Image Cover Sheet

CLASSIFICATION	SYSTEM NUMBER
UNCLASSIFIED	510039

TITLE

REVIEW OF THE SOR DEVELOPMENT PROCESS AND THE REQUIREMENT FOR SOR-SPEC MAKER SOFTWARE

System Number:

Patron Number:

Requester:

Notes:

DSIS Use only:

Deliver to:

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
APR 1998		**00-00-1998 to 00-00-1998**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Review of the SOR Development Process and the Requirement for SOR-Spec Maker Software	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Humansystems Incorporated,111 Farquhar Street,Guelph, Ontario, Canada, N1H 3N4,**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

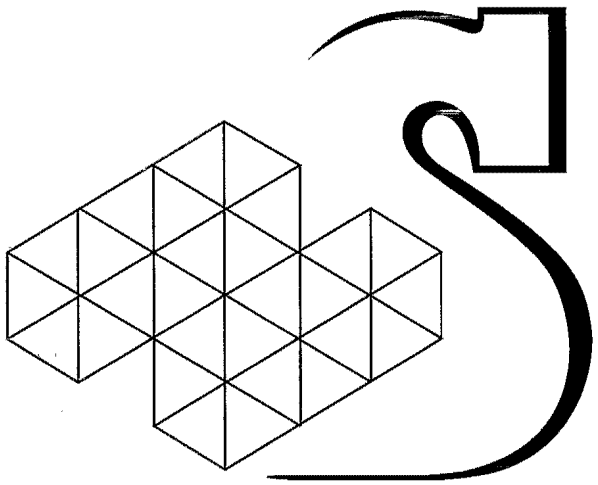
12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**87**	



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Review of the SOR Development Process and the Requirement for SOR-Spec Maker Software

PWGSC Contract No. W7711-6-7286/01-SRV

DCIEM No. 98-CR-55

REVIEW OF THE SOR DEVELOPMENT PROCESS AND THE REQUIREMENT FOR SOR-SPEC MAKER SOFTWARE

by

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PWGSC Contract No. W7711-6-7286/001-SRV
Order No. 7286-20

On behalf of
DEPARTMENT OF NATIONAL DEFENCE

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April 1998

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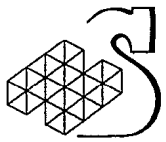

Executive Summary

This document is the final report of a project to review the process followed by the Directorate of Land Requirements (DLR) to develop a Statement of Operational Requirement (SOR), and to generate the requirements for a software tool to support the SOR development process.

The analysis of the requirements management process within DLR identified a number of deficiencies in the current system. These deficient areas included:

- DLR and Army Culture
- Lack of Scenarios, Doctrine, and Operational Concepts
- Access to Information and Resources
- SOR Development Process
- SOR Format
- Integration of Human Factors in the SOR
- The Link with ADM(Mat)
- Requirements Traceability

Each group of deficiency has generated a series of requirements for change in the SOR Development Process, proposed modifications to the SOR Format Template, and identified requirements to guide the procurement or development of SOR-Spec Maker (a requirements management tool).

This report is considered the first step in the SOR-Spec Maker project, with required future stages consisting of:

- Liaison with parallel projects developing new SOR formats for the Canadian Forces (through the Directorate of Force Planning and Project Coordination) to integrate the results of this study and ensure that the human factors aspects of the SOR Template are considered in force wide initiatives.
- Review of additional requirements management tools, resulting in the selection of one tool to be used in an example project. This example project should be used as the basis for user reviews, a part task user trial, and the development of a final set of SOR-Spec Maker Requirements to guide procurement.

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Appendices

1 Introduction

This document is the final report of a project to review the process followed by the Directorate of Land Requirements (DLR) to develop a Statement of Operational Requirement (SOR), and to generate the requirements for a software tool to support the SOR development process. The project has been completed by Humansystems Incorporated (HSI) under contract to the Defence and Civil Institute of Environment Medicine (DCIEM) under PWGSC Contract No.W7711-6-7286/001-SRV.

1.1 Background

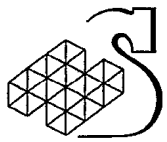
DCIEM has been considering the development of a requirements tool that will facilitate the integration of human factors provisions into system requirements. In parallel to this initiative, the Directorate of Land Requirements (DLR) has been investigating management tools to assist in the development, tracking, maintenance, and testing of system requirements on a large scale. As a result of this shared interest, DLR invited DCIEM to participate in an investigation of the SOR development process through the Defence Research and Development Branch (DRDB).

DCIEM chose to contract this analysis activity to Human*systems* Incorporated. Human*systems* had prior experience conducting this type of analysis on other DND software projects, in addition to extensive human factors experience on military acquisition projects.

1.2 Objective

The objectives of the project were to:

- Assist DLR and DCIEM in the identification of their needs for a requirements software management tool,
- Develop a clear understanding of the SOR development process and identify any recommended improvements to this process,
- Document the methods used to check and revise requirements during system development,
- Develop an SOR Requirements Template, including a human factors requirements package embedded in the template, and
- Determine the feasibility of incorporating a requirements management product as a module within, or linking it to, Soldiers Day and/or HFE Guide, either as stand alone software or a world-wide-web site.



1.3 Scope

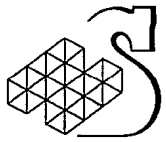
The analysis conducted under this project was limited in resources, which limited the scope in a number of ways:

- The analysis was "wide" and not "deep", focusing on a broad understanding of the SOR and Performance Specification development process.
- The resulting SOR-Spec Maker requirements are therefore high level, task related, requirements and should undergo more detailed development prior to being used as the complete basis for software procurement.
- A number of Land Forces projects were analyzed which were expected to provide a representative cross section of SORs. However, further projects should be reviewed against the results of this study to validate the results prior to changing the development process or finalizing software requirements.
- The Human Factors "package" of the SOR template was limited to the SOR sub-sections that should be added to properly integrate human factors, with some guidance on their expected contents.

1.4 Deliverables

A number of deliverables were required from this project including:

- Documentation of the SOR development process, including flow charts of information flow and task sequences.
- An SOR Template with an embedded Human Factors Package.
- A Final Report integrating the Method, Results, and Recommendations from the analysis and the above two deliverables.
- A Presentation of the Final Report in Ottawa.



2 Method

In order to analyze the SOR development process and derive the requirements for a management tool a series of analyses were conducted, including:

- The analysis of a number of project scenarios to understand the process in terms of how SORs are initiated, created, validated, edited, turned into Performance Specifications, tracked during development, and tested.
- The analysis of key tasks in the SOR Development Process in terms of key information sources, major challenges or sources of error, the types of requirements, the lessons learned on past projects, and the identification of areas where management software could provide assistance.
- The identification of areas where improvements could be made to the SOR Development Process.
- The derivation of SOR-Spec Maker software requirements from this analysis.

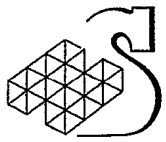
These analyses were completed using three primary methods of data collection:

- Interviews
- SOR Reviews
- Software Product Reviews

2.1 Interviews

At the project start up meetings with DLR, DCIEM, and DRDB discussions were held to determine who should be consulted in the analysis process. A number of sources were identified through these discussions, with five groups of personnel selected as important information sources:

1. The Technical Staff Course in Kingston
   This group was selected to provide an understanding of the background on SOR development that Requirements Officers obtain at the Tech Staff School prior to joining a DLR project office.
2. DLR Coordination Staff
   This group was selected to provide an overview of the overall process.
3. DLR Project Case Studies
   These projects were selected for more detailed study to provide insights on the range of methods used to develop SORs and the challenges that Requirements Officers must overcome.
4. DLERM and other Project Management Staff
   These personnel were selected to provide insights into the engineering side of the process,



and the development of the Performance Specifications used for procurement and development.

5. DCIEM Scientific Authorities
   These personnel were selected to provide insights into the integration of human factors in the requirements development process.

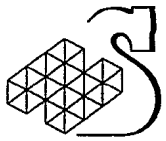
As a result of startup meeting discussions it was determined that DLR projects could be loosely classified into three groups, regardless of which DLR section they were initiated from. Within these groups a number of projects were identified for analysis with the understanding that not all could be fully investigated within the scope of the current project. The three groups, and the projects that were actually analyzed included:

1. C^3I/C^4I
   a) Land Force Command System (LFCS)
   b) Tactical Battlefield Command System (TBCS)
2. Major Equipment and Vehicles
   a) Armoured Combat Vehicle (ACV)
   b) Armoured Personnel Carrier Life Extention (APC LE) (SOR Review Only)
3. Soldier Centric Items
   a) Integrated Protective Clothing and Equipment (IPCE)
   b) Helmet and Soldier's Helmet Accessories
   c) Clothe the Soldier, including:
      - Cold Wet Weather Glove
      - Improved Environmental Clothing System
      - Combat Sock

   Note: *It is important to note that the Humansystems project team also had insights into the requirements development and management process on a number of other projects. This insight was developed through contracts completed during the preceding 10 years. These projects included a wide range of clothing and equipment contracts, the 105mm Howitzer projects, the Artillery Regimental Data System (ARDS) project, and the Advanced Land Fire Control System (ALFCS) and Defensive Aids Suite (DAS) projects.*

A rough interview protocol was developed to guide the interviews with DLR and Kingston Technical School Staff about the requirements development and management process. The key elements of these interviews included:

1. Introductions and a Discussion of the Purpose of the Interview
2. Questions on the History of the Project
   - Why was the project started, and what was the project goal?
   - What is the current SOR structure and content?

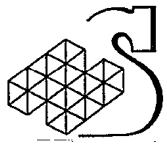


- What was the process or major steps in the development of the SOR?
  - How did the DLR staff determine the requirements ?
  - What were the key information inputs and sources ?
  - How were the requirements validated, with users and with others?
  - Were there any human performance related requirements developed?
- What were the major problems, challenges, and lessons learned during the development of the SOR and management of requirements throughout the project life cycle?

3. Transition of the SOR to the Specification and the RFP/SOW
   - How do requirements transition to specifications?
   - What are the key data to transfer from the SOR to the Spec?
   - What are the major problems or challenges in the transition of requirements to specifications?
4. Tracking Through Product/System Development or Implementation
   - How are requirements tracked through the implementation phase?
   - How are the requirements revised (if necessary)?
   - How is the history of decision making tracked?
   - How are requirements tested through development?
   - Where do testing criteria come from?
   - How is testing tracked?

In addition to these process related interviews, D.C.I.E.M. human factors personnel were interviewed for input on the integration of human factors engineering in systems design. Key issues in these interviewees included:

1. What are DCIEM staff expectations for the integration of Human Factors in Statements of Operational requirements?
2. What are the range of human factors requirements that should be integrated in an SOR?
3. What are the human factors lessons from past projects where human factors requirements have not been adequately addressed or integrated?
4. What are the lessons learned from the integration of human factors in other elements of the Canadian forces (Air/Navy/Service)?



2.2 SOR Reviews

The SORs for the listed projects were all reviewed for:

1. Structure and Boiler Plate
2. Types of Requirements
3. Volume of Requirements
4. Differences Between Project Types
5. Links to Other Documents or References
6. Integration of Human Factors Issues

2.3 Software Product Reviews

Two types of software products were reviewed during the project, including:

1. Requirements Management Tools.
   These tools included ReqMan and RT Expert, both of which are requirements management tools that are candidates for the SOR-Spec Maker product. These products were reviewed to determine if they generally meet the requirement for software based requirements management support.
2. Human Factors Tools.
   These tools included Soldier's Day and HFE Guide. Soldier's Day is a database tool with information on the missions/tasks/equipment of the infantry. HFE Guide is a hypertext based tool containing military human factors standards and guidance on task analysis and testing. These products were reviewed to determine if there is any role for them in a software suite to support the requirements development process.

3 Results

This section outlines the results of the analysis described in Section 2.0. The section contains two categories of information including:

1. A review of the requirements management process and the integration of human factors within this process.
2. Identification of the deficiencies in the current process and the requirements to address these deficiencies. The requirements to address each deficiency area are grouped into three categories:
   - Requirements for Changes in the SOR and Performance Spec Development Process,
   - Requirements for Changes to the SOR Document Format, and
   - Requirements for an SOR-Spec Maker Software Tool.

A summary of primary project recommendations, with comments on the "way-ahead" for the SOR-Spec Maker project, is provided in Section 4.0 of this report.

3.1 Analysis of the Requirements Management Process

3.1.1 The Directorate of Land Requirements

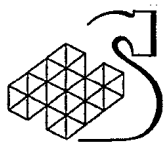
The Canadian Forces are functionally grouped into a number of elements that include the Army (Land Force), Navy, and Air elements. Each of these elements have headquarters directorates responsible for the specification and delivery of systems and equipment to support operations. In the Land Force element this group is called the Directorate of Land Requirements (DLR).

DLR exists to translate army needs into systems and equipment to support those needs. The major functions that DLR performs in support of this aim include:

- Monitoring of Technological Developments (both friendly and threat forces)
- Definition of Requirements and Projects
- Negotiation for Project Resources

To complete these tasks for the Land Forces, personnel are organized into functional teams according to the type of system or equipment that needs to be procured at any one time. During the analysis for this project DLR was organized within three groups (see Figure 1):

1. Program Co-ordination.
   This group of personnel is responsible for DLR issues common to the development of all systems and products, such as interfaces with other agencies, research and development, testing and evaluation, or the development of training and simulation.
2. Matrix Sections.
   This group of personnel support what are known as "matrix positions". These staff



generally deal with the monitoring of science and technology, and with projects either very early or very late in their life cycles. Also included in these sections are personnel who are assigned to smaller sized projects where the project team is composed of personnel who may work on other projects at the same time..

3. Project Management Offices.
This group of personnel are the DLR staff assigned to large Project Management Offices (PMOs) as the requirements and directing staff. These assignments occur on very large projects where the magnitude of the project requires the full time attention of one or more individuals from a DLR branch.

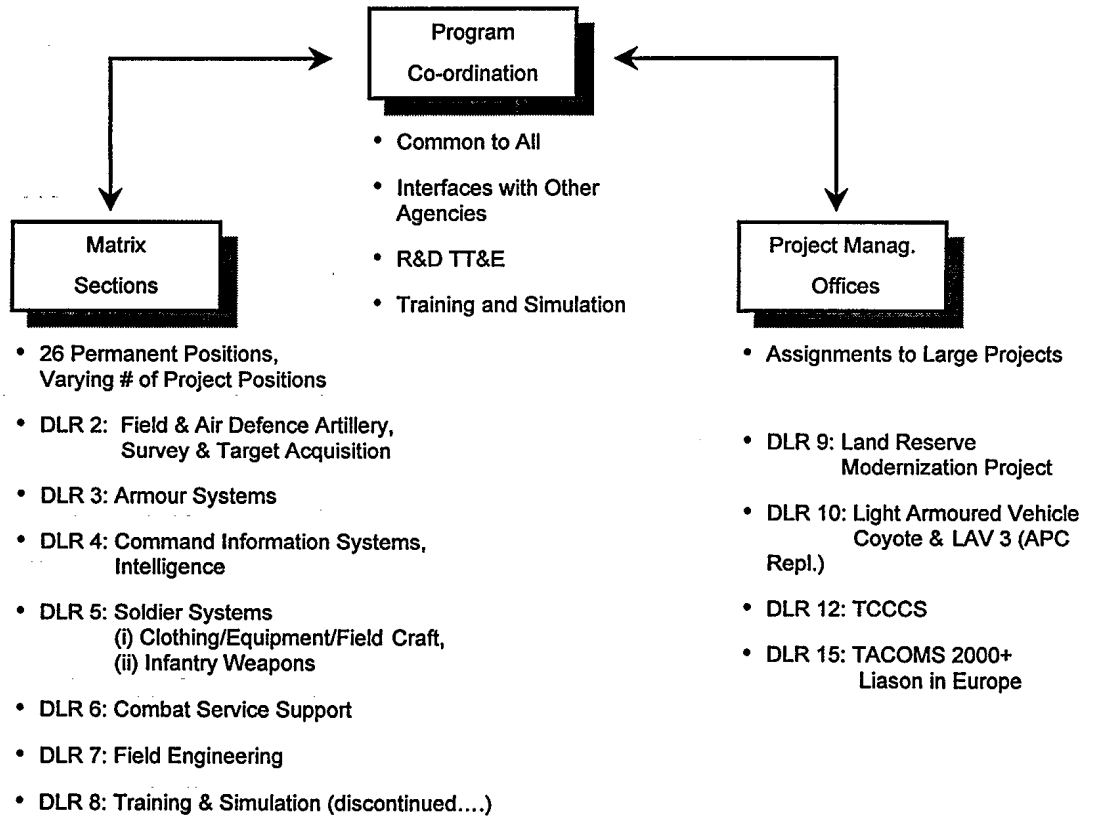
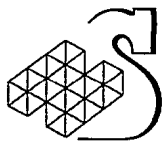


Figure 1: The General Structure of DLR



3.1.2 The Creation of a Project

A "project" within DLR can be initiated in a number of ways, but the initiation generally falls into one of three categories:

1. The army comes to DLR with a requirement.
2. DLR identifies a requirement by monitoring defence and industry literature.
3. The defence research and development branch (DRDB) identifies a potential requirement and seeks sponsorship from a DLR branch.

The Army can initiate a project for a number of different reasons, with common ones including:

- A deficiency based on recent field or training experience,
- A unit commander identifying a product that will enhance operational effectiveness through trade magazines or brochures,
- A directed purchase based on the political process, whereby there are some additional benefits to the good of the country as well as the operation of the military.

As a result of this wide range of project influences the Requirements Officer must be able to develop and manage a set of requirements under a range of very dynamic conditions.

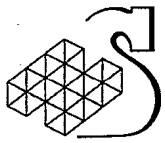
3.1.3 The Requirements Officer and the Project Team

The DLR contribution to a project team will most often consist of a Project Director at the least. If it is a small project the Project Director will also be the Requirements Officer, with larger projects having both a PD and a number of additional staff roles in support, one of which is likely to be the Requirements Officer for the project. For the remainder of this report the terms Project Director or Requirements Officer will be used interchangeably to describe the role of the DLR personnel responsible for the development and management of project requirements.

The Requirements Officer will be posted into their position from their units as per the normal career management and posting process. The typical posting to DLR is 2 to 6 years, with projects lasting from periods of months to decades.

There are no formal job requirements for a DLR staff member, however there are some desired qualifications for personnel being posted to Requirements Officer positions, such as:

- Recent operational experience
- Experience in the Combat Arms (Armour, Artillery, Infantry, Engineers)
- The rank of middle/senior Captain or Major
- Graduation from a Technical Staff Course in Shrivenham or Kingston (most have this)



The basic elements of a project team will include both Project Directing staff (from DLR) and Project Management staff from the engineering community who work under the Assistant Deputy Minister (Material) (ADM(Mat)).

3.1.4 Key Milestones of a Project

There are some key milestones of a project that relate to the development of requirements and specifications (see Figure 2). These milestones relate to Synopsis Sheets (SS) required by the Treasury Board to approve project funding. The three key milestones include:

1. Identification - SS(ID)
   This is the first presentation of a project, with the SS including:
   - The Definition of the Project, with a Rough Estimate of Project Cost
   - A Detailed Estimate of Project Development (Pre-Definition) Costs
   - If Approved, the Requirement Officer moves into the development phase and starts to evaluate different options to meet the project needs and initiate SOR development.
2. Preliminary Project Approval - SS(PPA)
   This SS goes to the Treasury Board for Analysis and Review and includes:
   - Project Proposal and Risk Analysis (PPRA)
   - A Better Estimate of Project Cost for Major Option Selected for the Project
   - A Substantive Cost for Project Definition
   - If Approved, the project has approval in principle and spending approval for the Project Definition Phase which will include the completion of a Statement of Operational Requirement (SOR).
3. Effective Project Approval - SS(EPA)
   At this point the Requirement Officer returns to Treasury Board for Review of:
   - The Statement of Operational Requirement
   - The Substantive Project Cost Estimates
   - If Approved, the project has expenditure authority for Implementation phase which will include receiving bids and procurement/development of the system. This expenditure approval may have gates associated with it whereby further funding will not be released until a milestone has been met (this is increasingly common on software projects).

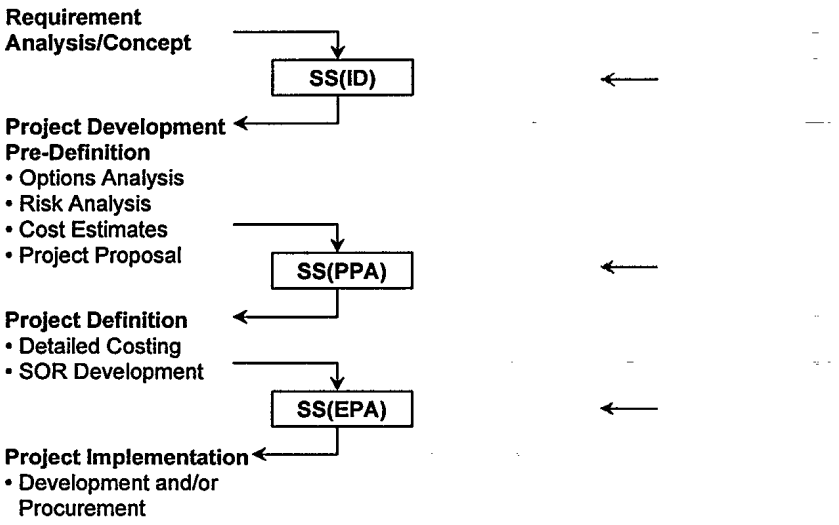


Figure 2: Project Milestones

3.1.5 The Statement of Operational Requirement

The Statement of Operational Requirement (SOR) for a project is the statement of the "users need" to meet a deficiency in the current operational capability of the Land Forces. As such, it contains the functional description of the requirements ("What" the system needs to do) and not a technical description of a system ("How" a system should be built). The final SOR document should not be linked to any particular product, but should outline:

- What the Product or System Needs to Do
- Key Features the Product Must Have to Support Task Performance
- Conditions Under Which the System Must Perform

Within the SOR, the requirements are prioritized as Essential or Desirable to provide some form of priority that can be used to guide procurement decisions.

Once completed, the SOR is used by the Requirements Officer as a tool to negotiate with Project Management staff as the basis of future performance and technical specifications.

3.1.6 The SOR Development Process

The SOR is initiated at any time, from prior to SS(ID) right up to the last minute prior to SS(EPA). The SOR is usually completed Prior to SS(EPA) but at the moment it is not absolutely required prior to moving on to project implementation. In most cases the SOR is initiated during Pre-Definition (Prior to SS(PPA)) and then "Tuned" during the Definition Phase (Prior to SS(EPA)).

The development of the SOR is usually the responsibility of one person within the DLR project team. At a minimum this Requirements Officer will:

- Search for All Available Information Sources
- Search for Previous or Similar SORs

- Develop the SOR to the Best of Ones Ability
- Distribute the SOR for Comment to:
  - the local DLR branch and then within the remainder of DLR,
  - the PM Engineering Staff,
  - the Units across Canada,
  - Scientists at the Defence Research Establishments (DREs),
  - the Combat Arm Schools, and the Technical Staff Course in Kingston,
  - other DND Directorates (Army Doctrine, Future Concepts, etc...).
- Edit and Finalize The SOR Document

This general process is as official as the process ever appears to get, as there is no known documented "SOR Development Process" within DLR.

Figure 3 attempts to illustrate this loose process, suggesting that a number of information inputs may be referenced in the development of an SOR, after which the requirements go through some form of iterative validation process, resulting in a final set of requirements that are used as the basis for a performance specification.

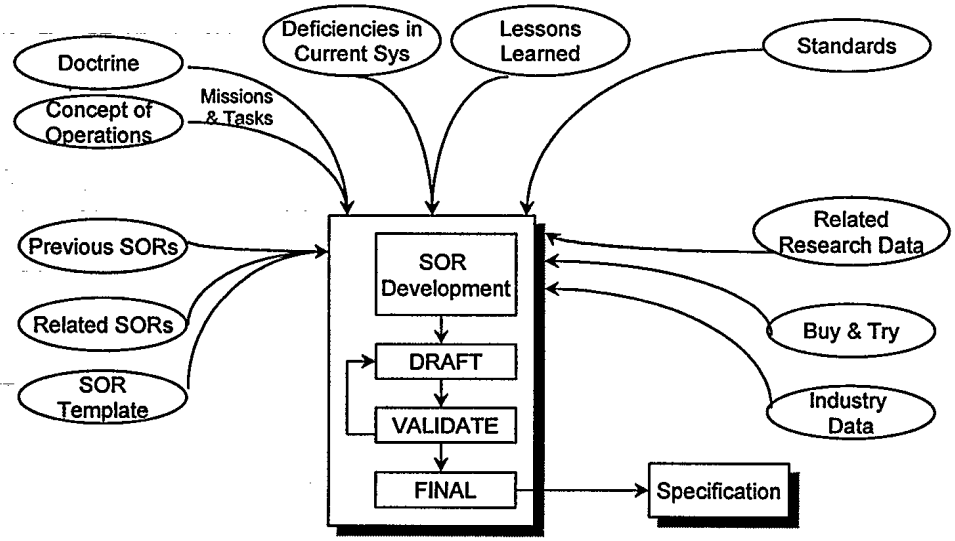


Figure 3: Overview of SOR Development

As illustrated in Figure 3, a wide range of inputs can be sought in the development of a set of requirements including:

- Previous SORs
- Related SORs
- SOR Format Templates
- Missions, Scenarios, and Tasks

- Standards
- Technical Characteristics of Available Equipment from Industry
- Research Data, from Defence and Industrial Sources

Which of these references are actually used is highly variable between projects, and is based on a number of factors including the Requirements Officer knowledge of resource locations, time, and funding.

The iterative requirement validation process is also highly variable across the projects within DLR. This range of validation can best be illustrated through a description of the two extremes of the spectrum (see Figure 4).

- On one extreme is the Document Review technique of requirements validation. In this case the Requirements Officer develops the SOR and distributes it for comment to a range of DND personnel. Usually the first circulation is among the location branch of DLR, and then all of DLR, and then to the Units, Schools, and Research Establishments. The Army Doctrine and Future Concepts groups are also likely to be included in later circulation of the document.
- On the other extreme is the Develop, Test, and Iterate technique of user centered requirements validation. In this case the SOR document will undergo the same review and comment process as above, but the requirements will be validated with the actual future users of the system through trials at the units. These trials will range from Focus Group discussions using illustrations of concepts early in the requirements analysis process, to task based performance trials of mockups, prototypes, or buy-and-try products. These user groups are often conducted by human factors personnel through D.C.I.E.M..

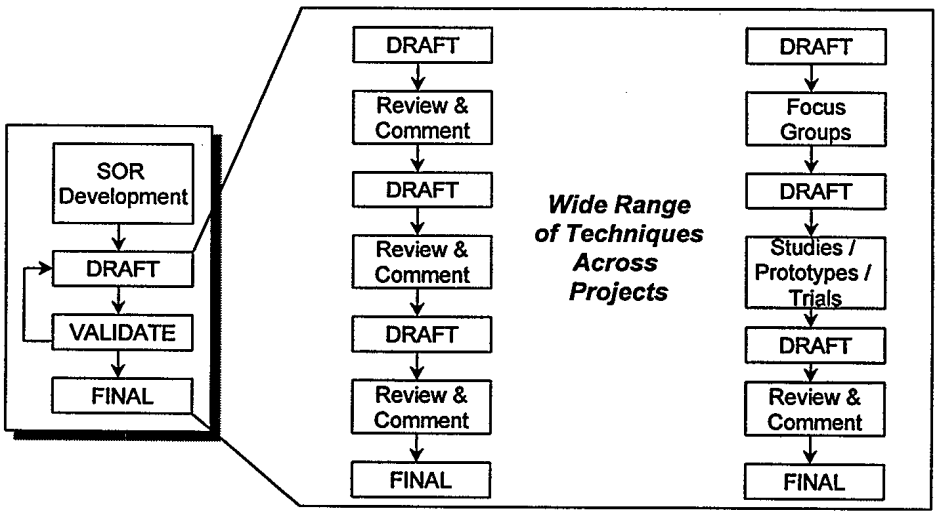
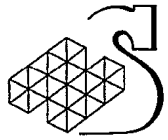


Figure 4: Range of Methods for SOR Review and Validation



3.1.7 SOR Format

Interviews with project personnel and the review of a number of SORs indicate that there is not one consistent format for SORs. Interviews determined that it is generally believed that there is no SOR format template to follow. In addition, it is taught in the Kingston Technical Staff Course that there is no formal SOR format and that future DLR officers will be required to develop their own format to suit their needs.

However, there are two major versions in existence that tend to reproduce themselves as new projects copy the format used in older projects. These two major types of SOR format include:

- The Armoured/Vehicles Version, which is based on a "landscape" oriented document that outlines the requirements for the equipment in key functional areas with an associated rationale or source reference beside each requirement set.
- The 'Template' Version, which is most similar to draft SOR templates that exist throughout the system. This format is based on a "portrait" oriented document that contains some description of the future missions and tasks for the system, but does not include rationale as part of the document itself.

3.1.8 The Performance Specification

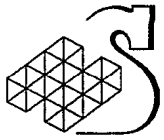
Once an SOR is completed and approved, most projects pass through SS(EPA) and become fully funded development or procurement initiatives. At this time the overall responsibility for a project shifts from the Project Director in DLR to the Project Manager on the engineering side (ADM(Mat)). Once this transition occurs the Requirements officer will remain responsible for the SOR and the representation of user interests but the PM staff are responsible for the direction of the project. The key document produced at the start of this phase of the project is the Performance Specification or "Spec".

To develop a Spec, the engineering staff use the SOR as the functional basis for a new product or system and endeavor to decompose a requirement into the technical and performance specifications that must be met to achieve the requirement. For example a requirement developed by DLR which stated a glove must be "waterproof and breathable" might turn into ten pages of specifications related to what the Land Forces require in a "waterproof and breathable" glove.

During the development of the Spec the engineering staff will follow a similar process to the one followed by the Requirements Officer in the development of the SOR. The engineers will consult a range of references and standards, in addition to literature from a number of research data sources. Prototype products may be obtained and tested as well, to determine if specifications are achievable and to validate specification testing techniques.

In the development of the Spec the engineers will attempt to determine if each of the requirements can be achieved based on industry capability, the state of current technology, and financial resources. When it is concluded that a requirement is not achievable the Requirements Officer will be consulted to determine if a lesser requirement can be stated.

On some projects the SOR and Spec develop in parallel with constant communication between the PD and PM staff. On these projects prototype products that are obtained or developed are often used by the PD staff in DLR to conduct user trials with soldiers at the Units, and then used by the



PM staff in ADM(Mat) to conduct engineering trials to evaluate the feasibility of technical specifications.

On other projects the SOR is developed entirely by DLR staff and then is "passed off" to the PM side of the procurement process for interpretation and Spec development.

Regardless of the process, once the Spec is completed it is attached to a Statement of Work and contractual requirements to form a Request for Proposal (RFP) which is sent out for industry to bid on.

3.1.9 Bid Evaluation and Contract Award

When bids are received from industry the project team assembles a bid evaluation team. Most often this will include the DLR Requirements Officer.

The method used for bid evaluation is dictated by the DND procurement strategies current at the time of evaluation. These strategies are established by ADM(Mat) and Treasury Board personnel and can change with changes in personnel at senior levels in these organizations.

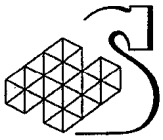
Two major techniques have historically been used in the bid evaluation process, Best Value and Lowest Compliant Bid. Best Value evaluation attempts to score a bid against a set of prioritized requirements to establish a technical score, after which the dollar amount of the bid is divided by this score to determine the best technical proposal per dollar spent. This technique is used less and less and has not been used in recent years.

Lowest Compliant Bid evaluation techniques attempt to determine which bid presents the "Lowest Cost to Meet the Minimum Requirement, With The Best Industrial Benefits". In this case the requirements prioritized as "Essential" are used to determine all the bids that meet these essential or minimum requirements. Then, the lowest cost bid from this group is selected. This technique has been used most in recent years.

Once the winning bid has been determined a contract is signed and the Implementation phase of a project begins. This process, and the subsequent implementation, will be conducted under the guidance of the Project Charter, which would have been established in the Development Phase, and a Project Implementation Plan developed by DND. These documents establish a number of roles in the implementation phase and designate individuals responsible for them. Example roles include management, requirements issues, testing, quality control, training, doctrine development, etc..

3.1.10 Tracking Requirements During Implementation

Throughout the Implementation phase, requirements and specifications are monitored and updated by the DLR and Engineering staff respectively. The focus of this activity is generally on the specifications upon which the contract is based. As design details are completed or prototype products are created and tested the impact on requirements is tracked by these DND personnel. If changes are required to the details of a specification the DLR Requirements Officer will get involved in the review of the issues and participate in design trade off analysis to approve any resulting changes to the requirements.



This tracking process requires that some form of "link" be maintained between the specifications and the requirements from which they were derived. In some projects this link is not documented but is re-evaluated as necessary (eg: specification "x" cannot be met, therefore analyze what requirement this will impact). On other projects this link is tracked explicitly at all times. An example in this category is the Land Force Command System (LFCS) which has developed a requirement and specification database that allows all of the links between and within the requirements and specification sets to be monitored.

During final design and prototype testing it is often necessary for DLR to approve the design and/or to select between design options in terms of which will best meet the "users need". In these cases the Requirements Officer may simply ask some questions and decide, or he/she may go to the units in the field and conduct user trials to actually determine the impact of different design alternatives on future task performance.

Once a product is finalized it will go into production. During production the quality assurance staff from DND will select items from each production run and conduct tests against the performance specification. The results of these tests are communicated throughout the project team. Typically the DLR staff simply review these for information and only get involved if tests are failing at which time several personnel may get involved to resolve the issues.

3.1.11 Integration of Human Factors in the SOR and Spec

One of the focuses of this project was to determine mechanisms to better integrate human factors into the requirements documented in the SOR. Therefore, interviews with project staff and SOR reviews explored the current state of human factors integration.

To evaluate the integration of human factors it was first necessary to define the potential requirement categories that could be derived from human factors analysis. This can be done using a number of human factors frameworks, two of which are illustrated in Figure 5.

On the left of Figure 5 is the basis for the United States MANPRINT process, with the human factors focus being on whether the user population equipped with the developed tools can perform the necessary tasks in the full range of operational environments. The role of human factors in this case is to analyze each of the these areas to determine the requirements of a future system to ensure a systematic integration of all factors.

On the right of Figure 5 is the Person Process Environment Model which expresses the same concept in more detailed terms. The PPE Model suggests that the users of a future system or product will be participating as part of a process to complete operational tasks, with the two key interfaces being the information interface and the control interface. The role of human factors is to determine the requirements of a future system within this context in terms of task performance, interface design, user characteristics, physical environment factors, training factors, and organizational factors.

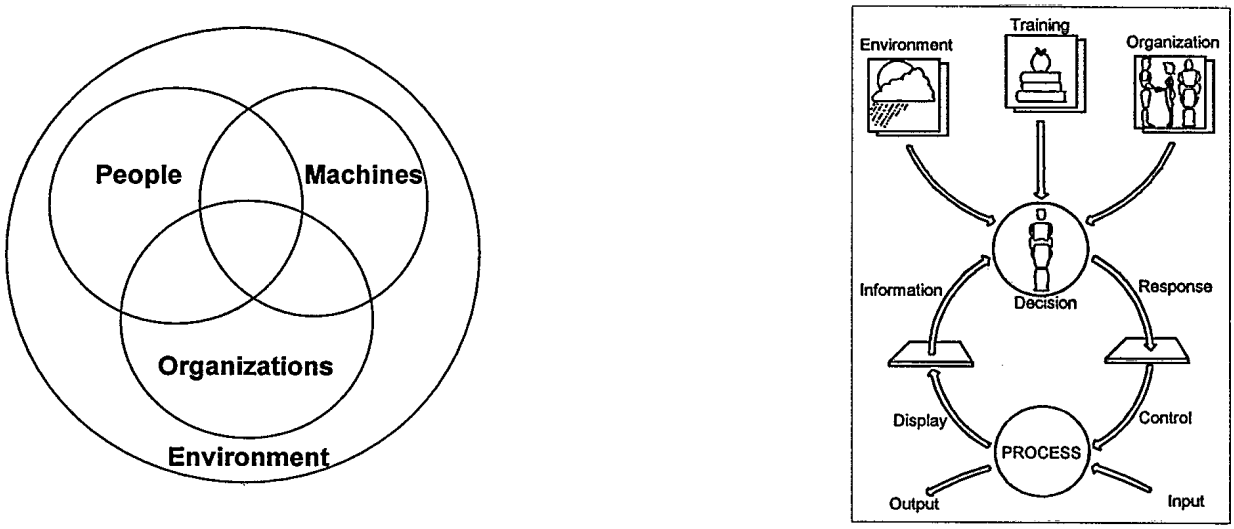


Figure 5: Frameworks for Human Factors Issues

To effectively consider and integrate these human factors issues in the development or procurement cycle of new products and systems a number of analysis tasks are typically conducted. Example tasks in this area include scenario development, function and task analysis, interface design prototyping and reviews, user trials, and performance evaluations. Figure 6 illustrates the integration of human factors activities into the development cycle of a recent clothing and equipment system.

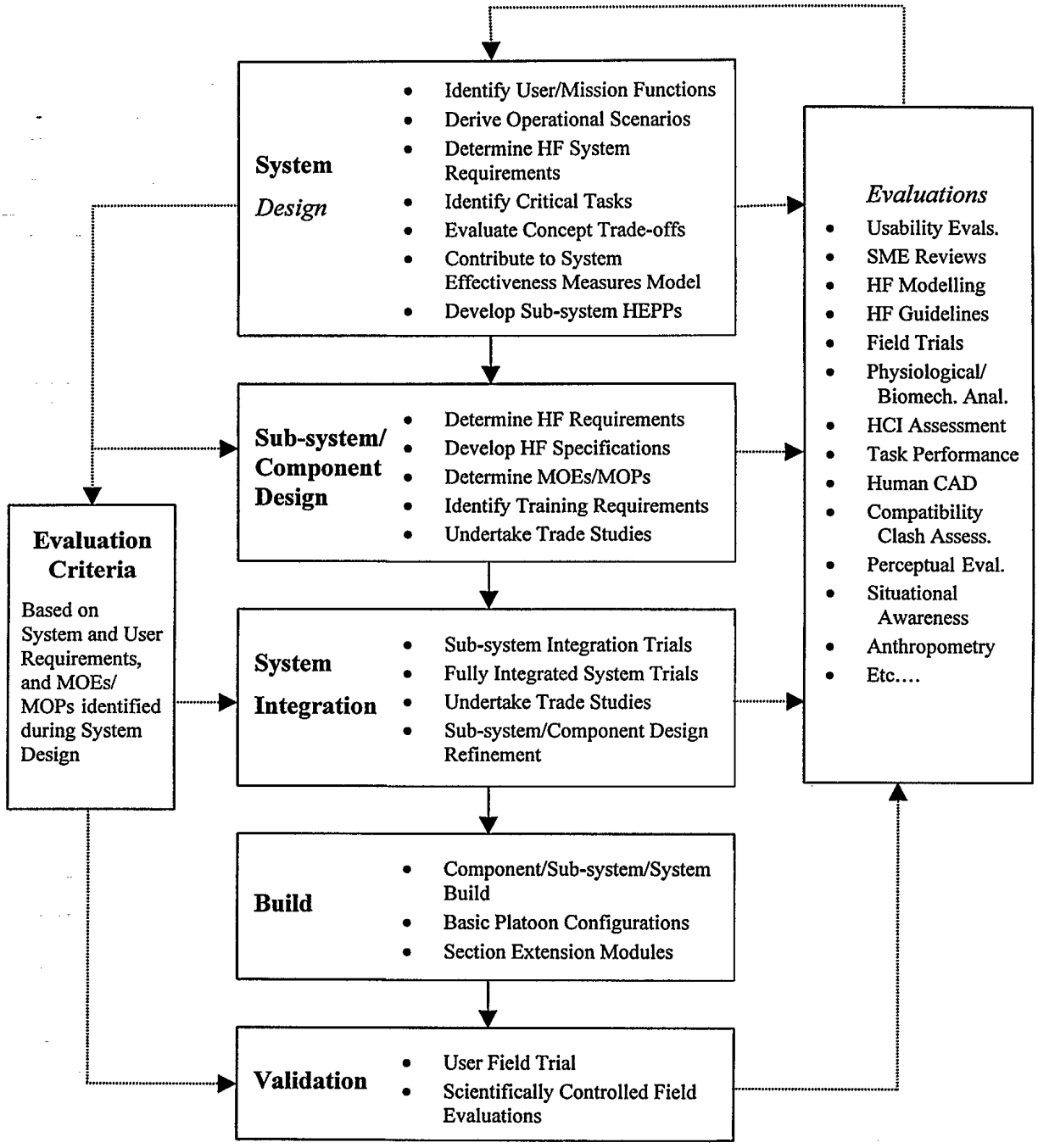
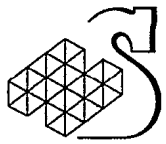
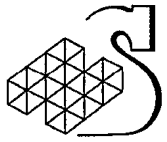


Figure 6: Example Integration of Human Factors in the Development Cycle
(DND Clothing and Equipment Project)



Regardless of the model used, there are a number of issues that will be addressed through the consideration of human factors during the requirements development process. Example issues include:

1. Operability,
   Which generates requirements in areas such as:
   - Organization, Personnel and Training Characteristics
     - Organizational Structure in Relation to Mission/Scenarios
     - Staffing, Required Experience, Training, Skills, and Ability
   - Soldier or Crew Task Performance
     - Task Performance - Speed/Accuracy, Fit, Usability
     - Workload and Situational Awareness
   - Soldier-Machine Interface and/or Crew Station Layout
     - Major Display and Control Requirements for Each Major Station
     - Major Crew Station Layout Requirements
     - Access/Egress, Arrangement Issues, Key Interfaces by Crew Member
   - User Acceptance
     - Perceived Ease of Use, Perceived Utility
     - User Evaluation Requirements
2. Maintainability
   Which generates requirements in areas such as:
   - Task Performance (Speed/Accuracy), Training Requirements, Personnel Requirements
   - Staffing Requirements, Skills and Training Requirements, Work Flow
   - Technology, Decision Aids
3. Reliability/Safety/Health
   Which generates requirements in areas such as:
   - Environmental Protection (Temperature, Lighting, Noise, Chemical)
   - Physical and Mental Demands with Variations in Op Tempo
   - Sustained Operations, Fatigue
   - Human Error Requirements or Limitations
4. Availability & Survivability
   Which generates requirements in areas such as:
   - Protective Clothing and Equipment
   - Sustained Operations, Fatigue
   - Human Availability and Survivability (Care, Food)



To systematically address these issues within the life cycle of a product or system a number of human factors analyses are typically conducted. These include activities such as the analysis of operational scenarios to determine the functions and tasks that a user will perform. Overall, these lead to a user centred approach to product development whereby user requirements and interface design specifications are derived from analysis of tasks within the range of operational environments. These requirements and specifications are then validated using concepts, prototypes, and final products evaluated through user trials.

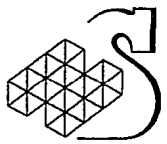
The integration of human factors in product development is increasing in the Land Forces. Data from interviews indicated that Requirements Officers are increasingly involved in user centred design processes, mainly in the area of user trials of concepts, paper drawings, prototype products, or near final products.

That said, there is by no means a systematic integration of human factors issues across DLR in the requirements development process. Analysis of the requirements development process, and interviews with D.C.I.E.M. personnel, indicate that there is room for improvement in a number of areas, including:

- A Systematic Application of Human Factors in the Requirements Development Process
- A Systematic Link Between Missions-Tasks-Requirements
- The Use of Task Analysis to Extract User Requirements
- A More Complete Consideration of the Full Range of Environmental Factors
- Consideration of the Range of Future User Characteristics
- Validation of Requirements Through Focus Groups and Trials with Future Users
- User Testing of Prototypes and Finals

The analysis of current development projects indicated that there are some good examples of human factors integration. These projects demonstrated some elements of a user centred analysis process, resulting in iterative development of requirements following user review of concepts, prototypes, or buy-and-try products. Example products in this category included:

- Soldiers Helmet and Helmet Subsystems (D. Palmer, I. Craigie), which has produced a good task oriented specification resulting from iterative development with the user community.
- Clothe the Soldier (N. Matern, C. Davis), which continues to involve the user community to evaluate prototype products to refine requirements and specifications in parallel.
- Land Force Command System (A. Gautier), which benefits from user validated requirements developed over several years through the Requirements Officer's previous experience with iterative development at units, and user groups continued during the final stages of SOR development.



3.1.12 The Technical Staff Course in Kingston

The Technical Staff Course in Kingston provides officers with education in the technology of military systems. This program is one of the desirable qualifications of a DLR Requirements Officer. Interviews with Kingston instructors during this project focused on two areas; the development of SORs, and the integration of human factors in the development of new systems.

There is no formal SOR Writing Module in the program at Kingston, as it is considered too resource intensive to develop the teaching and project materials for full SOR development. However, students get a range of exposure to the development of SOR content through the other modules in the course. This is accomplished through the development of:

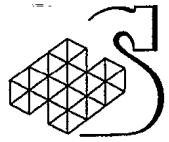
- A Deficiency Memo in one module, whereby the student must justify the creation of a new project based on a deficiency in operational capability.
- A series of Annexes to SORs on other modules, whereby the student must generate the requirements for one aspect of a system as an Annex. For example, in the NBC module of the course the students learn about NBC technology and then develop an NBC Annex for a system.

Throughout this instruction students are provided with some guidance about the development of SORs. This guidance is high level to help the student develop an overall approach to SOR development. Example guiding principles include:

- The SOR Should Focus on the Identification of the True Requirement
- The SOR Should Identify All the Requirements to Meet a Deficiency, Even If They Can't Be Fulfilled at this Time
- The SOR is a Description of a Need, Not Necessarily What You Get
- The SOR is an Iterative Document in order to Keep Up With Technology
- The Definition of an Essential and Desirable Requirement is Key
- There is No Template for SOR Format, Each Officer will have to Develop Their Own.

One of the modules in the Kingston program is a Human Factors module. This module introduces the students to the science of Human Factors with the goal of identifying that Human Factors exists, and to provide the students with a familiarity with key issues (eg: Man-Machine Interfaces, Data Displays, Ergonomics). The module contains lecture material on Human Factors, an orientation visit to the Defence and Civil Institute of Environmental Medicine (D.C.I.E.M.), and an exercise to develop a Human Factors Annex to an SOR. The exercise component provides the students with an SOR for an old Armoured Personnel Carrier (APC) and requires them to review it to identify any Human Factors requirements that it contains or that it is missing, and then compile these APC Human Factors Requirements into a Human Factors Annex.

As a result of this module, the new generation of Requirements Officer in DLR is more familiar with Human Factors issues and they are seeking to learn more about methods to integrate user needs into the development of SORs and Specs.



3.2 Deficiencies and Requirements

This section of the report outlines the improvements that can be made to the SOR development process, the enhancements that can be made to the SOR-Template, and the requirements for SOR-Spec Maker software.

To organize this discussion, and the corresponding requirements for future change, deficiencies in the existing system have been identified. For the purposes of this project a "Deficiency" has been defined as:

> *"A condition that makes it more difficult for the Requirements Officer to generate an SOR, or a situation that decreases the quality of the SOR in terms of its ability to meet the "true" users requirement in the field."*

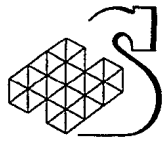
This definition suggests that the issues discussed throughout this section as "Deficiencies" are included because they impede the development of requirements and SORs. It is important to note that these conditions may exist for perfectly valid or understandable reasons from other perspectives, however, they are deficiencies when examining the system from the SOR perspective.

The deficiencies identified throughout the project have been organized into groups to facilitate discussion and the linkage with future requirements. The deficiency groups in this section include:

- DLR and Army Culture
- Lack of Scenarios, Doctrine, and Operational Concepts
- Access to Information and Resources
- SOR Development Process
- SOR Format
- Integration of Human Factors in the SOR
- The Link with ADM(Mat)
- Requirements Traceability

Following the description of each group of deficiencies, the requirements for future change are outlined. These requirements are grouped into three categories:

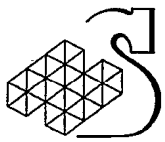
- Process Requirements, which outline the requirements for change in the process followed to develop SORs and Specs.
- SOR Template Requirements, which outline the requirements for the SOR format Template in order to address deficiencies in the current system.
- SOR-Spec Maker Requirements, which include the requirements for future Requirements Management software and thereby define the role for such software in the SOR and Spec development process.



3.2.1 DLR and Army Procurement Culture

There are a number of characteristics of the military environment and the culture within DLR that make it challenging for the Requirements Officer to effectively support the development of SORs and Specs. Example issues in this category include:

1. A Wide Range of Project Influences and Rationale.
   There are a number of reasons that a project exists within DLR and a number of personnel or government branches that feel they have a 'stake' in a project. As a result, the Requirements Officer is often pulled in many directions, and no two projects are ever likely to be the same. This makes it difficult to pass on lessons learned to other officers.
2. The Impact of the Posting Cycle
   DLR staff are typically in their positions for 2 to 6 years, however a project can last decades depending on its success in the ever changing list of priorities for funding. Therefore, the Requirements Officer or Project Director staff is likely to change at some point in the project life cycle. This change can lead to gaps in project knowledge and in the ability to understand, justify, or track requirements.
3. The Need to Innovate, Not Implement.
   The culture, and human nature, produces a need for the Requirements Officer to innovate. When officers are in charge of a project they have a need to make it "theirs" and to be recognized for their efforts. This need interferes with any opportunity that might exist to recognize that the previous person in the job might have mapped out a solid plan and a solid requirements set that should simply just be implemented. When this condition is combined with the posting cycle the direction of a project is highly likely to change at some point leading to confusion and traceability problems.
4. Personality Driven Procurement Priorities.
   The military procurement system is not driven by a documented set of deficiencies or objectives (see Section 3.2.2), which, when combined with points #1, 2, and 3 above leads to personality driven procurement priorities. This means that every few years the priority of projects for funding will change depending on who is posted into what positions. As a result, it can be difficult for DLR staff to guide their project through the system which can deter their ability to develop requirements as they spend more and more time on the administration of a project.
5. The Need to Represent the Entire Army.
   A Requirements Officer is most often from the Combat Arms and is likely to have recent operational experience. However, the environment or culture appears to require this person to know everything about the entire army, let alone everything about his/her own arm of it. This has a tremendous negative impact on the quality of requirements, as someone who has never completed a task, or who hasn't completed it for over 5 years, is required to "decide" how a system should operate in support of the task.



3.2.1.1 Process Requirements

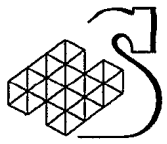
There are a number of process related changes that can address these deficiencies, including:

1. Develop a Process Bigger Than Any One Individual.
   A documented SOR development process should be created that introduces some key milestones in the development of an SOR. This process should be flexible enough to accommodate the wide range of project types, but formal enough that project staff can understand where each other are in their project sequence. This process should include systematic analysis of requirements, validation with the user community, and documentation of requirement rationale, all of which make it difficult for any one person to change the track of a project without evidence.
2. Define the DLR Requirements Officer as a Coordinator.
   The role of the DLR Requirements Officer should be officially defined as that of a coordinator. This role requires the officer to organize the integration of a wide range of user and technical specialist input into a requirements document, and does not require the officer to be the sole knowledge source behind a system.
3. Create a Project "Team" From Day 1.
   In the current system a Project Implementation Team is created once a project goes out for bid. This team identifies a number of support personnel for a project including requirements, training, doctrine, fielding, engineering, etc.. These same roles should be defined at SS(ID) such that the requirements coordinator (the DLR officer) has identified personnel who will expect him/her to call for input during the requirements development process. These team members (in a matrix approach) will include representatives from Doctrine/Operational Concepts, User Tasks (Ops & Maintenance), Deficiencies/Lessons Learned, Requirements, Project Management/Engineering, Research Resources (Personnel/Data/Studies), Quality Assurance, Public Works and Government Services Canada (PWGSC), Training, Staffing, and Deployment. Many of these personnel will only be called upon to review an SOR or provide some quick input, but input from all of these groups will increase the quality of the requirements set and prevent re-work at the last minute.

3.2.1.2 SOR Template Requirements

Changes to future SOR Templates that could address the deficiencies identified in this group include:

1. Identify the Project Team Members on the SOR.
   Each of the personnel identified to support a project should be listed on one of the cover sheets of the SOR. This formally recognizes the DLR Officer as the coordinator with multiple technical inputs, and clearly identifies those expected to provide technical input.



3.2.1.3 SOR-Spec Maker Requirements

To address the deficiencies identified in this group, the SOR-Spec Maker software should:

1. Provide a template to identify all key project support personnel, with contact information for each, including a direct e-mail link.

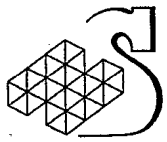
3.2.2 Lack of Scenarios, Doctrine, and Operational Concepts

Products such as scenarios, doctrine and future operational concepts provide the data necessary to give structure to the procurement process. In theory the Canadian Land Forces exist to perform a set of known tasks within the context of operational scenarios that Canada is likely to participate in. Within these scenarios are the likely operational environments and threats that our forces are expected to encounter. Looking ahead to participation in these scenarios there is a set of doctrine that defines how the forces will be organized, how they will deploy, and how they will act against these different threats. Combined, this data can define the operational concept for future systems to participate in these scenarios and provide the basis for the analysis of the requirements for these future systems. Unfortunately, very little of this information exists.

The DLR Requirements Officer is typically from the Combat Arms and usually has recent operational experience. As a result these personnel are very knowledgeable in military operations and task performance, and if given a military scenario they can analyze it to extract the key factors related to mission success. If scenarios, future doctrine, and operational concepts did exist the DLR staff would have a framework to guide their analysis of future requirements. In addition, there would be a force wide knowledge of requirements that would allow prioritization across projects in terms of their relative importance to provide operational capability across the defined set of Canadian operational scenarios and the current list of Army deficiencies.

As there are no defined scenarios, future doctrine, or operational concepts, the DLR staff are often required to generate this data on their own. In this situation a Captain has been tasked with the development of the SOR for a future system, but must also invent how the Land Forces might use this system at the same time. This makes it very difficult to develop requirements and can also be quite time consuming. The result is that there are a number of SORs in the system that define hundreds of requirements for a system but provide no documentation of how Canada will use the system (Missions, Scenarios, Tasks, Organization, Deployment) in the future. This leads to the procurement of multi-million dollar systems being delivered to the units who then start the process of determining how it will fit into operations.

Related to this lack of future operational context is a lack of systematic analysis to derive requirements for future systems. There is very little evidence of analysis of missions, scenarios, and tasks to extract requirements and/or to develop the key performance requirements to be used during system testing. This is partly due to the lack of scenario data, and partly due to a lack of understanding of how to conduct task analysis to extract user requirements for future systems. Some projects who recognize the need for this analysis have started to contract support through D.C.I.E.M. and human factors firms to develop scenarios and interact with future users to conduct task analysis and develop requirements.



3.2.2.1 Process Requirements

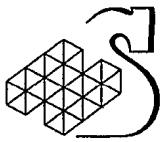
There are a number of required enhancements to the SOR development process in order to address the need for structured data sets to guide requirements analysis, including:

1. Develop Army Wide Scenarios/Missions
   The Canadian Forces should provide a series of standardized missions and scenarios that they expect the Land Forces to support. Over time the different arms should analyze how they would deploy to support these scenarios in the future, with support from the Directorate of Army Doctrine and Future Concept Groups. This information should be documented and integrated into the instruction program at the Kingston Tech Staff School.
2. Identify and Prioritize Army Wide Requirements
   Based on the Force wide scenarios, a set of deficiencies should be maintained that provides a prioritized list of deficiencies that DLR needs to address. This list should then be used as one input to guide the allocation of resources. This would not only provide structure and some predictability to the requirements analysis process, but would also address some of the concerns discussed in Section 3.2.1 related to personality driven procurement priorities.
3. DND Provide DLR with Doctrine and Future CONOPS Support
   DLR staff should be provided with links to personnel in the Directorate of Arm Doctrine and the Future Concepts group at the start of the project SS(ID) or prior to when the SOR will be developed. These personnel should provide guidance on where the project fits in to future operations and how it is likely to be deployed within the standard force scenarios.
4. Task Analyze to Develop Requirements
   Once future scenarios and operational concepts are defined for a project they should be task analyzed to determine the user requirements for the future system. This analysis should focus on the "What?" aspects of future task performance (i.e. what the system needs to do to support future task performance), and not on the "How?". This analysis should also produce some user requirements in the form of the performance measures and scenario vignettes necessary to develop user centred product acceptance trials.

3.2.2.2 SOR Template Requirements

To address the deficiencies in this group the template for SOR format should:

1. Include standard sections on Missions/Scenarios, Operational Concepts, and Key Tasks where the Requirements Officer can summarize the future operational context for the system.
2. Ensure that all SOR section titles in the template are mandatory, with "Not Applicable" or "Not Available" being acceptable input with an associated rationale. This will help ensure that these issues are addressed, if not in the initial development of an SOR, then through the review process.



3.2.2.3 SOR-Spec Maker Requirements

Assuming the above requirements are implemented, the SOR-Spec Maker software should:

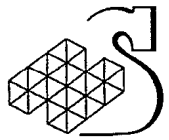
1. Contain the standard SOR Template.
2. Ensure that all section titles are mandatory, requiring the writer to fill in some content or state "Not Applicable" or "Not Available" with rationale.
3. Contain a Missions/Scenario section that provides a link to a summary of the Land Force scenarios that the system must support. The software should allow this scenario text to be placed in the Mission/Scenario section of the SOR or in an Annex depending on how much additional data the Requirements Officer has to incorporate with it.

3.2.3 Access to Information and Resources

The SOR development process involves the Requirements Officer searching for a range of information to integrate into the SOR. These information sources (see Section 3.1.6 and Figure 3) are contained in a number of locations, most of which are not known to the DLR staff. Interview data from this project indicated that DLR personnel can take 3 months or more searching for information related to their requirements set, and that many are never made aware of resources that might be available (such as personnel or literature at Defence Research Establishments). This search for information is less of a problem for graduates of the Kingston Tech Staff School as these students are provided with a solid introduction to the Canadian Procurement System, but it is still a challenge as the type and location of resources constantly change.

One key area of requirements development is understanding the relationship between the system being specified and other future products or systems under development. If this relationship is not understood multiple systems can be developed to support similar tasks and systems can be specified that will not work together within the same future scenario. Interviews with project personnel indicated that lack of a system wide view of the projects within DLR is a very frustrating aspect of the posting to DLR. Many staff reported that they were not aware that their project overlapped with others.

In addition to information on other projects, access to research data was another key deficiency in the requirements analysis process. One component of this was lack of awareness of how the DREs were organized, what expertise they had to offer, and what previous research had already been conducted. Another DRE related deficiency was the bias of different cells in the research establishments and the impact of this has on the use of DRE support. This second concern was expressed by DLR staff as "beware of the DREs", as some groups have a research bias and will attempt to integrate a "real" problem into a research program that will never provide the Requirements Officer with answers. On the other hand some DRE groups are focused on the development of products and patents and will integrate another "real" research problem into the functionality for some product that does not answer requirements questions for DLR. In addition, there were reports of DRE cells that were simply not interested or not able to provide technical support to DLR project teams. In general, there is also a lack of comprehension of the Requirements Development Process by many "scientists", and therefore a lack of understanding



of the information "products" required by DLR teams within compressed timelines. All of these factors make it difficult to integrate research data into the development of an SOR.

3.2.3.1 Process Requirements

In order to provide better access to information and resources, the SOR development process should:

1. Identify Links to Information for Each Project.
   Provide the Requirements Officer Links to a range of information sources, including Army Operations (Scenarios), Operational Concepts, Doctrine and Future Concepts, and Research personnel.
2. Define DRE Role to Support DLR Projects
   There is a need to define the role for DRE staff to support DLR projects and to communicate this in any future descriptions of the SOR Development Process. It would appear that key points in this definition should be that DREs must support DLR projects, but that they may not be able to do all the work themselves at which point they may be required to act as technical experts to help select or supervise contract personnel.
3. Train Scientists on the Development Process.
   The Scientific Authorities in the DREs should be provided with training on the System Development cycle and the SOR-Spec Development Process. This training should emphasize the information "products" that DLR staff require and the typical timelines that they are being asked to work within.

3.2.3.2 SOR Template Requirements

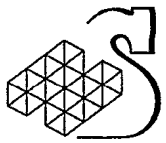
To support the integration of related requirements across projects, the SOR Template should:

1. Contain a Required Section that Identifies Related Projects

3.2.3.3 SOR-Spec Maker Requirements

To address the need for access for a wide range of information sources, SOR-Maker software should:

1. Provide software links to as many information sources as possible from one common Information Link tool. The data required by DLR officers is increasingly being produced in electronic form, which increases the future utility of a software based link to information. These links may be based on data available on CD-ROMs or over Intranet sites. A role should be defined within DLR Coordination to monitor electronic information sources and continually update these links for the project teams. Example links for this tool include:
   - Doctrine (Electronic Battle Box CD, Others...)
   - Task Data from Soldiers Day, or Other DND Documents
   - Literature (Research, Studies)
   - Past SORs, Related SORs



- Design Standards, Test Methods, Test Criteria
- Lessons Learned CD-ROMs or Databases
- Deficiencies in Existing Systems (eg: The Army Combat Clothing and Equipment Survey System (ACCESS), or UCRs)
- The Defence Research Establishments

2. Develop an SOR-Spec Library.
   Each time an SOR or Spec is 'frozen' as a version for distribution and comment the SOR-Spec Maker software should provide a facility to deposit the version into a library. The version deposited in the library should overwrite the last version that was placed there. The most recent version of an SOR or Spec should remain in the library for 10 years unless it is overwritten by a more recent one. The library should contain a search engine and the ability to copy requirements from a located document into the current SOR or Spec under development.

3.2.4 SOR Development Process

There are a number of deficiencies in the current SOR Development Process that were identified throughout the present study, including the lack of a process, and lack of iteration in the process.

The primary deficiency with the SOR Development Process is that there is no process to follow. As a result, each Requirements Officer must develop their own method and justify each step of their analysis to others. This can take up a considerable amount of DLR staff time if they decide, for example, that they should validate their requirements with the user community as opposed to simply conducting a document review.

The lack of a common process also makes it difficult to understand where different projects are in the process. This decreases the ability to share information across projects, and makes it difficult to manage or coordinate the activities of multiple projects engaged in different processes.

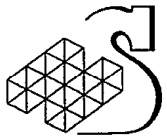
The additional deficiency identified in this group was that there is little iteration in the SOR development process for many projects. This results in an assumption that the first pass through requirements development will be basically correct, and provides very little opportunity to validate requirements with future users.

This second deficiency was recently commented on by DG Audit in their assessment of the Frag Vest project where it was noted that the $4.5 Million spent on re-design could have been avoided if the user trials conducted by human factors personnel were completed earlier in the project cycle, as opposed to at the very end of implementation (Auditor General Report 1995).

3.2.4.1 Process Requirements

To address these process related deficiencies there are a number requirements for future SOR processes, including:

1. An SOR Development Process should be established, documented, and taught. This process should include key milestones that all Requirements Officers should pass through in the development of SOR, including Mission/Scenario Definition, Function/Task Analysis, Identification of Related Projects, Internal SOR Review,



Requirements Validation with Units, Evaluation of Requirements through Trials of Prototypes or Mockups, etc..

2. Any formal SOR Development Process should include the requirement for review with the future user community and subsequent requirement iteration.

3.2.4.2 SOR Template Requirements

No SOR Template requirements were identified to specifically enhance the SOR Development process.

3.2.4.3 SOR-Spec Maker Requirements

To support a structured SOR Development Process, with key milestones common across projects, SOR-Spec Maker should:

1. Provide an SOR Development Process "Wizard" that provides the outline of the key steps requirement and the ability for the Requirements Officer to indicate where they are in the process.
2. Provide Dynamic To-Do Lists for the Major Milestones and Analysis Required.
3. Provide Context Specific Help with Pointers to DND Support Agencies for each of the major milestones that should be covered in the development of the SOR.

3.2.5 SOR Format

Similar to the SOR Development Process, the major deficiency with the SOR Format is that there is no standardized format to follow. Interviews throughout the project identified draft versions of "official" SOR formats, as part of draft versions of CFP 125, however few DLR personnel were aware of the existence of these templates.

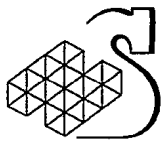
The lack of an SOR Format requires each project to develop their own format which takes resources and adds uncertainty to SOR development. In addition, it encourages projects to only develop SOR sections for which they have content. Therefore, many SORs end up dropping sections such as Missions, Operational Concepts, and Key Tasks.

The other deficiency identified with the format of SORs is that the various forms in use do not support the evolutionary development of requirements. This is increasingly common in information system projects that must "grow" requirements over time. The existing formats and the management of the SOR documents do not support the enhancement of requirements as they evolve, expand, or collapse.

3.2.5.1 Process Requirements

To address the deficiencies in SOR Format the following modifications to the development process are required:

1. Develop a common SOR format and have all projects follow it. This does not appear to be an unreasonable requirement as all SORs reviewed during this analysis could be reworked into a common format.



2. Make all SOR sections mandatory, with Not Applicable or Not Available as acceptable inputs to SOR sections provided there is a reasonable rationale provided.
3. Encourage the Requirements Officer to develop the full requirement for a system, at least on the first few passes, to ensure that the full range of requirement are documented at least once for future reference.

3.2.5.2 SOR Template Requirements

There is one key requirement to address the deficiencies in SOR Format:

1. Develop a common SOR format and have all projects follow it.

3.2.5.3 SOR-Spec Maker Requirements

To support a standardized SOR Format, SOR-Spec Maker software should:

1. Provide an SOR Template Based on the New Common SOR Format.
2. Provide On-Line "Help" on SOR Section Contents.
3. Provide On-Line "Pointers" to Resources within DND that could assist in the Completion of SOR Sections.

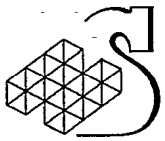
3.2.6 Integration of Human Factors in the SOR

The interviews conducted during this project indicated that Requirements Officers are increasingly aware of human factors issues, and increasingly see the benefits of human factors analysis based on project success. However, a number of challenges remain in regards to enhancing their understanding of the integration of human factors analysis and the difficulty associated with locating SOR sections to contain requirements related to human task performance.

3.2.6.1 Process Requirements

Several process requirements can be derived from the analysis related to human factors, including:

1. The requirements development process needs to incorporate standard analysis milestones related to systematic analysis of user requirements. This should include:
   - The definition of missions and scenarios.
   - The develop of a Concept of Operations in terms of how personnel will use the future system within the context of the identified missions and scenarios.
   - Function and task analysis of these scenarios to extract requirements.
   - The completion of a User Group(s) at operational units early in the requirements development process to validate the scenarios, the Concept of Operations, and the preliminary requirements.
   - The completion of a User Trial(s) later in the requirements development process using prototype products, storyboards of design concepts, or buy and try products.



- The integration of Human Factors standards into the requirements development process.
- The completion of User Trial(s) during Project Implementation to validate detailed design concepts and to provide the necessary data for Trade Off studies when choices must be made between design alternatives.

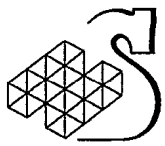
2. It would be beneficial if there was a qualified human factors staff member in Ottawa to support Land Force procurement. This officer would need to be a fully qualified human factors professional (according to industrial certification qualifications), and would be available to provide human factors support, link human factors requirements across projects, and liase with D.C.I.E.M. on research issues.

3.2.6.2 SOR Template Requirements

The key to ensuring that human factors issues are integrated in the SOR, is to address all the aspects of the system that will impact human performance and ensure the requirements in each area have been considered. These aspects include the design considerations (task performance under a range of operational conditions), the personnel and training considerations, and the organizational considerations in terms of manning and major human machine interfaces as a result of team organization.

To meet this need a number of mandatory sections are required in the SOR Template, including:

1. Related Projects. This section placed early in the document identifies the other ongoing projects that should be considered to ensure that the future user will have an integrated system to support overall mission and task performance.
2. Missions, and Scenarios. These sections outline, at least at a high level, the types of operations the new system or product must support. These descriptions must form the basis of task analysis activities to extract requirements, and the basis of user trial design to evaluate concepts with future users.
3. Concept of Operations. This section outlines how the future system will be used within the context of the missions, scenarios, and tasks. This information outlines how future equipment is likely to operate, how it will be staffed, how information will flow (in the case of information systems, and the major soldier-machine interfaces that will be required to operate the system.
4. Key Tasks. This sections outlines the key tasks to be performed at each of the major soldier-machine interfaces, when using the system in support of the future concept of operations, within the design basis mission and scenarios. These are the critical tasks that analysis must be based on, and the tasks that user trials must replicate to evaluate system performance with humans in the loop.
5. Concept of Support. This section outlines the organization of the support structure to maintain the system, the major support positions that are likely to be required, and identifies the key support tasks.

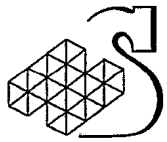


6. User Characteristics. This section identifies and describes the key characteristics of the user population, in terms of both operators and maintainers. Example user characteristics include age, sex, language, education, training, size, handedness, sensory capabilities (eg: sight, colour vision, hearing), or the amount and type of operational experience. References for these characteristics should be used wherever possible (eg: description of training levels or courses, Canadian Forces Anthropometric studies, or selection criteria). The range of the population in each category should also be defined, with the expected design goal being to accommodate 95% of the future user population through the acquisition of the new system and the training to accompany it. In some systems ,with small numbers of pre-selected specialized users (eg: pilots, navigators, divers), the system should accommodate 100% of the user population
7. Human Factors Performance Requirements. Within each set of requirements at the system or sub-system level there are four categories of requirements that must be identified:
    - Soldier / Crew Task Performance. These requirements outline the key task performance characteristics for the system or sub-system. These requirements describe key task elements that the future user must be able to complete, and describe the speed, accuracy, and usability criteria that must be met to achieve adequate system performance within the future concept of operations.
    - Soldier-Machine Interface / Crew Station. These requirement outline the key equipment interfaces that must be included to support each of the system or sub-systems. It will also identify any critical layout requirements related to equipment access, the range of the population that must be accommodated according to a number of parameters, or compartment access and egress.
    - System Safety / Health Hazards. These requirements will describe the features that the future system requires to ensure the safety of the future users.
    - User Acceptance. These requirements describe the requirements of the future system to ensure user acceptance, and details any future user testing requirements to evaluate performance, ease of user, and utility of proposed designs.
8. Personnel and Training. These requirements relate the number of personnel required to operate the system, the characteristics required of those personnel, and the details of the training systems and programs that will be required to develop skill in these future users.

3.2.6.3 SOR-Spec Maker Requirements

To support the integration of human factors into the design cycle, the SOR-Spec Maker product should:

1. Produce requirements in accordance with the proposed SOR template.



2. Provide pointers to human factors support agencies (eg:DCIEM) within the help system for the product in relation to those SOR sections related to human factors issues.
3. Provide links to Soldiers Day and any other task description tools available to support systematic analysis of user missions, scenarios, and tasks, or to provide other data such as a Target Audience Description.

3.2.7 The Link with ADM(Mat)

The link between Project Directing staff in DLR and Project Management staff in ADM(Mat) can have a variety of forms depending on personalities and the type of project. Some projects formalize this link early on and work together to develop requirements and specifications in parallel, while others simply pass documents back and fourth at the SS(EPA) and procurement stages as the SOR is finalized and the Spec is developed.

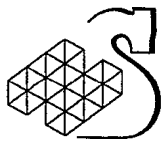
Regardless of the exact nature of this link, it is a weak link in the procurement process in many cases. Interviews will all parties indicated that there is often a "gap" in comprehension during the transition from an SOR to a Spec. This results is either a drawn out question and answer period as the PM staff attempt to understand what was intended by the requirement, or the PM staff continuing with procurement based on what they perceive the requirement to be. Any lack of comprehension also makes it very difficult during detailed design or development to relate changes in specifications back to the requirements that they impact. In combination these effects often lead to bad relations as the DLR staff feel that a product or system has been procured that does not meet their requirements.

One component of this relationship that is especially challenging is the impact of the bid evaluation methodology. The current practice is to evaluate candidates based on the Lowest Cost for the Minimum Essential Requirements with the Best Regional Benefits. It is generally understood that all "Desirable" requirements will simply be ignored and only "Essential" requirements will be used in the development of the Spec and/or in bid evaluation. This is a very large distraction for the DLR officer as they spend a considerable amount of time trying to re-word requirements and classify them as "Essential" or "Desirable".

3.2.7.1 Process Requirements

To address these concerns with the link between PD and PM staff a number of changes to the process are required:

1. Establish the Link Between the PD and PM Early in the Process.
   The few projects that do this now and really work together appear to really understand each other better, and do not appear to have to revisit issues during implementation.
2. Develop the SOR and Spec in Parallel.
   The few projects who do this appear to have a strong relationship between the PD and PM staff, with a general understanding of the issues driving each others documents. The DLR staff on the PD side understand the technical testing that the engineering staff will conduct and the issues related to the feasibility of delivering certain technologies, while the engineering staff on the PM side develop a better



understanding of how the system will be used and what the requirements mean. In these situations the DLR staff appear to be able to stay focused on making their document a statement of the requirement (the "What").

3. Conduct User Studies and Tech Studies in Parallel to Validate Requirements.
   When the PD and PM staff work together early in the process the development of operational analysis or the procurement of prototype products can meet both their needs. In these cases focus groups with users can answer questions of interest to both parties, while prototype products can be tested in user trials to validate requirements and then tested by engineering to validate specifications and testing criteria.
4. Track the Relationship Between Requirements and Specifications.
   The PD and PM staff should track the link between requirements and specifications to facilitate assessments of the impact of requirement changes on specs and the impact of specification changes on requirements.
5. Work Towards Best Value Bid Evaluation Methods.
   The more "Best Value" evaluation methods can be used, the more "honest" all parties can be about the relative priority of requirements and specs, which will decrease the time spent on exact wording and rating while providing a richer base of priorities to guide procurement decisions.

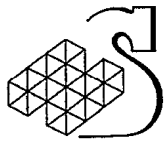
3.2.7.2 SOR-Template Requirements

There were no SOR Template format requirements identified to support the PD and PM link.

3.2.7.3 SOR-Spec Maker Requirements

To support the link between the PD and the PM, SOR-Spec Maker should be used by both parties, and the software should:

1. Allow the DLR staff and the engineers to develop the requirements and specifications for a project in parallel.
2. Allow the DLR staff to view but not edit specifications, and allow the engineers to view but not edit the requirements.
3. Provide the PM staff with a process wizard and information links related to the specification development process. Information links should include many of the same resources available to DLR staff in addition to technical standards (Defence and Industrial).
4. Allow the user to enter and edit specifications.
5. Establish and track a link between the latest set of requirements and the latest set of specifications.
6. Allow the user to merge and split specifications as necessary, while maintaining a consistent numbering system and maintaining the tracking of links within requirements, within specifications, and between specifications and requirements.



7. Allow the user to indicate the interdependency between requirements and therefore between specifications, and then track this interdependency.
8. Allow the user to describe how specifications will be tested, develop summaries of specification tests, and track whether specifications are passing tests or not during project implementation. These results should be viewable by both the PD and PM staff for a project.

3.2.8 Requirements Traceability

The last, and most significant, group of deficiencies in the current process is the complete lack of traceability that exists for requirements and specifications. As a result of a lack of process, the posting cycle, and decreasingly smaller office sizes within the headquarters the documentation trail for projects is reported to be less than complete.

As a result, there is little history behind the requirements on many projects, and therefore little justification or rationale for edits. This makes any current requirement set difficult to understand at times, and makes all requirements easier to edit (or too easy to edit).

This lack of traceability includes the link between a requirement and a specification, where one requirement can develop into pages of specifications making it very difficult to track the link back to a requirement.

3.2.8.1 Process Requirements

The required changes to the process in order to establish requirements and specification traceability include:

1. Obtain Requirements Management Software to Enter/Edit/Trace Requirements and Specifications Through the Life Cycle (i.e. SOR-Spec Maker Software)
2. Ensure that Requirements "Rationale" is Identified and Tracked Within the Software Requirements Database.
3. Ensure that the Software is Used by Both the PD and PM staff to establish traceability between requirements and specifications.

3.2.8.2 SOR-Template Requirements

There were no SOR Template format requirements identified that related directly to traceability.

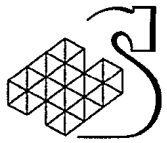
3.2.8.3 SOR-Spec Maker Requirements

There are a number of software requirements related to traceability, including the requirements to allow the user to:

a) Login as Author (only DLR alter Requirements, only PM staff alter Specs)

b) Enter Requirements (max 1 minute per entry)

c) Record Rationale



d) "Split" and "Merge" Requirements as Necessary while maintaining historical records

e) Number and Maintain Standard Numbering of Requirements and Specs

f) Identify Interdependencies Between Requirements

g) Record Priority of Each Requirement

h) Track up to 10,000 to 15,000 Requirements per projects, and therefore up to 100,000 entries per project including edits.

i) Ability to "Freeze" a Version of an SOR or a Spec for Distribution and Placement in an On-Line Library

j) Tag Requirements Once Validated With Users

k) Generate Standard Reports (SOR, SOR+Rationale, etc...)

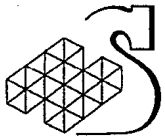
3.3 Lessons Learned on Past Projects

Throughout the interviews with current and past project staff a number of "Lessons Learned" were identified related to the SOR and Spec Development process. It is interesting to note that most of these lessons learned overlap with the requirements or recommendations for future changes to the process. This suggests that if these changes are implemented systematically there will be more widespread success similar to the "pockets" of success resulting from these lessons. The lessons learned identified included:

- Develop SOR/Spec as a PD/PM team
- Build context (i.e. scenarios) as you go, if operational scenarios or other context information is not available.
- Monitor and be aware of what current and near future technology is capable in order to develop a realistic SOR.
- Understand technical tests and results and their impact on requirements
- Ask the "experts", use the DREs
- Start SOR development early and iterate requirements
- Finalize SOR at the last minute
- Develop operational scenarios then task analyze
- Validate requirements with users through focus groups
- Obtain and evaluate prototypes through user trials.
- Continue user trials through detailed design/development.
- Get independent sources to conduct focus groups and trials.
- Develop an SOR template and follow it

3.4 Future Trends

The analysis for this study identified a number of future trends or initiatives related to the results outlined in this report. The primary future trend is a movement toward Benefit Driven procurement or the Tabular Format of procurement, and away from historical Tender-Theory models. These procurement strategies result in bid evaluations based more on capability with rewards for performance and 'gates' to track progress throughout development. These future



changes appear to have more of an impact on the design of the Spec and Subsequent Tracking of specifications as opposed to the requirements development process and the design of the SOR.

In addition to these future trends a parallel study was identified, managed from the Directorate of Force Planning and Project Coordination (DFPPC) and conducted by a consultant (B. Lowthian). One component of this work has been the development of proposals for new SOR formats. A draft version of the proposed SOR format was obtain in the final stages of this study. The Lowthian proposals address many of the recommendations in this report, including a focus of requirements on task performance requirements, and the analysis of 11 DND Scenarios.

There are a number of areas where the results of this report could be integrated as enhancements to the Lowthian SOR proposals, including the systematic integration of human factors issues. It is highly desirable to meet with these DFPPC personnel and determine if the these recommendations can be integrated into their initiatives.

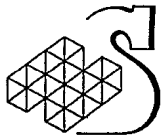
3.5 Summary of Process Requirements

Throughout this section a number of requirements have been identified for modifications to the SOR development process. In summary these requirements included:

1. Develop a Process Bigger Than Any One Individual.
   A documented SOR development process should be created that introduces some key milestones required in the development of an SOR. This process should be flexible enough to accommodate the wide range of project types, but formal enough that project staff can understand where each other are in their project sequence. This process should include systematic analysis of requirements, validation with the user community, and documentation of requirement rationale, all of which make it difficult for any one person to change the track of a project without evidence.

2. Define the DLR Requirements Officer as a Coordinator.
   The role of the DLR Requirements Officer should be officially defined as that of a coordinator. This role requires the officer to organize the integration of a wide range of user and technical specialist input into a requirements document, and does not require the officer to be the sole knowledge source behind a system.

3. Create a Project "Team" From Day 1.
   In the current system a Project Implementation Team is created once a project goes out for bid. This team identifies a number of support personnel for a project including requirements, training, doctrine, fielding, engineering, etc.. These same roles should be defined at SS(ID) such that the requirements coordinator (the DLR officer) has identified personnel who will expect him/her to call for input during the requirements development process. The team members (in a matrix approach) will include representatives from Doctrine/Operational Concepts, User Tasks (Ops & Maintenance), Deficiencies/Lessons Learned, Requirements, Project Management/Engineering, Research Resources (Personnel/Data/Studies), Quality Assurance, Public Works and Government Services Canada (PWGSC), Training, Staffing, and Deployment. Many of these personnel will only be called upon to review an SOR or provide quick input, but input from all of these groups will increase the quality of the requirements set and prevent re-work at the last minute.



4. Develop Army Wide Scenarios/Missions
   The Canadian Forces should provide a series of standardized missions and scenarios that they expect the Land Forces to support. Over time the different arms should analyze how they would deploy to support these scenarios in the future, with support from the Directorate of Army Doctrine and Future Concept Groups. This information should be documented and integrated into the instruction program at the Kingston Tech Staff School.

5. Identify and Prioritize Army Wide Requirements
   Based on the Force wide scenarios, a set of deficiencies should be maintained that provides a prioritized list of deficiencies that DLR needs to address. This list should then be used as one input to guide the allocation of resources. This would not only provide structure and some predictability to the requirements analysis process, but would also address some of the concerns discussed in Section 3.2.1 related to personality driven procurement priorities.

6. DND Provide DLR with Doctrine and Future CONOPS Support
   DLR staff should be provided with links to personnel in the Directorate of Arm Doctrine and the Future Concepts group at the start of the project SS(ID) or prior to when the SOR will be developed. These personnel should provide guidance on where the project fits in to future operations and how it is likely to be deployed within the standard force scenarios.

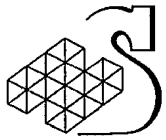
7. Task Analyze to Develop Requirements
   Once future scenarios and operational concepts are defined for a project they should be task analyzed to determine the user requirements for the future system. This analysis should focus on the "What?" aspects of future task performance (i.e. what the system needs to do to support future task performance), and not on the "How?".

8. Task Analyze to Develop Test Scenarios and Measures
   Task analysis of future scenarios and concepts should also be conducted to extract the performance measures and scenario vignettes necessary to develop user centred product acceptance trials.

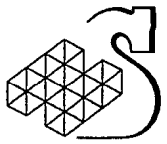
9. Identify Links to Information for Each Project.
   Provide the Requirements Officer Links to a range of information sources, including Army Operations (Scenarios), Operational Concepts, Doctrine and Future Concepts, and Research personnel.

10. Define DRE Role to Support DLR Projects
    There is a need to define the role for DRE staff to support DLR projects and to communicate this in any future descriptions of the SOR Development Process. It would appear that key points in this definition should be that DREs must support DLR projects, but that they may not be able to do all the work themselves at which point they may be required to act as technical experts to help select or supervise contract personnel.

11. Train Scientists on the Development Process.
    The Scientific Authorities in the DREs should be provided with training on the System Development cycle and the SOR-Spec Development Process. This training should emphasize the information "products" that DLR staff require and the typical timelines that they are being asked to work within.



12. A SOR Development Process should be established, documented, and taught. This process should include key milestones that all Requirements Officer should pass through in the development of SOR, including Mission/Scenario Definition, Function/Task Analysis, Identification of Relation Projects, Internal SOR Review, Requirements Validation with Units, Evaluation of Requirements through Trials of Prototypes or Mockups, etc..
13. Any formal SOR Development Process should include the requirement for review with the future user community and subsequent requirement iteration.
14. Develop a Common SOR Format and have all projects follow it. This does not appear to be an unreasonable requirement as all SORs analyzed during this project could be reworked into a common format.
15. Make all SOR Sections Mandatory, with Not Applicable or Not Available as acceptable inputs to SOR sections provided there is a reasonable rationale provided.
16. Encourage the Requirements Officer to develop the full requirement for a system, at least on the first few passes, to ensure that the full range of requirement are documented at least once for future reference.
17. The requirements development process needs to incorporate standard analysis milestones related to systematic analysis of user requirements. These milestones should include:
    - The definition of missions and scenarios.
    - The develop of a Concept of Operations in terms of how personnel will use the future system within the context of the identified missions and scenarios.
    - Function and task analysis of these scenarios to extract requirements.
    - The completion of a User Group(s) at operational units early in the requirements development process to validate the scenarios, the Concept of Operations, and the preliminary requirements.
    - The completion of a User Trial(s) later in the requirements development process using prototype products, storyboards of design concepts, or buy and try products.
    - The integration of Human Factors standards into the requirements development process.
    - The completion of User Trial(s) during Project Implementation to validate detailed design concepts and to provide the necessary data for Trade Off studies when choices must be made between design alternatives.
18. It would be beneficial if there was a qualified human factors staff member in Ottawa to support Land Force procurement. This officer would need to be a fully qualified human factors profession (according to industrial certification qualifications), and would be available to provide human factors support, link human factors requirements across projects, and liase with D.C.I.E.M. on research issues.
19. Establish the Link Between the PD and PM Early in the Process.
    The few projects that do this now and really work together appear to really understand each other better, and do not appear to have to revisit issues during implementation.

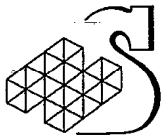


20. Develop the SOR and Spec in Parallel.
    The few projects who do this appear to have a strong relationship between the PD and PM staff, with a general understanding of the issues driving each others documents. The DLR staff on the PD side understand the technical testing that the engineering staff will conduct and the issues related to the feasibility of delivering certain technologies, while the engineering staff on the PM side develop a better understanding of how the system will be used and what the requirements mean. In these situations the DLR staff appear to be able to stay focused on making their document a statement of the requirement (the "What").
21. Conduct User Studies and Tech Studies in Parallel to Validate Requirements.
    When the PD and PM staff work together early in the process the development of operational analysis or the procurement of prototype products can meet both their needs. In these cases focus groups with users can answer questions of interest to both parties, while prototype products can be tested in user trials to validate requirements and then tested by engineering to validate specifications and testing criteria.
22. Track the Relationship Between Requirements and Specifications.
    The PD and PM staff should develop analysis that tracks the link between requirements and specifications to facilitate assessments of the impact of requirement changes on specs and the impact of specification changes on requirements.
23. Work Towards Best Value Bid Evaluation Methods.
    The more "Best Value" evaluation methods can be used, the more "honest" all parties can be about the relative priority of requirements and specs, which will decrease the time spent on exact wording and rating while providing a richer base or priorities to guide procurement decisions.
24. Obtain Requirements Management Software to Enter/Edit/Trace Requirements and Specifications Through the Life Cycle (i.e. SOR-Spec Maker Software)
25. Ensure that Requirements "Rationale" is Identified and Tracked Within the Software Requirements Database.
26. Ensure that the Software is Used by Both the PD and PM staff to establish traceability between requirements and specifications.

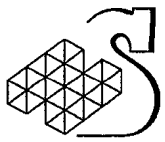
3.6 Summary of SOR Template Requirements

Throughout this section a number of requirements have been identified for modifications to the SOR Template format. A proposed SOR Template has been included as Annex A to this report. In summary the requirements for this SOR Template included:

1. Develop a Common SOR Format and have all projects follow it.
2. Identify the Project Team Members on the SOR.
   Each of the personnel identified to support a project should be listed on one of the cover sheets of the SOR. This formally recognizes the DLR Officer as the coordinator with multiple technical inputs, and clearly identifies those expected to provide technical input.



3. Include standard sections on Missions/Scenarios, Operational Concepts, and Key Tasks where the Requirements Officer can summarize the future operational context for the system.
4. Ensure that all SOR section titles in the template are mandatory, with "Not Applicable" or "Not Available" being acceptable input with an associated rationale. This will help ensure that these issues are addressed, if not in the initial development of an SOR, then through the review process.
5. The SOR Template should contain a Required Section that Identifies Related Projects
6. To support the systematic analysis of user requirement, include the following mandatory sections:
   a) Related Projects. This section placed early in the document identifies the other ongoing projects that should be considered to ensure that the future user will have an integrated system to support overall mission and task performance.
   b) Missions, and Scenarios. These sections outline, at least at a high level, the types of operations the new system or product must support. These descriptions must form the basis of task analysis activities to extract requirements, and the basis of user trial design to evaluate concepts with future users.
   c) Concept of Operations. This section outlines how the future system will be used within the context of the missions, scenarios, and tasks. This information outlines how future equipment is likely to operate, how it will be staffed, how information will flow (in the case of information systems, and the major soldier-machine interfaces that will be required to operate the system.
   d) Key Tasks. This sections outlines the key tasks to be performed at each of the major soldier-machine interfaces, when using the system in support of the future concept of operations, within the design basis mission and scenarios. These critical tasks should be the focus of task analysis, and user trials must replicate these tasks to evaluate system performance with humans in the loop.
   e) Concept of Support. This section outlines the organization of the support structure to maintain the system, the major support positions that are likely to be required, and identifies the key maintenance support tasks.
   f) User Characteristics. This section identifies and describes the key characteristics of the full range of potential operators and maintainers. Example user characteristics include age, sex, language, education, training, size, handedness, sensory capabilities (eg: sight, colour vision, hearing), or the amount and type of operational experience. References for these characteristics should be used wherever possible (eg: description of training levels or courses, Canadian Forces Anthropometric studies, or selection criteria). The range of the population in each category should also be defined, with the expected design goal being to accommodate 95% of the future user population through the acquisition of the new system and the training to accompany it. In some systems ,with small numbers of pre-selected specialized users (eg: pilots, navigators, divers), the system should accommodate 100% of the user population



g) Human Factors Performance Requirements. Within each set of requirements at the system or sub-system level there are four categories of requirements that must be identified:

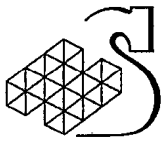
- Soldier / Crew Task Performance. These requirements outline the key task performance characteristics for the system or sub-system. These requirements describe key task elements that the future user must be able to complete, and describe the speed, accuracy, and usability criteria that must be met to achieve adequate system performance within the future concept of operations.
- Soldier-Machine Interface / Crew Station. These requirement outline the key equipment interfaces that must be included to support each of the system or sub-systems. It will also identify any critical layout requirements related to equipment access, the range of the population that must be accommodated according to a number of parameters, or compartment access and egress.
- System Safety / Health Hazards. These requirements will describe the features that the future system requires to ensure the safety of the future users.
- User Acceptance. These requirements describe the requirements of the future system to ensure user acceptance, and details any future user testing requirements to evaluate performance, ease of use, and utility of proposed designs.

h) Personnel and Training. These requirements relate the number of personnel required to operate the system, the characteristics, skills, and experience of available personnel, and the details of the training systems and programs that will be required to develop skill in these future users.

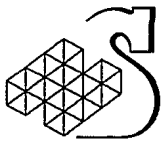
3.7 Summary of SOR-Spec Maker Requirements

Throughout this section a number of requirements have been identified for procurement of requirements management software. These SOR-Spec Maker software requirements are detailed further in a Statement of Operational Requirements in Annex B to this report. However, in summary the high level SOR-Spec Maker requirements include:

1. Provide a template to identify all key project support personnel, with contact information for each, including a direct e-mail link.
2. Provide an SOR Development Process "Wizard" that provides the outline of the key steps requirement and the ability for the Requirements Officer to indicate where they are in the process.
3. Provide an SOR Template Based on the New Common SOR Format.
4. Ensure that all section titles are mandatory, requiring the writer to fill in some content or state "Not Applicable" or "Not Available" with rationale.
5. Provide Dynamic To-Do Lists for the Major Milestones and Analysis Required.
6. Provide Context Specific Help with Pointers to DND Support Agencies for each of the major milestones that should be covered in the development of the SOR.
7. Provide On-Line "Help" on SOR Section Contents.



8. Provide On-Line "Pointers" to Resources within DND that could assist in the Completion of SOR Sections.
9. Provide pointers to human factors support agencies (eg:DCIEM) within the help system for the product in relation to those SOR sections related to human factors issues.
10. Contain a Missions/Scenario section that provides a link to a summary of the Land Force scenarios that system must support. The software should allow this scenario text to be placed in the Mission/Scenario section of the SOR or in an Annex depending on how much additional data the Requirements Officer has to incorporate with it.
11. Provide links to Soldiers Day and any other task description tools available to support systematic analysis of user missions, scenarios, and tasks.
12. Provide software links to as many information sources as possible from one common Information Link tool. The data required by DLR officers is increasingly being produced in electronic form, which increase the future utility of a software based link to information. These links my be based on data available on CD-ROMs or over Intranet sites. A role should be defined within DLR Coordination to monitor electronic information sources and continually update these links for the project teams. Example links for this tool include:
    - Doctrine (Electronic Battle Box CD, Others...)
    - Task Data from Soldiers Day, or Other DND Documents
    - Literature (Research, Studies)
    - Past SORs, Related SORs
    - Design Standards, Test Methods, Test Criteria
    - Lessons Learned CD-ROMs or Databases
    - Deficiencies in Existing Systems (eg: The Army Combat Clothing and Equipment Survey System (ACCESS), or UCRs)
    - The Defence Research Establishments
13. Develop an SOR-Spec Library.
    Each time an SOR or Spec is 'frozen' as a version for distribution and comment the SOR-Spec Maker software should provide a facility to deposit the version into a library. The version deposited in the library should overwrite the last version that was placed there. The most recent version of an SOR or Spec should remain in the library for 10 years unless it is overwritten by a more recent one. The library should contain a search engine and the ability to copy requirements from a located document into the current SOR or Spec under development.
14. Allow the DLR staff and the engineers to develop the requirements and specifications for a project in parallel.
15. Allow the DLR staff to view but not edit specifications, and allow the engineers to view but not edit the requirements.
16. Provide the PM staff with a process wizard and information links related to the specification development process. Information links should include many of the same resources available to DLR staff in addition to technical standards (Defence and Industrial).
17. There are a number of software requirements related to traceability, including the requirements to allow the user to:



a) Login as Author (only DLR alter Requirements, only PM staff alter Specs)

b) Enter Requirements (max 1 minute per entry)

c) Record Rationale

d) "Split" and "Merge" Requirements as Necessary

e) Number and Maintain Standard Numbering of Requirements and Specs

f) Identify Interdependencies Between Requirements

g) Record Priority of Each Requirement

h) Track up to 10,000 to 15,000 Requirements per projects, and therefore up to 100,000 entries per project including edits.

i) Ability to "Freeze" a Version of an SOR or a Spec for Distribution and Placement in an On-Line Library

j) Tag Requirements Once Validated With Users

k) Generate Standard Reports (SOR, SOR+Rationale, etc...)

18. Allow the user to describe how specifications will be tested, develop summaries of specification tests, and track whether specifications are passing tests or not during project implementation. These results should be viewable by both the PD and PM staff for a project.

3.8 Review of Candidate Software Tools

Throughout this study a number of software products were reviewed for their potential integration into the requirements management process. The ReqMan and RT Expert products were quickly reviewed for their potential as requirements management tools, while the Soldier Day and HFE Guide applications were briefly reviewed for potential links to the requirements management process.

3.8.1 ReqMan

ReqMan is a requirements management tool under development at the Defence Resereach Establishment Valcartier (DREV). At the time of review it was a prototype product.

ReqMan provides the user with a graphical user interface to a requirements database and the capabilities to enter, edit, merge, split, and number requirements. Standard reports can be generated using these data.

ReqMan was the easier to use of the products reviewed, but had extremely low performance (eg: 10 minutes to enter a requirement where 500+ entries were in the database). ReqMan also lacked some key features required by users, as identified in this study, such as interdependency tracking and tools to support interdependency analysis.

ReqMan would not be suitable for widespread use within DLR until further development was completed to extend its functionality.

3.8.2 RT Expert

RT Expert is a commercial requirements management application available through a developer in the Montreal area. It is a polished software product available for sale.

RT Expert is more difficult to use than ReqMan as the interface is more complex, and the user must develop an understanding of the "structure" of the requirements managed with RT Expert. This requires the user to identify static and dynamic requirements, and input and output requirements, among others. As a result RT Expert has a very steep learning curve and is likely not suitable in its current form for use throughout DLR, as users would be unlikely to enter their requirements into the software (which is the most critical aspect of SOR-Spec Maker).

However, once requirements are entered correctly into RT Expert it appears to provide powerful tools for tracking and visualizing requirements interdependencies, and recording the status of requirements and specification in terms of testing results.

In summary RT Expert has the tools more suited for the engineering side of the procurement process, but lacks a simple interface for the user to enter and edit requirements, and then later establish interdependencies between them. As a result it is not suitable for wide spread use across DLR at this time.

3.8.3 ReqMan vs RT Expert

A comparison between ReqMan vs RT Expert indicates that they each provide a general coverage of equal proportions of the SOR-Spec Maker requirement, but in different areas, while RT Expert provides an additional suite of capabilities for which no requirement has been identified to date. This relationship is illustrated in Figure 7.

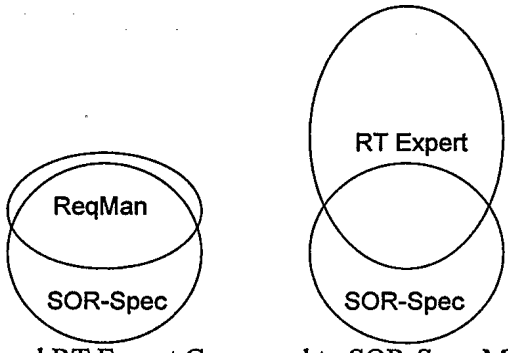
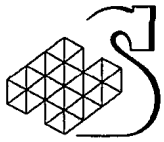


Figure 7: ReqMan and RT Expert Compared to SOR-Spec Maker Requirements

3.8.4 LFCS Requirements Management Tool

During the analysis for this project it was discovered that the PD and PM staff for the Land Force Command System (LFCS) project have developed a Windows based tool to enter, edit, split, merge, and track the interdependencies of requirements, while maintaining numbering and generating standard SOR and Spec reports. This tool "grew up" as necessary during the evolution of the project and now tracks the history of a 10,000+ requirements database with associated specifications.



While this product was not fully investigated during the analysis it appears to offer the core features for requirements management and should be given further review.

3.8.5 Soldiers Day

Soldiers Day is a CD-ROM based Windows application developed by D.C.I.E.M. to provide a multi-media record of the key missions, tasks, and equipment related to dismounted infantry operations. This product may in the future include mounted infantry operations, from the perspective of equipment compatibility.

Soldiers Day primarily supports the needs of DLR 5 personnel, but is likely to have some utility for other branches as well. The product "shell" is suitable for housing task and equipment based data on any form of military activity, and when populated provides a very rich data resource to guide requirements development and design. Soldier's Day includes a search engine that facilitates the rapid location of information related to entered keywords.

Soldiers Day should be linked to SOR-Spec Maker through the Information Links component of the product, whereby the SOR-Spec Maker user could click on an "icon" to access Soldiers Day over a network or over the Intranet and search for information related to their project. It should also be considered by other branches of DLR as a candidate to hold task and equipment data to be used as a basis for requirements analysis and design.

3.8.6 HFE Guide

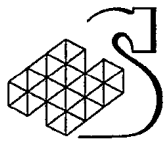
HFE Guide is a MacIntosh based software application that must be installed on the users computer. The product is currently in a prototype form, but is used by some human factors personnel through the Canadian Forces.

HFE Guide provides human factors design guidance in a number of different areas, including:

- Human Factors Design Guidelines (Mil Std 1472D)
- Aircraft Design Standards (STANAG and ASCC)
- Generic Task Analysis Information
- Human Factors Methods
- Human Factors Process (Mil Std 46855)
- User Test Methods

In general, HFE Guide provides quick access to military standards for basic human factors analysis processes and design guidelines, and therefore has the potential for a useful resource during the requirements analysis. This utility is likely to increase as Requirements Officers continue to become more familiar with human factors issues and methods.

It would be useful to link HFE Guide to SOR-Spec Maker software as a human factors guideline and process resource link. To accomplish this, it would appear that HFE Guide must be converted to a PC or Intranet format. Plans to complete this transition are documented at D.C.I.E.M and should be considered for implementation once the final format the requirements management core of SOR-Spec Maker is known.

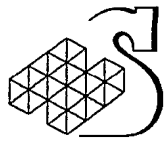


4 Recommendations

This section outlines a series of recommendations to guide future work on the SOR-Spec Maker Project. These recommendations include:

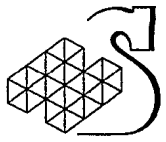
1. A small number of DLR personnel have indicated the desire to obtain a Requirements Management software tool immediately. The two tools reviewed for this project (ReqMan and RT Expert) are not suitable in their current form, as discussed in Section 3.8. Therefore, if it is essential to obtain a requirements management tool immediately it is recommended that the tool in use by the LFCS project be reviewed further and obtained by those projects interested. However, further analysis is recommended prior to deploying a system across DLR as outlined below.
2. To further this study and implement the requirements described throughout Section 3.0 the following activities are recommended:
   - Refine a Process for SOR Development and Finalize an SOR Template, working with the DFPPC initiatives in this area and incorporating the need for user centred requirements development as described in this report.
   - Conduct a review of the Requirements Management Tools available as Commercial Off The Shelf (COTS) products. This activity is likely to review a number of products available through commercial software vendors but may also involve the posting of a Request for Information (RFI) on the government procurement bulletin boards.
   - Using the information obtained from the wider review of available software tools, and the information in this report, conduct a Focus Group with future users from DLR and ADM(Mat) who will use the SOR-Spec Maker tool. This Focus Group should review the proposed changes to the process and the features of the potential software tools, with the goal of providing feedback to process developers and focusing in on one software product for pilot testing.
   - Procure a software tool and pilot test it on an example project. This is likely to require support from a contractor to input and work through the requirements management process in parallel to the actual project team continuing with their work.
   - Conduct a part task user trial based on the example project data. This trial should involve users interacting with the software to complete task elements common to the requirements management process.

   It is important to note that one software product may not be the best solution to meet all SOR-Spec Maker requirements, and that a COTS product may be best for the requirements management portion, while Intranet tools with databases and search engines are better suited for the Information Links features and the Process Wizard features. If this proves to be true an example product should be procured and evaluated for requirements management, while a design for the Intranet product concepts is developed as "storyboards" for use in the user review process.



- Based on the results of the Focus Group, the Example Project, and the Part Task User Trial the final set of SOR Spec Maker Requirement should be developed and used as the basis of procurement or development of a final SOR-Spec Maker software tool.
- Once a tool is procured the data from the Example Project and the modified Process should be integrated into a Training Package to be used for informal immediate training at NDHQ and to be passed to the Tech Staff School in Kingston for Future Use.

3. Throughout the interviews for this project, several officers indicated that they are increasingly aware of the role of human factors in the development cycle, and those who have experimented with human factors integration preach the benefit in terms of the resulting design quality. However, these same personnel also indicate that understanding how to integrate human factors analysis into the develop of requirements and specifications remains one of their greater challenges. One of the larger challenges is understanding how to link systematic analysis of operational scenarios to the development of requirements and interface design concepts. It is therefore recommended that a Human Factors Guidance Module be developed, extracting "cases" from recent projects that have more extensive human factors programs to demonstrate the link between analysis (Operational Scenarios, Function Analysis, Task Analysis, User Reviews) and design (Requirements and Specification Development, Interface Design, Measures for Performance testing). Current Advanced Development Model (ADM) projects (eg: the Advanced Land Fire Control System (ALFCS) and Integrated Protective Clothing and Equipment (IPCE)) would be good candidates to extract sample human factors analysis cases, as would some ongoing matrix projects within DLR (Helmet, Clothe the Soldier, Leopard Thermal Sight, and TBCS).
4. Once the SOR-Spec Software is deployed and being used by several projects, efforts should be made to regularly extract the human factors related design requirements and specification from SORs and Specs. This activity should be co-ordinated through a central human factors group within DND to generate Canadian human factors specifications for use on military projects, and to help identify areas where R&D activities are likely required.
5. A number of the "requirements" for process changes identified in Section 3 should be reviewed as recommendations for change within the operation of the Land Force procurement process, including:
   - The need for Land Force operational scenarios to guide analysis.
   - The need for prioritized Land Force deficiencies to guide the management of DLR projects.
   - The need for Ottawa based Land Force human factors support (qualified as per the established commercial human factors certification agencies) to provide ongoing guidance to project teams and liaison with D.C.I.E.M..
   - Educate scientific authorities on the System Development process, the "products" needed by project personnel to support procurement decisions, and the timelines that these projects must attempt to adhere to.



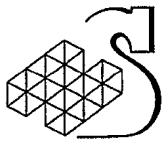
Annex A: SOR Template

Scope of the SOR Template and the Need for Future Analysis

Throughout this report a number of requirements for a future SOR Template have been identified. These requirements fall primarily into the category of human factors, and the systematic analysis of user requirement within the context of operational scenarios.

This annex illustrates a proposed SOR Template that incorporates these human factors sections. An effort has been made to integrate these sections within the framework of exiting draft SOR formats. This format requires the user to document requirements in a top down fashion, presumably in the order that issues are analyzed (from missions, to tasks, to requirements, etc.).

No effort has been made to integrate these sections with the proposed frameworks resulting from recent DFPPC studies as these formats are still under review and discussion. These results and the DFPPC studies should be integrated through combined analysis and discussion in the future to produce a final SOR Template that blends the results of both studies wherever possible.



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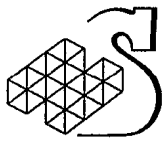


Draft for DND Review

Statement of Operational Requirement

1. INTRODUCTION

1.1. GENERAL

This section identifies and introduces the project.

1.2. AIM

This sections describes the aim of the project.

1.3. BACKGROUND

This section summarizes background analysis that has led up to the creation of the SOR.

1.4. CAPABILITY DEFICIENCIES

This section describes the capability deficiencies that form the basis of the project.

1.5. PROJECT LIMITATIONS AND CONSTRAINTS

This section outlines any identified limitations or constraints that bind the scope or timeline of the project.

1.6. RELATED PROJECTS

This section identifies any other ongoing projects that should be considered to ensure that the future user will have an integrated system to support overall mission and task performance.

2. MISSIONS, CONCEPT OF OPERATIONS, AND TASKS

2.1. MISSIONS AND SCENARIOS

This section summarizes the types of operations the new system or product must support. These descriptions must form the basis of task analysis activities to extract requirements, and the basis of user trial design to evaluate concepts with future users.

2.2. CONCEPT OF OPERATIONS

This section outlines how the future system will be used within the context of the missions, scenarios, and tasks. This information outlines how future equipment is likely to operate, how it will be staffed, how information will flow (in the case of information systems), and the major soldier-machine interfaces that will be required to operate the system.

2.3. KEY TASKS

This section outlines they key tasks to be performed at each of the major soldier-machine interfaces, when using the system in support of the future concept of operations, within the mission and scenarios it will have to support. These critical tasks must the focus of further task analysis, and be replicated during user trials conducted to evaluate system performance with humans in the loop.

2.4. CONCEPT OF SUPPORT

This section outlines the organization of the support structure to maintain the system, the major support positions that are likely to be required, and identifies the key support tasks.

2.5. USER CHARACTERISTICS.

This section describes the key characteristics of the full range of operators and maintainers. Example user characteristics include age, sex, language, education, training, size, handedness, sensory capabilities (eg: sight, colour vision, hearing), or the amount and type of operational experience. References for these characteristics should be used wherever possible (eg: description of training levels or courses, Canadian Forces Anthropometric studies, or selection criteria). The range of the population in each category should also be defined, with the expected design goal being to accommodate 95% of the future user population through the acquisition of the new system and the training to accompany it. In some systems ,with small numbers of pre-selected specialized users (eg: pilots, navigators, divers), the system should accommodate 100% of the user population

3. OPERATIONAL ENVIRONMENT

3.1. GENERAL

This section describes the range of operating conditions that the system must operate under when supporting the missions and task described in Section 2.

3.2. THREATS AND THREAT PRIORITIES

This section outline the key threats, and any known performance characteristics of these threats, based on the operational scenarios and operating environments identified.

4. OPERATIONAL REQUIREMENTS

4.1. GENERAL

This section describes any requirements that apply across the entire system.

4.2. DESIGN AND CONCEPT GUIDANCE

This section provides any design or concept guidance that the Requirements Officer feels is necessary to express the intent of the SOR, without focusing a particular product or solution.

4.3. SYSTEM REQUIREMENTS

This section details the system level requirements related to the overall features the system must provide.

4.3.1. Performance Capability

This section details any system level requirements related to overall system performance, not related to human performance.

4.3.2. Human Factors Requirements

This section details outlines the requirements related to human operation of the system, broken down into at least the following mandatory subsections:

4.3.2.1.Soldier / Crew Task Performance.

These requirements outline the key task performance characteristics for the system. These requirements describe key task elements that the future user must be able to complete, and describe the speed and accuracy, criteria that must be met to achieve adequate system performance within the future concept of operations.

4.3.2.2.Soldier-Machine Interface / Crew Station.

These requirement outline the key equipment interfaces that must be included to support the system. It will also identify any critical layout requirements related to equipment access, the range of the population that must be accommodated according to a number of parameters including environmental clothing, or compartment access and egress.

4.3.2.3.System Safety / Health Hazards.

These requirements will describe the features that the future system requires to ensure the safety of the future users.

4.3.2.4.User Acceptance.

These requirements describe the requirements of the future system to ensure user acceptance, and details any future user testing requirements to evaluate performance, ease of use, and utility of proposed designs.

4.3.3. Quantity

This section summarizes the number of units that will be required.

4.3.4. Quality

This section details any quality requirements.

4.3.5. Location

This section lists where the units will be distributed about the forces.

4.4. SUB - SYSTEM REQUIREMENTS

This section is repeated for each major sub-system that must be specified. The section details the sub-system level requirements related to the features the specific sub-system must provide.

4.4.1. Performance Capability

This section details any system level requirements related to overall system performance, not related to human performance.

4.4.2. Human Factors Requirements

This section details outlines the requirements related to human operation of the sub-system, broken down into at least the following mandatory subsections:

4.4.2.1.Soldier / Crew Task Performance.

These requirements outline the key task performance characteristics for the sub-system. These requirements describe key task elements that the future user must be able to complete, and describe the speed, accuracy, and usability criteria that must be met to achieve adequate system performance within the future concept of operations.

4.4.2.2.Soldier-Machine Interface / Crew Station.

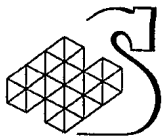
These requirement outline the key equipment interfaces that must be included to support each of the sub-systems. It will also identify any critical layout requirements related to equipment access, the range of the population that must be accommodated according to a number of parameters, or compartment access and egress.

4.4.2.3.System Safety / Health Hazards.

These requirements will describe the features that the sub-system requires to ensure the safety of the future users.

4.4.2.4.User Acceptance.

These requirements describe the requirements of the sub-system to ensure user acceptance, and details any future user testing requirements to evaluate performance, ease of user, and utility of proposed designs.



4.4.3. Quantity

This section summarizes the number of units that will be required.

4.4.4. Quality

This section details any quality requirements.

4.4.5. Location

This section lists how the total number of units will be distributed about the forces.

5. TOTAL SUPPORT REQUIREMENTS

5.1. SUPPORT REQUIREMENTS

This section outlines the method to be used to support and maintain the system.

5.2. PERSONNEL AND TRAINING

This section outlines the requirements related to the number of personnel required to operate the system, the characteristics required of those personnel, and the details of the training systems and programs that will be required to develop skill in these future users.

6. SCHEDULING REQUIREMENTS

6.1. CRITICAL MILESTONES

This section outlines the critical milestones and timings for the project up to and including fielding.

6.2. SYSTEM SERVICE LIFE EXPECTANCY

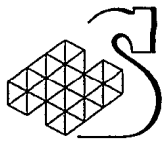
This section details the life expectancy for the system once fielded.

7. REQUIREMENTS TABLE

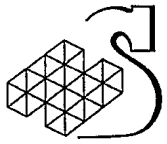
This section summaries all the requirements identified throughout the document.

8. GLOSSARY

This section defines key terms used throughout the document.



Annex B:
Requirements for SOR-Spec Maker



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Draft for DND Review

Statement of Operational Requirement

For

SOR-Spec Maker
Requirements Management Tool

DRAFT

by
Mike Greenley

April 1998

Draft for DND Review

Table of Contents

Draft for DND Review

SOR-SPEC MAKER
Statement of Operational Requirement

1 INTRODUCTION

1.1 General

1.1.1 A recent study of the development of Statement of Operational Requirements (SORs) by Requirements Officers (ROs) in the Directorate of Land Requirements (DLR) identified a number of deficiencies in the ROs ability to develop and track requirements for new systems. One of the recommendations to address these deficiencies was the procurement of a software tool to support the requirements management process. This software has been labeled the SOR-Spec Maker Software.

1.2 Aim

1.2.1 This SOR defines the requirements for the SOR-Spec Maker software tool.

1.3 Background

1.3.1 A study of the SOR and Performance Specification development process was conducted by the Defence and Civil Institute of Environmental Medicine (D.C.I.E.M) during the winter of 1998. This investigation reviewed the requirements and specification development process through a series of interviews and sample SOR reviews.

1.3.2 Sources of information in this D.C.I.E.M. study included:

1.3.2.1 DLR Co-ord staff.

1.3.2.2 DLR Staff on seven active projects.

1.3.2.3 ADM (MAT) Project Management staff on select projects.

1.3.2.4 Instructor staff at the Technical Staff School in Kingston.

1.3.2.5 Human Factors Scientists at D.C.I.E.M.

1.3.3 This D.C.I.E.M. study recommended a number of changes to the process of developing SORs and Performance Specifications, focusing on User Centred Design principles and a standardized SOR template. Commensurate with these process changes were a series of recommendations related to requirements management software.

1.4 Capability Deficiencies

1.4.1 Requirements Officers (ROs) do not have a standardized process to follow in the development of SORs.

1.4.2 It is very difficult for a Requirements Officer to locate and obtain a number of reference sources that are frequently used in SOR development. Examples of these references include:

1.4.2.1 Historical SORs for similar systems.

1.4.2.2 Current SORs for related systems.

1.4.2.3 Relevant DND research reports on both technology and operations.

1.4.2.4 Relevant Doctrine impacting the system of interest.

1.4.2.5 Future Operational Concepts related to the system under development.

1.4.2.6 Design standards related to user performance.

1.4.2.7 Lessons Learned from unit operations.

1.4.3 There is no common template for SORs currently followed within DLR.

1.4.4 Once developed, it is very difficult to track the rationale for requirements in an SOR.

1.4.5 It is very difficult to track how requirements have been merged or split into new versions of requirements during the editing process.

1.4.6 Most projects do not allocate the resources to track the interdependencies between requirements.

1.4.7 Most projects do not track which requirements have been validated with users.

1.4.8 It is very easy to edit requirements without recording the rationale for editing, which decreases the ability to track the sources of requirements.

1.4.9 It is very difficult to track the relationship between requirements and specifications.

1.4.10 It is labour intensive to calculate a "Best Value" bid evaluation score using multiple layers of requirement/spec priority. This challenge contributes to the rationale to use "Lowest Cost" bid evaluation techniques. The Lowest Cost evaluation results in requirements being classified as "Essential" or "Desirable" only, which is a major distraction for the project staff.

1.5 Project Limitations and Constraints

1.5.1 The D.C.I.E.M. study that developed this draft SOR was conducted rapidly, with limited resources which did not allow for validation of the SOR-Spec Maker requirements with the future user community. These future users should be consulted prior to finalization of this SOR and development of the system specification for product evaluation purposes.

1.5.2 The focus of the D.C.I.E.M. study was on DLR operations and the development of the SOR for Army systems. Limited analysis was conducted of Project Management and Engineering staff tasks, which should be extended prior to finalizing this SOR.

1.6 Related Projects

1.6.1 Ongoing projects within DND that SOR-Spec Maker MUST be compatible with include:

1.6.1.1 The Directorate of Force Planning and Project Co-ordination (DFPPC) studies to update CFP 125 and produce a new SOR Template. Once finalized this Force wide SOR template MUST be incorporated as the SOR template within the SOR-Spec Maker software.

1.6.2 Ongoing projects within DND that SOR-Spec Maker SHOULD monitor for potential links include:

1.6.2.1 Soldiers Day, as a reference source for field task information and equipment requirements.

1.6.2.2 HFE Guide, as a reference source for human factors design requirements and analysis processes if this tool is converted to a PC format.

1.6.2.3 Army Lessons Learned Centre CD-ROM development efforts, as a key source of for future system requirements.

2 MISSION, ROLES, AND TASKS

2.1 Mission

2.1.1 The mission of the DLR Requirements Officer is to translate Army needs into Systems and Equipment to meet those needs. This typically consists of three primary tasks:

2.1.1.1 Monitoring of Technological Developments, both domestic and international.

2.1.1.2 Definition of Operational Requirements.

2.1.1.3 Negotiation for Project Resources.

2.1.2 The mission of the Project Management and Engineering staff within ADM(Mat) is to translate Operational Requirements into achievable, testable performance specifications.

2.2 Roles / Scenarios

2.2.1 The SOR-Spec Maker software tool provides support to two classes of user:

2.2.1.1 The Requirements Officer (RO) – who is the DLR staff member responsible for the development of a Statement of Operational Requirements, which contains the functional statements of system requirements to meet user needs.

2.2.1.2 The Engineer – who is responsible for the development of the Performance Specification, which contains the technical engineering specifications used in the procurement process.

2.2.2 Three project scenarios have been considered in the development of the requirements for the SOR-Spec Maker software tool:

2.2.2.1 Projects identified by operational units through field deficiency reporting mechanisms.

2.2.2.2 Projects identified by Commanders or Other DND HQ Staff through the review of industry and trade literature.

2.2.2.3 Projects directed by the political process.

2.3 Concept of Operations

2.3.1 SOR-Spec Maker will be a software tool that will provide support to the requirements and specification management process in three key areas:

2.3.1.1 Links to Supporting Information and References – which will allow the user to access key sources of information used in the development of requirements or specifications.

2.3.1.2 A Process Wizard – which will provide the user with guidance through the key steps of the requirements development process.

2.3.1.3 Requirements/Specification Management – which will provide the user with the tools necessary to enter, edit, and track the status of project requirements and specifications.

2.3.2 The SOR-Spec Maker software tool will be used by ROs within DLR and by PM to develop, record, edit, and track operational requirements and specifications throughout the life cycle of a system.

2.3.3 There will be two users per project (The DLR Requirements Officer, and the Engineer on the Project Management Team), and subsequently at least two instances of SOR-Spec maker per project. These users will most often be geographically separated, working in separate buildings or separate floors of the same building.

2.3.4 The software will be networked such that the both user can view the current version of both the SOR and Performance Specification, however, passwords will permit only DLR staff to edit requirements and only ADM(Mat) staff to edit specifications.

2.4 Key Tasks

2.4.1 The general work flow with the SOR-Spec Maker software will involve the DLR Requirements Officer using the tool to conduct the following key tasks:

2.4.1.1 Determine the key steps in the SOR development process and track progress.

2.4.1.2 Search for reference sources for requirement development.

2.4.1.3 Enter and Edit requirements, indicating rationale.

2.4.1.4 Merge and Split requirements as necessary.

2.4.1.5 Identify and track interdependencies between requirements.

2.4.1.6 Indicate requirements as "validated" with users.

2.4.1.7 Number requirements.

2.4.1.8 Prioritize requirements.

2.4.1.9 Print requirement reports.

2.4.2 The general work flow with the SOR-Spec Maker software will involve the Engineering staff on the Project Management Team using the tool to conduct the following key tasks:

2.4.2.1 Search for reference sources for specification development.

2.4.2.2 Enter and Edit specifications, indicating rationale.

2.4.2.3 Merge and Split specifications as necessary.

2.4.2.4 Identify and track the link between specifications and their source requirements.

2.4.2.5 Identify and track interdependencies between specifications.

2.4.2.6 Indicate specification test results.

2.4.2.7 Number specifications.

2.4.2.8 Prioritize specifications based on requirement priorities.

2.4.2.9 Print specification reports.

2.5 Concept of Support

2.5.1 SOR-Spec Maker training will initially be provided through informal courses taught to active DLR staff.

2.5.2 The materials developed for initial DLR training will be passed to the Technical Staff School in Kingston for the training of future DLR Requirements Officers.

2.5.3 Network support will be provided by local system administration personnel in DND facilities.

2.5.4 SOR-Spec Maker technical support will be provided by the developer of the software selected to meet this requirement.

3 OPERATIONAL ENVIRONMENT

3.1 General

3.1.1 SOR-Spec Maker will be used on desktop Personal Computers (PCs) in a networked environment.

3.1.2 The software will be used at desks under typical office environmental conditions.

3.2 Threat

3.2.1 N/A – office information system.

4 OPERATIONAL REQUIREMENTS

4.1 General

4.1.1 SOR-Spec Maker **should** provide a networked, integrated, software environment that consolidates system requirements, specifications, and their rationale.

4.1.2 SOR-Spec Maker **must** be accessible by both DLR and ADM(Mat) staff working on a project from their PC in their primary office area.

4.1.3 SOR-Spec Maker **must** provide login and password protection for each DLR and ADM(Mat) user with different privileges for each. Key privileges include restrictions whereby only the authorized DLR officer can edit requirements and only the authorized ADM(Mat) officer can edit specifications.

4.1.4 SOR-Spec Maker **must** provide a template to identify all key project support personnel, with contact information for each, and **should** provide a direct e-mail link to each.

4.1.5 SOR-Spec Maker **must** allow users to enter and edit data in either English or French.

4.2 Design and Concept Guidance

4.2.1 It is expected that SOR-Spec Maker is a Microsoft Windows based product, most likely procured as Commercial Off the Shelf (COTS) software.

4.2.2 These requirements may be met by one product, or by up to three different products consisting of:

4.2.2.1 A Microsoft Windows based Requirements Management tool.

4.2.2.2 An Information Source product, possibly Intranet based.

4.2.2.3 An SOR Wizard product, possibly Intranet based.

4.3 Total System Requirements

4.3.1 Performance Capability – Information Links

4.3.1.1 SOR-Spec Maker **must** provide the user with a means to directly access CD-ROMs and Intranet sites within DND that are used as reference materials for SOR development.

4.3.1.2 Links to CD-ROMS **should** be common links whereby a central program storage device is used for many users to access.

4.3.1.3 Information links **must** be updateable over the network by one system administrator for all users.

4.3.1.4 Information links **should** be grouped as Force Wide, Element (Army, Navy, Air, Support), and Army (Infantry, Armoured, etc..) specific.

4.3.1.5 SOR-Spec Maker **should** contain a Missions/Scenario section that provides a link to a summary of the Land Force scenarios that system must support. The software should allow this scenario text to be placed in the Mission/Scenario section of the SOR or in an Annex depending on how much additional data the Requirements Officer has to incorporate with it.

4.3.1.6 Information links **should** be provided to:

4.3.1.6.1 Electronic Battle Box (CD-ROM from Directorate of Army Doctrine)

4.3.1.6.2 Soldiers Day (Multi-media task/equipment database for Mounted and Dismounted Infantry)

4.3.1.6.3 SOR/Spec Library (consisting of the most recent versions of SOR's and Specs from all Force Elements).

4.3.1.6.4 DND Branches, Schools, and Unit Intranet Sites.

4.3.1.6.5 Defence Research Establishments (DREs) including links to personnel by research interests, recent reports, and library holdings.

4.3.1.6.6 DRDIM literature search services.

4.3.1.6.7 Industrial Search Engines (eg: NTIS)

4.3.1.6.8 Lessons Learned Centre Databases

4.3.1.6.9 Recent Deficiency Databases from Sources such as UCRs or the Army Combat Clothing and Equipment Survey System (ACCESS).

4.3.1.6.10 Listings of DND Libraries for Military and Industrial Standards and Design Guidelines.

4.3.1.7 SOR-Spec Maker **must** allow users to cut and paste from open documents viewed through the Intranet or Windows based applications.

4.3.1.8 SOR-Spec Maker **should** include links to Intranet sites as a component of a document reference in an electronic SOR.

4.3.2 Performance Capability – SOR Wizard

4.3.2.1 SOR-Spec Maker **must** provide the user with an SOR Wizard that indicates the key milestones and process expected in the development of an SOR.

4.3.2.2 The SOR Wizard **must** be based on a documented process for SOR development within DLR (to be developed).

4.3.2.3 The SOR Wizard **must** allow the user to initiate a project, and define the anticipated schedule to meet each of the major project milestones.

4.3.2.4 The SOR Wizard **must** provide the user with a mechanism to indicate when each major milestone has be completed. This feature must include the ability to enter a free text description of the activities completed towards the milestone.

4.3.2.5 The SOR Wizard **must** generate work planning reports including:

4.3.2.5.1 A Status Report indicating all milestones, date of planned completion, and data of actual completion.

4.3.2.5.2 "To Do" lists summarizing uncompleted task and date planned for completion.

4.3.2.6 SOR Wizard, and any associated help system, **should** provide links to DND resources related to tasks that must be completed or SOR sections that must be completed (eg: links to DCIEM for human factors issues).

4.3.3 Performance Capability – SOR Development

4.3.3.1 SOR-Spec Maker **must** allow the DLR Requirements Officer to:

4.3.3.1.1 Very easily enter a new requirement.

4.3.3.1.2 Copy and Paste a new requirement from other Windows based software.

4.3.3.1.3 Edit a requirement already entered into the software.

4.3.3.2 A Requirement in SOR-Spec Maker **must** contain at least the following information:

4.3.3.2.1 A Number.

4.3.3.2.2 A Title.

4.3.3.2.3 A Priority (numerical value).

4.3.3.2.4 The Full Requirement Description.

4.3.3.2.5 The Source of a Requirement.

4.3.3.2.6 The Rationale for a Requirement or it's Edit.

4.3.3.2.7 A comments field.

4.3.3.3 SOR-Spec Maker **must** allow the user to delete a requirement from the active requirements list, but **must** maintain it (any rationale entered for deletion) in the history of the project.

4.3.3.4 SOR-Spec Maker **must** allow the user to split a requirement into multiple requirements.

4.3.3.5 SOR-Spec Maker **must** allow the user to merge multiple requirements into one requirement.

4.3.3.6 SOR-Spec Maker **must** number and maintain the numbering of requirements through editing, deleting, splitting, and merging. This numbering **must** follow the approved DND template.

4.3.3.7 SOR-Spec Maker **must** provide context sensitive help to provide direction on the expected contents of each section of the SOR being completed.

4.3.3.8 SOR-Spec Maker **should** provide direction to the user on resources within DND (DREs, Schools, Libraries, etc..) that can provide assistance on completing each section.

4.3.3.9 SOR-Spec Maker **must** allow the user to define interdependencies between requirements in a hierarchical fashion such that requirements are nested within "parent" and "children" relationships.

4.3.3.10 SOR-Spec Maker **must** allow the user to indicate whether a requirement in its current form has been validated by users since it's last edit.

4.3.3.11 SOR-Spec Maker **should** indicate the method used to validate the latest version of each requirement, including at least the following methods:

4.3.3.11.1 Document Review

4.3.3.11.2 User Focus Group

4.3.3.11.3 Product Trial

4.3.3.12 SOR-Spec Maker **must** allow the user to 'freeze' an SOR whereby the current list of active requirements are consolidated into an SOR document with a revision number, suitable for distribution and review.

4.3.3.13 SOR-Spec Maker **must** provide a means for the user to submit each 'frozen' version of an SOR or a Specification to an SOR Library, where the most recent version overwrites the older version if one exists.

4.3.3.14 The SOR/Spec Library **must** be a searchable database, using the SOR-Spec Maker software, allowing the user to open a located SOR and copy requirements or specifications from the located document.

4.3.3.15 SOR-Spec Maker **must** output active requirements in report format. Modifiable report templates **must** include:

4.3.3.15.1 SOR Report, in the current standard DND format.

4.3.3.15.2 SOR Report, with requirement rationale in tabular format to support document review.

4.3.3.15.3 A Requirement Interdependency Report that illustrates the hierarchical relationship between requirements in an understandable tabular or graphical format.

4.3.4 Performance Capability – Specification Development

4.3.4.1 SOR-Spec Maker **must** allow the DLR Specifications Officer to:

4.3.4.1.1 Enter a new specification.

4.3.4.1.2 Copy and Paste a new specification from other Windows based software.

4.3.4.1.3 Edit a specification already entered into the software.

4.3.4.2 A Specification in SOR-Spec Maker **must** contain at least the following information:

4.3.4.2.1 A Number.

4.3.4.2.2 A Title.

4.3.4.2.3 A Priority (linked to the priority of the requirement upon which it was based).

4.3.4.2.4 The Full Specification Description.

4.3.4.2.5 The Source of a Specification.

4.3.4.2.6 The Rationale for a Specification or it's Edit.

4.3.4.2.7 A comments field.

4.3.4.3 SOR-Spec Maker **must** allow the user to delete a specification from the active specifications list, but **must** maintain it (any rationale entered for deletion) in the history of the project.

4.3.4.4 SOR-Spec Maker **must** allow the user to link a specification to the requirement in the SOR upon which it was based. This link **must** be incorporated into interdependency reports.

4.3.4.5 SOR-Spec Maker **must** allow the user to split a specification into multiple specifications.

4.3.4.6 SOR-Spec Maker **must** allow the user to merge multiple specifications into one specification.

4.3.4.7 SOR-Spec Maker **must** number and maintain the numbering of specifications through editing, deleting, splitting, and merging.

4.3.4.8 SOR-Spec Maker **must** allow the user to define interdependencies between specifications in a hierarchical fashion such that specifications are nested within "parent" and "children" relationships.

4.3.4.9 SOR-Spec Maker **must** allow the user to indicate whether a specification in its current form has been tested since it's last edit.

4.3.4.10 SOR-Spec Maker **should** indicate the method used to test the latest version of each specification.

4.3.4.11 SOR-Spec Maker **must** allow the user to 'freeze' a SPEC whereby the current list of active specifications are consolidated into an SPEC document with a revision number, suitable for distribution and review.

4.3.4.12 SOR-Spec Maker **must** provide a means for the user to submit each 'frozen' version of an SOR or a Specification to a SPEC Library, where the most recent version overwrites the older version if one exists.

4.3.4.13 The SOR/Spec Library **must** be a searchable database, using the SOR-Spec Maker software, allowing the user to open a located SPEC and copy specifications or specifications from the located document.

4.3.4.14 SOR-Spec Maker **must** output active specifications in report format. Modifiable report templates **must** include:

4.3.4.14.1 SPEC Report, in the current standard DND format.

4.3.4.14.2 A Specification Interdependency Report that illustrates the hierarchical relationship between requirements in an understandable tabular or graphical format.

4.3.5 Human Factors Requirements

4.3.5.1 Soldier / Crew Task Performance

4.3.5.1.1 SOR-Spec Maker **must** permit a trained user to enter the details of a new requirement in one minute or less. This time of entry **must** be achievable at the initiation of a project and also when there are over 5000 entries in the document.

4.3.5.1.2 SOR-Spec Maker **should** alert the user that duplicate requirements or specifications are active in the project.

4.3.5.2 Soldier-Machine Interface / Crew Station

4.3.5.2.1 SOR-Spec Maker **must** be a compatible with the operating system used by DLR staff on their networked desktop computers.

4.3.5.2.2 SOR-Spec Maker **should** adhere to the interface style guides for the operating system used on the DLR staff desktops (eg: Windows '95 Style Guide).

4.3.5.3 Health Hazards and System Safety

4.3.5.3.1 N/A – no concerns with environmental or systems safety from software design, software not used for extended periods therefore no concerns with human error or excessive mental workload.

4.3.5.4 User Acceptance

4.3.5.4.1 The SOR-Spec Maker candidate product **must** be reviewed by representative future users through part-task user trials.

4.3.5.4.2 The SOR-Spec Maker product reviewed **must** be judged by a majority of users to be useful and easy to use.

4.3.6 Quantity

4.3.6.1 The initial purchase of SOR-Spec Maker software **must** be sufficient to support both DLR and ADM(Mat) staff for the projects it will be used in support of.

4.3.6.2 The initial purchase of SOR-Spec Maker software **should** include 110 units to support the staff complement within the current active project set and instructional needs at the Kingston Technical Staff School.

4.3.7 Quality

4.3.7.1 SOR-Spec Maker **must** be a completed, final, polished software product with full documentation and commercial support. It **must** not be a product under development.

4.3.8 Location

4.3.8.1 SOR-Spec Maker **should** be installed with:

4.3.8.1.1 52 DLR users at their offices.

4.3.8.1.2 52 ADM (Mat) users at their offices.

4.3.8.1.3 6 workstations at the Kingston Technical Staff School.

5 TOTAL SUPPORT REQUIREMENTS

5.1 Support Requirements

5.1.1 SOR-Spec Maker **must** be supported on the network by existing DND system administration staff.

5.1.2 SOR-Spec Maker products **must** come with technical support from the developer.

5.2 Personnel and Training

5.2.1 SOR-Spec Maker **must** be staffed by the Requirements Officer (DLR) and Project Management Engineering Officer (ADM(Mat)) for each active project.

5.2.2 Therefore, SOR-Spec Maker **must** be operable by a wide range of users. The "worst" case users (from a design perspective) include those with limited knowledge of the procurement process, limited knowledge of SOR content and structure, and little computer knowledge or typing skills. The "best" case users will have significant SOR and acquisition experience and knowledge, and by extremely computer literate. The SOR-Spec Maker software must provide the ease of use necessary for novice users to complete an SOR effectively and easily, while providing short cuts and more advanced data manipulation techniques to be perceived as easy to use and useful by the more sophisticated users.

5.2.3 Initial deployment of the software tool **must** be accompanied by information training at DLR.

5.2.4 Computer Based Training **should** be considered for ongoing and refresher training within NDHQ.

5.2.5 Subsequent training **should** be incorporated into the Technical Staff School course in Kingston.

5.2.6 All SOR-Spec Maker training **should** be task based within the context of realistic procurement scenarios.

6 SCHEDULING REQUIREMENTS

6.1 Critical Milestones

6.1.1 Proposed milestones for the project include:

6.1.1.1 SOR-Spec Maker Concept Presentation - April 1998;

6.1.1.2 SOR-Spec Maker Prototype Use on Example Project - Nov 1998;

6.1.1.3 SOR-Spec Maker Software Specification - Feb 1999;

6.1.1.4 SOR-Spec Maker Software Procurement - Mid 1999.

6.2 System Service Life Expectancy

6.2.1 It is expected that SOR-Spec Maker will be in Service mid 1999, and that it will be effective to 2010+ assuming ongoing manufacturer support and upgrades to maintain compatibility with Operating Systems and no revolutionary changes to DND Staffing or procurement procedures.

7 REQUIREMENTS TABLE

To Be Completed in Next Version.

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