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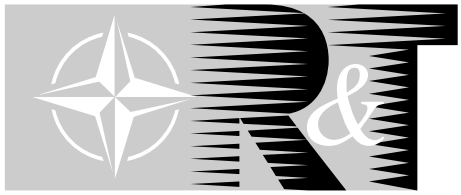

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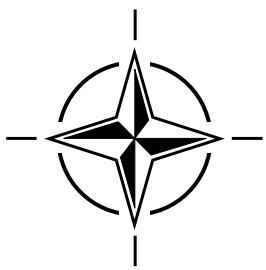

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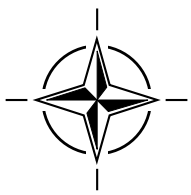

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The total spectrum of R&T activities is covered by the following 7 bodies:

- 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.

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Soldier Mobility: Innovations in Load Carriage System Design and Evaluation

(RTO MP-056 / HFM-043)

Executive Summary

Many NATO nations have soldier modernization programmes that aim to equip soldiers with fully-integrated state-of-the-art technologies that will enhance the five NATO soldier capability areas: lethality, protection, mobility, sustainability, and command and control. Military load carriage systems (LCS), which include clothing and personal equipment designed to carry the range of soldier loads, can have an impact on all of these capability areas. In particular, LCS are critical to soldier mobility and sustainability, and ultimately, to soldier performance and survival on the battlefield. In order to develop advanced integrated LCS that will actually enhance the performance, safety and comfort of the future fighting NATO soldier, it is necessary to further NATO's collective understanding of the factors affecting human LC capabilities, and the interactions between relevant components of the soldier system.

Scientists and equipment designers from NATO, PfP and non-NATO nationals from 10 nations met in Kingston, Canada on 27-29 June 2000 for a Specialists' Meeting sponsored by the Human Factors and Medicine Panel (HFM) of NATO's Research and Technology Organization. Participants examined the current state of knowledge in LC, exchanged findings from recent research and development efforts, explored what initiatives were needed to develop new concepts in design and evaluation, and identified opportunities for collaboration. Specific sessions were held on the physiology, biomechanics and performance measures of LC, approaches and tools for assessment, development and validation of objective tests and their use in design solutions, mathematical modeling, and the accuracy of pressure sensor measurement systems. There were two keynote addresses, 25 scientific research papers, four workshops and tours of research facilities at Queen's University during the Specialists' Meeting.

Soldiers must be able to carry heavy loads under a range of hostile environmental and operational conditions while maintaining peak performance for other demanding battlefield tasks. This poses a complex matrix of unique requirements for military LCS and demands a comprehensive understanding of the factors that contribute to human LC tolerance and ultimate soldier operational effectiveness. Physiological research has provided mathematical equations that will allow to evaluate the 'total time of marching' expectations for a specific mission. However, these estimates do not take into account any localized fatigue, discomfort, and/or injury. Soldiers experience up to two times the actual weight carried and specific body regions become fatigued before total body fatigue. Results obtained from instrumented backpacks (or biomechanical gait analysis) can be used to improve the design of personal LCS and to develop mathematical algorithms and improved models of LC to estimate the rest time needed to recover. Further research is recommended to develop predictive tools that may be used in future to maximize NATO soldier performance.

Innovative thoughts on energy transfer between the LCS and the person were presented and discussed. Once the mechanism for these energy transfers is understood, it should be possible to create a "smart" suspension system that will optimize load transfer and load control for the individual and the operational circumstances, and to design "tunable" LCS that give energy back to the soldier during the gait cycle. To accomplish this, further research is needed. A cross-comparison of objective measures and human trial findings should yield similar results for the same systems and generate design strategies needed to "lighten the load".

Because of the need to optimize LC for soldier mobility, sustainability, performance and survival, NATO countries should consider working together. Improved models, as well as more efficient and reliable, objective test methods and performance criteria are needed. The current STANAG for LC gives general design guidance only and does not help identify poor designs. As a result, many nations experience difficulties writing requirements or procurement specifications that will ensure the design or supply of improved LCS. The current STANAG should be improved by including efficient standardized testing and minimum objective performance specifications that are related to human tolerance and soldier acceptability. This would require that military scientists from interested NATO countries meet to develop a common research plan. The product of this collaborative effort would be standardization, interoperability and the enhancement of the mobility, sustainability and ultimate performance of NATO soldiers in future.

la Mobilité du combattant : innovations dans la conception et l'évaluation des gilets d'intervention

(RTO MP-056 / HFM-043)

Synthèse

De nombreux pays de l'OTAN ont mis en place des programmes de modernisation visant à doter le combattant de l'OTAN des dernières technologies intégrées afin d'apporter des améliorations aux cinq domaines opérationnels suivants : la létalité, la protection, la mobilité, la soutenabilité et le commandement et contrôle. Les gilets d'intervention militaires (LCS), qui comprennent l'habillement et l'équipement individuel destinés à recevoir l'ensemble des charges transportées par le soldat, peuvent avoir un impact sur chacun de ces domaines. En particulier, les LCS sont décisifs pour la mobilité et la soutenabilité du soldat, et en dernière analyse, pour les performances et la capacité de survie du soldat sur le champ de bataille. Afin de développer des systèmes LCS intégrés de pointe, susceptibles d'apporter de véritables améliorations des performances, de la sécurité et du confort du futur combattant de l'OTAN, il est nécessaire d'approfondir les connaissances des pays membres de l'Alliance concernant les facteurs ayant une influence sur les capacités humaines de transport de charges (LC), ainsi que les interactions entre les composants incontournables du fantassin.

Des scientifiques et des concepteurs d'équipements des pays de l'OTAN, des pays du PpP et de 10 autres pays se sont réunis à Kingston au Canada du 27 au 29 juin 2000 dans le cadre d'une réunion de spécialistes organisée par la commission sur les Facteurs Humains et la Médecine (HFM) de l'Organisation pour la Recherche et la Technologie de l'OTAN. Les participants ont examiné l'état actuel des connaissances en LC, ont échangé les résultats de différents projets récents de recherche et développement, ont réfléchi aux initiatives à prendre pour permettre le développement de nouveaux concepts de création et d'évaluation, et ont identifié des possibilités de coopération. Des sessions individuelles ont été organisées sur : la physiologie, la biomécanique et le calcul des performances en LC; les outils et les méthodes de développement, d'évaluation et de validation d'essais objectifs; la mise en oeuvre de tels outils et méthodes pour la conception, la modélisation mathématique et l'amélioration de la précision des capteurs de pression. Le programme de la réunion comportait 2 discours d'ouverture, 25 communications scientifiques, 4 ateliers et plusieurs visites des installations de l'Université du Queens.

Le combattant doit être capable de porter des charges importantes dans un large éventail de conditions opérationnelles et environnementales hostiles tout en maintenant ses performances au plus haut niveau pour faire face à d'autres tâches exigeantes de combat. Cela représente une combinaison complexe de besoins uniques en LCS militaires et nécessite une compréhension globale des facteurs qui contribuent à la tolérance humaine du LC et à l'efficacité optimale du combattant sur le champ de bataille. La recherche physiologique a fourni des équations mathématiques qui permettront d'évaluer le "temps global de marche" prévue pour une mission donnée. Cependant, ces estimations ne tiennent pas compte d'éventuels cas de fatigue, malaise et/ou blessure localisés. En règle générale, le soldat ressent jusqu'à deux fois la charge réellement portée et certaines parties de son corps fatiguent avant l'apparition d'une fatigue généralisée du corps. Des résultats obtenus à partir de sacs à dos instrumentés (ou de l'analyse biomécanique de la démarche) peuvent être utilisés pour améliorer la conception des LCS individuels et pour développer des algorithmes mathématiques et des modèles améliorés de matériel LC afin de pouvoir estimer le temps de récupération nécessaire. Il est recommandé de poursuivre les recherches dans ce domaine afin de développer des outils de prévision qui pourraient être mis en oeuvre à l'avenir pour améliorer les performances des soldats de l'OTAN.

Des idées novatrices sur les transferts d'énergie entre le LCS et le porteur ont été présentées et discutées. Une fois que les mécanismes permettant ces transferts d'énergie auront été compris, il

devrait être possible de créer un système de suspension “intelligent” qui optimisera le transfert et le contrôle des charges en fonction de l’individu et des circonstances opérationnelles, ainsi que des LCS “accordables” qui rediffuseront de l’énergie au soldat pendant le cycle de marche. Des travaux de recherche supplémentaires sont nécessaires pour y parvenir. Une comparaison contradictoire entre mesures réalistes et résultats d’essais sur l’homme devrait donner des résultats équivalents pour des systèmes similaires et permettre d’élaborer les stratégies de conception nécessaires pour “alléger le fardeau”.

Vu la nécessité d’optimiser le matériel LC du point de vue de la mobilité, la capacité de soutien, les performances et la survie des soldats de l’OTAN, les pays membres de l’Alliance devraient réfléchir aux possibilités de coopération dans ce domaine. Il y a lieu de prévoir des modèles améliorés, ainsi que des méthodes d’essais objectives et des critères de performances plus efficaces et fiables. L’actuel STANAG régissant le matériel LC ne fournit que des directives de la conception générales, et ne permet pas d’identifier les conceptions inadaptées. Par conséquent, bon nombre de pays membres ont de la difficulté à rédiger les spécifications de besoins ou d’approvisionnement susceptibles d’assurer la conception ou la fourniture de LCS améliorés. L’actuel STANAG devrait être amélioré en y ajoutant des procédures d’essais normalisées et des spécifications objectives de performances minimales en relation avec la tolérance humaine et l’acceptabilité par le combattant. Pour cela, il est important que les scientifiques militaires des pays de l’OTAN intéressés par ce sujet se rencontrent pour élaborer ensemble un plan commun de recherche. Cet effort de collaboration aurait pour résultat la normalisation, l’interopérabilité et l’amélioration de la mobilité, de la capacité de soutien et des performances ultimes des soldats de l’OTAN à l’avenir.

Click inside the blue boxes or on the titles to view the corresponding section
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SESSION VIII: LOAD CARRIAGE MODELLING & SIMULATION

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14. Abstract

On 27-29 June 2000, NATO, Partners for Peace and Non-NATO nationals from 10 countries met in Kingston, Canada to discuss soldier mobility through innovations in load carriage system design and evaluation. Sponsored by the Human Factors and Medicine Panel (HFM) of the North Atlantic Treaty Organization's Research and Technology Organization, the specialist's meeting participants examined the current state of knowledge in load carriage, exchanged findings from recent research and development initiatives, explored what initiatives were needed to develop new concepts in design and evaluation and identified opportunities for collaboration. Specific sessions were held on the physiology, biomechanics and performance measures of load carriage, approaches and tools for assessment, development and validation of objective tests and their use in design solutions, mathematical modelling and the accuracy of pressure sensor measurement systems. There were two keynote addresses, twenty-five scientific papers, four workshops on future directions and tours of load carriage research facilities during the conference. The meeting unveiled many new findings, such as: possible energy transfers between body segments and between the pack and the person; objective assessment technologies for better understanding and design of load carriage systems; an interest in mathematically modelling the pack-person interactions and their effects on the carrier; and a willingness to work together toward sharing resources, data and the development of an improved STANAG for personal load carriage.

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