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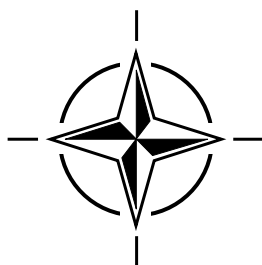
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RTO MEETING PROCEEDINGS 54

# **The Capability of Virtual Reality to Meet Military Requirements**

(la Capacité de la réalité virtuelle à répondre aux besoins  
militaires)

*Papers presented at the RTO Human Factors and Medicine Panel (HFM) Workshop held in  
Orlando, Florida, USA, 5-9 December 1997.*



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# The Research and Technology Organization (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective coordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also coordinates RTO's cooperation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of initial cooperation.

The total spectrum of R&T activities is covered by 7 Panels, dealing with:

- SAS Studies, Analysis and Simulation
- SCI Systems Concepts and Integration
- SET Sensors and Electronics Technology
- IST Information Systems Technology
- AVT Applied Vehicle Technology
- HFM Human Factors and Medicine
- MSG Modelling and Simulation

These Panels are made up of national representatives as well as generally recognised 'world class' scientists. The Panels also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier cooperation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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# **The Capability of Virtual Reality to Meet Military Requirements**

## **(RTO MP-54)**

### **Executive Summary**

#### **PURPOSE**

The purpose of the workshop was to examine military requirements for Virtual Reality technology, consider human factors issues in the use of Virtual Reality and review recent research in development of Virtual Reality applications to meet military needs.

#### **SUMMARY**

The workshop was organized into three daylong sessions. The first day focused on military applications for Virtual Reality systems and identified particular requirements for Human Factors research to meet the requirements. The second day examined Human Factors issues in the use of Virtual Reality technology. Presentations discussed sensory interfaces, measures of effectiveness, importance of the sensation of presence, and cybersickness. The third day reviewed assessment methods and applications research. Speakers reviewed existing or completed Virtual Reality projects designed to meet military needs. The papers discussed how the projects overcame human factors problems and how their effectiveness was evaluated. Summaries of the paper presentations are incorporated in the chairman's notes for each day of the workshop.

#### **MAIN CONCLUSIONS**

Virtual Reality technology is of great interest to the military. Requirements for its use encompass a wide range of applications including concept development of systems for dismounted combatants, mission rehearsal for special operations, training ship handling skills, telerobotics, and practicing military medical procedures. Virtual Reality's success in meeting these needs will be determined by the ability of its human-computer interfaces to provide the means necessary to deliver stimuli and allow appropriate responses from those using it. These human factors issues were the focus of the workshop. Through research on Virtual Reality's interface technologies and applications, it is clear that Virtual Reality has promise for the military, but serious human-computer problems limit its potential. In particular, helmet mounted displays need to be improved, cybersickness limits use by a significant number of people, haptics and walking interfaces are in their infancy. The workshop pointed to these and other areas that require further research and development in order for Virtual Reality to meet its potential for the military.

#### **MAJOR RECOMMENDATIONS**

Research needs to continue on the many human factors issues involved in the use of Virtual Reality to meet military requirements. The Virtual Reality technologies are maturing and the feasibility of developing cost-effective Virtual Reality based tools is increasing. Research on the usability of this technology will enable militaries to be smart buyers. It will ensure that Virtual Reality hardware and software is capable of meeting the perceptual, fidelity, transfer of training, and health and safety requirements of applications. Military research needs to focus on those issues that are unique to the military and not likely to be addressed by other potential users of Virtual Reality.

# **la Capacité de la réalité virtuelle à répondre aux besoins militaires**

**(RTO MP-54)**

## **Synthèse**

### **OBJET**

Cet atelier a eu pour objet : d'examiner les besoins militaires en matière de technologies de réalité virtuelle, de considérer les aspects facteurs humains de la réalité virtuelle et de faire une synthèse des travaux de recherche récents sur le développement d'applications de réalité virtuelle pour satisfaire aux besoins militaires.

### **RÉSUMÉ**

L'atelier a été organisé en trois sessions d'une journée : La première journée a porté sur les applications militaires des systèmes à base de réalité virtuelle et a identifié des voies de recherche dans le domaine des facteurs humains susceptibles de répondre aux besoins. La deuxième journée a été dédiée au problème des facteurs humains dans l'application des technologies de réalité virtuelle. Les communications présentées ont traité des interfaces sensorielles, de l'évaluation de l'efficacité, de l'importance de la sensation de présence et des maladies cybernétiques. La troisième journée a privilégié les méthodes d'évaluation et la recherche en applications. Les conférenciers ont examiné les projets existants ou réalisés dans le domaine de la réalité virtuelle appliquée aux besoins militaires. Les présentations ont décrit l'approche des problèmes liés aux facteurs humains et leur résolution, ainsi que les méthodes retenues pour l'évaluation de l'efficacité des différents projets. Des résumés des présentations ont été incorporés aux notes du Président pour chaque journée de l'atelier.

### **CONCLUSIONS PRINCIPALES**

Les technologies de réalité virtuelle sont d'un grand intérêt pour les militaires. La demande pour ces technologies couvre un large éventail d'applications comprenant le développement de concepts de systèmes pour infanterie débarquée, la préparation de missions pour les opérations spéciales, l'entraînement au pilotage des navires, la télérobotique et la formation à l'usage des procédures médicales militaires. La capacité de la réalité virtuelle à répondre à ces besoins sera déterminée par la capacité de ses interfaces homme-machine à transmettre les stimuli et à solliciter les réponses appropriées de la part des utilisateurs. L'atelier a fait une place privilégiée à ces sujets. Les résultats des recherches entreprises sur les technologies d'interface de la réalité virtuelle indiquent très clairement que si la réalité virtuelle est prometteuse pour les applications militaires, son potentiel se trouve limité par d'importants problèmes homme-machine. En particulier, les visuels montés sur casque sont à améliorer, les malaises cybernétiques limitent l'accès à ces technologies pour bon nombre de personnes et les interfaces haptiques et ambulateurs sont à leur début. L'atelier a mis en exergue ces domaines entre autres, pour lesquels des travaux de recherche et développement complémentaires sont nécessaires pour que la réalité virtuelle puisse atteindre la plénitude de ses possibilités militaires.

### **RECOMMANDATIONS PRINCIPALES**

Il importe de poursuivre les recherches sur l'influence des facteurs humains dans l'application des technologies de réalité virtuelle aux besoins militaires. Ces technologies viennent à maturité et le développement d'outils basés sur la réalité virtuelle à coût abordable semble de plus en plus accessible. Des recherches doivent être entreprises sur la facilité d'utilisation de ces technologies afin de permettre aux militaires de s'en approvisionner en connaissance de cause. Ils pourraient ainsi s'assurer que le matériel et les logiciels de réalité virtuelle sont compatibles avec les exigences en matière de perception, de fidélité, de transfert d'entraînement et d'hygiène et sécurité des applications. Les chercheurs militaires doivent se concentrer sur les questions qui concernent uniquement les applications militaires et qui ne sont pas examinées par d'autres utilisateurs de la réalité virtuelle.

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# Foreword

Virtual Reality (VR) has the potential to meet needs across a wide range of applications within the military. VR military applications include combat training, mission rehearsal, concept development, materiel design, materiel testing, medical training, and personnel selection. The ability of VR in meeting requirements in these areas will depend upon establishing an effective match between technological capabilities, application requirements and human sensory, cognitive and motor capabilities and limits.

NATO Research Study Group 28 (RSG 28) was established to: 1) identify human factors issues involved in the use of VR technology for military purposes; 2) determine the state of knowledge with regard to those issues; and 3) recommend a research agenda that will address critical questions and enable effective products to be produced to meet the military's needs. RSG 28 has adopted the following definition for its use of the term Virtual Reality:

Virtual Reality is the experience of being in a synthetic environment and the perceiving and interacting through sensors and effectors, actively and passively, with it and the objects in it, as if they were real. Virtual Reality technology allows the user to perceive and experience sensory contact and interact dynamically with such contact in any or all modalities.

This report summarizes a workshop conducted by RSG28. The purpose of the workshop was to: 1) discuss issues related to military requirements for Virtual Reality; 2) consider human factors issues and research focusing on the interfaces between human beings and virtual environments; and 3) review VR military applications research and assessment methods. A day of the three-day workshop focused on each of these broad topics. The workshop brought together experts in Virtual Reality from ten NATO countries. It was attended by over 60 people and included 30 paper presentations. Stephen Goldberg, US served as the overall workshop chair. Neil Hardinge, UK chaired the first day on military requirements. Robert Breaux, US chaired the second day on human factors issues, and Peter Werkhoven, The Netherlands, chaired the final day, focused on applications research.

The workshop demonstrated that the military is looking to VR technology to answer a number of its problems from dismounted infantry simulations to training ship-handling skills. The technology is improving, and there have been VR research success stories. Nevertheless, substantial improvements in VR technology are required before a natural man-machine interface is available for many applications, and products are regularly produced that will be institutionalized for use by the military.



# Welcome

Médecin Chef des Services Papin welcomed the participants to the open workshop and outlined the aims of the Research Study Group. He provided two definitions of virtual reality (VR) for the workshop to consider. The working definition of the RSG is, “Virtual Reality Technology is a multi-dimensional human experience which is totally or partially computer generated and can be accepted by those experiencing the environment as consistent.”

General Papin also gave his own definition of VR. In his lectures, he defines VR as having 5 key features (the 5 I s), as follows:

- Information (computer-generated)
- Interface (using a physical interface)
- Illusion (of the real-world)
- Immersive (in a virtual environment)
- Imagination (imaginative rendering of the real-world by computer-programmers).

It is expected that VR systems will be used by the military for:

- Design (to develop man-machine systems suitable for military tasks)
- Training (to teach new skills & knowledge in complex environments)
- Rehearsal (to practice skills and procedures in operational settings)
- Telepresence (i.e. remote interaction with a real object as with robotic sensors)
- Test & evaluation (e.g. of new equipment or in new environments)
- Operational analysis (using man in the loop to assess outcomes of military forces, tactics, etc).

The aim of this group is to study the human factors problems arising from these kinds of applications. Each day of the workshop is devoted to examining one of the group’s 3 principal themes — military applications; human factors issues; virtual reality technologies.

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