

MEETING ANNOUNCEMENT

for a Technical Course organized by

THE APPLIED VEHICLE TECHNOLOGY PANEL (AVT)

on

**APPLICATION OF ADAPTIVE STRUCTURES IN ACTIVE  
AEROELASTIC CONTROL**

*(Application des structures adaptatives dans la commande aéroélastique  
active)*

to be held at

The Cultural and Convention Center,  
METU,  
Inonu Bulvari  
Ankara,  
Turkey

on

25-29 March 2002

**LATEST ENROLMENT DATES:**

NATO Nations: 11 March 2002

Non-NATO\* and PfP\* Nations: 15 February 2002

\* Non-NATO and PfP Nationals wishing to attend the Technical Course  
are required to contact RTA/OCD Executive before 15 February 2002

## **THEME**

### **APPLICATION OF ADAPTIVE STRUCTURES IN ACTIVE AEROELASTIC CONTROL**

Active control of flight vehicles has many military advantages. Active Aeroelastic Control in particular, provides solutions to potentially hazardous structural problems commonly faced by various aircraft. Recently by the introduction of adaptive structures, the Aeroelastic Control techniques start yielding very promising results. The enhancement of flutter stability, the elimination of vertical tail buffeting, the improvement of roll control, the alleviation of blade-vortex interaction, the introduction of active wing and active tail concepts are a few successful research and development areas in which adaptive structures are used.

The Technical Course will focus on the application of adaptive structures in Active Aeroelastic Control of Flight Vehicles and will cover the following topics: (1) Computational aeroelasticity, (2) Experimental aeroelasticity, (3) MDDO and its applications in active aeroelastic control, (4) Smart materials, (5) Recent trends and applications of adaptive structures in active aeroelastic control.

### ***APPLICATION DES STRUCTURES ADAPTATIVES DANS LA COMMANDE AEROELASTIQUE ACTIVE***

Le contrôle actif des véhicules aériens offre de nombreux avantages militaires. Le contrôle actif aéro-élastique, en particulier, fournit des solutions aux problèmes de structure potentiellement hasardeux posés par différents aéronefs. Les techniques de contrôle aéro-élastiques commencent à donner des résultats très prometteurs, suite à l'introduction récente de structures adaptatives. L'amélioration de la stabilité en cas de flottement, l'élimination du tremblement vertical de l'empennage, l'amélioration du contrôle en roulis, l'allègement des interactions pales/tourbillons, l'introduction de concepts de voilures et d'empennages actifs sont autant d'exemples de domaines de recherche et développement où les structures adaptatives ont été utilisées avec succès.

Ce cours technique sera principalement consacré à l'étude de la mise en œuvre des structures adaptatives pour le contrôle actif aéro-élastique des véhicules aériens et couvrira les sujets suivants: (1) L'aéro-élasticité numérique, (2) L'aéro-élasticité expérimentale, (3) La MDDO et ses

applications au contrôle actif aéro-élastique, (4) Les matériaux intelligents, (5) Les tendances récentes et les applications des structures adaptatives au contrôle actif aéro-élastique.

## PROGRAMME

### APPLICATION OF ADAPTIVE STRUCTURES IN ACTIVE AEROELASTIC CONTROL

#### 25 March 2002

0830-0900 Registration

0900-0910 Welcome

0910-0930 Introduction-Overview  
Prof. Y. Yaman

0930-1030 Principles of Computational Aeroelasticity  
- Overview of Computational Aeroelasticity  
- Static Aeroelasticity  
Mr R. Kolonay

1030-1100 Break

1100-1200 Principles of Computational Aeroelasticity  
- Dynamic Aeroelasticity  
- Commercial Programs with Aeroelastic Analysis/Design Capabilities  
Mr. R. Kolonay

1200-1330 Lunch

1330-1430 Principles of Experimental Aeroelasticity  
- Historical overview of aeroelastic testing  
- Overview of aeroelastic experimental research at NASA Langley Research Center  
- Introduction to aeroelastic wind-tunnel testing  
Mr. S. Cole

1430-1530 Principles of Experimental Aeroelasticity  
- Calibrations and statistical quality control associated with testing  
- Specific discussion of the Langley Transonic Dynamics Tunnel (TDT)  
- Videos of aeroelastic testing (primarily at the TDT)  
Mr. S. Cole

1530-1600 Break

1600-1700 Principles of Experimental Aeroelasticity  
- Standard and advanced instrumentation techniques

- Preliminary aeroelastic model design: support system considerations  
- Aeroelastic model design  
- Model fabrication  
Mr. S. Cole

#### 26 March 2002

0900-1000 Principles of Experimental Aeroelasticity  
- Smart structure materials and construction  
- Flutter and divergence testing, including subcritical response techniques  
- Experimental flutter clearance case study (A-6 vehicle)  
- Buffet and general dynamic response testing  
Mr. S. Cole

1000-1030 Break

1030-1130 Principles of Experimental Aeroelasticity  
- Active control testing  
- Active Flexible Wing model program case study  
- A review of smart structure applications in wind tunnel tests and results  
- High Speed Research program case study  
Mr. S. Cole

1130-1230 Active Aeroelastic Aircraft Concepts  
Mr. J. Schweiger

1230-1400 Lunch

1400-1500 Active Aeroelastic Design of a Vertical Tail  
Mr. J. Schweiger

1500-1530 Break

1530-1615 Multi Disciplinary Design and Optimization  
- Basic Principles  
Prof. P. Hajela

1615-1700 Multi Disciplinary Design and Optimization  
- Sensitivity Analysis  
Prof. P. Hajela

**27 March 2002**

0900-1000 Active Aeroelastic Flutter Suppression and Active Control of Fin Buffeting (Video Presentation)  
Mr. J. Schweiger

1000-1030 Break

1030-1130 Structural Optimization and MDDO in Industry  
Mr. J. Schweiger

1130-1230 Aeroelastic Optimization  
- Linear Static Aeroelastic Optimization  
- Linear Dynamic Aeroelastic Optimization  
- Trim Optimization  
- Commercial Programs with Aeroelastic Design Capabilities  
- Static and Dynamic Aeroelastic Sensitivity Analyses  
Mr. R. Kolonay

1230-1400 Lunch

1400-1700 Field Trip (TBD)

**28 March 2002**

0900-1000 Nonlinear Aeroelastic Optimization  
- Nonlinear Unsteady Aerodynamic Approximations  
- Nonlinear Unsteady Aeroelastic Analysis for Design  
- Nonlinear Unsteady Aeroelastic Sensitivity Analysis  
- Nonlinear Unsteady Aeroelastic Optimization (Transonic)  
- Nonlinear Static Aeroelasticity Analysis for Design (Transonic)  
Mr. R. Kolonay

1000-1030 Break

1030-1130 Multi Disciplinary Design and Optimization  
- Problem Decomposition  
Prof. P. Hajela

1130-1230 Multi Disciplinary Design and Optimization  
- Soft Computing Applications  
Prof. P. Hajela

1230-1400 Lunch

1400-1500 General Characteristics of Smart Materials  
Mr. E. Prasad

1500-1530 Break

1530-1615 Characteristics of Piezoelectric Ceramics  
Mr. E. Prasad

1615-1700 Piezoelectric Adaptive Wing  
- Design Methodology and Experimental Set-up  
Prof. A. Suleman

**29 March 2002**

0900-1000 Characteristics of other Smart Materials  
- Electrostrictive Materials  
- Shape Memory Alloys  
- Electro-rheological Fluids  
- Fibre-optics  
Mr. E. Prasad

1000-1030 Break

1030-1130 Characteristics of Smart Structures  
Mr. E. Prasad

1130-1230 Piezoelectric Adaptive Wing  
- Wind tunnel tests for buffeting and gust-alleviation response  
Prof. A. Suleman

1230-1400 Lunch

1400-1500 Piezoelectric Adaptive Wings for Remote Operated Aircraft  
Prof. A. Suleman

1500-1530 Break

1530-1645 Round Table Discussion

1645-1700 Concluding Remarks  
Prof. Y. Yaman

**LOCAL/ENROLMENT COORDINATORS**  
*COORDONNATEURS D'INSCRIPTION*

FOR TECHNICAL COURSE IN:

Turkey

Professor Yavuz YAMAN  
Middle East Technical University (ODTU)  
Aeronautical Engineering Department  
Inonu Bulvari 06531  
Ankara  
TURKEY

Tel. 90 312 210 4285  
Fax: 90 312 210 1272  
Email: [yyaman@metu.edu.tr](mailto:yyaman@metu.edu.tr)

**ENROLMENT COORDINATOR**

For PfP and Non-NATO Nationals

RTO/OCD Executive

RTA

BP 25, 7 rue Ancelle

F-92201 Neuilly-sur-Seine Cedex

France

Tel. +33 (0)1 55 61 22 14

Fax +33 (0)1 55 61 96 10

Email: [brooks@rta.nato.int](mailto:brooks@rta.nato.int)

**PANEL EXECUTIVE**

Dr P. Tonn

RTO/AVT Executive

RTA

BP 25, 7 Rue Ancelle

F-92201 Neuilly sur Seine Cedex

France

Tel: +33 (0)1 55 61 22 85

Fax: +33 (0) 1 55 61 22 96 41

Email: [tonnp@rta.nato.int](mailto:tonnp@rta.nato.int)

## **COURSE DIRECTOR**

Prof. Yavuz YAMAN  
Middle East Technical University (ODTU)  
Aeronautical Engineering Department  
Inonu Bulvari  
06531 - Ankara  
Tel: +90 312 210 4285  
Fax: +90 312 210 1272  
Email: [yyaman@metu.edu.tr](mailto:yyaman@metu.edu.tr)

## **COURSE LECTURERS**

Mr Raymond KOLONAY, Ph.D  
GE Corporate Research & Development  
Mechanical Design Methods and Processes  
Bldg. Ki, room 2A60  
One Research Circle  
Niskayuna, NY, 12309  
USA  
Tel. 1 518 387 5067  
Fax. 1 518 387 5459  
Email: [kolonay@crd.ge.com](mailto:kolonay@crd.ge.com)

Mr Stan COLE  
Aeroelasticity Branch  
NASA Langley Research Center  
218 Dodd Boulevard, Building 648  
Mail Stop 340  
Hampton, VA 23681-2199  
USA  
Tel. 1 757 864 1207  
Fax. 1 757 864 8678  
Email: [s.r.cole@larc.nasa.gov](mailto:s.r.cole@larc.nasa.gov)

Professor Prabhat HAJELA, Ph.D.  
Rensselaer Polytechnic Institute  
Mechanical Eng. Aero. Eng. & Mechanics,  
110 8<sup>th</sup> Street,  
Troy,  
NY 12180 3590 ,  
USA  
Tel. 1 518 276 6624  
Fax. 1 518 276 2623  
Email: [hajela@rpi.edu](mailto:hajela@rpi.edu)

Mr Afzal SULEMAN, Ph.D.  
Associate Professor  
IDMEC - Instituto Superior Tecnico  
Dpto de Engenharia Mecanica  
Av. Rovisco Pais 1  
1096 Lisbon Cedex  
PORTUGAL  
Tel. 351 21 841 7548  
Fax. 351 21 847 4045  
Email: [suleman@alfa.ist.utl.pt](mailto:suleman@alfa.ist.utl.pt)

Mr Johannes SCHWEIGER, Dipl.-Ing.  
Head, Structural Dynamics and  
Aeroelasticity,  
Daimler-Chrysler Aerospace AG  
Military Aircraft  
P.O. Box 801160  
81663 Munich  
GERMANY  
Tel. 89 607 23124  
Fax. 89 607 32158  
Email: [Johannes.Schweiger@m.dasa.de](mailto:Johannes.Schweiger@m.dasa.de)

Mr Eswar PRASAD, Ph.D.  
Chairman, Sensor Technology Ltd  
P.O. Box 97  
Collingwood, Ontario, L9Y 3Z4  
CANADA  
Tel. 1 705 444 1440 Ext.25  
Fax 1 705 444 6787  
Email: [eprasad@sensortech.ca](mailto:eprasad@sensortech.ca)

**GENERAL INFORMATION**  
*RENSEIGNEMENTS GENERAUX*

**WHO MAY ATTEND/PARTICIPATION**

Attendance at RTO Technical Courses is normally limited to citizens of NATO Nations. However, this Technical Course is also open to PFP nations.

**NATO's Research & Technology Organization (RTO)**

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 the following 7 bodies:

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

These bodies 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.

The mission of the Applied Vehicle Technology Panel (AVT) is to improve the performance, affordability and safety of vehicle platforms, propulsion and power systems through the advancement of appropriate technologies. The panel addresses technology issues related to vehicle platforms, propulsion and power systems operating in all environments, including land, sea, air and space, for both new and aging systems.