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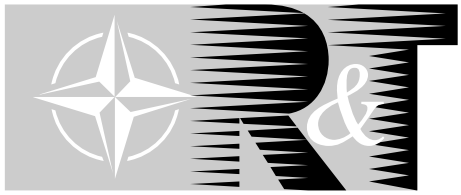

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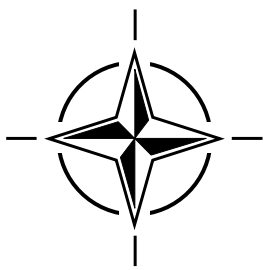
RTO LECTURE SERIES 221 bis

Technologies for Future Precision Strike Missile Systems

(les Technologies des futurs systèmes de missiles pour frappe de précision)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Systems Concepts and Integration Panel (SCI) and the Consultant and Exchange Programme of RTO presented on 18-19 June 2001 in Tbilisi, Georgia, on 21-22 June 2001 in Bucharest, Romania, on 25-26 June 2001 in Madrid, Spain, and on 28-29 June 2001 in Stockholm, Sweden.



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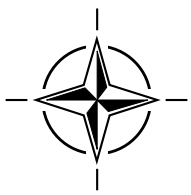

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RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA),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

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Technologies for Future Precision Strike Missile Systems

(RTO EN-018 / SCI-087 bis)

Executive Summary

This report documents the results of NATO Research and Technology Organization (RTO) lecture series number 221, entitled "Technologies for Future Precision Strike Missile Systems." The primary purpose of the lecture series was the disseminating of state-of-the-art scientific and technical knowledge among a wide audience. The lecture series identified significant developments in the enabling technologies and provided examples of the advancements. It also addressed the challenging requirements in areas such as adverse weather capability, time critical targets, high kill probability, no collateral damage, high survivability light-weight expeditionary warfare weapons, and affordability.

Emerging technologies for precision strike missile systems that were addressed in the lecture series included:

Mission planning technology. Assessments included off-board sensor integration, near-real-time mission planning, flight altitude, terrain following, and missile data links for in-flight targeting.

Missile aeromechanics technology. Assessments included hypersonic airframes, low cost/high temperature structure, and ramjet propulsion.

Guidance & control technology. An overview of existing guidance and control was given. Assessments included precision guidance and optimal guidance laws.

Missile GPS/INS sensor technology. Assessments included low cost INS and GPS/INS integration.

Missile design technology. An overview of the missile design process was given. Assessments included computer programs and electronic spreadsheets for conceptual design and missile deign criteria.

Seeker technology. Assessments included active and passive imaging infrared and radar seekers.

Missile/aircraft integration technology. Assessments included high firepower weapon concepts, reduced observables, and insensitive munitions.

Simulation/validation technology. Assessments included hardware-in-the-loop and design validation.

Automatic target recognition technology. Assessments included robust algorithms and hardware/algorithm optimization.

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Systems Concepts and Integration (SCI) Panel and the Consultant and Exchange programme of RTO. The lectures were first held March 23-24, 2000 in Atlanta Georgia USA, at the Georgia Institute of Technology. Following the lectures at Georgia Tech, the lectures were held April 3-4, 2000 in Turin, Italy and April 6-7, 2000 in Ankara, Turkey. Due to the interest in the lectures, they were reprised in 2001. Updated lectures were presented in Tbilisi, Georgia (18-19 June 2001), Bucharest, Romania (21-22 June 2001), Madrid, Spain (25-26 June 2001), and Stockholm, Sweden (28-29 June 2001).

les Technologies des futurs systèmes de missiles pour frappe de précision

(RTO EN-018 / SCI-087 bis)

Synthèse

Ce rapport présente les résultats du Cycle de conférences No. 221 sur «les technologies des futurs systèmes de missiles de frappe de précision» organisé par l'Organisation pour la recherche et la technologie de l'OTAN (RTO). Ce cycle de conférences a eu pour objectif principal la diffusion, auprès d'un large public, de l'état des connaissances scientifiques et techniques dans ce domaine. Le cycle de conférences a permis d'identifier des développements significatifs dans le domaine des technologies habilitantes et a fourni des exemples de ces avancées. Il a également permis d'examiner les besoins les plus contraignants dans les domaines suivants : capacité tous temps, cibles à fenêtre de frappe restreinte, probabilité de destruction élevée, absence de dommages collatéraux, armes légères à haute capacité de survie pour corps expéditionnaires, et coûts abordables.

Les technologies naissantes suivantes, relatives aux systèmes de missiles de frappe de précision, ont été abordées durant le Cycle de conférences :

Les technologies de planification de mission, avec une évaluation de l'intégration des senseurs non embarqués, de la planification des missions en temps quasi-réel et des liaisons de données missiles pour la désignation des objectifs en vol.

Les technologies concernant l'aéromécanique des missiles, avec une évaluation des cellules hypersoniques, des structures à coût modéré résistant aux hautes températures, et de la propulsion par statoréacteur.

Les technologies de guidage et de pilotage. Un tour d'horizon des technologies existantes dans ce domaine a été présenté, avec une évaluation des lois de guidage de précision et de guidage optimal.

Les technologies des capteurs GPS/INS avec une évaluation de l'intégration à coût modéré du matériel INS et GPS/INS.

Les technologies de conception des missiles Un tour d'horizon du processus de conception des missiles a été présenté, avec une évaluation des programmes informatiques et des tableurs pour les études de définition, ainsi que des critères de conception des missiles.

Les technologies des autodirecteurs avec une évaluation des autodirecteurs actifs et passifs à ondes millimétriques et infrarouges.

Les technologies d'intégration missile/aéronef, avec une évaluation des concepts d'armements à grande puissance de feu, de la furtivité et des munitions à risques atténués.

Les technologies de simulation/validation avec une évaluation du matériel dans la boucle et de la validation de la conception.

Les technologies de reconnaissance automatique de la cible, avec une évaluation des algorithmes robustes et de l'optimisation du matériel par rapport aux algorithmes.

Les textes présentés dans cette publication ont servi de support à un cycle de conférences organisé sous l'égide de la commission sur les concepts et l'intégration de systèmes (SCI) dans le cadre du programme de consultants et d' échanges de la RTO. Les premières conférences ont été présentées les 23 et 24 mars 2000 à l'Institut de Technologie de Géorgie à Atlanta, Géorgie, Etats-Unis. Les mêmes conférences ont également été présentées les 3 et 4 avril à Turin, en Italie et les 6 et 7 avril à Ankara, en Turquie. En raison de l'intérêt manifesté pour ce cycle de conférences, il a été repris en 2001. Des conférences mises à jour ont été présentées à Tbilisi en Géorgie (les 18 et 19 juin 2001), à Bucarest en Roumanie (les 21 et 22 juin 2001), à Madrid en Espagne (les 25 et 26 juin 2001), et à Stockholm en Suède (les 28 et 29 juin 2001).

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Aerodynamics	Design	Technology assessment
Missile airframes	Warheads	Infrared seekers
Missile guidance	Kinetic energy	Smart weapons
Missile control		

14. Abstract

This lecture series addressed recent advances in the state-of-the-art for precision strike missile systems. Emerging technologies that were addressed in the lecture series included:

- **Mission planning technology.** Assessments included off-board sensor integration, near-real-time mission planning, flight altitude, terrain following and missile data links for in-flight targeting.
- **Missile aeromechanics technology.** Assessments included hypersonic airframes, low cost/high temperature structure, and ramjet propulsion.
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