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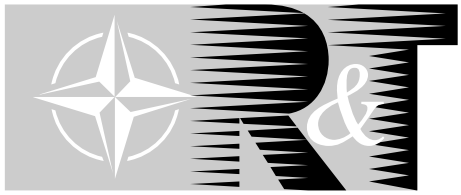

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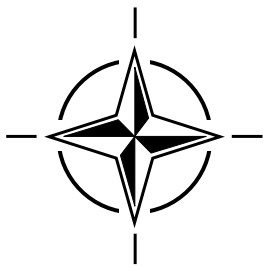
What Is Essential for Virtual Reality Systems to Meet Military Human Performance Goals?

(les Caractéristiques essentielles des systèmes VR pour atteindre les objectifs militaires en matière de performances humaines)

Papers presented at the RTO Human Factors and Medicine Panel (HFM) Workshop held in The Hague, The Netherlands, 13-15 April 2000.



Published March 2001

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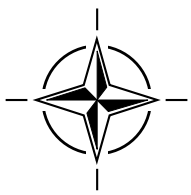

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RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), 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 the following 7 bodies:

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

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They 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.

Published March 2001

ISBN 92-837-1057-6

Printed by St. Joseph Ottawa/Hull
(A St. Joseph Corporation Company)
45 Sacré-Cœur Blvd., Hull (Québec), Canada J8X 1C6

What Is Essential for Virtual Reality Systems to Meet Military Human Performance Goals?

(RTO MP-058 / HFM-058)

Executive Summary

PURPOSE

The purpose of the workshop was to:

- identify the functional requirements of potential military applications of Virtual Reality (VR) technology,
- report the state-of-the-art and projected capabilities of VR technologies, and
- propose future research requirements and directions for military applications.

SUMMARY

The workshop was organised into three daylong sessions. The first day focused on functional requirements for military VR applications in the domains of training, robotics, remote operations and command and control. On the second day, we examined available VR techniques now and in the near future. Presentations discussed visual, haptic, auditory and motion feedback, navigation interfaces, and scenario generation, modelling software and rendering hardware. The third day addressed missing VR capability and future research and concluded with a panel discussion.

During the workshop discussions forty participants from military organisations, academia and industry put forward their opinions on the biggest bottlenecks and opportunities in the development of military VR applications.

MAIN CONCLUSIONS

Virtual Reality technology is of great interest to the military. Its most important application domain is training. VR for training can reduce cost and risk of casualties and improve flexibility and performance monitoring. Furthermore, great opportunities are identified in the domains of planning and mission rehearsal, simulation supported operation, remotely operated systems and product design.

At the same time a number of factors seem to frustrate successful applications in this field. One of the significant bottlenecks is that VR developments are usually not user driven. Application developers and designers do not pay enough attention to human factors requirements. Consequently, applications may fail because of a lack of natural interfaces and motion sickness. So far, user interfaces have been poorly attuned to natural human skills (crude input devices and inconsistent visual, auditory and proprioceptive feedback) and to the tasks to be performed in VR. A second bottleneck is the lack of standardisation causing problems with integrating VR systems and VR software tools. A third is the lack of behavioural models of people and objects in VR scenarios and facilities for team interactions (poor visual human representations and communication tools).

MAJOR RECOMMENDATIONS

In general, better co-ordination between military organisations, industry and academia is essential in order to identify gaps in current knowledge and co-ordinate research. To this purpose the military should develop a vision on the use of VR technology and specify their needs more clearly. Industry should work on standardisation and should substantially implement human factors into their development process. Academia and research institutes should co-ordinate and accelerate their long-term research efforts to focus on natural interfaces (innovative metaphors) and on how to model (intelligent) human and object behaviour. In the short term academia should focus on human factors metrics and metrics for team performance (cognition, communication), and a standard evaluation methodology.

A specific suggestion made during the workshop that could contribute to solving the bottlenecks is to establish a RTO Task Group to (1) identify applications with a high return of investment, user requirements and technologies for investment by the military and (2) foster development of natural VR interfaces and behaviourally realistic intelligent agents and models (identify new funding sources).

The enthusiasm of the workshop attendees and the evident willingness to share ideas and to discuss their findings provide a promising base for a co-operation between military agencies, industry and academia. Research on the usability of VR 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.

les Caractéristiques essentielles des systèmes VR pour atteindre les objectifs militaires en matière de performances humaines

(RTO MP-058 / HFM-058)

Synthèse

OBJET
L'atelier avait pour objet :

- d'identifier les besoins fonctionnels découlant des applications militaires possibles des technologies de réalité virtuelle (VR),
- de rendre compte de l'état actuel des connaissances et des capacités anticipées dans ce domaine, et
- de proposer de futurs sujets de recherche et des orientations vers des applications militaires.

RÉSUMÉ
L'atelier a été organisé en trois sessions d'une journée : La première journée a été consacrée aux besoins fonctionnels découlant des applications militaires des technologies VR dans les domaines de l'entraînement, la robotique, les opérations à distance et le contrôle. Le deuxième jour, nous avons examiné les techniques VR actuelles et émergentes. Des présentations ont été données sur le bouclage de l'information dans les domaines visuels, haptiques, auditifs, et cybernétiques, les interfaces de navigation, la génération de scénarios, les logiciels de modélisation et le matériel de rendu d'image. La troisième journée a été centrée sur les capacités faisant défaut dans le domaine de la VR, ainsi que les travaux de recherche futurs, et s'est terminée par une discussion entre les membres de la commission.

Au cours des discussions qui ont eu lieu pendant les trois jours de l'atelier, une quarantaine de participants venus d'organisations militaires, d'universités et de l'industrie ont exprimé leurs opinions sur les impasses les plus importantes, ainsi que sur les opportunités offertes de développer de nouvelles applications VR militaires.

CONCLUSIONS PRINCIPALES
Les technologies de réalité virtuelle sont d'un grand intérêt pour les militaires. Le domaine d'application le plus important est celui de l'entraînement. L'emploi de techniques VR pour l'entraînement permettrait de réduire son coût, ainsi que le risque d'accidents corporels, et pourrait apporter des améliorations au niveau de la flexibilité et du contrôle des performances. En outre, de grandes possibilités ont déjà été identifiées dans les domaines de la planification et la préparation des missions, de la conduite des opérations à l'aide de la simulation, de la télécommande des systèmes et de la conception des produits.

En même temps, un certain nombre de facteurs sembleraient entraver la réussite des applications dans ce domaine. Le fait que les développements en matière de VR soient rarement orientés par les utilisateurs représente l'une des principales gênes. Les développeurs d'applications et les concepteurs ne tiennent pas suffisamment compte des besoins du point de vue des facteurs humains. Par conséquent, les applications risquent d'échouer du fait du mal des transports et du manque d'interfaces naturelles. Jusqu'à présent, les interfaces utilisateurs ont été mal adaptées aux capacités humaines naturelles (des unités d'entrée rustiques et des boucles d'information visuelles, auditives et proprioceptives incompatibles) ainsi qu'aux tâches à accomplir en VR. Le manque de normalisation, qui crée des problèmes d'intégration des systèmes et des outils VR représente une deuxième gêne importante. Enfin, le manque de modèles du comportement humain et d'objets dans les scénarios VR, ainsi que le manque de possibilités d'interactions interéquipes (représentations visuelles du corps humain et outils de communication de mauvaise qualité) est la troisième gêne identifiée.

RECOMMANDATIONS PRINCIPALES

De façon générale, il est indispensable d'assurer une meilleure coordination entre les organisations militaires, l'industrie et les universités, afin d'identifier les éventuelles lacunes dans les connaissances et de coordonner les travaux de recherche. Avec cet objectif en vue, les militaires devraient élaborer une philosophie de mise en oeuvre des technologies VR et exprimer leurs besoins plus clairement. L'industrie devrait travailler sur la normalisation et faire une large place aux facteurs humains dans leurs processus de développement. Les universités et les instituts de recherche devrait coordonner et intensifier leurs efforts de recherche à long terme afin de se concentrer sur les interfaces naturelles (métaphores novatrices) et sur la modélisation (intelligente) du comportement des objets et des êtres humains. A court terme, les universitaires devraient privilégier la métrologie des facteurs humains et la métrologie du travail en équipe (l'approche cognitive, la communication), ainsi que l'élaboration d'une nouvelle méthodologie normalisée d'évaluation.

L'une des propositions faites au cours de l'atelier, qui pourrait contribuer à l'élimination de impasses, consisterait à créer un groupe de travail RTO pour (1) identifier des applications ayant un bon rendement, les besoins des utilisateurs et les technologies méritant des efforts d'investissement de la part des militaires, et (2) encourager le développement d'interfaces VR naturelles, ainsi que des agents et des modèles intelligents ayant des comportements réalistes (identification de nouveaux bailleurs de fonds).

L'enthousiasme manifesté par les participants durant l'atelier, ainsi que leur volonté évidente de partager leurs idées et de discuter de leurs conclusions a constitué une base prometteuse pour une coopération future entre les agences militaires, l'industrie et les universités. Des recherches doivent être entreprises sur la facilité d'utilisation de ces technologies afin de permettre aux militaires de les acheter en connaissance de cause. Ils pourraient ainsi s'assurer que le matériel et les logiciels de réalité virtuelle seraient compatibles avec les exigences de perception, de fidélité, de transfert d'entraînement et d'hygiène et sécurité demandées pour les applications.

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REPORT DOCUMENTATION PAGE

1. Recipient's Reference	2. Originator's References	3. Further Reference	4. Security Classification of Document
	RTO-MP-058 AC/323(HFM-058)TP/30	ISBN 92-837-1057-6	UNCLASSIFIED/ UNLIMITED

5. Originator Research and Technology Organization
North Atlantic Treaty Organization
BP 25, 7 rue Ancelle, F-92201 Neuilly-sur-Seine Cedex, France

6. Title

What Is Essential for Virtual Reality Systems to Meet Military Human Performance Goals?

7. Presented at/sponsored by

the Workshop of the RTO Human Factors and Medicine Panel (HFM) held in The Hague, The Netherlands, 13-15 April 2000.

8. Author(s)/Editor(s)	9. Date
Multiple	March 2001
10. Author's/Editor's Address	**11. Pages**
Multiple	172

12. Distribution Statement There are no restrictions on the distribution of this document. Information about the availability of this and other RTO unclassified publications is given on the back cover.

13. Keywords/Descriptors

Military training
Human factors engineering
User needs
Interfaces
Research projects
Motion sickness
Similators
Performance
Humans
Man machine systems
Perception
Virtual reality
Virtual environments

14. Abstract

This workshop aimed to identify the functional requirements of potential military applications of Virtual Reality (VR) technology, to report the state-of-the-art and projected capabilities of VR technologies, and to propose future research requirements and directions for military applications.

During the workshop discussions, forty participants from military organisations, academia and industry put forward their opinions on the significant bottlenecks and opportunities in the development of military VR applications. Presentations discussed visual, haptic, auditory and motion feedback, navigation interfaces, and scenario generation, modelling software and rendering hardware.

VR research transition opportunities include the domains of training, planning & mission rehearsal, simulation supported operation, remotely operated systems and product design.

Critical bottlenecks are a lack of natural interfaces, a lack of technology standardisation and a lack of behavioural models and team interaction tools in VR.

In general, better co-ordination between military organisations, industry and academia is necessary in order to identify gaps in current knowledge and to co-ordinate research. Suggestions for closing gaps are included.

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(also available online in the NTIS Bibliographic Database or on CD-ROM)

Printed by St. Joseph Ottawa/Hull
(A St. Joseph Corporation Company)
45 Sacré-Cœur Blvd., Hull (Québec), Canada J8X 1C6

ISBN 92-837-1057-6