

# 1. Visualisation-projects in Denmark

Visualisation-projects in Denmark can be categorised as either civilian or military. Civilian projects are either commercial or research and development. Those will be mentioned in the next chapter. Military VR-projects are either simulators or research and development. The military projects will be mentioned in the last chapter. A common event for both the civilian and military society is the founding in May 1999 of DK-VRS (Danish Virtual Reality Society).

## 1.1. Civilian VR-projects

Commercially VR is used by television stations and advertising agencies. VR in research and development is of growing interest. Two universities have established VR laboratories and a third is in the process of establishing a VR centre. These will be mentioned in the next section. Examples of research and development VR-projects will be mentioned in the following section.

A Danish Virtual Reality Society (DK-VRS) was established in 1999 (for further information see <http://www.dk-vrs.dk/>).

### 1.1.1. Civilian VR research laboratories

#### 1.1.1.1. Centre for Advanced Visualisation and Interaction

CAVI (Centre for Advanced Visualisation and Interaction) is a centre where industry, research, and education collaborate on visualisation. The centre is a collaboration of Alexandra Institutet A/S, Aarhus Universitet and the Danish National Centre for IT Research (CIT). The VR-equipment is the following:

- 3D Panorama Cinema
  - Curved screen
  - Active stereo glasses
  - Tracking



Figure 1.2 3D Panorama Cinema at CAVI



Figure 1.1 3D Panorama Cinema at CAVI with consoles

- TAN Holobench (horizontal and vertical screens, both 180 cm x 110 cm)



Figure 1.3 Holobench at CAVI

- Virtual studio

Live persons and physical objects can be mixed with virtual computer generated objects.



**Figure 1.4 Virtual Studio at CAVI**

- Onyx2 Infinite Reality2 Rack, 6X250 MHZ MIPS R10000, 1.5 Gb RAM, 2 graphics pipelines (each 64 Mb texture memory)
- Polhemus FASTRAK (3 sensors)
- Stereographic glasses.
- 6 Octanes
- 20-30 O2

Several CAVI-projects will be mentioned in a section 1.1.2.

For further information on CAVI see <http://cavi.alexandra.dk> (in Danish).

#### **1.1.1.2. VR Centre North**

VR Centre North is located at the University of Aalborg. Its main feature is:

- Cave with 6 walls  
(2,5x2,5x2,5 m)  
Active stereo glasses



**Figure 1.5 CAVE with 6 walls at VR Centre North**

- Powerwall  
Big screen (8mx2.85m)  
Passive stereo glasses



**Figure 1.6 Powerwall at VR Centre North**

- Panoramic screen  
160-degree screen (diameter 7.1m, height 3.5m)  
Active stereo glasses  
Magnetic-tracking device.



**Figure 1.7 Panoramic screen at VR Centre North**

These are run by:

- Onyx2 Infinite Reality2 Rack, 6 graphics pipelines



**Figure 1.8 Onyx2 at Aalborg University**

For further information on VR Centre North see <http://www.vrcn.auc.dk/>.

### **1.1.1.3. VR•C**

VR•C is a VR centre at the Technical University (DTU) in Lyngby north of Copenhagen. It is collaboration between UNI•C (a national IT-centre under the ministry of education) and The Technical University (DTU). VR•C's main facilities are:

- TAN Powerwall (6.5 m x 2.5 m)  
2×3 projectors (TANORAMA/Electrohome) for passive stereo  
Ascension Flock of Birds Tracking system with 2 trackers + 1 6-degrees-of-freedom

mouse  
 8 active speakers  
 3 subwoofers  
 1 Microsoft SideWinder Forcefeedback Pro joystick  
 1 control for audio panel and SGI terminal

- 3 n-vision DataVisor HiRes Head Mounted Display  
 See-through (augmented reality)  
 2xXSGA CRT  
 Headphones and microphone  
 Ascension MotionStar tracking system with 8 trackers  
 3x24" Monitors



**Figure 1.9 HoloDeck  
 Labororium at  
 VR•C**

- SGI Onyx2 InfiniteReality2 Graphic Supercomputer  
 16 195 MHz MIPS R10.000 CPU's  
 8 GB RAM  
 356 GB Hard disc  
 3 graphic pipes each with 2 Rastermanagers and up to 24 displays
- Lake Huron 20 sound computer  
 8 Quad DSP processors  
 32 I/O ports
- 4 SGI O2 Workstations
- 1 SGI 320 Personal Workstation



**Figure 1.10 Supercomputer at VR•C**

Keywords for VR•C are industry, education and research. Areas of interest are architecture and landscape modelling, scientific visualisation, visual simulation and education, and collaborative VR. For further information on VR•C see <http://www.vr-c.dk/> (in Danish).

#### **1.1.1.4. Danish Maritime Institute**

Danish Maritime Institute (DMI) has developed great expertise through many years in the area of simulator development and training especially for ships crew.

For further information on DMI see <http://www.danmar.dk/>.



### **1.1.1.5. Centre for Pervasive Computing**

The Centre for Pervasive Computing is an open partnership between industry and research. The Danish National Centre for IT Research (CIT) has decided to create a Centre-of-Excellence within the area of pervasive computing. The main location of the centre will be the new IT-city Katrinebjerg in Aarhus located next to the campus of the University of Aarhus. The purpose of the centre for pervasive computing is to work with the next generation computing environments where computers are everywhere, for everyone, at all times. IT will be a still more integrated part of our environments with processors, sensors, and actuators connected via high-speed networks and combined with new visualization devices ranging from projections directly in the eye to large panorama displays.

The goal of the centre is to make Denmark one of the leading countries within the area of pervasive computing. The centre will develop new concepts for support of activities and processes across time and space based on a broad spectrum of media, equipment and locations.

The centre shall contribute to the development of business models based on pervasive computing and models for start-up companies, e.g. in the form of business incubators, with science and development park facilities and access to venture capital.

The centre shall cooperate with the best international groups within pervasive computing and develop a network of national and international partners such that the centre will be a dynamo/leader in the building of competencies and business innovation in Northern Europe.

The centre shall contribute to a strong future basis for hiring IT specialists to Danish research and industry.

Initially, the centre is based on the following research areas:

- Software technology, especially object technology
- Architecture for pervasive computing
- Internet technology and hypermedia, including web & wap
- Data network and communication protocols
- Modeling and analysis of distributed systems
- Interaction and user interfaces for a broad spectrum of devices
- Augmented Reality: seamless integration between the physical and virtual reality
- CSCW: computer supported cooperative work, interactive and collaborative rooms
- Cooperative system development / participatory design
- Multi-media, including Virtual Reality and sound
- Design disciplines, primarily industrial design and architecture.

A central partner will be the Alexandra Institute A/S (<http://www.alexandra.dk/>).

Further information can be found on <http://www2.cit.dk/default.asp?id=79>.

### **1.1.2. Civilian Visualisation research and development projects**

#### **1.1.2.1. Distributed Multimedia Technologies and Applications (DMM)**

The DMM project focuses on research issues central to the development and use of distributed multimedia. Distributed multimedia technologies possess much potential for improvement of work-practices and collaboration in network organisations, e.g. through intranets; in society, e.g. electronic commerce and mass communication; and in distributed education, e.g. virtual seminars and distance learning. To explore this potential, the project will undertake three main kinds of experimental research activities:

- participatory analysis and design in the three listed application domains
- technology research and development within the areas of collaborative hypermedia, virtual reality, and real-time multi-modal communication
- demonstrator development, pilot tests, and evaluation in an industrial network organisation as well as an educational setting

With respect to network organisations and electronic commerce, the empirical and the demonstrator activities will take place in modern Danish network organisation applying multimedia technologies both in products, commerce, and business processes. With respect to distributed education, the corresponding activities will take place in the context of establishing joint multimedia courses at Masters and Ph.D. levels between the Technical University of Denmark and Aarhus University. The results of the project will include theories about distributed multimedia, prototypes of new, distributed multimedia technologies, and documented user experience. Further information can be found on <http://www.intermedia.au.dk/projekter/dmm/index.html>.

### 1.1.2.2. Product development

CAVI has for 2 years cooperated with Centre for Product Development at the Technical University of Copenhagen on visualisation. The following are examples where 3D visualisation have been used:

<a href="#">Arla Foods</a>	Packaging design
Kampsax/Lundbeck	Landscape visualisation
Arkitektfirmaet Schütze A/S	Architecture
CF Møller/CADpeople	City planning
Danmarks Radio	Virtual set activities / Ren Kagemand (Danish television show)
<a href="#">Jydsk Dykkerfirma</a> (Diving firm in Jutland)	Beaching Museum St. George

Further information can be found on <http://cavi.alexandra.dk/html/projekter.html> (in Danish).

### 1.1.2.3. Medical visualisation

The holobench have been used in a project with f. ex. the MR-centre at Aarhus University Hospital at Skejby. The goal was to produce a 3D model of a heart from several 2D scannings. The heart surgeons can use the model to decide how to operate on children born with heart failure problems. More information is available on <http://www.daimi.au.dk/~svorre/heart.html>.

### 1.1.2.4. The family factory

The family factory is a theatre show that combines ordinary theatre with traditional animation, puppet handling and live 3D computer animations. The virtual creations are not just programmed ahead with a limited set of actions. Actors control them with motion capture while they perform their one role. The project is a corporation between CAVI, The Danish Film School, and Schule für Schauspiel-kunst "Ernst Bush" Berlin. Further information can be found on <http://www.multimedia.au.dk/JCa1/ff/fabrikinfo.html>.

#### **1.1.2.5. The Staging of 3D-Virtual Spaces**

The topics of the staging project are analysis and construction of 3D virtual space with avatars and intelligent agents. Research areas are motion capture, 3D space and sound, digital theatre, and virtual sets.

The objective of the construction team is to coordinate the activities of the construction team members and integrate the software components developed by them, in order to develop the Virtual Staging Platform (VSP) as an Interactive Virtual Environment (IVE), augmented with facilities/functionalities enabling the staging of virtual 3D spaces using the theatre metaphor. The main task of the construction team is to design and implement the necessary tools in order to facilitate the staging of virtual 3D-spaces, i.e., to realise the ideas behind the Virtual Staging Platform. The implementation will consist of software as well as hardware components, where the expectation is that off-the-shelf commercial hardware components will be used whereas the software will be mainly developed by the construction team and in part based on tools currently available from the individual partners. A major challenge in this endeavour is, in tight coupling with the other teams, to coordinate the ongoing conceptualisation of the VSP, with due consideration to an operational balance between technologically feasible, and ideologically desirable functionalities. Further information can be found on <http://www.intermedia.auc.dk/staging/> and <http://www.vision.auc.dk/~paolo/staging/index.html>.

#### **1.1.2.6. The Digital Theatre**

An Experimentarium examines the artistic possibilities involved in the encounter between real and virtual performers, between virtual beings in real spaces and real beings in virtual spaces. These encounters will be established by various means of digital technology transforming movements in time and space into 3D-animations via digital data. The technology used for this purpose is motion capture technique, animation programs and projection techniques. Further information can be found on <http://www.daimi.au.dk/~sdela/dte/index.html>.

#### **1.1.2.7. 3D Visual Data Mining**

Technology to store and process large amounts of data has during the last decades improved dramatically. This has led many companies to store ever increasing amounts of customer information in large databases. The hope has been that it would be possible to discover unknown relationships in the data, and thereby obtain a knowledge which could give commercial advantages. This could, e.g., be the knowledge of which good customers would soon leave the company. This knowledge could then be used by the company to make the customers concerned a more attractive offer.

However, finding hidden relationships in large amounts of data is not easy. Purely numerical methods have been supplemented with visual methods. This has led to the emergence of "Visual Data Mining". Visual Data Mining has traditionally employed 2D techniques, such as geometric, icon-based, pixel oriented, hierarchical, and graph-based methods. With the 3D Virtual Reality (VR) facilities available at VR Media Lab it is now possible to explore how our ability to interpret 3D objects can be used in Visual Data Mining.

The 3DVDM project aims at exploiting all the possibilities that immersive 3D VR technology may provide to Visual Data Mining, and then adapt the data processing methods to this. The project has collaborators from four areas of science: Database Systems, Statistical Analysis, Perception Psychology, and Visualization. Researchers in the database area are responsible for handling and delivering large amounts of data from databases. Statisticians are

responsible for finding interesting problems, creating statistical models for data analysis, and guiding the entire project in experiments of 3DVDM system. Perception psychology researchers are responsible for finding ways of good interaction and human perception of VR environment. Visualization researchers are dealing with the visualization of data using VR Media Lab facilities and implementation of a novel VR environment for data mining. Further information can be found on [http://www.vrcn.auc.dk/english/project\\_activities/listofprojects/datamining\\_e/datamining\\_e.html](http://www.vrcn.auc.dk/english/project_activities/listofprojects/datamining_e/datamining_e.html).

## 1.2. Military Visualisation-projects

Military Visualisation-projects are either ready-made bought simulators or research and development. Two exceptions are **Mission Debriefing System for the Air force** and **RTP 6.14 Virtual Environment in Military Decision Making** mentioned below. Military research and development takes place at the Danish Defence Research Establishment (<http://www.ddre.dk/>).

### 1.2.1. Mission Debriefing System for the Airforce

Systematic (<http://www.systematic.dk/>) has developed a debriefing system for aircraft crews to improve their skills based on experiences from completed missions. The system is developed on Commercial Off The Shelf (COTS) software and on a PC. It is a portable, low-cost Virtual Reality (VR) training system for aircraft crews. The benefit of the portability is that the system can be **used anywhere** the unit is deployed and **by any crewmember**. Flight hours are rather expensive and therefore the air forces must maximise the benefits from spent flight hours. This, combined with the fact that most air force units need to operate from different deployments remote from home bases, led the operational fighter squadrons to express a need for a low-cost debriefing system. The users were directly involved in the design and the focus was set on functionality — not technology. This approach has resulted in a system, which gains acceptance among users and therefore becomes an everyday training tool. Driven by user requirements, the system is developed to run on a Microsoft Windows 2000 platform, and the system can interface with other systems. Furthermore, it has been essential to develop a system, which could be rapidly implemented.

The debriefing system uses already existing information from the aircraft. The aircraft is equipped with Global Positioning System (GPS), three video cameras, and a microphone system to record the pilot's voice communication. The video cameras record the pilot's view through his head-up display and the entire instrument panel. Prior to the debriefing session all information from the aircraft (GPS-data, video- and audio recordings) is fed into the debriefing system. The GPS-data is loaded into a three dimensional (3D) model

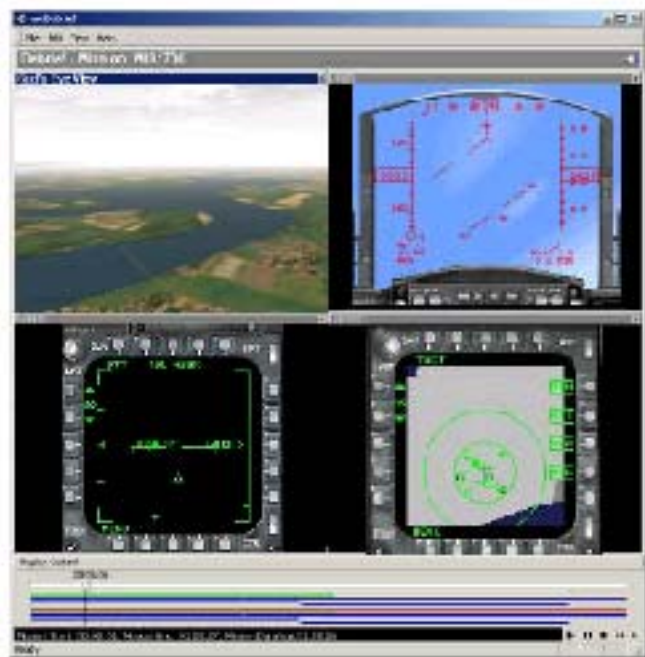


Figure 1.12 Mission Debriefing System

containing geographical information, the video and audio recordings are digitised, and all data are synchronised. On each monitor, four visual sources can be displayed concurrently, e.g. video recordings from three different aircraft and the graphical 3D view of the area, including aircraft. The selected visual sources are displayed along with a selected audio recording. The 3D graphic makes it possible to see and follow selected aircraft from different perspectives on their mission. Furthermore, it is possible to see them chase other aircraft and to track their route by position, direction, and speed. The crew and other mission participants can by themselves prepare and execute the debriefing session.

Presently the system is developed as a 1. generation version with basic functionality. For further information contact Major Birger I. Johansen (bij@systematic.dk).

### **1.2.2. HCI-Lab.**

The HCI-Lab at the Danish Defence Research Establishment is used for testing VR hardware and software. In 1999 the laboratory had the following hardware:

- Intergraph TDZ-410 (dual Pentium pro 200MHz)  
256 MB RAM  
64Mb texture memory  
13 GB hard disk
- TDZ 2000 GT1 (dual Pentium II 700MHz)  
512 MB RAM  
Wildcat 4105  
35 GB hard disk
- TDZ 2000 GX1 (dual Pentium II 450MHz)  
512 MB RAM  
Wildcat 4000  
27 GB hard disk
- Assorted PC's
- Ascension's Flock of Birds
- V6 helmet
- I/O glasses
- Gloves
- Logitech Spacemouse

The laboratory has the following software:

- SuperScape
- Sense8
- Multigen Creator

### **1.2.3. Tactical trainer for a group leader.**

The tactical trainer for a group leader is a research and development project at the Danish Defence Research Establishment. It started 1998, and is a tactical trainer for education and training a group leader. It combines a programmed simulation model with a geographical information system and a VR system and will have a speech interface. The duration is estimated to 5 years. The first prototypes are 'Attack of mechanised infantry'. The conceptual model is pictured in Figure 1.13. The ordering of the soldier is done by voice. A new window for these orders are under development. Figure 1.14 shows the screen the trainee sees

(window screen dumps are in Danish). VRT window shows the group leaders view. The siluet is the trainee. This is shown so the trainee knows which way his head is turned. The map shows the area for the exercise and the position of the soldiers and the armoured vehicle. The window to the left of the map shows the relative position of the soldiers and the vehicle in relation to each other. It is possible to draw lines such as routes to move, attack-line etc on the map. The trainee can choose to stand still, walk or run. He can choose to do it standing up, ducking or crawling. His position is constantly shown in UTM co-ordinates, and a small window shows how long the simulation has been running. Communication messages to and from the trainee are shown to the left the maps. Since last update more object have been added, and the soldiers have been equipped with bags around the waist. They are now being equipped with guns, and the vehicle are being changed to the correct type.

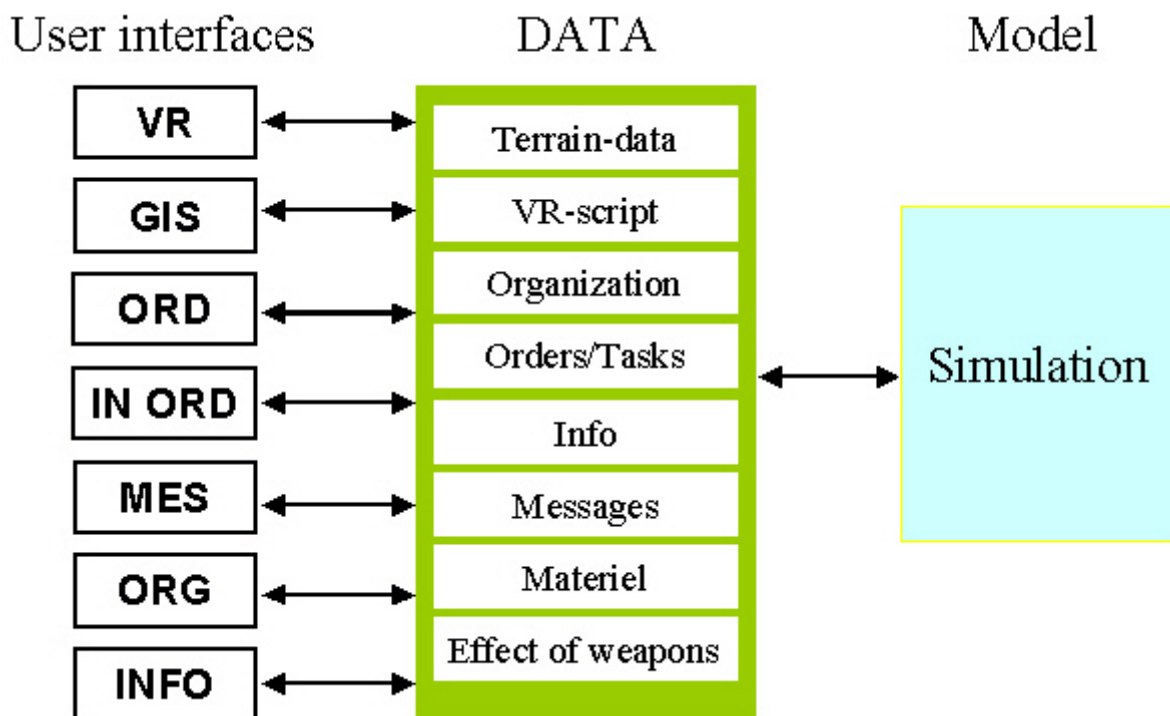


Figure 1.13 Conceptual model

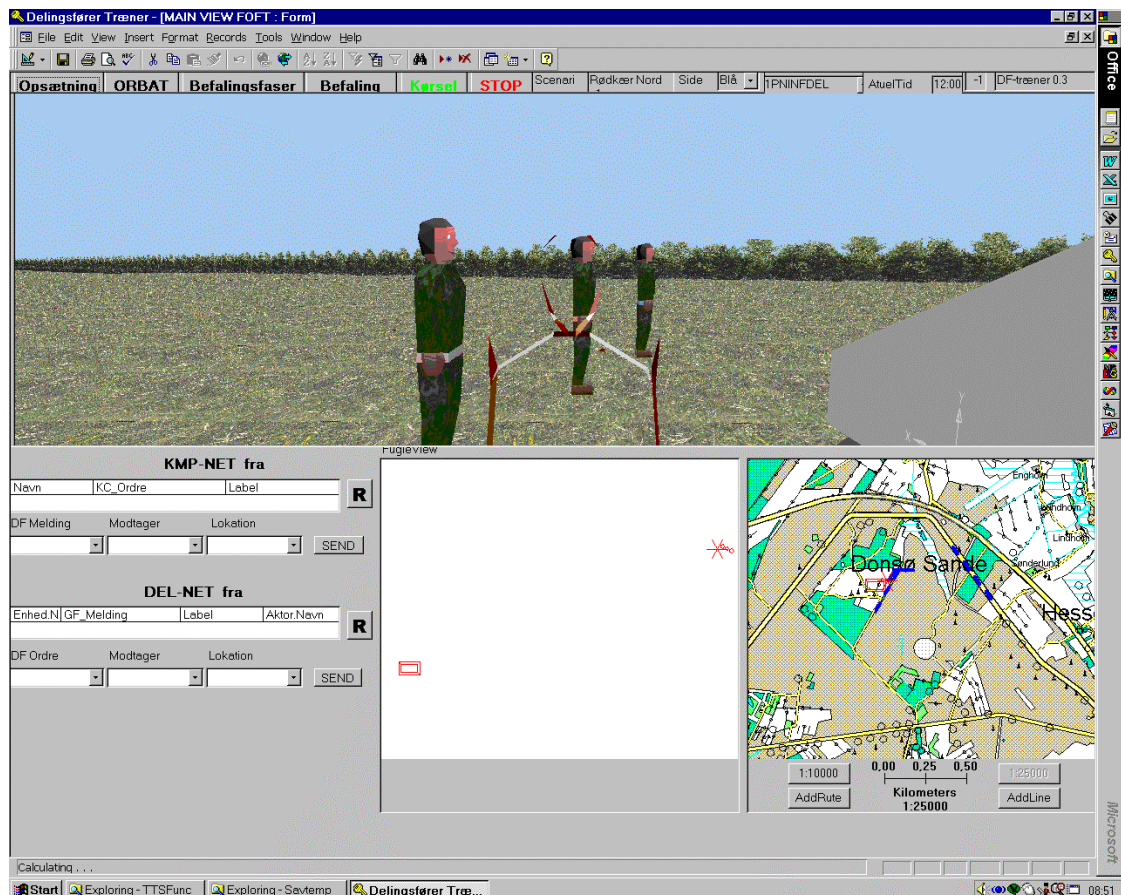


Figure 1.14 Screen dump from the Tactical trainer for a group leader

#### 1.2.4. VIKING GIS

Denmark, Norway, and Sweden have a joint project. They want to design a common new submarine that can be purchased for all three nations. In this project different studies are made. One of these is VIKING GIS. All the defence research establishments from the three countries participate in this study (which is the first common project between all three establishments).

VIKING GIS is divided into two parts:

- Establishing a database describing available data and its sources and quality.
- Building a demonstrator to show how GIS can be used in the submarine.

The database will contain description of available digital and digitisable relevant marine geographic information from both civilian and military sources. An overview of future planned marine surveys shall be included. Special emphasis shall be given to the following parameters: depth, bottom characteristics, wrecks/objects, temperature and salinity or sound velocity profile, current, and acoustic and magnetic properties. The study shall include an assessment of data quality such as accuracy, resolution, and coverage. The database will have a graphical interface, where you can ask what information is available for defined areas.

A first version of a demonstrator package, named Concept Presenter (ConPres), shall be developed. Issues concerning modelling and visualisation of seabed terrain shall be

addressed, especially evaluation of methods, technologies and functionality. ConPres shall demonstrate the use of GIS technologies for navigational purposes, more specifically:

- 1) use of several types of marine geographical information such as seabed topography, sediment types, acoustic profiles and wrecks/objects;
- 2) assess quality parameters as data resolution and data accuracy;
- 3) illustrate compression and visualisation techniques for large amounts of data;
- 4) use of sensor information.

ConPres will be composed of individual, more or less coupled components as articles, pictures and software.

Second version of the demonstrator (if approved) will show how GIS can be incorporated in other functions in the submarine.

### **1.2.5. RTP 6.14 Virtual Environment in Military Decision Making**

The Western European Union (WEU) places contracts for research and development (R&D) projects under the European Co-operation for Long Term in Defence (EUCLID) programme. EUCLID's objectives are to provide European defence with basic technologies fully consistent with the aim of the Western European Armaments Organisation (WEAO) and to promote European industrial co-operation in R&D.

EUCLID consists of a set of Common European Priority Areas (CEPAs). CEPA 6 concerns "Advanced Information Processing and Communications". Within CEPA 6 the WEU is running a Research and Technology Project (RTP) number 6.14 entitled "Virtual Environment for military decision-making". The objectives of the RTP 6.14 project are to:

- Demonstrate the feasibility of using Virtual Reality (VR) techniques and a Virtual Environment (VE) in military decision-making in two functional areas: intelligence and logistics.
- Show how the military decision-maker's situational awareness is improved by using a demonstrator developed in the RTP.

The scope of RTP 6.14 is limited to decision-making at battalion and brigade levels during wartime and peace support operations on the (battle)field.

The RTP 6.14 project is being performed by an industrial team, led by Atos Origin (Netherlands). Atos Origin's partners are IFAD (Denmark), INTRACOM (Greece) and DATAMAT (Italy). The industrial team is named "Military Applications foR VE in Logistics and intelligence" (MARVEL). The demonstrator to be developed during the MARVEL project will be named the "MARVEL demonstrator". The client is the Western European Armaments Organisation's Research Cell (WRC). A Management Group (MG) of the Ministries of Defence of Denmark, Greece, Italy, and The Netherlands manages the RTP 6.14 project on the WRC's behalf. The Dutch Ministry of Defence leads the MG.

There are four Work Packages (WPs) in the RTP 6.14 project:

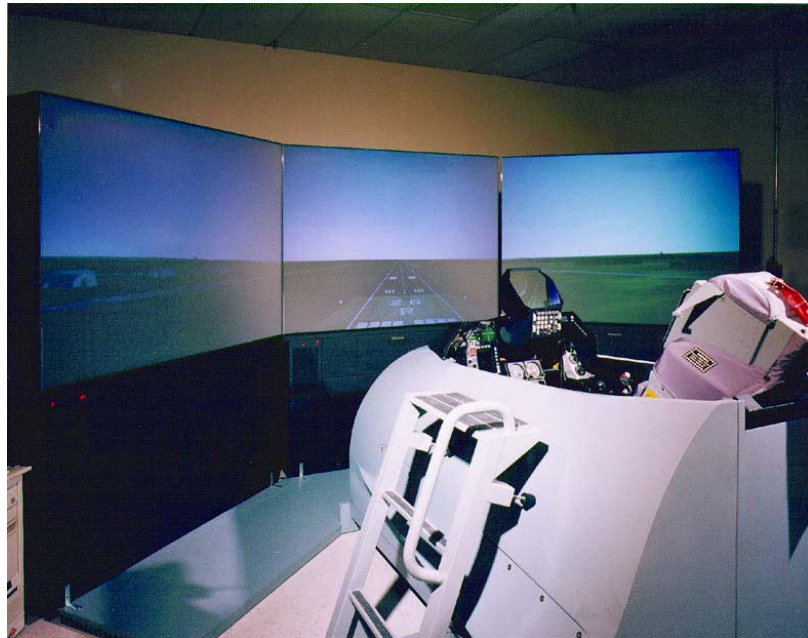
- *WP 0 Management and Integration.* The objective of WP 0 is to manage the project and to integrate the various components into the MARVEL demonstrator. 30
- *WP 1 Preparation Elements.* The objective of WP 1 is to prepare for the research and implementation phases of the project.

- *WP 2 Research Elements.* The objective of WP 2 is to perform research in the various areas that are relevant for the evaluation of VE for military decision-making.
- *WP 3 Implementation and evaluation of demonstrator.* The objective of WP 3 is to 35 implement and evaluate a demonstrator supporting military intelligence and logistics decision-making for the land-battle domain using VE display and user-input devices.
- *WP 4 Presentation.* The objective of WP 4 is to communicate the technical results of the project to parties outside the MARVEL consortium.

The status of the project is: WP 0 and WP 1 are done.

### 1.2.6. F16 flight simulator

The F16 flight simulator is a readymade bought system from Hughes for the Air force. It consists of a mock-up of a cockpit standing in front of 3 screens as shown in Figure 1.15. The simulation is run on a Silicon Graphic's computer from a control room.



**Figure 1.15 F16 flight simulator**

### 1.2.7. The Tank simulator

The Tank simulator is a readymade bought system from Siemens (NL) and Simtech (Israel) for the Army. It is for shooting and battle exercises for platoon and below. The simulator has 4 40-foot containers. 3 of the containers have a technician room, a leopard 1A5 DK mock-up, a local instructor control panel, and a leopard 2A5 DK mock-up. The last container has a technician room, a central instructor control panel, and a report room with 12 seats. The set-up is shown in Figure 1.16 and Figure 1.17 show a picture from one of the containers.

