



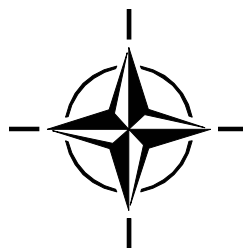
**RTO MEETING PROCEEDINGS**

**MP-HFM-123**

# **New Directions for Improving Audio Effectiveness**

(Nouvelles orientations pour l'amélioration  
des techniques audio)

Papers presented at the RTO Human Factors and Medicine Panel (HFM)  
Symposium held in Amersfoort, The Netherlands, 11-13 April 2005.



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- AVT Applied Vehicle Technology Panel
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- 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

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# **New Directions for Improving Audio Effectiveness**

**(RTO-MP-HFM-123)**

## **Executive Summary**

This Symposium reviewed:

- 1) The technical challenges and opportunities for more effective protection of human hearing in adverse military environments;
- 2) Efforts to optimize the portrayal of auditory information, especially via helmets and headphones; and
- 3) Research on improving the intelligibility of speech communication, especially through channels that encode and transmit multiple speech and data signals.

Participants included experts in human factors engineering, acoustics, speech & hearing sciences, military occupational health & safety, and end-users of military audio devices. The agenda included three keynote addresses and thirty-two technical papers, representing research efforts in eight nations.

This Symposium follows a 1996 AGARD meeting in Copenhagen on “Audio Effectiveness in Aviation,” and two recent HFM studies; one concerned with the effects of impulse noise, the other with technology for Active Noise Reduction (ANR).

The technical papers ranged from basic scientific studies to surveys of equipment usability in operational settings. Three papers focused on Active Noise Reduction (ANR). Four discussed bone-conducted sound and/or contact transduction for voice communication. Six papers discussed aspects of auditory perception and/or hearing mechanisms. Seven dealt with methods of presenting audio information in 3-dimensional spatial displays. Eight papers presented work on the evaluation of hearing protection devices. There were also eight on speech intelligibility.

This Technical Evaluation Report (TER) describes the background of substantial scientific and technical progress since the Copenhagen meeting, and sets forth seven primary challenges for future research efforts. The Report commends the HFM Panel and the Symposium organizers for developing a coherent and stimulating agenda, but urges planners for future meetings to seek stronger participation from the scientific community.

Although considerable progress has been made in devising hearing protection for personnel exposed to high levels of noise, such as the 150 dB sound fields near military jet aircraft, the number of persons who are disabled by noise exposure continues to mount, and it remains the No.1 military disability in this regard. One priority is to increase the use of protective equipment, through design improvements, custom fitting, education, and more rigorous implementation of policy. The goal of improved hearing protection also requires fundamental research in three specific areas:

- 1) Refined methods are needed to assess the risks from impulse noises (e.g. from small arms fire, blasts, etc.).
- 2) Research should discover how exposure to ototoxic chemicals (such as jet fuel, or solvents) exacerbates the damaging effects of noise, and evaluate possible treatments, such as anti-oxidants.

- 3) Long-term studies are needed to measure and understand the apparently wide variations among individuals in their vulnerability to noise-induced hearing loss.

This Technical Evaluation Report also recommends new efforts to improve speech intelligibility and to restore ambient spatial perception for wearers of helmets and headphones. These technical challenges cannot be met without strong investments in fundamental science aimed at a deeper understanding of human hearing. The importance of these challenges for human effectiveness cannot be overestimated. A broad, sustained effort is required in which international cooperation is vital.

# Nouvelles orientations pour l'amélioration des techniques audio (RTO-MP-HFM-123)

## Synthèse

Le travail du symposium a porté sur les points suivants :

- 1) défis techniques et possibilités de protéger plus efficacement l'audition du personnel dans les environnements militaires hostiles ;
- 2) efforts à déployer pour optimiser l'interprétation des informations auditives, notamment par le biais de casques et d'écouteurs ; puis,
- 3) activités de recherche sur l'amélioration de l'intelligibilité des communications verbales, notamment par le biais de canaux qui encodent et transmettent des signaux de données et vocaux multiples.

Participants au symposium : spécialistes en ergonomie, en acoustique, en sciences de la parole et de l'audition, en sécurité et santé professionnelles du personnel militaire et utilisateurs de dispositifs audio militaires. Le programme incluait trois discours et trente-deux documents techniques illustrant les efforts de recherche déployés dans huit pays.

Ce symposium fait suite à la réunion AGARD qui s'est tenue à Copenhague en 1996 et qui était consacrée à l'efficacité audio dans l'aéronautique (Audio Effectiveness in Aviation), et à deux études HFM récentes, l'une étant consacrée aux effets du bruit impulsif et l'autre aux technologies de réduction active du bruit (ANR).

Les documents techniques allaient des études scientifiques fondamentales aux recherches sur l'utilisation des équipements en configuration opérationnelle. Trois d'entre eux étaient consacrés à la réduction active du bruit (ANR). Quatre documents traitaient de la conduction du bruit par voie osseuse et/ou de la transduction par contact de la communication vocale. Six autres documents abordaient les aspects de la perception auditive et/ou de l'appareil auditif. Sept documents avaient trait aux méthodes de présentation des informations audio sur des écrans spatiaux tridimensionnels. Huit documents présentaient les travaux réalisés sur l'évaluation des dispositifs de protection de l'ouïe. Enfin, huit autres documents traitaient de l'intelligibilité de la parole.

Ce rapport d'évaluation technique (TER) décrit le contexte des avancées scientifiques et techniques substantielles réalisées depuis la réunion de Copenhague, et énumère les sept défis principaux que devront prendre en compte les efforts de recherche futurs. Le rapport félicite le Comité HFM et les organisateurs du symposium pour avoir mis sur pied un programme cohérent et stimulant, mais il recommande vivement aux planificateurs d'organiser d'autres réunions afin de renforcer la participation de la communauté scientifique.

Même si de réels progrès ont été faits pour protéger l'ouïe du personnel exposé à des niveaux de bruit élevés – personnel travaillant près des avions militaires générant des champs acoustiques de 150 dB par exemple – le nombre de personnes frappées d'incapacité en raison d'une exposition au bruit ne cesse de croître, et ce problème reste le premier facteur d'incapacité du personnel militaire. L'une des priorités

consiste à encourager davantage le port des équipements de protection en améliorant leur concept, en les adaptant aux situations, en informant le personnel et en mettant en place des politiques plus draconiennes. Optimiser la protection de l'ouïe passe également par la mise en œuvre d'activités de recherche fondamentale dans trois domaines spécifiques :

- 1) il est nécessaire d'affiner les méthodes permettant d'évaluer les risques induits par le bruit impulsionnel (p. ex. : tir d'armes à feu légères, explosions, etc.) ;
- 2) les activités de recherche doivent permettre de découvrir en quoi l'exposition à des produits chimiques ototoxiques (carburéacteur ou solvants) exacerbe les effets ravageurs du bruit, et d'évaluer les traitements potentiels, tels que le recours aux anti-oxydants ; enfin,
- 3) il est nécessaire de mettre sur pied des études à long terme afin d'évaluer et de comprendre les écarts apparemment importants qui existent entre les individus en termes de vulnérabilité à la perte d'audition due au bruit.

Ce rapport d'évaluation technique conseille par ailleurs de mettre en œuvre des moyens visant à améliorer l'intelligibilité de la parole et à restaurer la perception spatiale ambiante du personnel équipé de casques et d'écouteurs. Il n'est pas possible de faire face à ces défis techniques sans investir de façon appropriée dans les sciences fondamentales qui permettront de mieux comprendre la fonction auditive chez l'homme. L'importance de ces défis pour l'efficacité humaine ne peut pas être surévaluée. Il est par conséquent nécessaire de déployer des efforts soutenus à grande échelle pour lesquels une coopération internationale s'avère vitale.



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<b>14. Abstract</b>	Participants from eight nations reviewed (1) technical challenges for more effective protection of human hearing in adverse military environments, (2) efforts to optimize the portrayal of auditory information via helmets and headphones, and (3) research to improve speech intelligibility, especially via channels that encode and transmit multiple speech and data signals. This report summarizes progress and recommends seven areas for future research concentration.		





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