Defence Research and Development Canada
Recherche et développement pour la défense Canada

Advanced Vetronics Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration Human Factors Engineering (HFE) Definition Project

User Requirements Final Report

A. Scipione, J. Armstrong, J. Brooks and M. Espenant
Greenley & Associates

Contract Scientific Authority:
R.H. Chesney
DRDC Suffield

Contract Report
DRDC Suffield CR 2006-223
August 2006

Canada

Advanced Vetronics Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration Human Factors Engineering (HFE) Definition Project

User Requirements Final Report

A. Scipione, J. Armstrong, J. Brooks and M. Espenant
Greenley & Associates

Greenley & Associates
1135 Innovation Drive, Suite 200
Kanata, ON
K2K 3G7

Contract Number: W7714-030816

Contract Scientific Authority: R.H. Chesney (403 544-4764)

Defence R&D Canada – Suffield

Contract Report

DRDC Suffield CR 2006-223

August 2006

Advanced Vetronics Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration

Human Factors Engineering (HFE) Definition Project

User Requirements

Final Report

Completed by:

Scipione, A., Armstrong, J., Brooks, J. & Espenant, M.

G&A
GREENLEY & ASSOCIATES
A CAE Company

Prepared For:

Robert Luiz
DAVPM 4-3-2

August 2006

Table of Contents

1 Scope

This document is an Interim Report for a project entitled "The Advanced Vehicle Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration (TD) Human Factors Engineering (HFE) Definition Project. The purpose of this Interim Report is to detail a preliminary set of User Requirements for the ADVANCE project. This report is submitted by Greenley & Associates Incorporated (G&A) of Ottawa, Ontario, Canada in support of Public Works and Government Services Canada (PWGSC) contract No W7714-030816 Task Number 2005-165.

1.1 Identification

The ADVANCE TD was implemented to design and evaluate a series of advanced vehicle concepts such as: the integration of a multi-layered Vetronics network and a fully Active Suspension to exploit the potential of a Vetronics architecture in the network-centric battlefield of the Army of Tomorrow (AoT). The ADVANCE project is in its Definition Phase and requires the specification of User Requirements for the future development of Armoured Fighting Vehicle (AFV) Crew stations and Operator Machine Interfaces (OMIs).

1.2 Background

Military vehicles include numerous electrical and electronic systems that are controlled and monitored by the crew. In current vehicles, system control and monitoring is facilitated by standalone user interfaces (UIs) that are specific to an individual sub-system. As vehicles became more complex, the number of standalone controls and displays has increased. Combat vehicles also include a variety of optical systems, which are used by the crew for driving, local situational awareness (SA), surveillance and for target acquisition. Furthermore, recent net-enabled operations allow a considerable amount of information in relation to the crew's environment (e.g., own vehicle position, systems status, contact detection, etc.) to be available through both internal and external sources. Net enabled operations also allow information to be available to dismounts, other nearby vehicles, and the Command and Control (C2) system.

Modern vehicle systems integration (Vetronics) is based on distributed control and network connected sensors and communications systems which provide the ability to integrate all vehicle functions through a common Operator-Machine Interface. This interface is also exploited to support other combat functions including communications and command and control. However, the integration of information on a single OMI may become too complex for a crewmember to efficiently operate, especially during high stress situations, as well as sustained operations when the crew is fatigued.

To achieve the most simplistic OMI, the crew workstation and the OMI software must be designed with a comprehensive understanding of: crew task requirements, the crew's relative priorities, task schedules, task completion times, and task type (e.g., cognitive, vigilance, fine motor control, etc.). Requirements must be categorised and prioritized to develop simple and effective interfaces that will facilitate the crew in maintaining situational awareness and in rapidly responding to combat threats. Furthermore, designing a common crew station (CCS) can decrease individual training across multiple vehicle platforms for common functionalities.

Though the Vetronics architecture could potentially integrate a very large subset of components both on and off a vehicle platform, the resources and time available for the ADVANCE TD are limited. Therefore, some non-critical network functions will be emulated rather than implemented using actual hardware. The components that could feasibly lend themselves to emulation, while preserving the requirements of the demonstrator must be determined, along with their associated costs, schedule and integration risk.

1.3 ADVANCE TD Objectives

The ADVANCE TD aims to demonstrate improved crew performance through a completely integrated multi-layered Vetronics network, whereby all subsystems are accessible from any node on a vehicle. System controls and displays will be integrated and shared among each crewmember's workstation, and through the Land Command Support System (LCSS). Information from the Vetronics system will also be accessible from external platforms. The C2 system, other vehicles, dismounts and uninhabited aerial and ground vehicles (UAVs/UGVs) will be able to receive data and commands through the Vetronics network. The project also aims to design a system that facilitates diagnostic and prognostic evaluation from the same interface ports to increase maintainability.

A secondary objective of the TD is to develop and integrate a fully Active Suspension to exploit the potential of the Vetronics architecture and to demonstrate the benefits of a stabilized and levelled platform.

This project will provide information to a number of ongoing Major Crown Acquisition projects, which have identified the requirement to conduct mobile surveillance and engagements from combat vehicles that are currently limited to static applications. It is envisaged that Active Suspension will significantly increase the effectiveness of the crew, while reducing the impact of vibration and mechanical shock on the vehicle and cargo.

The ADVANCE TD is not focussed on designing technical solutions and crew interfaces for a single vehicle configuration. The project focuses on developing crew interfaces that can be readily adapted and reconfigured to a broad range of roles as well as to provide support to these roles and hardware configurations that may evolve over time. As a result, requirements must be developed to determine which tasks will be required in a particular configuration. Furthermore, the workstation interface must be generic and adaptable to multiple functions through software re-configuration.

1.4 Document Overview

This document presents an initial specification of the expected User Requirements for the ADVANCE TD. This document is a preliminary attempt to define and consolidate design influences and resulting design concepts for the ADVANCE TD. Ongoing refinement of these inputs and analysis of the resulting design concept will occur during the course of the ADVANCE TD, resulting in multiple iterations of the specified User Requirements.

1.5 User Requirements Objectives

The objectives of this User Requirements document is to detail design concepts for the ADVANCE TD for AFV operations within the context of a net-enabled operations environment. The ADVANCE User Requirements are categorized according to the following:

- Common Crew Station Design and Layout
- Common Crew Station Functions;
- Common Crew Station Personnel; and
- Maintenance and Supportability Requirements.

1.6 Document Structure

This User Requirements Interim Report has the following structure:

- Scope: Presents the background and overall project objectives;

- Reference Documents: Contains references for the documents used during the development of the User Requirements;
- ADVANCE TD Force Concepts: Provides brief overview of the projected ADVANCE Force Concepts, along with a brief overview of the proposed ADVANCE technologies.
- User Requirements: Identifies the preliminary User Requirements for the ADVANCE TD;
- Conclusion: Discusses the "way ahead" for the ADVANCE TD; and
- Acronyms: Provides the acronyms used in this report.

2 Reference Documents

The following documents of were referenced during the development of the User Requirements.

2.1 ADVANCE TD Reference Documents

1. Espenant, M., Scipione, A., Armstrong, J. & Brooks, J. (2006). *ADVANCE HFE Definition Project: Stakeholder Control Document Rationalization.* ADVANCE Interim Final Project Report to DAVPM 8-4-4.
2. Scipione, A., Armstrong, J., Brooks, J. & Espenant, M. (2006). *ADVANCE HFE Definition Project: Mission, Function, & Task Analysis.* ADVANCE Interim Final Project Report to DAVPM 8-4-4.

2.2 Additional Armoured Fighting Vehicles Resource Documents

3. Armstrong, J., Lai, G., Brooks, J., and Williams, S. (2006). *Multi Mission Virtual Vehicle Mission, Function and Task Analysis Version 2.* Project Report to General Dynamics Canada (In Press).
4. Brooks, J., Armstrong, J., and Williams, S. (2004). *Multi Mission Virtual Vehicle Mission, Function and Task Analysis Version 1.* Project Report to General Dynamics Canada.
5. Brooks, J. and Greenley, M. (1998). *Battle Group and Combat Team Command & Control Information System User Requirements*. Report to Defence and Civil Institute of Environmental Medicine.
6. Greenley, M. and Brooks, J. (1998) *The Integration of Tactical Computer into the Turret of an Armoured Fighting Vehicle. Designing for Human Performance*, 30th Annual Conference Human Factor Association of Canada, October 19-22, 1998.
7. Greenley, M. and Brooks, J. (1996). *Human Factors Analysis of ALFCS Function Allocation.* Project Report to the Department of National Defence.
8. Greenley, M. and Brooks, J. (1996). *Human Factors Analysis of ALFCS Information and Task Flow.* Project Report to Computing Devices Canada.
9. Tousigant, J. (2005) *ARC3RRO Project – ADATS Detachment Commander / Radar Operator Task Analysis (Reference System Requirements Version 0.15).* Project Report Oerlikon Contraves, Inc.
10. Wells, P., Banbury, S., and Brooks, J. (2006). *Mission, Function Task Analysis (MFTA) of the ALERT-Enhanced Coyote Reconnaissance & Surveillance Vehicle*. Project Report to General Dynamics Canada.

2.3 Canadian Forces (CF) Documentation

11. Government of Canada (2004). *The Force Deployment Concept for the Army*. Department of National Defence Position Paper.
12. Chamberland, A. (1998). Anthropometric Survey of the Land Forces. Survey on behalf of Department of National Defence (DND)
13. Directorate of Land Strategic Concepts (2003). *Future Force: Concepts for Future Army Capabilities*. Department of National Defence Position Paper.

14. Maurer, LCol M.C. (2005). *Project Charter: Canadian Army of Tomorrow Force Employment Concept.* Director General Land Concept Development, Department of National Defence.

2.4 Military Standards

15. *MIL-STD-1472F.* Department of Defence Criteria Standard. Human Engineering. August 1999.

16. *MIL-STD-411F.* Department of Defence Criteria Standard. Human Engineering. March 1997.

3 ADVANCE TD Force Concepts

The ADVANCE TD was implemented to design and evaluate a series of advanced vehicle concepts including the integration of a multi-layered Vetronics network and a fully Active Suspension to exploit the potential of a Vetronics architecture in the network-centric battlefield of the Army of Tomorrow. The ADVANCE TD was conceived with a number of objectives, including:

a. Mobility. The integration of AS technology will significantly enhance the range of environments conditions in which AFVs will operate at maximum effectiveness.

b. Information Superiority. The ADVANCE TD will exploit Reconnaissance, Surveillance, and Target Acquisition (RSTA) technologies, on both manned and robotic platforms connected in a network centric manner to obtain and maintain information superiority.

c. Precision Fires. The ADVANCE TD will employ advances in RSTA, network connectivity, and smarter munitions to deliver precision fires on the battlefield thereby optimizing ammunition requirements and battlefield damage requirements.

d. Dominant Manoeuvre. Using information superiority with enhanced survival and manoeuvre systems, AFVs equipped with ADVANCE technologies will have dominant manoeuvre on the battlefield.

3.1 Combat Vehicle Concept

The ADVANCE TD will impact a number of uninhabited air and ground vehicles, and a range of AFVs within the CF. The focus of this design report is the development of a Common Crew Station for application across the range of AFVs included within the scope of ADVANCE.

To achieve maximal operational flexibility, AFVs within the scope of the ADVANCE TD should be able to operate under the following conditions:

a. Autonomously - the Operator will define the vehicle destination or waypoints and the vehicle will autonomously navigate the established route.

b. Remotely – the Operator will control vehicle systems using a mobile control, or dismounted version of the Operator Machine Interface. This extends to controlling other vehicles within a troop.

c. Manned – the vehicle will be operated by a crew onboard the vehicle, working from a Common Crew Station.

3.2 ADVANCE Key Technologies

The key technologies under exploration in ADVANCE include:

- Integrated Multi-Layered Vetronics Network; and
- Fully Active Suspension System.

3.2.1 Integrated Vetronics

The integration of a Vetronics network has the potential to influence a range of systems including high-level command structures, individual vehicle platforms, dismounted soldiers and UAVs/UGVs in each of the five operational functions. Vetronics may directly impact performance by facilitating the following:

- Common Crew stations: A common crew station will reduce the configuration requirements specific to individual vehicle platforms. Implementing a common look and feel across crew stations may also reduce training requirements, and facilitate the cross-training of Operators across platforms;
- Reconfigurable Crew stations: The integration of Vetronics will facilitate crew interfaces to be readily adapted and reconfigured for a broad range of roles;
- Remote Operation of Systems: Vetronics may facilitate the control and management of remote vehicle systems. The integration of Vetronics may provide the capability to rapidly distribute information from remote vehicle platforms;
- Information Distribution/Data Exchange: The C2 system, other vehicles, dismounts and UAVs/UGVs will be able to receive data and commands through the Vetronics network. Information can be integrated into a Common Operating Picture (COP) and incorporate significant data fusion capabilities to minimize information redundancy;
- Integrated Simulation Training Capability: The integration of Vetronics systems may support the development of in-vehicle training systems that would reduce the requirement for off-board simulation systems and that would support mission rehearsal. Data capture technology could also be used to record data for mission play-back and after-action reviews.
- Systems Diagnostics and Monitoring: The integration of Vetronics systems may provide the ability to conduct remote system diagnostics and assist in the recognition and identification of system failures while in-situ. Integrated Vetronics systems will also support the fusion of multiple on-board sensors (e.g. Radar/IR/MAWS) as part of Defensive Aides Suite (DAS) and Local Situation Awareness System (LSAS) capabilities, as well as support power management activities for the vehicle (e.g., maximize silent watch capabilities).

3.2.2 Active Suspension System

The integration of an Active Suspension system across the Light Armoured Vehicle (LAV) fleet has the potential to influence vehicle level performance by providing:

- Improved Mobility (Operational and Tactical): The integration of Active Suspension may facilitate greater mobility over a wider range of terrain types, thereby improving planning and increasing the number of possible routes. Active Suspension may improve operational mobility and increase the range of conditions in which vehicle systems could be operated while the vehicle is mobile;
- Improved Stability: Active Suspension may provide stabilization for both sight and weapons. This will increase the range of conditions in which a vehicle can accurately and successfully engage targets and conduct surveillance operations;
- Decreased Vibration: The reduction of vibration may improve crew performance by increasing an Operator's ability to conduct tasks and operate systems while mobile. The reduction of vibration may also increase work duration by decreasing Operator fatigue; and
- Improved Maintainability: Through reductions in vehicle vibration, vehicle components should experience reduced wear and increased longevity. Reductions in associated maintenance costs should also be expected due to decreases in equipment failure and longer preventative maintenance intervals.

4 User Requirements

The User Requirements illustrate a preliminary attempt to define and consolidate design influences and resulting design concepts for the ADVANCE TD. The User Requirements detail design concepts for the ADVANCE TD for AFVs within the context of net-enabled operations. The User Requirements were primarily derived from previous project experience in the AFV domain and have evolved from recommendations provided in the ADVANCE Mission, Function, and Task Analysis (MFTA). Ongoing refinement of these requirements and analysis of the resulting design concept is required during future phases of the ADVANCE TD.

This section details the following User Requirements:

- Common Crew Station Design and Layout;
- Common Crew Station Functions;
- Common Crew Station Personnel; and
- Maintenance and Supportability Requirements.

4.1 Assumptions

- The term "systems" refers to all vehicles functions and capabilities that are integrated within the Vetronics network that are available for control by the Operator.
- "Other vehicle systems" refer to Uninhabited Air and Ground vehicles directly controlled from the AFV platform and not controlled by higher-level assets.
- The current User Requirements are intended to provide a general guideline for the development and integration of ADVANCE technologies across AFV platforms. As the ADVANCE TD progresses towards implementation within specific AFV platforms, these User Requirements will need to be further analysed and refined.

4.2 Common Crew Station Design and Layout

Common CCS design and layout User Requirements include:

- The sub-systems shall be integrated under a common interface.
- Interaction with each sub-system shall be identical.
- The user interface shall conform to a user-centered design that accounts for the Operators' cognitive, perceptual, and physical capabilities and limitations.
- Crew stations, work spaces and crew interfaces shall draw upon appropriate Human Factors (HF) Design Standards and Guidelines (e.g., MIL-STD 1472F).
- The user interface shall allow the Operator to manage multiple simultaneous tasks.
- The user interface shall allow the Operator to quickly and efficiently transition from one task to another.
- Redundant displays shall be provided in the case of primary display failure.
- Display parameters (e.g., brightness, contrast, colour) shall be manually configurable by the Operator.

- Displays shall be Night Vision Imaging System (NVIS) compatible.

4.3 Common Crew Station Functions

The User Requirements for the CCS functions are characterised according to the following functions:

- General Function User Requirements;
- Combat Operations User Requirements;
- Command and Control User Requirements;
- Navigation User Requirements;
- Network Centric Operations User Requirements; and
- Advisories, Cautions, and Warnings (ACWs) User Requirements.

4.3.1 General User Requirements

CCS general function User Requirements include:

- A back-up system shall exist, such that if the Vetronics system fails, the Operators can still access and control all vehicle systems.
- All vehicle capabilities shall be operated from any crew position within the vehicle.
    - An interlock shall be provided to ensure uninterrupted operation of critical tasks.
    - An interface shall be provided to allow crew members to override vehicle systems, if required.
- The CCS shall provide access to all vehicle sensors for the purposes of sensor control, manipulation, configuration, and monitoring of data streams.
- The functions of "launching, operating, and recovering" uninhabited air and ground vehicles shall be conducted through the CCS interface.
- Other vehicle (e.g., UAVs/UGVs) functions, including system configuration, navigation, and sensor and weapon control shall follow the same design principles and methods of interaction as own vehicle functions.
- Own and other vehicle systems shall allow automatic configuration of systems settings and characteristics.
- Own and other vehicle systems shall allow manual configuration of systems settings and characteristics.
- Initial default systems settings for own and other vehicle settings shall be mission specific, as well as user specific.
- Default system configuration shall be shall be optimized for all systems based on the Standard Operating Procedure (SOP), user preferences (user ID), and technical capabilities of the system.
- A shared interface shall be provided to the crew within a vehicle platform.
- The representation of tactical information shall be maintained between Operators within a vehicle platform.

- Tactical information shall be presented in a manner that enables Operators to easily access a dedicated and centralized tactical map display.
- The CCS shall support automated data entry to reduce manual data entry requirements.
- The CCS shall allow the Operator to efficiently access, assess, and monitor all systems within the vehicle, including automated and command and control systems.
- The CCS shall allow the Operator to manually control automated systems when required.

4.3.2 Combat Operations User Requirements

Combat Operations User Requirements include:

- Tactical information (e.g., including Blue-Force and Red-Force pictures) shall be rapidly distributed from any platform on the battlefield through a digital network, including UAVs, UGVs, and remote sensors.
- Tactical information shall be integrated into a Common Operating Picture, and shall incorporate significant data fusion capabilities to minimize information redundancy and to support platform-level requirements.
- Automatic Target Detection and Recognition (ATDR) systems shall support automatic target detection, tracking, identification, prioritization and classification.
- The Operator shall be able to manually perform target detection, tracking, identification, classification and prioritization using vehicle sensors and weapon systems.
- The CCS shall support the engagement of ground and air targets while static or on the move.
- The CCS shall support digital network engagements including call-for-fire and the execution of fire requests.
- Any new high-priority targets provided through the COP shall be immediately alerted to the crew.
    - Further analysis is required to determine appropriate target priorities.
- Automatic and manual configuration of weapon systems shall be supported.
- The weapon system shall support default weapon and ammunition selection based on target classification, range and priority.
- The weapon system shall provide integrated Combat Identification (CID) ACW's within the primary display.
- The weapon system shall support target-handoff between crew members within the CCS.
- The weapon system shall support target-handoff between different vehicle platforms.
- The CCS shall support a reconfigurable field of view (i.e., narrow to wide and vice versa) to support the type of situation, mission, and environment.

- The CCS shall provide sufficient magnification levels in both Electro-Optical (EO) and LSAS systems to support manual target engagement at extended ranges.
- The CCS shall provide the ability to hand-off targets to other vehicles within a troop.
- A Battle Management System (BMS) shall be implemented to track target engagements, including all incoming and outgoing network engagements.

4.3.3 Command and Control User Requirements

Command and Control User Requirements include:

- The Command and Control systems shall allow the Operator to efficiently manage all information from on-board and off-board data sensors.
- The Command and Control systems shall provide the Operators with the ability to transmit Mission Information, including tactical maps, mission orders, and digital messages to other Blue-Force entities.
- The Command and Control systems shall provide the ability to conduct mission playback and rehearsal.
- The Command and Control systems shall provide the ability to remotely operate other vehicles' systems (e.g., drive, weapon control, sensor control) within a troop.

4.3.4 Navigation User Requirements

Navigation User Requirements include:

- Tactical information and digital maps shall be integrated within a shared tactical display.
- Own vehicle and troop waypoints shall be supported within the tactical display and primary sight.
- Tactical navigation systems shall be provided to all Operators within a vehicle.
- Tactical navigation systems shall provide the ability to conduct route planning.
- Tactical navigation systems shall integrate enhanced decision aids (e.g., terrain assessment, line of sights calculations) to support route planning.
- Tactical navigation systems shall integrate Vetronics data from vehicle propulsion and vehicle health-management systems to support route planning.
- The vehicle shall be capable of using on-board vision systems and sensors, integrated with digital map data to support autonomous navigation to a desired location identified through way-points and routes provided by an Operator.
- The crew shall be able to make way point corrections as required to achieve the desired route.
- Automatic navigation systems shall be integrated with the Active Suspension monitoring system to allow for predictive analysis of terrain to assist in the prevention of manoeuvres that may exceed vehicle safety limits.

4.3.5 Network Centric Operations User Requirements

Network Centric Operations User Requirements include:

- If the External Command Center is disabled, a redundant system shall exist on the vehicle level to continue to provide data fusion for that platform.
- The systems at the vehicle level shall implement information filters in order to remove faulty information provided by the Command Center.
- Digital data transmission latency for Red and Blue Force updates shall be minimal.
- A Vetronics enabled Battle Management System shall support the digital transmission of pertinent communication (e.g., mission orders, vehicle health, status and contact reports).
- Contact type and status shall be broadcasted for digital fire requests and orders.
- The External Command Post (CP) shall integrate all fire requests within the Local Land Picture which is broadcasted back to all members of the Combined Arms Teams via the digital map displays.
- Network Operations shall support direct and efficient interactions between the sensor and shooter for network engagements.

4.3.6 Advisories, Cautions, and Warnings User Requirements

Advisories, Cautions, and Warnings User Requirements include:

- Advisories, cautions, and warnings shall be consistently implemented across vehicle platforms.
    - ACW design shall draw upon appropriate Human Factors Design Standards and Guidelines (e.g., MIL-STD 1472F, MIL-STD 411F, and Joint Services Specification Guide)
- The system shall integrate and prioritize all ACWs, such that the crewmembers are provided with the highest level alert in the primary display.
- **Note**: There is currently insufficient information to determine which advisories, cautions and warning should be displayed on the primary and secondary displays.
    - A functional analysis must be performed to determine the appropriate prioritization of all system ACWs.

4.4 Common Crew Station Personnel Requirements

CCS personnel User Requirements include:

- The design of the CCS shall consider the anthropometrics (range of size, shape, and gender) of the crewmembers.
- The design of the CCS shall consider the clothing worn (all types) by the crewmembers.
- The design of the CCS shall accommodate 95% of the user population as defined in the 1997 Land Forces Anthropometric Survey.
- The design of the CCS shall facilitate cross-training among crewmembers and across vehicle platforms.

- A Common Look and Feel (CLF) across crew stations shall be implemented to reduce training requirements and facilitate the cross-training of Operators across vehicle platforms.
- Crew rotation cycles shall support adequate rest periods to reduce Operator fatigue and to support recovery for sustained operations.
- **Note:** Military Occupational Specialities (MOSs) and Military Occupational Code (MOCs) shall be further analysed to ensure that existing MOS and MOC structures adequately support the requirements of AFVs equipped with ADVANCE technologies.

4.5 Maintenance and Supportability User Requirements

Maintenance and supportability User Requirements:

- Common systems and displays shall increase the ease of maintainability by utilizing the same procedures and maintenance processes across vehicles.
- Replacement components for common systems and displays shall not differ between vehicle platforms.
- System status and vehicle health data shall be facilitated through the inclusion of Vetronics, enhancing the ability to predict system failures.
- Vetronics shall provide the ability to conduct remote system diagnostics.
- Vetronics shall facilitate the recognition and identification of system failures while in-situ.
- Systems shall allow vehicle health status to be monitored in real-time by maintainers to support Combat Units in the field.
- Active Suspension and Vetronics systems shall be maintainable while deployed.
- The CCS shall be able to remotely identify and diagnose other vehicles, including UAVs/UGVs health status.

5 Conclusion

This interim document presents the preliminary User Requirements for ADVANCE capabilities in relation to AFVs within the CF. The preliminary set of User Requirements was derived from previous relevant projects and from recommendation in the ADVANCE MFTA, and is further extended to include additional tasks associated with net-enabled combat.

As the ADVANCE TD is currently in the Definition Stage of the project, the User Requirements specified in this document provide a preliminary attempt to define and consolidate design influences and resulting design concepts for the ADVANCE TD. Ongoing refinement of these inputs and analysis of the resulting design concept will occur during the course of the ADVANCE TD, resulting in multiple iterations of the MFTA, which will evolve the existing User Requirements. Significant involvement from the AFV operational community will be required to aid in the identification and definition of future User Requirements, along with aiding in the refinement of the User Requirements currently specified.

During this Definition Stage of the project, the following activities were also completed:

- Mission, Function, and Task Analysis: The MFTA provided an initial definition of the function and tasks relevant to AFV operations within the scope of the ADVANCE TD. This MFTA were developed to aid the future definition of: the system functions that should be machine implemented or software controlled, and the system functions that should be reserved for the human Operator/Maintainer; the tasks that Operators and Maintainers must accomplish; the system requirements, potential equipment, and human/equipment requirements; and the Operator and Maintainer involvement in the system to establish and analyze: crew size; equipment procedures; and skill, training and communication requirements.
- Experimental and Test Plan: Experimental and Test Plans were developed, outlining the assessment strategy for future system evaluations. The plan were outlined the requirements for the system evaluations, and provided a plan to conduct the experimentation. The system evaluations will focus on the effectiveness of the Soldier Machine Interface (SMI), including human performance, usability, crew station ergonomics and human computer interaction.
- Human Systems Integration (HSI) and HFE Program Plan: The HSI and HFE Program Plan detailed and scheduled future HSI and HFE activities for the project's implementation phase. The HSI and HFE plan detailed the following activities: verification of user and technical requirements, the conduct of HSI and HFE analysis to provide HFE design input to the SMI, the conduct of user groups, and the planning and execution of experimental trials.

6 Acronyms

ACW	Advisories, Cautions, and Warnings
ADVANCE	Advanced Vehicle Architecture for a Net-Enabled Combat Environment
AFV	Armoured Fighting Vehicle
AoT	Army of Tomorrow
ATDR	Automatic Target Detection and Recognition
BMS	Battlefield Management System
C2	Command and Control
CCS	Common Crew station
CF	Canadian Forces
CID	Combat Identification
CLF	Common Look and Feel
COP	Common Operating Picture
CP	Command Post
DAS	Defensive Aides Suite
DND	Department of National Defence
EO	Electro-optical
G&A	Greenley & Associates Inc.
HF	Human Factors
HFE	Human Factors Engineering
HSI	Human Systems Integration
LAV	Light Armoured Vehicle
LCSS	Land Command Support System
LSAS	Local Situational Awareness System
MFTA	Mission Functions Task Analysis
MOC	Military Occupational Code
MOS	Military Occupational Specialities
NVIS	Night Vision Imaging System
OMI	Operator Machine Interface
PWGSC	Public Works and Government Services Canada
RSTA	Reconnaissance, Surveillance, & Target Acquisition
SA	Situation Awareness
SMI	Soldier Machine Interface

SOP	Standard Operating Procedure
TD	Technology Demonstration
UAV	Uninhabited Aerial Vehicle
UGV	Uninhabited Ground Vehicle
UI	User Interfaces

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for who the document was prepared, e.g. Establishment sponsoring a contractor's report, or tasking agency, are entered in Section 8.)

Greenley and Associates Incorporated
1135 Innovation Drive, Suite 200,
Kanata, ON K2K 3G7

2. SECURITY CLASSIFICATION
(overall security classification of the document, including special warning terms if applicable)

UNCLASSIFIED

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title).

ADVANCE TD Human Factors Engineering Definition Project – User Requirements Final Report (U)

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Scipione, Andrea; Armstrong, Joe; Brooks, Jeremy; and Espenant, Mark

5. DATE OF PUBLICATION (month and year of publication of document)

August 2006

6a. NO. OF PAGES (total containing information, include Annexes, Appendices, etc) 20

6b. NO. OF REFS (total cited in document) 0

7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Contract Report

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address.)

DRDC Suffield (through DAVPM), Box 4000 Medicine Hat, AB, T1A 8K6, CANADA

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)

12SH01 – ADVANCE TD Project

9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)

W7714-030816 Task Number 2005-165

10a. ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)

DRDC Suffield CR 2006-223

10b. OTHER DOCUMENT NOs. (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

n/a

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification)

(x) Unlimited distribution
( ) Distribution limited to defence departments and defence contractors; further distribution only as approved
( ) Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved
( ) Distribution limited to government departments and agencies; further distribution only as approved
( ) Distribution limited to defence departments; further distribution only as approved
( ) Other (please specify):

12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally corresponded to the Document Availability (11). However, where further distribution (beyond the audience specified in 11) is possible, a wider announcement audience may be selected).

Unlimited

13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C) or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual).

(U) This document is the final report for the first phase of a project entitled “The Advanced Vehicle Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration (TD) Human Factors Engineering (HFE) Definition Project. The purpose of this Report is to detail a preliminary set of User Requirements for the ADVANCE project. This report is submitted by Greenley & Associates Incorporated (G&A) of Ottawa, Ontario, Canada in support of Public Works and Government Services Canada (PWGSC) contract No W7714-030816 Task Number 2005-165.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifies, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Vetronics, Technology Demonstrator, ADVANCE, Crew Workstation, SMI, Human Factors, Net-Enabled