 836-1722

<http://www.humansys.com>

**Human Factors Integration Requirements
for Armoured Fighting Vehicles (AFVs)**

**Part I: Guidance on Addressing the
Human System Integration (HSI) Content of
Statements of Operational Requirements (SORs)**

**PWGSC Contract No. W7711-7-7429/01-SRV
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**HUMAN FACTORS INTEGRATION REQUIREMENTS FOR ARMoured
FIGHTING VEHICLES:**

**PART 1: GUIDANCE FOR ADDRESSING THE
HUMAN SYSTEMS INTEGRATION (HSI) CONTENT OF STATEMENTS OF
OPERATIONAL REQUIREMENTS (SORs)**

by

M. Greenley*, H. Angel*, J. Brooks*, J. Kumagi*

* Greenley & Associates Incorporated

*Humansystems Incorporated

111 Farquhar St., 2nd Floor

Guelph, ON N1H 3N4

(519) 836-5911

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On behalf of

DEPARTMENT OF NATIONAL DEFENCE

as represented by

Defence and Civil Institute of Environmental Medicine

1133 Sheppard Avenue West

North York, Ontario, Canada

M3M 3B9

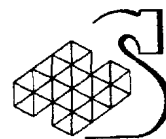
DCIEM Scientific Authority

David Beevis

October 1999

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Executive Summary

This document is the final report of a project to review the new Guidelines on the Preparation of a Statement of Operational Requirement (SOR) from a Human Systems Integration (HSI) perspective. The project was sponsored by the Defence Research and Development Branch (DRDB) Work Unit 6K, using Armour Systems projects as an example at the request of the Directorate of Land Requirements 3 (DLR 3). The project has been completed by Humansystems Incorporated (HSI) under contract to the Defence and Civil Institute of Environmental Medicine (DCIEM).

This report was developed to provide some guidance for addressing the Human Systems Integration content requirements of DND SORs and to discuss the options for electronic distribution of HSI related information. It is the first of three reports developed under this project.

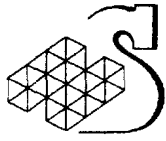
In general, the inclusion of HSI related requirements in SOR's appears to be straight forward based on a systematic analysis of future systems, within the context of future scenarios and operational/support concepts. It is recognized, however, that it will take time for such analysis to become practiced and routine throughout all DND environments. It is recommended that the DRDB community support any efforts to ensure that HSI is included in SOR's over the next several years and that early samples be provided on the HSI Web Site as examples for other projects to learn from.

In addition, it is recommended that the feedback on SOR structure and content related to HSI issues outlined in this report be integrated into future versions of the SOR template and associated guidelines.

This project has concluded that the basic process for analysis and validation of HSI related requirements is known, however, a more detailed, integrated, HSI process is still required. It is recommended that such a process be developed, and it is recognized that DND is already initiating efforts to do so.

It has also been concluded that the key to conducting an integrated analysis is to use techniques and tools that allow a core analysis of (i) Operational Experience, (ii) Scenarios/Functions/Tasks, and (iii) Workstations or Interfaces to be shared by each of the domains of HSI. This shared assessment increases the efficiency and accuracy of analysis and ensures that all requirements are kept up to date throughout the acquisition cycle. It is recommended that tools and techniques continue to be developed to facilitate the sharing of analysis between these three primary assessment areas, and it is recognized that DND is already initiating efforts to do so.

It is recommended that the Armour community, in conjunction with other military environments, consider the conversion of the Soldier's Day software tool to a web based product, with the introduction of an add on module for building SOR's. This solution is preferable to simply creating annotated bibliographies accessible on the Intranet, however, both electronic distribution mechanisms could be introduced in parallel.



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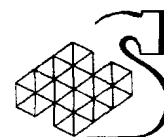
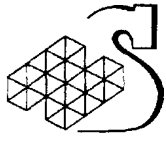
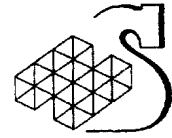


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1 Introduction

This document is the final report of a project to review the new Guidelines on the Preparation of a Statement of Operational Requirement (SOR) from a Human Systems Integration (HSI) perspective. The project was sponsored by the Defence Research and Development Branch (DRDB) Work Unit 6K, using Armour Systems projects as an example at the request of the Directorate of Land Requirements 3 (DLR 3). The project has been completed by Humansystems Incorporated (HSI) under contract to the Defence and Civil Institute of Environmental Medicine (DCIEM).

1.1 Background

During the period 1994 to 1999 a number of activities conducted by the Defence Research and Development Branch (DRDB) focused on the level of Human Systems Integration (HSI) analysis in the acquisition and development process. These efforts culminated in 1998 with a project that generated a proposed new template for the Statement of Operational Requirements (SOR). At the request of the Directorate of Business Change Management (DBCM) this SOR template was merged with another proposed SOR template to create the new "Guideline on the Preparation of a Statement of Operational Requirement", which also included a recommended process for determining and validating requirements on an acquisition project.

Throughout 1999 the defence acquisition community has adopted the new SOR template. The Vice Chief of Defence Staff, through the Defence Management System (DMS) produced by the Directorate of Force Planning and Project Coordination (DFPPC), now directs project staff to the new SOR guideline hosted on the DBCM 2 intranet site.

The new SOR template includes Human Systems Integration (HSI) requirements in several areas including: Missions and Scenarios, Key Roles, Key Tasks; User Characteristics; Crew Station and Interface Design; User Acceptance; Operability; Survivability; Maintainability; Safety and Health; Performance Measures; Personnel and Training Requirements.

This breakdown of human factors into the topics listed above may change the nature of the demand for HSI information (requirements, specifications, performance measures) for future acquisitions. For example, the Soldier's Day database is a software tool that was previously developed to provide information on the activities of dismounted soldiers for use by desk officers preparing SORs and by contractors developing equipment. The information in the Soldier's Day database is structured by Organization, Tasks and Equipment, which may not be the most effective structure for the new SOR templates. It was determined that a worked example was required to explore how the new SOR templates may dictate the organization and types of HSI information needed for future acquisition projects.

HSI issues related to Armoured Fighting Vehicles (AFVs) were identified as a possible worked example for such a study. According to DLR 3-2-2, "Current AFVs lack valid HF requirements specifications,... battlefield days for Operations Other than War (OOTW) must be defined,... another weakness in AFV HF engineering has been the availability of valid anthropomorphic data [which are now available through *Clothe The Soldier*],... mounted and dismounted clothing and equipment requirements must be harmonized in order to provide soldiers (such as section commanders) with personal clothing and equipment for both mounted and dismounted operations,



... mounted soldier performance can therefore be improved, and mounted/ dismounted requirements harmonized, by the accurate definition of AFV HF requirements.”

DLR 3 staff proposed an AFV HSI initiative to maximize mounted soldier performance by:

- Improving the current and future vehicle environments;
- Improving personal equipment and clothing;
- Modifying mounted tactics, techniques and procedures (TTPs);
- Improving current recruiting, selection and training methods; and
- Enhancing the soldier’s physiological state through food and drugs.

The aim of this project was to use the DLR-3 AFV HSI initiative as a worked example to explore the kinds of information required, and the information which is currently available, to complete the HSI sections of the new DND SOR templates.

1.2 Objective

The objectives of this project were:

1. to develop a structure for the HSI requirements for AFVs that matches the structure of the new DND SOR templates;
2. to explore methods to make this HSI information available to members of AFV project teams using electronic means, possibly including the use of a modified version of Soldier’s Day.

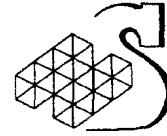
1.3 Deliverables

The deliverables from this project included:

- A report on how the HSI requirements in the new SOR templates can be addressed and how the AFV HSI information could be distributed as part of a www site using AFV HSI as a worked example.

Additional project work completed in parallel generated a companion report that provides:

- An annotated bibliography of available information relevant to HSI requirements for future AFV related SORs, organized to match the SOR templates.
- A report on what AFV HSI information is known, what information needs to be collected, how much of it requires R&D, what R&D needs to be completed, and the outline of an AFV HSI R&D program to generate the requirements for the future.



2 Method

This section outlines the method followed in this project. The primary tasks completed by the project team are reviewed in the following sub-sections.

2.1 Start Up Meetings

The project was initiated with a series of start up meetings. These began with the Humansystems project team meeting to review the contract documents and conceptualizing their approach to the analysis. Two start up meetings followed in Ottawa, first with the DRDB scientific authority, and a second with the project sponsor in DLR 3.

In combination, this series of meetings refined the scope of the project, assisted in the development of the method for the project, and identified information sources that the project team should review.

The meeting with DLR 3 personnel was also used to identify the types of project for which SORs may have to be developed over the next 5 to 10 years. The identification of these projects was important to guide the analysis of future HSI requirements.

2.2 Develop Project Review Framework

The project team met on a number of occasions to develop the framework for analysis of HSI requirements during the project. This process started with a review of the new SOR in the Guidelines for the Preparation of a Statement of Operational Requirements (DBCM 1998) to identify SOR sections with HSI components

This review generated a structure for classifying literature in relation to future AFV SORs. This structure was felt to be generic for all projects, with some minor tailoring to meet the specific needs of future Armour Systems projects.

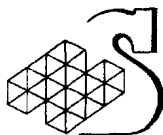
2.3 Obtain and Review Available Literature

The project team obtained any immediately available literature related to HSI for AFV SORs. This literature came from DRDB Laboratories, DLR 3 filing cabinets, and recent AFV related projects completed by the Humansystems team. Some literature was also obtained from related projects (eg: Clothe the Soldier) which was immediately available to the project team.

It was decided to first review the available literature and then determine if there were sufficient project resources to extend the search further. In the end, an enhanced literature search was not feasible due to the volume of initial materials obtained.

2.4 Organize and Prioritize Literature by SOR Section

The literature reviewed was annotated and categorized according to the SOR framework developed. All reviews and categorizations were entered into an Endnote (bibliographic software) database. The annotation of each article included a ranking of the relevance of the paper to future DLR 3 acquisition projects.



2.5 Develop HSI Information Distribution Concepts

Once the HSI framework for the new SOR template was established, and some of the AFV related literature was reviewed, the project team started to analyze how HSI related information could be effectively distributed to interested parties using electronic means.

This process began with a review of electronic distribution requirements identified in previous projects, including the SOR Spec Maker projects (Greenley, Tack, Angel, and Webb 1998; Greenley, 1999a, Greenley, 1999b) and the Human Factors Engineering Tools project (Greenley, 1999c).

Additional material reviewed included recent descriptions of the DRDB HSI Web Site (Vallerand 1999), and the latest description of the Soldier's Day database (Kumagai, 1999).

The user requirements were compared against the capabilities of the HSI Web Site and the Soldier's Day database to determine what the options might be for electronic distribution.

2.6 Identify Gaps in Existing Knowledge

The review of AFV related literature against the SOR categories resulted in the identification of areas where future Armour Systems SORs would have sufficient requirements, and areas where there are currently gaps in the existing knowledge about HSI requirements. These gaps were identified and briefly described.

2.7 Develop Future R&D Program

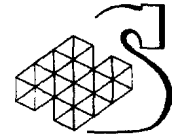
The gaps in the existing HSI requirements literature were mapped against R&D activities that could be completed to produce the missing requirements, which were then organized into a series of R&D projects to form the description for an AFV HSI R&D Program. Where possible, cost estimates were developed for elements of this HSI R&D Program as a tool for future planning.

2.8 Develop Final Reports and Presentation

The outputs of this work were integrated into two reports and one presentation. The two reports included:

1. **Guidance for Addressing the Human Systems Integration Content of DND SORs (this report)**
2. **A Review of Human Systems Integration Material Available for Armour Systems SORs and a Plan for Future HSI R&D.**

The results of both reports were integrated into one presentation that was delivered in Ottawa to the DRDB, DLR 3, and DLR 10 communities.



3 Results

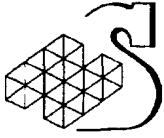
This section of the report contains the results of the project that relate to addressing HSI components of the SOR and electronic mechanisms for distributing HSI information amongst project teams.

3.1 SOR Structure

The “Guidelines on the Preparation of a Statement of Operational Requirements” (DBCM 1998) outlines an SOR with the structure illustrated in Figure 1. This structure results in a SOR with two core themes; (i) Systems Effectiveness, and (ii) Human System Integration. The SOR contents result in solid traceability from the Defence Planning Guidance scenarios down to the performance requirements of an individual system.

<ul style="list-style-type: none">1. Introduction1.1. Aim1.2. Background – Origin1.3. Deficiency1.4. Project Constraints1.5. Current Situation1.6. Related Projects2. System Operation2.1. Missions and Scenarios2.2. Environment2.3. Threats2.4. Concept of Operations2.5. Concept of Support2.6. Key Roles2.7. Key Tasks2.8. User Characteristics3. Design and Concept Guidance4. System Effectiveness Requirements4.1. General4.2. Operability<ul style="list-style-type: none">4.2.1. Performance Capability4.2.2. Crew Station and Interface Design4.2.3. User Acceptance4.3. Survivability4.4. Maintainability<ul style="list-style-type: none">4.4.1. Maintenance Task Performance4.4.2. Crew Station and Interface Design4.4.3. User Acceptance	<ul style="list-style-type: none">4.5. Availability4.6. Reliability4.7. Environmental Sustainability4.8. Safety and Health4.9. Delivery Requirements<ul style="list-style-type: none">4.9.1. Quantity4.9.2. Quality4.9.3. Location5. Sub-System Effectiveness Requirements6. Performance Measures6.1. System Level Measures6.2. Sub-System Level Measures7. Personnel And Training Requirements7.1. Personnel – Staffing<ul style="list-style-type: none">7.1.1. Operational Staff7.1.2. Maintenance Staff7.2. Training<ul style="list-style-type: none">7.2.1. Operational Training7.2.2. Maintenance Training7.2.3. Simulation8. Scheduling Requirements9. Requirements Table
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Figure 1: SOR Structure



3.1.1 Human Systems Integration in the new SOR Framework

Human Systems Integration is defined as:

The technical process of integrating the areas of:

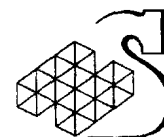
1. *human engineering,*
2. *manpower,*
3. *personnel,*
4. *training,*
5. *systems safety, and*
6. *health hazards,*

with a materiel system to ensure safe, effective operability and supportability.

This concept is highlighted in the new SOR guidelines along with the concept of Systems Effectiveness, both as guiding principles behind the acquisition process. As a result, there are a number of the SOR sections and sub-sections that contain HSI requirements. These sections are not necessarily exclusive to the HSI domain, however, HSI requirements are expected to be included in the resulting content. HSI related sections and sub-sections are highlighted and bolded in Figure 2.

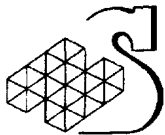
<ul style="list-style-type: none"> 1 Introduction 1 1. Aim 1 2. Background – Origin 1.3. Deficiency 1.4. Project Constraints 1.5 Current Situation 1 6. Related Projects 2 System Operation 2.1. Missions and Scenarios 2.2 Environment 2.3. Threats 2.4. Concept of Operations 2.5. Concept of Support 2.6. Key Roles 2.7. Key Tasks 2.8. User Characteristics 3 Design and Concept Guidance 4 System Effectiveness Requirements 4.1 General 4.2. Operability 4.2.1. Performance Capability 4.2.2. Crew Station and Interface Design 4.2.3. User Acceptance 4.3. Survivability 4.4. Maintainability 4.4.1. Maintenance Task Performance 4.4.2. Crew Station and Interface Design 4.4.3. User Acceptance 	<ul style="list-style-type: none"> 4.5. Availability 4.6. Reliability 4.7 Environmental Sustainability 4.8. Safety and Health 4.9 Delivery Requirements 4.9.1. Quantity 4.9.2 Quality 4.9.3 Location 5 Sub-System Effectiveness Requirements 6. Performance Measures 6.1. System Level Measures 6.2. Sub-System Level Measures 7. Personnel And Training Requirements 7.1. Personnel – Staffing 7.1.1. Operational Staff 7.1.2. Maintenance Staff 7.2. Training 7.2.1. Operational Training 7.2.2. Maintenance Training 7.2.3. Simulation 8 Scheduling Requirements 9 Requirements Table
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Figure 2: SOR Structure with Highlighting Sections with *HSI Related* Content



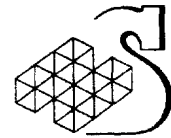
The following points outline the type of HSI requirements that are typically defined in the highlighted sections of Figure 2:

- **Deficiency.** This section will often contain human centric deficiencies related to concerns with current system or task performance, training systems, staffing, or personnel safety.
- **Missions and Scenarios.** This section will contain a description of the missions and scenarios that the system will operate under. These scenario descriptions will define the operational environment, own force composition, threat force composition, typical deployment patterns, and scenario event sequences. The main body of the SOR will often contain only a summary of these scenarios, with more complete analysis in an Annex or a referenced report. These missions and scenarios are required as the basis for the subsequent analysis of future requirements for the system and provide a traceable link back to the Defence Planning Guidance scenarios for the entire Canadian Forces.
- **Concept of Operations.** This section will summarize the future concept under which the system will operate. This section will outline own force composition, deployment, and the general use of the system or sub-system in operations.
- **Concept of Support.** This section will define the concept for the maintenance and support of the future system. Of importance to HSI analysis is the relative role of military and commercial support in the future concept, and task performance concepts such as component repair versus component replacement.
- **Key Roles.** This section identifies and briefly describes the key positions related to operations and support as they in turn relate to the Concepts of Operation and Support.
- **Key Tasks.** This section identifies and briefly describes the key tasks to be performed by the personnel filling the key roles for both operation and support of the future system, using the new Concept of Operation and Concept of Support.
- **User Characteristics.** This section will identify the range of characteristics of the entire user community, not necessarily just those of the key users listed under Key Roles. These characteristics will include anthropometric ranges, gender, medical characteristics (vision, hearing), task skill sets, and qualification standards, among others.
- **Operability - Performance Characteristics.** This section of the SOR will contain a range of key performance characteristics many of which may be technical. However, the key user task performance requirements of the future systems will also be defined here as they relate to the key tasks to be performed within the identified scenarios, using the previously defined concept of operations.
- **Operability - Crew Station and Interface Design.** This section will identify key user centered requirements related to the layout of future crew stations or interfaces. These requirements will identify any critical layout issues or task performance requirements to ensure that each of the key roles will be able to perform their key tasks within the scenarios under the Concepts of Operation and Support identified. Often these requirements will list the critical equipment, displays, or controls that will need to be accessible by each class of user from their crew station.
- **Operability - User Acceptance.** This section of the SOR will identify requirements regarding how user acceptance will be evaluated on the project, any baseline criteria that must be met, and the criteria for meeting user acceptance thresholds for the project. In some cases these



criteria may be linked to baseline surveys of existing products using ACCESS measures (Greenley 1999c) or comparable systems.

- **Survivability**. This section of the SOR will identify requirements for system survivability against the threats identified earlier in the SOR, however, from an HSI perspective it will also define requirements related to the survivability of the human while operating the future system. These requirements will often relate to personnel protection related to threats, with general safety and health hazard requirements identified later in the SOR.
- **Maintainability - Maintenance Task Performance**. This section will identify the primary maintenance task performance requirements of the future system for tasks to be performed within the scenarios, using the previously defined Concept of Support.
- **Maintainability - Crew Station and Interface Design**. This section of the SOR will identify any crew station or interface layout requirements associated with maintenance task performance. These may relate to maintenance specific displays or controls, or general access/egress to/from key equipment, as examples.
- **Maintainability - User Acceptance**. Any requirements related to future measurement of maintainer acceptance of the system will be included in this SOR section. These requirements may often be similar to the User Acceptance requirements in the operations section of the SOR.
- **Availability**. This section will identify system availability requirements, which should always include the human component of the availability equation. From an HSI perspective these requirements will often relate to sustained operations and the required availability of the entire system including its human operators. These requirements will also include skill fading requirements (the duration that a trained user will retain their skill level) related to training needs, and associated training frequency.
- **Reliability**. This SOR section will include requirements related to overall system reliability including the human error component in system.
- **Safety and Health**. This section of the SOR will include requirements related to preserving the safety and health of the future operators and maintainers within the physical and threat environments defined in the scenarios.
- **Performance Measures**. These requirements will include a range of system and task level performance measures to be used throughout procurement to evaluate the system. Many of these measures will require humans to be operating the system in order to measure them, and will therefore require HSI based analysis to establish and validate the measures in addition to HSI methods to collect performance data during future system user trials.
- **Personnel-Staffing**. This SOR section will include the staffing requirements based on the project scenarios, the Concept of Operations, and the Concept of Support. Alternatively, these HSI requirements may state limits on the staffing impact of the future system (eg: the new system shall not alter staffing requirements).
- **Training - Operational and Maintenance**. These requirements include the HSI requirements related to the training systems for both operators and maintainers, and will include requirements for both courses and facilities.
- **Simulation**. This section will include requirements for simulation in the training plan. This will include simulation based facilities for training key operational and maintenance tasks.



3.1.2 Evaluation of HSI Related Sections in SOR Template

This project has allowed the team to review the content of the new SOR and the associated guidelines from an HSI perspective. In order for users of the SOR template to be able to effectively develop and document HSI requirements it is important that the structure of the document allow for all domains of HSI to be addressed effectively. It is also important that the HSI related sections do not create overlap or confusion as to where different requirements should be entered.

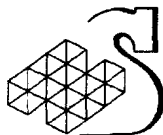
In general the SOR framework and the new guidelines cater to and accommodate the full range of HSI issues, however, it would take a user with some HSI experience to be able to identify, analyze, and document all of the relevant HSI requirements into the appropriate sections. The existing guidelines provide a very high level of prompting of the issues that should be considered in the various sections, however, a further level of prompting is required for the average project staff member to realize the extent of the HSI issues involved. An example of the prompting level required can be found in the USA MANPRINT program where a list of “typical questions” are identified for each of the domains of HSI.

Particularly lacking in the current SOR guidelines is a complete definition of the Health Hazards Assessment (HHA) area. Again the system employed in the USA, and a component of their MANPRINT system, provides a systematic structure for the HHA domain. This American HHA taxonomy was used during the current project as the basis for the review of HSI literature for AFVs and was found to be quite effective. It would be of benefit for the Canadian system to adopt a similar framework to guide the requirements development process in this area.

There are two components of the SOR that appear to overlap and have the potential to lead to confusion for the author. The first relates to the documentation of requirements related to human error, while the other relates to human performance requirements.

Human error requirements are identified through human factors analysis and safety analysis, and could be documented in the SOR in a number of areas. Two primary areas are the section on Reliability, which includes the reliability of the human operator and any errors they may make that decreases overall system reliability; and the section on Safety which includes requirements to ensure that human operators or maintainers don't make errors causing harm to themselves. Human error can also be interpreted at times to be a component of Availability. At the moment it appears that human error issues are best documented in the Reliability section and the SOR guidelines could be enhanced to make this clearer.

Human task performance requirements are to be documented in the SOR in the section on Operability – Performance Characteristics. This is clear to the SOR author, however, the later section on Performance Measures naturally overlaps with the performance requirement section which can lead to confusion. For example, a Performance Characteristic might be that an AFV crew be able to engage and destroy a target of type “x” at 2000m within 20 seconds. This could also easily be an entry in the Performance Measure section. It seems natural that the Performance Measure section would “roll up” or summarize the key performance requirements of the future system, including key human task performance measures. However, the guidelines on SOR development are not clear as to whether it is expected that earlier requirements can be repeated in the Performance Measures section or not, and if so what the subsequent impact on numbering and tracking should be.



3.1.3 Human Systems Integration in the SOR Development Process

The Guidance on the Preparation of a Statement of Operational Requirements (DBCM 1998) also includes a recommended basic process for the development of new requirements. This process includes a series of steps, listed in Figure 3. Many of these steps include analyses or evaluations that centre on the human operators or maintainers of the future system, and their requirements. These more human centric elements of the sequence, highlighted in Figure 3, can utilize HSI methods, tools, and techniques to determine and validate user requirements.

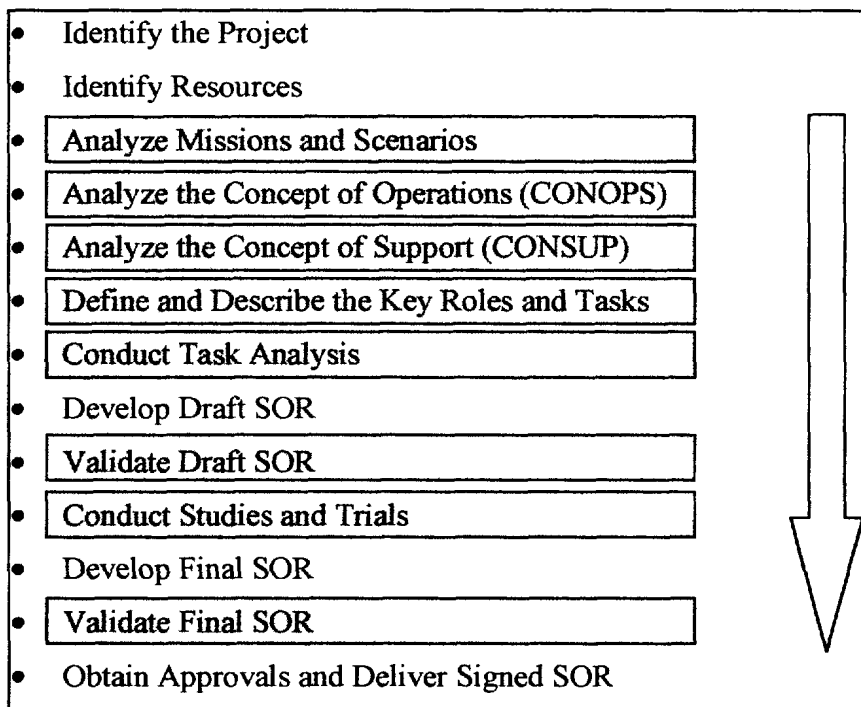
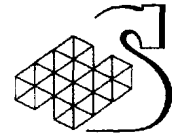


Figure 3: Recommended SOR Development Process with HSI Related Analyses Highlighted

At the core of the HSI component of this SOR development process is a very user centred sequence with many analyses linked to one another. The analysis begins with scenario definition and leads to analysis of key roles and tasks, after which the described tasks are analyzed for future requirements related to performance, displays, controls, safety, training, safety, etc.. HSI techniques are often then used to validate draft requirements with the user community through questionnaires or focus groups using mockups or prototypes. When more in depth investigation is still required to detail the requirements for a future system, studies are often conducted that include performance modeling, field trials, or human-in-the loop simulation. The sequence is completed with final validation of the requirements set through group meetings or further studies and trials.



3.2 How to Address Human Systems Integration in the new SOR

This section of the report attempts to provide guidance on how to address the foregoing HSI requirements, using a future Armour System SOR as the worked example.

Throughout the requirements development process, the basic method to address HSI requirements of the SOR consists of three key activity streams:

1. Deficiency Analysis. Systematically analyze the operational deficiencies that the project must address. This is an activity area in itself, but is also a key component of the next two activity areas.
2. Literature Review. Conduct a review of the available literature to identify HSI requirements in the areas indicated by the SOR.
3. Scenario Based Analysis. Follow the analysis sequence recommended in the new SOR guidelines (see Section 3.1.2 of this report) working from scenarios, to operations and support concepts, to analysis of functions and tasks, to detailed task analysis, to the development of requirements and performance measures. As previously discussed, this sequence will be initiated with a solid analysis of the deficiencies of existing systems within this scenario context, and may involve additional studies or evaluations with future users throughout.

The success of this analysis sequence depends on a number of factors, including:

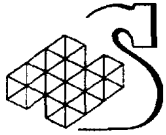
- Available Literature. Existing literature needs to be available in a readily accessible format.
- Integrated HSI Analysis Process. An integrated analysis process is required, that allows the requirements for each of the HSI domains to be determined, tracked, and evaluated.
- Integrated HSI Tools and Techniques. Tools and techniques are required that allow a range of HSI requirements to be determined or evaluated.

Each of these three factors is addressed further in the following sub-sections.

3.2.1 Available Literature

Ensuring that the relevant literature is available for future SORs is dependent on proactive initiative within each Directorate or cell in DND. Using Armour Systems as an example, this project identified four types of SORs that were likely to be developed over the next 5 to 10 years and then reviewed the available literature for HSI related requirements that may be relevant to those SORs, ranking the material by the likely level of HSI relevance. During this project over 500 papers were identified and briefly reviewed for HSI related Armour Systems requirements, resulting in over 100 papers being classified as directly relevant to future SORs for DLR 3 or DLR 10.

The low tech way of organizing this information is using filing cabinets and binders, indexed according to the types of SOR (eg: vehicle, clothing systems) that it may pertain to, and even the SOR section that it may pertain to (eg: Deficiencies, Performance Measures). This method is difficult in the current DND environment due to the restrictions on both storage space and the number of filing cabinets.



A more advanced, and more effective method, of distributing and sharing this literature would be to organize it and make it available in an electronic form. This issue is addressed further in Section 4.0 of this report as it was requested that particular attention be paid to it throughout this project.

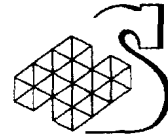
The method selected to organize reviewed literature must also accommodate efficient organization of the analyzed deficiencies for the project. These deficiencies may have been identified through a literature review, but will also include inputs from communications throughout DND, the UCR system, or more systematic analysis such as the ACCESS method which was developed to systematically document deficiencies and subsequent requirements for future systems (see Greenley 1999c).

3.2.2 Integrated HSI Analysis Process

The development, validation, and tracking of HSI requirements is best facilitated through an integrated analysis sequence. An HSI Process of this nature is currently required in Canada, especially one that integrates with the Defence Management System and the DND Materiel Acquisition and Support (MA&S) process. It is expected that such a process will be generated through the DRDB over the next several years, assuming that current levels of support for an HSI program are maintained.

An example of an integrated HSI Process is illustrated in Figure 4. This figure demonstrates that many of the analyses in a typical HSI analysis sequence can be used to generate and validate requirements in multiple HSI domains. This type of sequence is critical to ensure that as an analysis is updated throughout the acquisition cycle, the impact on requirements in each HSI domain is simultaneously realized, tracked, and evaluated.

This type of integrated process is absolutely essential to facilitate tradeoff analysis, which is one of the most complex aspects of an HSI program. An example of tradeoff analysis would be when the technology of a new system impacts the relative roles of crew members, which then impacts training requirements, and potentially even staffing or recruitment requirements. If there are limits on the permitted personnel impact or training requirements for the future system then trade offs must be made within the operational or support concepts to utilize the technology in a different fashion.



Project Stages	Human Systems Integration	HFE	Training	Personnel/ Staffing	Safety/ Health
1. Pre Acquisition	a. Identify Operational Deficiency	✓	✓	✓	✓
	b. Determine High Level Requirements	✓	✓	✓	✓
	c. Identify Solution Options	✓	✓	✓	✓
2. Plan	a. Negotiate Human Engineering Plan	✓	✓	✓	✓
3. Scenario Development	a. Identify Key Operational & Support Scenarios	✓	✓	✓	✓
	b. Describe Characteristics of Key Scenarios	✓	✓	✓	✓
4. System Analysis	a. Mission Analysis	✓	✓	✓	✓
	b. Function Analysis	✓	✓	✓	✓
	c. Potential Operator Capability Analysis	✓	✓	✓	✓
	d. Potential Equipment Identification	✓	✓	✓	✓
	e. Function Allocation	✓	✓	✓	✓
5. Analysis of System & Maintainer Tasks	a. Timeline Analysis	✓	✓	✓	✓
	b. Task Analysis	✓	✓	✓	✓
	c. Critical Task Analysis	✓	✓	✓	✓
	d. Decision Analysis	✓	✓	✓	✓
	e. Error Analysis	✓	✓	✓	✓
	f. Loading and Crew Composition Analysis	✓	✓	✓	✓
	g. Training Analysis (Knowledge, Skill, Ability)	✓	✓	✓	✓
6. Preliminary System & Sub-system Design	a. Information Requirements Analysis	✓	✓	✓	✓
	b. Control Requirements Analysis	✓	✓	✓	✓
	c. Workspace Requirements Analysis	✓	✓	✓	✓
	d. Environmental Analysis	✓	✓	✓	✓
	e. Safety and Hazard Analysis	✓	✓	✓	✓
	f. Personnel and Staffing Analysis	✓	✓	✓	✓
7. Project Research	a. Studies, Experiments & Laboratory Tests	✓	✓	✓	✓
	b. Dynamic Simulation & Rapid Prototyping	✓	✓	✓	✓
8. Test & Evaluation	a. Identification of T&E Parameters	✓	✓	✓	✓
	b. Test and Evaluation Plan	✓	✓	✓	✓
	c. Conduct Usability & Performance Trials	✓	✓	✓	✓
9. Equipment Detailed Design	a. Application of Human Engineering Standards	✓	✓	✓	✓
	b. Procedures Development	✓	✓	✓	✓
	c. Staffing Concept and Organizational Structure	✓	✓	✓	✓
	d. Training Development	✓	✓	✓	✓
	e. Rapid Prototypes, Mockups, and Models	✓	✓	✓	✓
10. Post Acquisition	a. Monitor Operational Effectiveness	✓	✓	✓	✓
	b. Identify New Design/Manufacturing Deficiencies	✓	✓	✓	✓

Figure 4: Example HSI Process Integrating all of the HSI Domains
(adapted from Greenley 1999c)

As indicated in Figure 5, the HSI Process is not completed once, but is repeated at least three times throughout the acquisition and development cycle to define requirements, detail performance specifications, generate designs, and evaluate final systems. Therefore, the establishment and maintenance of an integrated process is essential to provide efficiency and traceability throughout any one project.

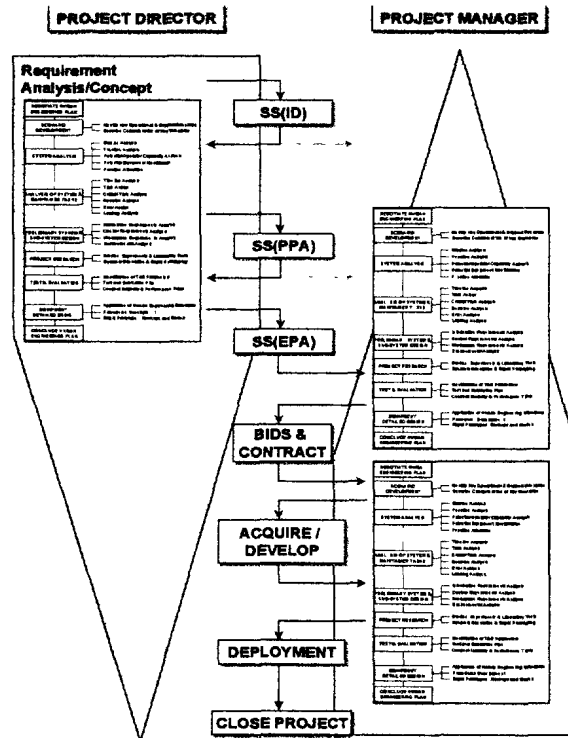
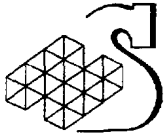


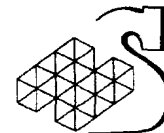
Figure 5: Illustration of HSI Process Repeating Several Times Throughout a Project (from Greenley 1999c)

3.2.3 Integrated HSI Tools and Techniques

At the core of an integrated analysis process are tools and techniques that result in common data being shared by each of the HSI domains. When tools developed and used that facilitate this sharing of data, the analysts are able to generate, validate, and track requirements in several HSI domains each time a core analysis is repeated or updated. For the purposes of this report, the critical sets of HSI tools or techniques can be organized into three groups:

1. Operational Experience and Lessons Learned
2. Scenario Analysis
3. Workspaces and Human – Machine Interfaces

Figure 6 maps these three groups of tools against the illustrative HSI process to indicate the tool coverage and the inter-linking of the analysis throughout. Figure 7 illustrates how Operating Experience (Literature and Deficiency Analysis), Scenario Analysis, and Workspaces integrate into the SOR development process.



Project Stages	Human Systems Integration	HFE	Training	Personnel/ Staffing	Safety/ Health	
Pre Acquisition	a Identify Operational Deficiency	✓	✓	✓	✓	Operating Experience
	b Determine High Level Requirements	✓	✓	✓	✓	
	c Identify Solution Options	✓	✓	✓	✓	
Plan	a Negotiate Human Engineering Plan	✓	✓	✓	✓	Scenarios
Scenario Development	a Identify Key Operational & Support Scenarios	✓	✓	✓	✓	
	b Describe Characteristics of Key Scenarios	✓	✓	✓	✓	
System Analysis	a Mission Analysis	✓	✓	✓	✓	Workspace Interfaces
	b Function Analysis	✓	✓	✓	✓	
	c Potential Operator Capability Analysis	✓	✓	✓	✓	
	d Potential Equipment Identification	✓	✓	✓	✓	
	e Function Allocation	✓	✓	✓	✓	
Analysis of System & Maintainer Tasks	a Timeline Analysis	✓	✓	✓	✓	
	b Task Analysis	✓	✓	✓	✓	
	c Critical Task Analysis	✓	✓	✓	✓	
	d Decision Analysis	✓	✓	✓	✓	
	e Error Analysis	✓	✓	✓	✓	
	f Loading and Crew Composition Analysis	✓	✓	✓	✓	
	g Training Analysis (Knowledge, Skill, Ability)	✓	✓	✓	✓	
Preliminary System & Sub-system Design	a Information Requirements Analysis	✓	✓	✓	✓	
	b Control Requirements Analysis	✓	✓	✓	✓	
	c Workspace Requirements Analysis	✓	✓	✓	✓	
	d Environmental Analysis	✓	✓	✓	✓	
	e Safety and Hazard Analysis	✓	✓	✓	✓	
	f Personnel and Staffing Analysis	✓	✓	✓	✓	
Project Research	a Studies, Experiments & Laboratory Tests	✓	✓	✓	✓	
	b Dynamic Simulation & Rapid Prototyping	✓	✓	✓	✓	
Test & Evaluation	a Identification of T&E Parameters	✓	✓	✓	✓	
	b Test and Evaluation Plan	✓	✓	✓	✓	
	c Conduct Usability & Performance Trials	✓	✓	✓	✓	
Equipment Detailed Design	a Application of Human Engineering Standards	✓	✓	✓	✓	
	b Procedures Development	✓	✓	✓	✓	
	c Staffing Concept and Organizational Structure	✓	✓	✓	✓	
	d Training Development	✓	✓	✓	✓	
	e Rapid Prototypes, Mockups, and Models	✓	✓	✓	✓	
Post Acquisition	a Monitor Operational Effectiveness	✓	✓	✓	✓	
	b Identify New Design/Manufacturing Deficiencies	✓	✓	✓	✓	

Figure 6: Three Groups of HSI Analysis Techniques vs the HSI Analysis Process

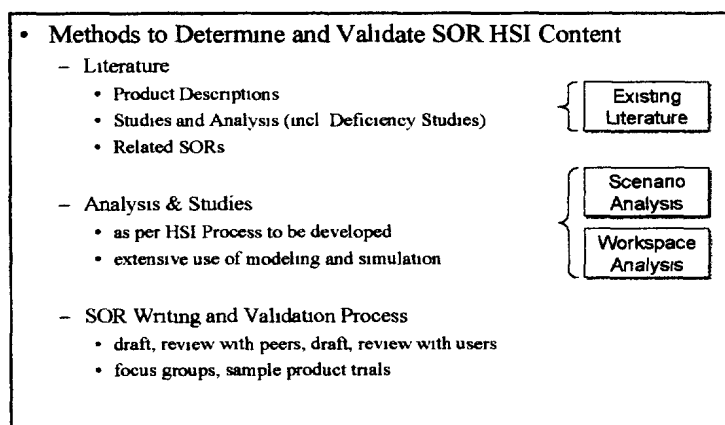
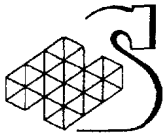


Figure 7: Three Groups of HSI Analysis Techniques vs The SOR Development Sequence



3.2.3.1 Operational Experience and Lessons Learned

Tools that analyze and track operational experience and lessons learned are used by each of the HSI domains. In the case of Human Factors, these tools identify task performance concerns, or component integration concerns. For Training these tools identify concerns with training from past versions or related in-service systems. For Personnel & Staffing these tools generate concerns with staffing from past or related systems. For Safety & Health Hazards accident/incident data from previous systems are organized or tracked by experience or lessons learned based tools.

The lower tech tools to process this class of requirement includes literature reviews, or interviews.

The higher tech tools in this category include the ACCESS set of tools, or enhanced versions of ACCESS linked with electronic distribution mechanisms such as the Soldier's Day database. With these tools different Directorates are able to systematically analyze and track operator or maintainer concerns with systems and then organize and distribute the results in a format that all classes or geographically distributed users can take advantage of.

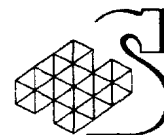
3.2.3.2 Scenarios (Descriptions, Functions, Tasks, Organization, Users)

Scenario based analysis consists of describing future operational and maintenance scenarios, identifying and analyzing the allocation of functions to be performed, and analyzing the tasks allocated to the human operators or maintainers. This analysis must be complimented by parallel and linked analysis of the organizational structure of the operational and support concepts, in addition to an assessment of the characteristics of the user populations.

Scenario based analysis tools are employed by the Human Factors domain to conduct function allocation, to generate system and interface requirements, and to develop performance measures. The Training domain uses these tools to determine and track knowledge/skill/ability requirements and future training measures. The Personnel domain identifies preliminary personnel and staffing requirements throughout the acquisition cycle using these tools, while the Safety and Health Hazards community uses the same types of analysis to identify and design for safety and hazard concerns/requirements.

The lower tech version of hierarchical scenario based analysis of systems involves different flow charting techniques to map out function flows, decision-action sequences, or the task flow between system components using techniques such as Operational Sequence Diagrams. Each time these analyses are updated, the resulting impact on each of the HSI domains is then tracked, usually in some tabular format.

The higher tech tools to conduct scenario based analysis, and then predict the impact of a future system design on each of the HSI domain areas, involves the use of Task Network Modeling. The DND tool of choice for this type of modeling is the Integrated Performance and Modeling Environment (IPME) supported through R&D at DCIEM.



In each case, re-usable models of the operation and support scenarios are decomposed into the associated functions and tasks, and kept up to date throughout the acquisition and support cycle.

3.2.3.3 Workspaces and Interfaces

Workspace and interface design tools are used to create mockups, prototypes, or simulations of crew stations and human-machine interfaces. These representations are then used as the basis for analysis of requirements or specifications in each of the HSI domains. If kept up to date, the impact on all domains can be tracked and evaluated throughout the acquisition cycle. Areas of interest to Human Factors when using these tools includes workstation ergonomics or interface controls and displays. The Training domain uses these representation to determine the requirements for future simulations, or the content of training materials. Personnel analysts are interested in these tools to investigate any potential constraints of the design on selection of future personnel (eg: crew size or sensory characteristics) Safety & Health Hazard personnel use these tools to conduct preliminary safety and health hazard analysis of a proposed future design.

The lower tech versions of workspace and interface design tools consist of dimensioned drawings, 2D CADD files, and "Power Point" level illustrations of interfaces.

The higher tech tools for workspace and interface design include 3D CADD modeling, computer based human form mannequin software, and virtual reality based reviews. Products such as Safework (Greenley 1999c) provide capabilities in each of these areas, allowing the user to create representations of workspaces in 3D, analyze them for conflicts using human form mannequins, and facilitating review by future operators and maintainers using virtual reality techniques.

3.2.3.4 Integrated Tool Sets

The "integration" aspects of HSI analysis have been emphasized several times throughout this report. As the analysis sequence and analysis tools get more integrated, there are two primary benefits:

1. The analysis becomes more efficient, and therefore more timely and cost effective.
2. The impact of design changes on all HSI domains can be determined simultaneously, resulting in a higher quality of assessment, design, and design evaluation.

Within a given project, there is a logical flow of analysis between the three primary groups of tools described earlier in this section. The same flow applies to both the lower tech and higher tech tools identified, with the flow of data having the potential to be more direct in the higher tech solutions.

Figure 8 illustrates the flow between the lower tech analysis techniques. In this case, the task flow generated through scenario analysis forms the basis for the evaluation of crewstation or interface drawings, when can then lead to the creation of actual mockups or prototypes that can be reviewed with future operators or maintainers using table top analysis or some form of usability test/field trial.

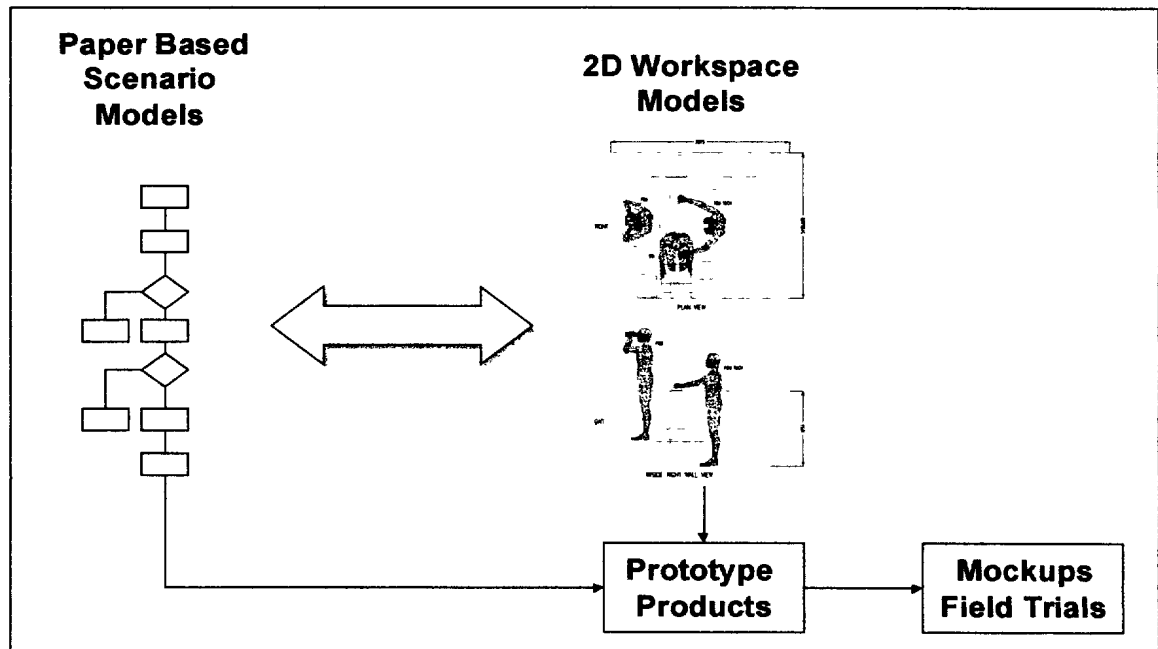
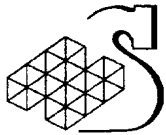
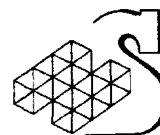


Figure 8: Low Tech Integrated Analysis Tools

Figure 9 illustrates a similar flow using software based tools that share data. In this case the task flow from a Task Network Model (eg: in IPME) can be exported into the mannequin based software where the full size range of the population can be “asked” to complete the task sequences in 3D representation of a workspace generating an analysis of any layout conflicts, in addition to information on the physical demands placed on different sizes of the population. Similarly, actual operators or maintainers can be asked to “review” the design by “immersing” themselves into the environment and completing the task sequences (using various sensors on their joints, and head mounted displays). In the higher tech stream of analysis, the scenarios and task flows can then be exercised by real users in full scale simulations of a future system, after which operational versions of the refined system can be developed and evaluated in field trials.

This higher tech sequence has recently been exercised by the Armour community to determine the requirements for future armour vehicles, fire control systems, and defensive aids suites through the Advanced Land Fire Control System (ALFCS) and Pronghorn programs. Using Defensive Aids Suites (DAS) as an example, the program started with identification of the range of scenarios that Armoured Personnel Carriers, Reconnaissance Vehicles, and Main Battle Tanks might have to operate within. These scenarios were then used to as the basis for engineering and task flow analysis to determine the basic configuration of a DAS for Canadian vehicles. This DAS was then prototyped on paper and reviewed with users, after which it was installed in the full motion ALFCS crew station simulator (the interior of which was designed using mannequin based software tools). Following evaluation with crews in the simulator, the requirements for a DAS were then refined and developed into an operational prototype which was then installed on an AFV and evaluated in the international Pronghorn Trials (TTCP trial involving 4 countries hosted by Canada). The results of this analysis sequence then generated both requirements and design concepts for future systems that might be developed or acquired, in addition to identifying other HSI requirements related



to doctrine, roles and responsibilities, task flow requirements, interface requirements, future training requirements, and some personnel issues related to the characteristics of future AFV crews.

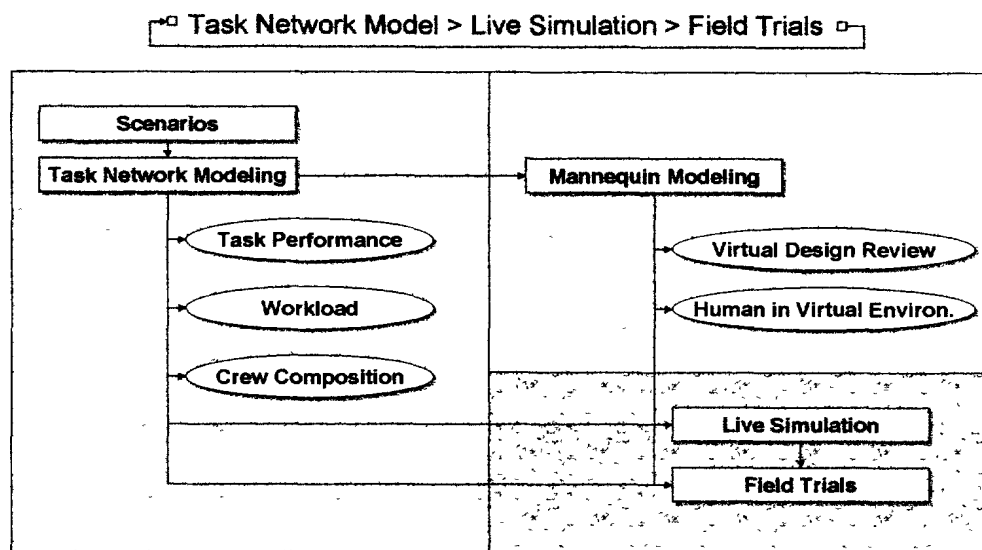


Figure 9: High Tech Integrated Analysis Tools
(from Greenley and Beevis 1999)

Fortunately, the basic tools and technical capability to conduct all of these low and high tech analysis exist in the DND community. Future efforts to integrate analysis process and tools in these areas will continue to make it easier for projects to manage HSI requirements on projects.

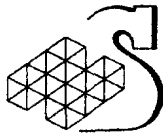
3.3 Distribution of HSI Information

It was stated earlier in this report that one of the basic methods for determining and managing HSI requirements within a Directorate was to use literature reviews, and electronic archival of relevant requirements, design guidance, and performance measures. This project required that the team review the requirements for electronic sharing of this type of information, and review the options for electronic distribution over the DND Intranets or perhaps someday the Internet.

3.3.1 Options for “Web Based” Distribution

This project required an assessment of “Web Based” distribution to meet the user’s requirements for electronic information distribution. In this context “Web Based” refers to some form of browser based access of the information, whether that be through the DND Intranets (eg: DWAN/DIN) or perhaps someday the Internet (World Wide Web).

This assessment of the potential for Web Based distribution of information was completed using AFV related HSI information as a “worked example”. This means that the analysis of presenting HSI information on the HSI Web Site or through a Web Based version of Soldier’s Day was conducted using Armour System SOR information as the example data set. The analysis and



associated recommendations apply to all environments, based on the project teams experience with a range of land, air, and maritime SORs.

3.3.1.1 HSI Web Site

The HSI Information Repository is a web site that has just been initiated on the Descartes system within DRDB and on the DIN intranet for access throughout DND. At some point in the future it is intended that portions of this site will be accessible by the outside community through the Internet. For the purposes of this report, this site will be called the "HSI Web Site".

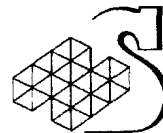
At the time of this report the HSI Web Site contained basic information, such as descriptions of HSI, and access to key documents that outline the application of HSI in defence projects. In addition, summaries of each of the HSI Tools was available. Long term strategic plans related to Human Factors and HSI related R&D were also included to inform of the DND community of these programs.

Interviews with the responsible personnel indicated that future plans for the HSI Web Site called for expansion in a number of areas including:

- Development of more "web pages" to summarize the HSI field and each of the domains.
- An illustration and description of the recommended HSI Process, once it is developed.
- An indication of which HSI Tools should be used at different phases of the HSI Process.
- Potential access to some of the HSI Tools.
- Access to HSI contacts in each of the domains throughout DND and Industry in Canada.

Within these expansion plans, and within the structure of the HSI Web Site itself, there is certainly room for the introduction of an information repository for HSI related requirements.

Analysis by the project team concluded that it would likely be possible to create some form of a database, with a web based interface, that would allow for the classification and storage of HSI related references that would permit the user to access them by military environment and/or SOR section of relevance. The military environment classification would result in an access structure similar to that in Figure 10 (using AFV as an example). Once a specific arm of the military was accessed information could be presented using the SOR structure (as illustrated in Figure 11).



- About
- HSI in SOR and Spec
- Evaluating HSI in Future
- HSI Literature SORSand
 - General
 - Air
 - Maritime
 - Land
 - Infantry
 - Artillery
 - Armour
 - Vehicles
 - Sub-systems
 - Clothing and Equipment
 - Ergogenic Aids

Figure 10: Potential Access to SOR HSI Information Through the HSI Web Site

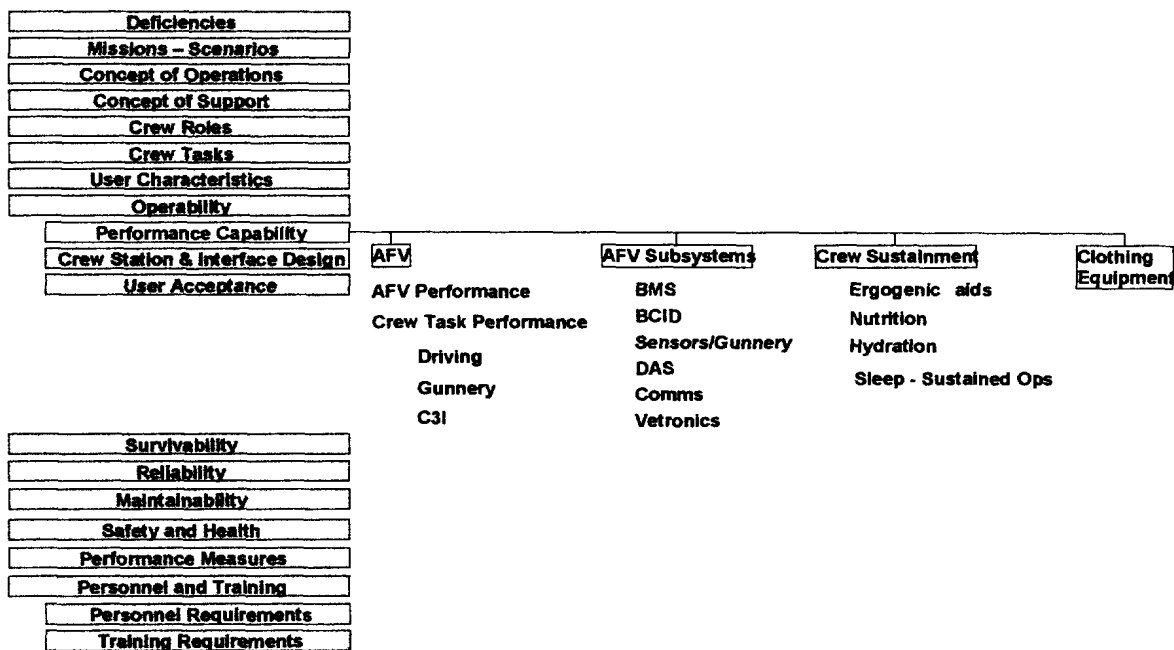
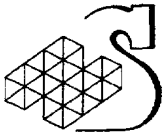


Figure 11: HSI Information Structure for Web Site Using AFVs as Worked Example

The structure in Figure 9 suggests for any one operational domain, such as Armour Systems, the HSI related information for most SOR sections is common across the various SOR's that might be produced for that domain. However, the structure and contents of the performance requirements will vary with each class of system to be



acquired. In the case of AFVs as a worked example, this means that different requirements will exist specific to vehicles, vehicle subsystems, mounted soldier clothing and equipment, and crew sustainment related procurement.

The advantages of the HSI Web Site method for distributing information is that it is simple, straightforward, and easier to maintain. The disadvantage is that it is difficult to link related requirements in the mind of the reader, and the association between linked requirements might not be made. The pro's and con's of a Web based version of Soldier's Day are the reverse.

3.3.1.2 Browser Based Version of Soldiers Day

Soldier's Day is a multimedia database developed to present information on soldiers, their missions and tasks, and the equipment they use. This tool was developed to promote a shared understanding of soldiers and their requirements between DND project staff, researchers, and industry representatives. Soldier's Day was originally created for the dismounted infantry community, and is used by personnel involved in Clothe the Soldier and the Integrated Personal Clothing and Equipment projects.

The current version of Soldier's Day is distributed using a CD ROM. This project required that an assessment be made on the applicability of Soldier's day to distribute HSI Information for SOR's (using AFVs as a worked example) and to do so using a browser based interface instead of a CD ROM.

The conversion of Soldier's Day to a browser based application has been reported by experts to be a straight forward exercise and technically feasible (Greenley 1999c). From a user perspective this would be desirable as it would ensure maximum access throughout DND. Presumably a web based product would also decrease maintenance and distribution resource requirements.

From an HSI perspective, Soldier's Day is an effective medium to distribute the information required for SOR's. The current Soldier's Day product has information streams for Missions and Tasks, Organization and Personnel, and Clothing and Equipment. These same information streams apply to all military environments, and the links within the software between personnel and their tasks, or tasks and the related equipment are the links required to conduct HSI assessments in all environments. The only major structural change required is the addition of an information stream for "vehicles/crew stations" (in the case of AFVs). Once a vehicle based information stream is added the Soldier's Day product will then be applicable to all vehicles, including land vehicles, aircraft, and ships.

Figure 12 illustrates the concept of the addition of a "vehicles" information stream to Soldier's Day, presented in a browser based interface.

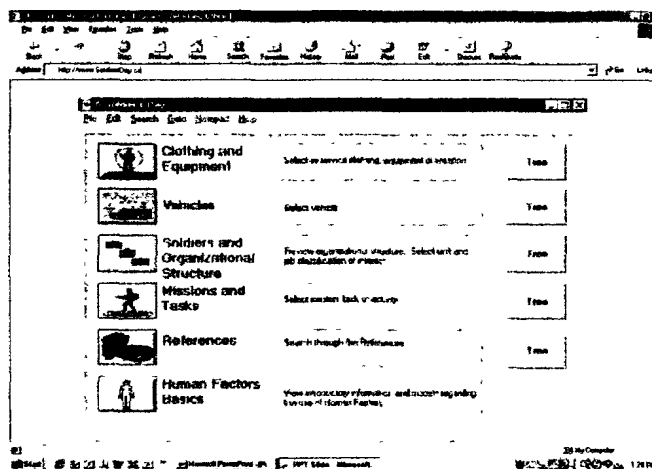
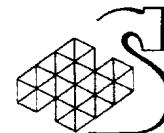


Figure 12: Concept for Browser Based Version of Soldiers Day with the addition of a Vehicles Information Stream.

Figure 13 illustrates the current structure of the Soldier's Day database. This figure indicates that many of the HSI domains are already covered, including scenarios, missions, tasks, key roles, key tasks, user characteristics, safety and health, equipment requirements, and related references. Any military environment that was to adopt the Soldier's Day tool as an information repository would then be able to enter and track the HSI related requirements in these categories.

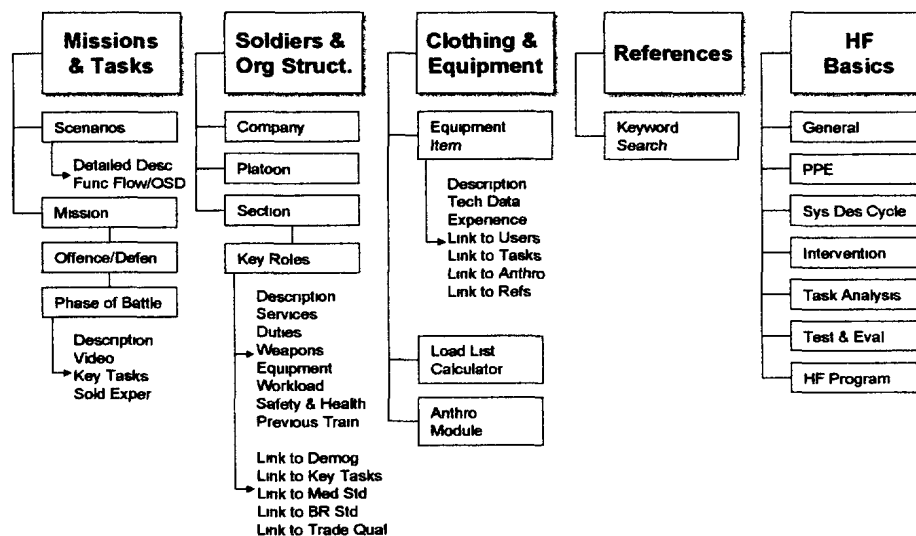
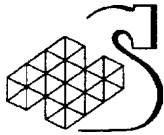


Figure 13: Current Soldier's Day Structure

However, there are some categories missing that are necessary to complete the full picture, in addition to some recommended enhancements to support the larger scope of HSI compared to the original focus on Human Factors, which is only one HSI domain.



The recommended enhancements to the Soldier's Day structure are illustrated and highlighted in Figure 14, and include:

1. There should be links to relevant references throughout the database.
2. Modification for a particular domain will require minor modifications to match organizational and personnel structure. Figure 14 illustrates the modifications required to adapt Soldier's Day to a Crewman's Day product for the Armour community.
3. A vehicle stream of information is required. This stream must use the multimedia capabilities of the system to present information on the vehicle, its crew stations, and the equipment used at each crew station. Within this stream links must be made to the personnel that operate each crew station and the primary tasks performed at each station using the equipment identified. Figure 14 illustrates these required changes using the AFV example, however the same principle applies to the other military environments (eg: in a ship this stream would identify decks, spaces, and then equipment or consoles in each space).
4. For each military environment, the opportunity for HSI related analysis tools should be investigated. The current Soldier's Day provides a Load Carriage Calculator under Clothing and Equipment to allow the user to "what if" the impact of altering the items to be carried on the demands of different sized soldiers. Figure 14 proposes that a Stowage Calculator be provided for A Crewman's Day to allow the user to "what if" the impact of adding new equipment on the stowage capacity of different vehicles.
5. All references that are used in any particular version of Soldier's Day should be classified with a tag by SOR category.
6. The "About Human Factors" section of the tool should be extended to provide information "About HSI". If the tool is to become web based, then the About HSI section should likely be covered off by the content already, or soon to be, available on the HSI Web Site.

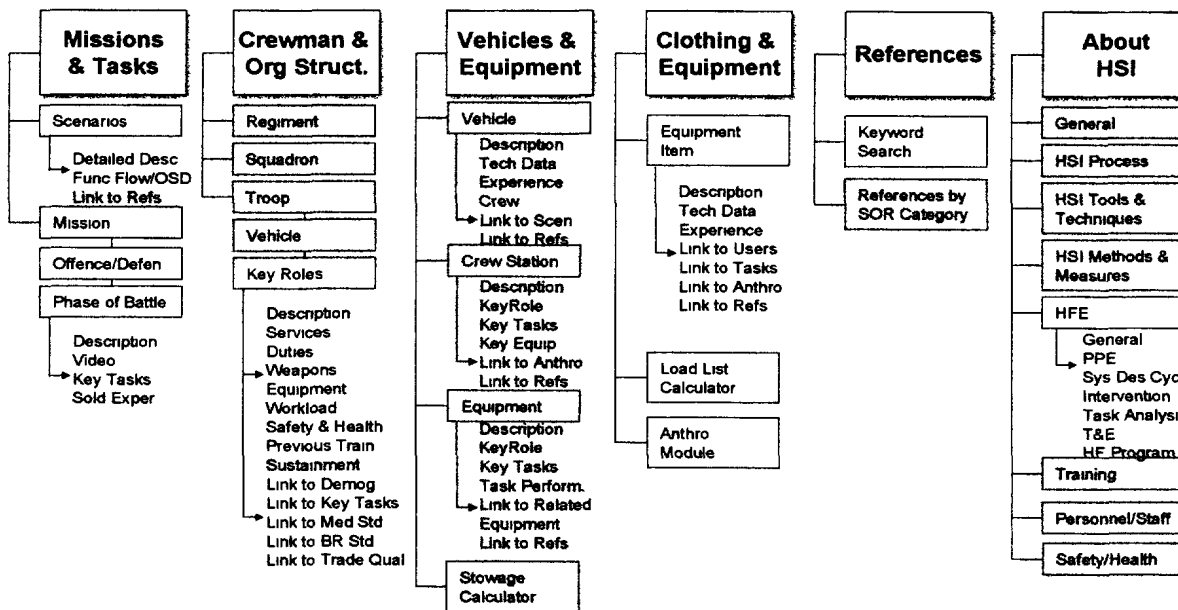
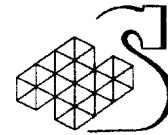


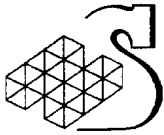
Figure 14: HSI Enhanced Soldier's Day Modified for AFV Systems as Worked Example (AFV and HSI Enhancements Highlighted)

3.3.1.3 Soldiers Day SOR Builder

Section 3.3.1.2 reviews the necessary changes to Soldier's Day to include information for all HSI domains, and to provide a structure to support all military environments. The reader should note that this analysis did not recommend that the Soldier's Day product be restructured to align itself with the sections of the new SOR template, but instead to insert the information inside the existing database structure with SOR category flags on references only. The rationale for this is that the current Soldier's Day structure was developed over several years with considerable input from the user community. This community includes DND project staff, researchers, industry designers, manufacturers, and consultants. Altering the structure to specifically support SOR developers would decrease the utility of the system to the other user categories.

It is therefore recommended that an SOR Builder tool be developed as an "add on" to the Soldier's Day product. Such a tool would take advantage of the links already inside soldiers day to extract the HSI related information available to support the development of a specific type of SOR.

For example, if a DLR 3 user was using Crewman's Day to develop the requirements for a new sight they would access the SOR Builder and indicate that they wanted to learn about HSI related requirements for a new sight (or would select an in-service sight that they wanted to replace using the Crewman's Day structure). Once selected the software would then be able to follow the links in the software to identify the users of that sight, the characteristics of those users, the tasks the sight is used for, the scenarios that the sight is used within, the crew station characteristics where the sight is used, any known deficiencies with the current sight or comparable sights (on this vehicle or related



vehicles), etc.. Once this search was complete the SOR Builder tool would generate a series of links by SOR category that would allow the user to jump into different sections of the Soldiers Day database to extract information of relevance to their SOR (which can be cut and pasted into word processing software). This concept is illustrated in Figure 15.

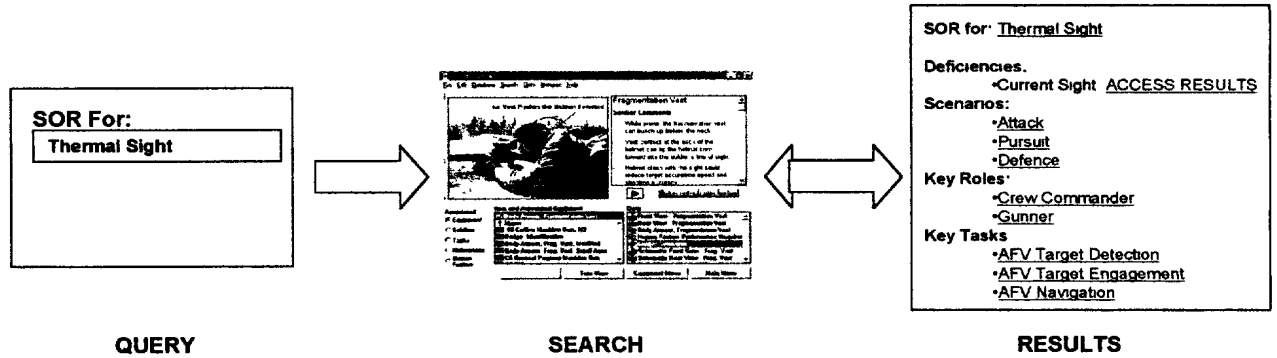
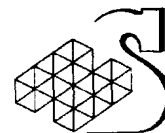


Figure 15: Concept for SOR Builder Add-On to Soldier's Day Software



4 Conclusions and Recommendations

This report was developed to provide some guidance for addressing the Human Systems Integration content requirements of DND SORs and to discuss the options for electronic distribution of HSI related information.

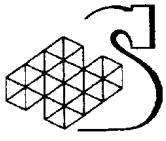
In general, the inclusion of HSI related requirements in SOR's appears to be straight forward based on a systematic analysis of future systems, within the context of future scenarios and operational/support concepts. It is recognized, however, that it will take time for such analysis to become practiced and routine throughout all DND environments. It is recommended that the DRDB community support any efforts to ensure that HSI is included in SOR's over the next several years and that early samples be provided on the HSI Web Site as examples for other projects to learn from.

In addition, it is recommended that the feedback on SOR structure and content related to HSI issues outlined in this report be integrated into future versions of the SOR template and associated guidelines.

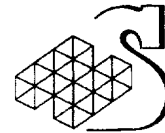
This project has concluded that the basic process for analysis and validation of HSI related requirements is known, however, a more detailed integrated HSI process is still required. It is recommended that such a process be developed, and it is recognized that DND is already initiating efforts to do so.

It has also been concluded that the key to conducting an integrated analysis is to use techniques and tools that allow a core analysis of (i) Operational Experience, (ii) Scenarios/Functions/Tasks, and (iii) Workstations or Interfaces to be shared by each of the domains of HSI. This shared assessment increases the efficiency and accuracy of analysis and ensures that all requirements are kept up to date throughout the acquisition cycle. It is recommended that tools and techniques should continue to be developed to facilitate the sharing of analysis between these three primary assessment areas, and it is recognized that DND is already initiating efforts to do so.

It is recommended that the Armour community, in conjunction with other military environments, consider the conversion of Soldier's Day to a web based product, with the introduction of an add on module for Building SOR's. This solution is preferable to simply creating annotated bibliographies accessible on the Intranet, however, both electronic distribution mechanisms could be introduced in parallel.

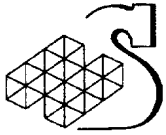


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This document is the final report of a project to review the new Guidelines on the Preparation of a Statement of Operational Requirements (SOR) from a Human Systems Integration (HSI) perspective. The project was sponsored by the Defence Research and Development Branch (DRDB) using Armour Systems projects as an example. This report was developed to provide guidance for addressing the Human Systems Integration content requirements of DND SORs and to discuss the options for electronic distribution of HIS related information. In general, the inclusion of HIS related requirements in SOR's appears to be straight forward based on a systematic analysis of future systems, within the context of future scenarios and operational/support concepts. However, it will take time for such analysis to become practiced and routine throughout all DND environments. It is recommended that the DRDB community support any efforts to ensure that HSI is included in SOR's over the next several years and that early samples be provided as examples for other projects to learn from. In addition, it is recommended that the feedback on SOR structures and content related to HSI issues outlined in this report be integrated into future versions of the SOR template and associated guidelines. This project concluded that the basic process for analysis and validation of HIS related requirements is known, however, a more detailed, integrated, HSI process is still required. It is recommended that such a process be developed, and it is recognized that DND is already initiating efforts to do so. It has also been concluded that the key to conducting an integrated analysis is to use techniques and tools that allow a core analysis of (i) Operational Experience, (ii) Scenarios/Functions/Tasks, and (iii) Workstations or Interfaces to be shared by each of the domains of HIS. It is recommended that tools and techniques continue to be developed to facilitate the sharing of analysis between these three primary assessment areas. It is also recommended that the Armour community, in conjunction with other military environments, consider the conversion of the Soldier's Day software tool to a web based product, with the introduction of an add on module for building SOR's.

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