Swedish Projects

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The Swedish part of this report focus on research within virtual reality in the military sector. Of course there is a lot of research conducted at different universities in Sweden but these activities are not included here. The military research work presented here includes the three military administrations, FOI – Swedish Defence Research Agency, FMV – Swedish Defence Materiel Administration, and SNDC – Swedish National Defence College. Some work is done at the military units but the main research effort within the virtual reality area within the Swedish defence organization is included within these three administrations.

1.0 FOI – SWEDISH DEFENCE RESEARCH AGENCY

The presentation bellow is different projects conducted at FOI which includes virtual environments.

1.1 Operator Site

The main aim of the project is to render more effective operator environments in complex systems by developing and adjusting operator supports that generate workload reduction and performance enhancement (Figure 1). The focus is on integration of operator supports characterised by being intuitive and thus requiring low degrees of human information processing. Experimental studies of visual, tactile and 3D audio displays are performed, including Human Factors evaluation and concept development for both manned and unmanned platforms.

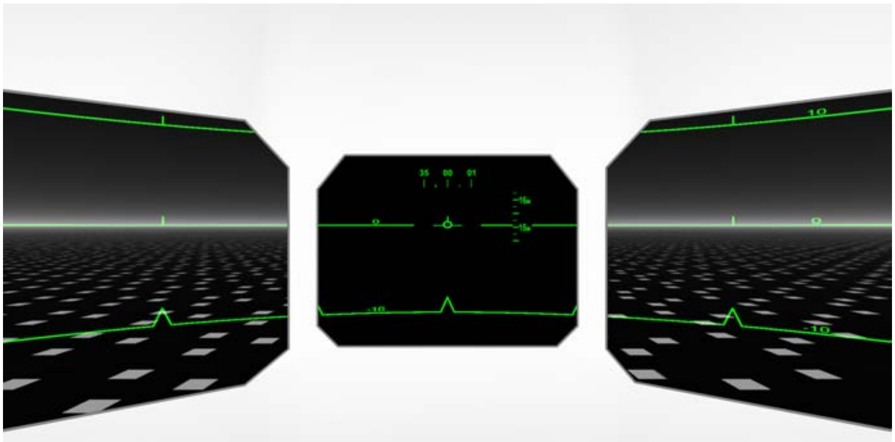

Figure 1: Example of Presentation that can be used during Low Visibility Conditions in Military Aircrafts.

1.2 Cognitive Overview

Every day there are numerous of important decisions made by decision makers in complex and dynamic environments. A leader of a rescue operation who is facing a major fire in a multi-storey building must act rapidly and accurately in order to cope with the situation. In another part of the world a taskforce is entering an urban area that has been occupied by terrorists. Somewhere else an air-traffic controller has discovered two airplanes that are on collision course and must decide how to handle the situation to

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prevent a disaster. All these decision makers are facing different kinds of problems that they need to handle in different ways. However, they all have at least one thing in common – they need to make important decisions in a dynamic environment – decisions that often are a matter of life or death.

Researchers all over the world work to find ways to help these decision makers. The technological advancement has created new opportunities. Today air-traffic controllers use two dimensional (2D) radar displays to monitor and guide air-traffic. In a similar way, the staffs that lead the taskforce usually have access to some kind of 2D command and control (C2) system that monitors the soldiers' movements. The technological development has now made it possible to present this kind of information in three dimensions, 3D. The question is if 3D presentation is better than 2D presentation, i.e. if it generates better decision making and better performance? The game industry uses 3D and the subjective effect is easy to see, but that does not mean 3D should be used for command and control (C2) systems too.

Research shows that 2D lead to better performance for some tasks while 3D lead to better performance in other tasks [1-3]. It is not easy to say when 2D should be used and when 3D should be used. One rule of the thumb is that 2D is good for tasks involving metric judgments and 3D is good to gain overall situation awareness (SA) [4]. SA is generated over time and is an important part of dynamic decision making. Reference [5] divides SA into three levels; perception, comprehension and prediction. The third level, prediction, is very important for dynamic decision making since the decision maker needs to be able to predict how a situation is going to evolve. At the Swedish Defence Research Agency (FOI) several studies relating to this problem has been conducted [1, 6-7].

In Military Operations in Urban Terrain (MOUT) it can be difficult to acquire and maintain good SA. In these environments threats can come not only from a close range but also from above. Enemies may hide behind a building and there may be snipers luring in a window or on a roof. Therefore, the commander of a MOUT needs a lot of support, probably 3D information, in order to make accurate decisions. One important question is if the commander should operate from a command vehicle where he is protected and has access to various decision supports? However, he is then taken away from the actual scene and that will most likely affect his SA negatively. Thus, there is a need to find a solution where the commander can use a C2-system and stay in the field where he belongs. It is also essential to find out what kinds of decision support the commander needs and if the information should be presented to him in 2D or 3D. The Swedish Defence Research Agency has developed a research platform to study these research questions.

1.2.1 A Research Platform: CoMap

The research platform is primarily developed for the military domain but it can easily be modified to meet the needs for the civil domain. The platform is called CoMap, Cognitive Map. The reasoning behind the name is that CoMap, besides a traditional 2D map, has a 3D map with some operational functionality which gives cognitive decision support for the operator. CoMap is constantly being developed in cooperation with possible end-users, e.g. the Swedish Military Combat School, MSS Kvarn. With its current functionality CoMap can be used as an information and decision aid during an exercise or as a planning- and evaluation-tool.

CoMap consists of three different parts; a 2D map, a 3D map, i.e. a 3D model of an urban area in Norrköping[1], and a toolbar (Figure 2). The toolbar consists of tools to create lines of approach, to place symbols and arrows to indicate for example own and enemy forces. The symbols are shown both in the 3D map and in the 2D map.

[1] This area was chosen because the Swedish Army Combat School, MSS Kvarn, uses this area for MOUT-exercises and it is possible to test the platform in cooperation with them.

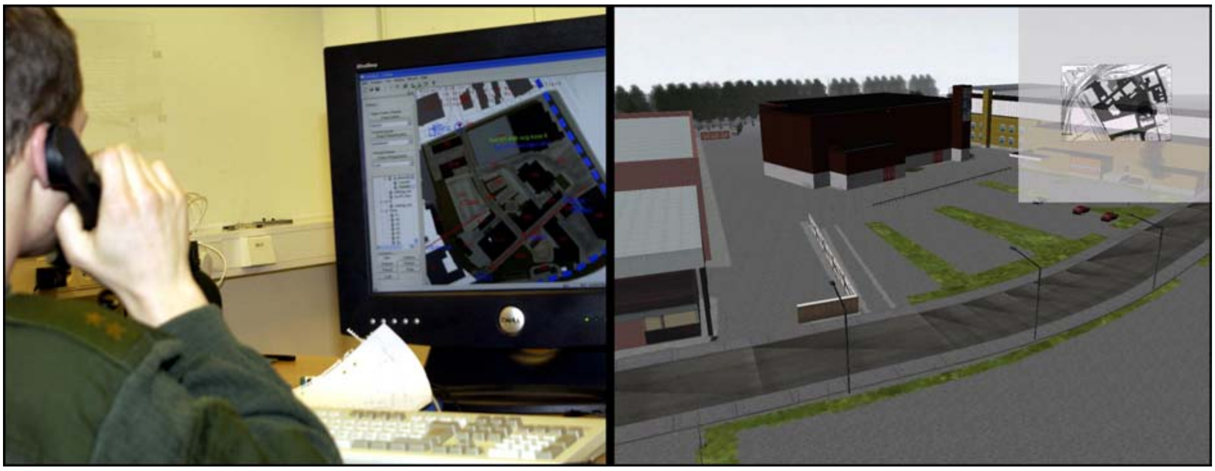

Figure 2: Left: A View of CoMap used by a Soldier in during a Real Military Exercise. Right: The 3D map used in CoMap.

The 3D map also has functionality that makes it possible to click in the model to get information about specific objects or to change field of vision to that specific place. The operator can move around in the 3D model and see it from different angles, e.g. it is possible to fly around and see everything from above or walk around on ground level. There are also tools to measure distances and to get line of sight analysis from certain positions, which can be valuable information in order to make accurate decisions. The operator can also use an overlay-function to show certain symbols and/or dispositions. CoMap can be used on more than one computer so if several computers are connected to a network an overlay can be sent to different operators within the network (Figure 3).

Figure 3: A Portable Version of CoMap used in the Field. The portable system is connected with a stationary systems of CoMap placed in away from the action.

[1] Andersson, P. and Alm, T., "Perception Aspects on Perspective Aircraft Displays". In *Displays, 24*, 2003, pp. 1-13.

[2] Bemis, S., Leeds J., and Winer, E., "Operator Performance as a Function of Type of Display: Conventional versus Perspektive." *Human Factors, 30*(2), 1988, pp. 163-169.

[3] John, M., Cowen, M., Smallman, H., and Oonk, H., "Use of 2D and 3D Displays for Shape-Understanding versus Relative-Position Task." *Human Factors, 43*(1), 2001, pp. 79-98.

[4] Haskell, I. and Wickens, C., "Two- and Three-Dimensional Displays for Aviation: A Theoretical and Empirical Comparison." *The International Journal of Aviation Psychology, 3(2*), 1993, pp. 87-109.

[5] Endsley, M., "Situation awareness in aviation systems." In: D.J. Garland, J.A. Wise and V.D. Hopkin (Eds.), *Handbook of aviation human factors*, pp. 257-276, MaHwah, 1999.

[6] Alm, T., Andersson, P., and Öberg, M., (2003). Evaluation of Monocular Depth Cues in 3D Aircraft Displays. *International Symposium on Aviation Psychology 2003*.

[7] Andersson, P. and Alm, T., (2002). Perception Aspects on Symbols and Symbol Relations in 3D Aircraft Displays. *Human Factors and Ergonomics Society 46th Annual Meeting*.

1.3 Future Soldier Concepts

Future soldiers, with ground mission as main task, can perform operations as a traditional army soldier, as sensor operator, an operator of unmanned vehicles, artillery commander, or operate other weapons, working with groups located at other places. The have to work with other soldiers and platforms to efficiently use different sensor and information. It is essential that the soldier can send and receive information about targets, hostile positions, and location of own forces. The soldier is very limited when it comes to carrying equipment, endurance, and energy supply the size of the equipment. It is of importance to understand the abilities the future soldier needs to have. Ability to perceive, assess the situation, and communicate perceived targets, or receive information from others, is probably the most fundamental ability. This ability must be preserved during different light conditions, different terrains, and all setting. The basic MSI question in this project is what demands that must be maid on the soldier's presentation equipment, to minimize distraction from the actual combat mission, and not to reduce his mobility. What size and where should the display be placed on the soldier? What kind of information should be available? Interaction principles with the display system will also be studied. Performance will be measured in terms of reaction times and direction understanding between the map and the reality, which leads to better situation awareness.

1.4 Operator Functional Status Assessment

The project develops measurement methods to quantify single operators and teams' mental workload, operative performance and situation awareness. The methods are developed in highly applied settings such as the operational environment of the Swedish Air Force, Army and Navy. The methods have been used to support tactics development, evaluate training regimes and design of new systems with complex man-machine interface problems. The project uses advanced statistical methods to combine online psycho physiological measures (both standard methods such as ECG, EPOG, EOG and new methods like NIRS and PPG), subjective rating methods, and objective measures (computer logs etc) to develop psychological models of human performance. The project studies the use of psycho-physiological measures to provide input to adaptive man-machine interfaces. The goal of the projects is to further develop measurement methods with high validity and reliability, which also are usable in applied settings such as real aircraft.

1.5 Computer Generated Forces and Human Behavior Models

During 2003, there have been two projects conducting research in Computer Generated Forces and Human Behavior modeling. Because of common interests and research activities the projects have had a close research relation with joint presentations and demonstrations. At the Division of Systems Modeling the focus has been on development of a joint library containing cognitive- and human behavior models for various tasks and applications, while at the Division of Command and control Systems the focus has been on development of cognitive models for individual infantry warriors. Both projects have common interests in methods of task analysis, AI-algorithms (path-finding, formation, etc), utilization of data from experiments and case-studies. Verification and Validation and implementation of behavior models for simulator systems. Both projects rely on their work to result in improved military simulation activities where many units need to participate.

There is evidence of an increased demand for computer generated forces and human behavior models for analysis and simulations within the M&S community, including a number of projects and applications at FOI. The research activities for this year, have been concentrated on studies and analysis of Performance Modifier Functions including prototype models used in simulations, design of a model library architecture, development of tools to aid in creation of behavior models and to integrate them into existing and future simulation frameworks and development of a database with physiological and psycho-physiological data to aid in development of human behavior models of individual infantry warriors.

1.6 An Analysis of CMMS Focusing on Knowledge Acquisition and Knowledge Engineering

CMMS is about conceptual descriptions and models of military operations.

It is the first level of abstraction when describing reality and aims to address characteristic details of the problem space. The concept of CMMS consists not only of conceptual models but also of tools for their development and reusability, a common library to store them, and standards for acquisition and integration of knowledge. Conceptual models are supposed to act as a bridge in the communication between modelers, system engineers, domain specialist and end users. The foremost reason for using conceptual modeling is to catch misunderstandings early in the development processes. The project's work during 2003 has focused on the concept of knowledge acquisition and knowledge engineering i.e. the KA/KE process. In conjunction to this, issues related to the problem domains; language and tools have been addressed. These three domains have a natural connection to each other in the way that they all are needed in order to map the early phases of the CMMS development process.

The part of KA is discussed thoroughly together with some methodologies for knowledge acquisition. The KE part describes guidelines on knowledge engineering in a similar manner while the language and tools chapters are only briefly discussed.

1.7 Methods for Producing High Resolution Synthetic Environments / Environment Models for Sensor Simulation

Models of the natural environment, environment models or Synthetic Natural Environments (SNE) have a central part in the M&S activities of the Swedish Armed Forces.

They form the common "playfield" where the simulated operations and interactions take place. Depending on the purpose, SNEs represent different environmental aspects for ground, sea and land operations (sometimes also space) across the whole spectrum of applications (armed combat, peace support operations, crisis management, etc.). The project "Synthetic Environments" has comprised of knowledge building concerning SNEs and studies and development of methods for constructing high resolution and detailed SNEs. A new standards proposal called SEDRIS has been studied and some tests have been implemented. A demonstrator in the form of a high resolution SNE for visual 3D real-time simulation has been produced using the developed methods. The project "Sensor Simulation" has comprised of knowledge building concerning SNEs for sensor simulation. Requirements for carrying out IR sensor simulation have been particularly studied. During the course of the activities, many successes and interesting results have been achieved. Methods have been developed to handle the different steps in the data production process. During the course of the project, even more applications for high resolution SNEs have been identified, both military and civilian.

1.8 Computer Generated Forces – Methods and Means

Modeling and Simulation, M&S, is a powerful tool that is used to support development of military concepts as well as training, studies and analysis of military operations in different environments. There are a number of important technologies that can be applied to military simulations. Computer Generated Forces, CGF, is one such technology.

CGF are used as Human Behavior Representations, HBR, of individuals or groups as operators or commanders in military simulations. Defence driven M&S is demanding more realistic HBR models in simulations. To confront the growing need of such models, the Swedish Armed Forces has sponsored a study of CGF development since 2001, conducted at FOI. The main purpose of the project is to construct a framework to support CGF development and to maintain a component based library of HBR models to be used in existing and future simulations.

1.9 Web-based HLA Federations and Simulations – Methods and Possibilities

Modelling and Simulation (M&S) is a vital part of the Network-Centric Warfare (NCW) concept, adapted by the Swedish Armed Forces (SwAF).

However, simulation model development, implementation, testing, and execution are time consuming and expensive processes. Hence, it is of great interest to combine the web and Internet technologies, and M&S in order to e.g. utilize the simulation models and computing resources more efficiently. This report presents the results from research conducted within the area of Web-based M&S. The project "Web-based HLA Federations and Simulations" was carried out during 2001 and 2002 on behalf of the SwAF. The main objective of the project was to investigate and study the benefits and advantages of the impact of networking technologies and distributed computing techniques on M&S for the SwAF. During the first year the potential of the combination of Web-technology and HLA federations, and Web-technology and legacy simulations was investigated. The focus of the project during 2002 was on component-based model development, distributed computing techniques, particularly Peer to-peer computing, and collaborative model development and execution. The results from the project confirm our preliminary assumptions regarding the advantages of combining networking technologies, such as Internet and the World Wide Web, and M&S.

We believe that the area has a great potential and will play a central role in the future NCW systems.

1.10 Mission Specific Mapping and Visualization

Task specific environment models of the area of operations are critical for e.g. mission planning, execution and after action review. In complex and rapidly changing environments such as urban areas, there is an increasing demand for updated and detailed environment information. With advanced sensors and sophisticated signal processing methods, this kind of information can be made available in a future network centric defence, enabling mission specific 3D models of areas of operation to be rapidly produced and distributed.

1.10.1 Data Acquisition

Future advanced sensors for reconnaissance and surveying provide data that enable reconstruction of the area of operations. For example, using a 3D laser and digital camera it is possible to obtain elevation data, intensity data, multiple signal returns and visual imagery.

1.10.2 Analysis and Data Processing

As a basis for generation of environment models of areas of operation, sub models area created using analysis and processing of sensor data.

1.10.3 3D Modeling of Areas of Operations

Mission specific 3D models of the areas of operations are produced using the generated sub models. The images on the previous page shows a detailed 3D model of an area generated using a ground elevation model, an orthophoto, 3D models of buildings and 3D models of single trees. The image below shows a model of the same area generated using only a digital surface model and an orthophoto (Figure 4).

Figure 4: The Image shows a Model of an Area Generated using a Digital Elevation Model, an Orthophoto, 3D Models of Buildings and 3D Models of Single Trees.

1.11 Applications of the New Swedish Dynamic Flight Simulator

1.11.1 Introduction

The Dynamic Flight Simulator (DFS) is a versatile high performance pilot training and research device (Figure 5). Technically it is a man-rated centrifuge combined with fully controlled and motor operated pitch and roll gimbals (2-axis) and a flight simulation system based on JAS 39 aircraft models and controls. A unique perception algorithm modeling the expected sensations provides a “realistic” flight experience and increased comfort since undesired sensations are minimized. A variety of operation modes allow traditional centrifuge training as well as extended or applied G-training. In applied G-training the pilot being in full control of a realistic environment is given meaningful tasks leading to more effective G-training.

Figure 5: The DFS Machine.

1.11.2 Dynamic Flight Simulation Requirements

Dynamic flight simulation can be described simply as a flight simulator that uses a human centrifuge as its motion base. DFS requirements arise out of a need to train high performance aircraft pilots to perform more effectively as they execute their flight missions and also from a need to study the human responses to acceleration with possible methods to increase pilot safety and effectiveness.

The DFS device then must be able to recreate the acceleration time histories that occur in flight and also provide the perception of flight motion so that training can be effective and so that research is applicable to the actual flight environment. Since the acceleration time histories include sustained acceleration, the DFS motion base must be a centrifuge with a reasonably large radius arm in order to minimize the disorienting effects of angular accelerations on the pilot vestibular system.

Time history requirements also mandate using a two-axis controllable gimbal system to support the gondola containing the DFS simulated cockpit, the pilot and the various simulator support systems. An important, perhaps non-obvious, feature is that the pitch axis, defined with the pilot facing tangential to the arm motion, must be supported within the roll axis gimbal. This allows the DFS to respond quickly to changes in the commanded linear acceleration vector. Finally, there must be a configurable control algorithm that can allow the DFS to be used to give the pilot the perception of flight or to give a researcher the ability to command accurate acceleration time histories in all axes.

1.11.3 Technical Description Flight Simulation System

The gondola (Figure 6) consists of permanent systems and configurable inserts. The training insert, a Gripen cockpit mock-up, can accommodate positioning of subject heart- or head level in the center of gondola. A separate insert for acceleration research is a turnable seat, which can be rotated or tilted in various angles.

Figure 6: Training Insert.

The flight simulation capabilities are based on:

- JAS 39 Cockpit mock-up containing real Aircraft hardware such as MB-seat, stick, throttle and Oxygen regulator.
- Aerodynamic model delivered by Saab (ARES). Current setup contains one weapon load, no fuel system simulation or ground handling.

- Head-up and head down display instrumentation. Head down software is a derivative of Saab glass cockpit (virtual front panel) from 1997. The software contains basic avionics- and weapon system functionality such as simplified IR and Radar modes and a choice of gun of missile.
- Visual out-the-window displays consisting of 3 monitors with a total field-of-view of approximately 90 degrees. The database is in Open Flight format and shows an area around Oakland CA.

1.11.4 Field of Application

The DFS has been developed for a wide field of applications such as:

- Pilot training and qualification
- Screening of pilot applicants
- Medical evaluation
- Research in Flight physiology
- Research in Spatial Disorientation
- Research in Man-Machine Interaction
- Development and testing of life-support equipment
- Aircraft equipment
- Evaluation of cockpit design approaches
- Tactical evaluation

1.12 ACES – Air Combat Evaluation System

For more information, please contact: Staffan Nählinder (staffan.nahlinder@foi.se).

ACES – "Air Combat Evaluation System" is a research flight simulator specialized in within visual range (WVR) air-to-air combat. The system consists of two simulator cabins (pilot stations) and one instructor station. ACES is built around several pedagogical tools intended to make WVR-combat much easier to learn (Figure 7). ACES is a research simulator used for evaluation of pedagogical concepts of learning dogfight and to serve as a development simulator to demonstrate and evaluate the strengths of embedded pedagogical tools and online (real-time) analyses of important air combat flight parameters. During fall of 2004, ACES will be evaluated together with the FlygS (The Swedish Air Force Flight School). ACES will also serve as a concept facility for studying Forward Air Controlling. ACES will soon be linked to (FLSC) Swedish Air Force Air Combat Simulation Centre in Stockholm, for distributed simulation.

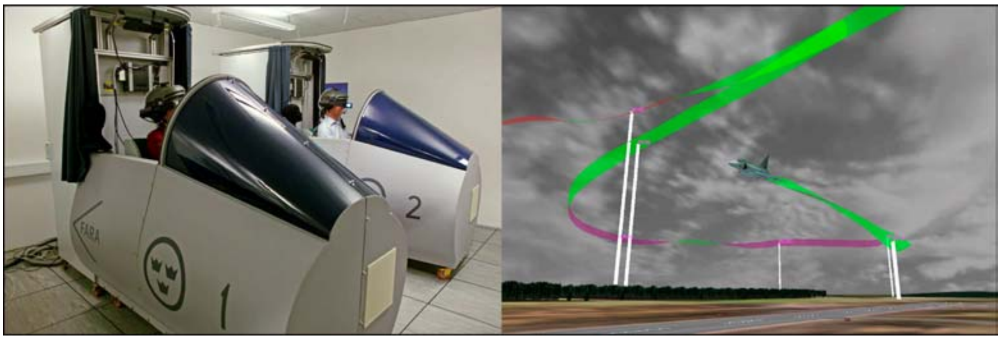

Figure 7: ACES Simulator and Example of Pedagogical Tool.

1.13 MOSART – A Platform for Integration of Research Results

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1.13.1 Overview

The primary objective of the MOSART project is to simplify integration of research results into larger simulations and demonstrators (Figure 8). Within the project, a modular software environment is developed which provides basic simulation functionality and enables an efficient integration of own and commercial software. The environment that is developed in the project is called MOSART Test-bed. The test-bed contains three main parts:

- Software for integration
- Basic features for simulation
- Integrated results from research projects

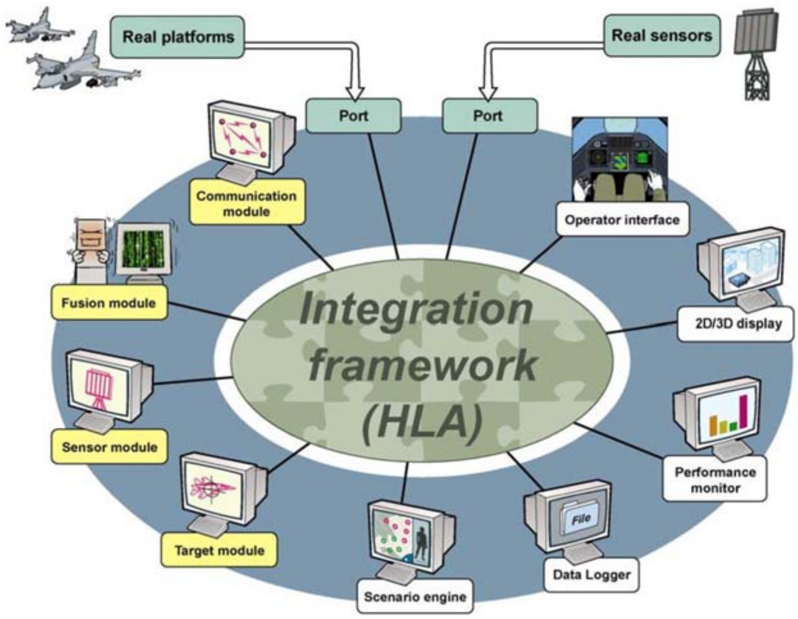

Figure 8: Overview of MOSART.

These main parts in the test-bed make it easier for research projects to evaluate results in a larger context by setting up more advanced simulations and demonstrators. This is accomplished by integration of the own research results, the basic features and other research results integrated in the test-bed. Through the development of the test-bed:

- Other research can be made more cost efficient.
- Greater opportunities for research collaboration is accomplished.
- Experience from integration of systems and data sources is gained.

1.13.2 Modules and Integration

The software for integration of modules decreases the complexity of developing large simulations and demonstrators, since the demand for user knowledge in the area of distributed simulation (High Level

Architecture, HLA) is minimised by the software. In the test-bed there are also a number of simulation support features, such as scenario editor and engine, visualisation in 2D and 3D, maps and high resolution synthetic environments, real sensor data, logging and scenario management. In addition, there are the modules that research projects have integrated into the test-bed, which can be reused by other research projects that wants to develop simulations and demonstrators.

In the figure below, screenshots from some of the modules in the MOSART Test-bed are shown. A) 3D visualisation and synthetic 3D environment B) Flames, simulation framework C) 2D visualisation D) IR sensor simulation module (Figure 9).

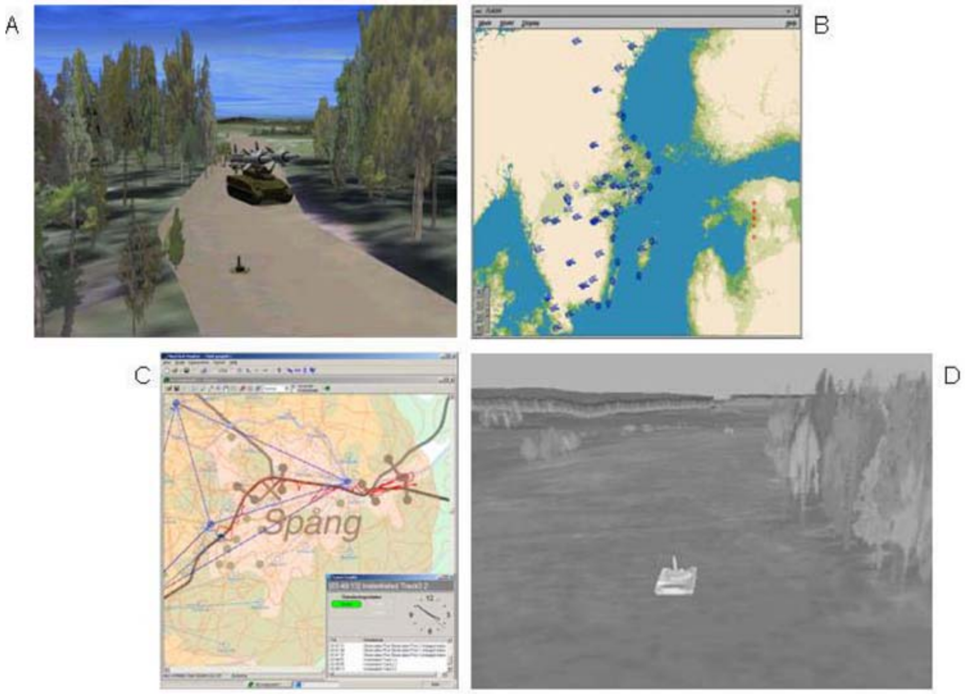

Figure 9: A) 3D Visualisation of 3D Environment; B) Flames, Simulation Framework; C) 2D Visualisation; and D) IR Sensor Simulation Model.

1.13.3 External Links

The development of the test-bed and the choice of HLA as the simulation mechanism, aim at accomplishing compatibility with similar environments in other organisations, e.g. the Swedish Armed Forces, FMV and the industry. This enables MOSART to be a link between FOI research and external collaborators, which in turn enable development projects to use research results. Today there is an established collaboration with DSO in Singapore, in which FOI and DSO develop compatible test-beds and perform common demonstrations.

1.13.4 Development

To maintain MOSART as an interesting environment for integration of research results, the test-bed functionality must be continuously improved. A coming development step is to introduce the possibility to use a service based approach for the modules in a demonstrator or simulation in order to be an active part of the development of a network based defence for the Swedish Armed Forces. Another important step for the test-bed is to create ports to real sensors and systems. By doing that, there is an option in the test-bed to mix real and simulated entities in a scenario and thereby be able to test future concepts and system configurations.

2.0 RESEARCH AT SWEDISH DEFENCE MATERIEL ADMINISTRATION

2.1 SMART-*lab*

Within the Swedish Defence Materiel Administration headquarter in Stockholm there is a unique laboratory environment installed for analysis and development of the Total defence. SMART-lab consists of around 2000 m^2 of projects rooms, offices and laboratories.

SMART-lab offers an advanced environment for its two main services. SMART-lab main service is Systems and enterprise analysis. SMART-lab also offers an arena for Technology demonstrators and C2 exercises.

SMART-lab has a focus of competence in System and enterprise analysis, Human to Systems interactions and Modelling and simulation. SMART-lab relies also heavily on partnership with the customers and other agencies for fulfilment of competent analysis team.

2.1.1 Systems and Enterprise Analysis

Within SMART-lab main service examples of different type of projects are Business and mission modelling, Organizational analysis and business development, Crisis management analysis, Process modelling of business and military operations and Analysis of future international military operations.

It is a wide range of different analysis projects with one thing in common. They all consists of analysis work done in the early phases of the acquisition process, before any procurement action of military systems, i.e. the work is mission centric. SMART-lab does not work with actual military platforms.

2.1.2 Technology Demonstrators and C2 Exercises

Within the area of using SMART-lab as an efficient information technology arena, customers often use SMART-lab for research and technology demonstration when requiring more advanced presentations.

The usage of SMART-lab as a Command and Control exercise arena has lately increased. During one of many exercises in SMART-lab the lab itself was refurnished and technically prepared to simulate a Command and Control Centre and its distributed Command and Control containers – as an actual field operation. Military personnel then trained and analysed different situations using a scenario and mission simulator for the exercise.

2.1.3 SMART-lab Technology Development

SMART-lab conducts technology development in Modelling and simulation in areas such as Simulation Based Acquisition, Verification, Validation and Accreditation, Conceptual modelling and in the arena of Commercial and defence gaming.

In the domain of Human to Systems interactions SMART-lab focus is on Perception of information and systems interaction, Command and decision support in distributed systems, Communications in a network based defence and Methods of evaluation.

More information at http://www.smart-lab.se.

2.2 SMART-lab VR-Projects

SMART-lab has supported some FMV projects that have a need of visualisation techniques for a cost-effective solution in the procurement cycle.

2.3 (2003-2004) SSG120 Armoured 120mm Mortar Project

SMART-lab is at the moment supporting the FMV Armoured 120mm Mortar Project. The support consists of preparing an evaluation of an industry produced 3D-model in the forthcoming Development Phase. The purpose of the evaluation is to perform a cost-effective development of a prototype. Evaluation sessions include both consumer and customer with their requirements and provide feedback to the developer. The evaluation will be performed from different views, e g Integrated Logistics Support (ILS) and Human to Systems interactions. A variety of VR-techniques will be used to meet the needs from consumer and customer.

2.4 (1999-2001) STRPBV90 Forward Command Vehicle, Ergonomics

There was a need to study new design concepts of the command and control version of the StrPBV90 to enable international duty. SMART-lab supported with the production of a virtual prototype of the chassis and turret, including all interior equipment (Figure 10). The 3D-model was used for stereoscopic visualization and simulation in the VR-tool "SmartScene". The purpose of the study was to examine ergonomic topics, test and present modifications of the design in 3D. The project team could view the model projected on a power-wall wearing stereoscopic shutter-glasses. For documentation of the used methodology in the project, a video film "VR-som verktyg" ("VR as a tool") was produced.

Figure 10: STRPBV90 Forward Command Vehicle.
3D-model: Peter Schyllberg och Björn Ramsell, FMV SMART-lab.

2.5 (2002-2004) Submarines of the Gotland, and Sodermanland Class, Half-Time Modification

To enable an efficient half-time modification and for testing of new design concepts of the submarines of the Gotland and Sodermanland class, the project needed 3D virtual models of the command and control room. CAD data from industry was converted to polygon models and adapted for stereoscopic viewing in the VR-tool "SmartScene". The 3D-models was painted and textured realistically (Figure 11). A number of design sessions were held at FMV and the project team evaluated different concepts projected on a power-wall wearing stereoscopic shutter-glasses. Animated video films and snapshots of the designs were rendered to act as presentation material.

Figure 11: Gotland Class Submarine Interior.
3D-models: Peter Schyllberg och Björn Ramsell, FMV SMART-lab.

2.6 (2003-2004) HMS Carlskrona, Half-Time Modification

There was a need to perform an efficient half-time modification of HMS Carlskrona. As the submarine project, 3D virtual models of the command and control room were produced for testing of new design concepts. The design concepts were evaluated by the project team and presented on a big screen with stereoscopic visualisation.

3.0 SNDC – SWEDISH NATIONAL DEFENCE COLLEGE

3.1 AQUA – Project

We present a prototype command and control system that is based on view-dependent co-located visualizations of geographically related data. It runs on a 3D display environment, in which several users can interact with view consistent visualizations of information. The display system projects four independent stereoscopic image pairs at full resolution upon a custom designed optical screen. It uses head tracking for up to four individual observers to generate distortion free imagery that is rendered on a PC based rendering cluster. We describe the technical platform and system configuration and introduce our unified software architecture that allows integrating multiple rendering processes with head tracking for multiple viewers. We then present results of our current visualization application in the field of military command and control. The command and control system renders view consistent geographical information in a stereoscopic 3D view whereby command and control symbols are presented in a viewpoint adapted way (Figure 12). We summarize our experiences with this new environment and discuss technical soundness and performance.

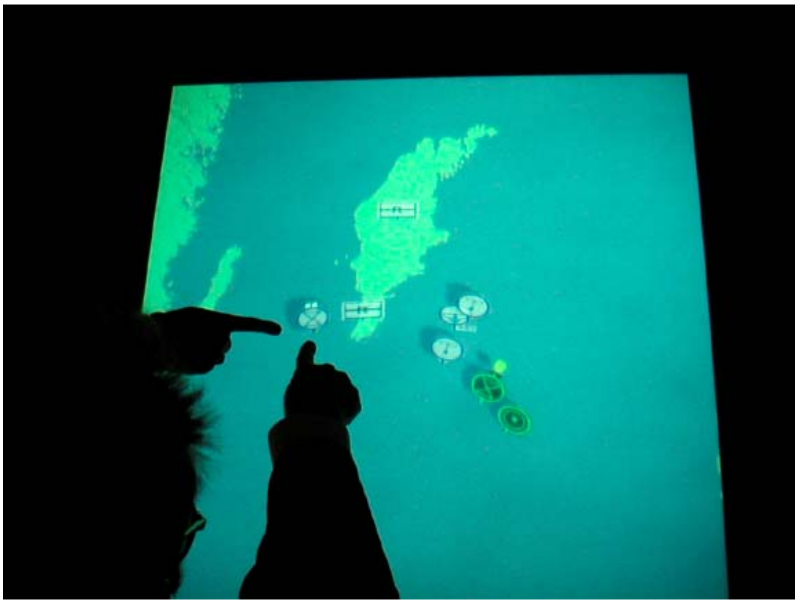

Figure 12: Two Users are shown Collaborating in the Multiple Viewer Display Environment.