

SCIENCE AND TECHNOLOGY ORGANIZATION

APPLIED VEHICLE TECHNOLOGY PANEL



Science & Technology Organization Collaboration Support Office Applied Vehicle Technology Panel

AVT-305 Research Specialists' Meeting on

Sensing Systems for Integrated Vehicle Health Management for Military Vehicles

Athens, Greece 12-13 December 2018

This Workshop is open to NATO Nations, Australia, Finland, Sweden, New Zealand and Ukraine

Theme and Topics

Two thirds of the cost of ownership of military equipment is spent during the operational life. A significant portion of these costs comes from maintenance. Maintenance based on the condition of the vehicle is an enabler for reducing these costs, which relies on novel health management concepts, such as Structural Health Management (SHM), Integrated Vehicle Health Management (IVHM) and Health and Usage Management Systems (HUMSs). These health management concepts strongly rely on sensor data for early fault detection, vehicle state diagnostics, prognostics, and reasoning. In recent years, there has been a significant progress in various fields directly and indirectly related to sensing technologies. New developments on sensors include novel vibrational, optical, and nano sensing technologies, new approaches for embedding sensors in structural components, "smart sensor" concepts, thin film sensors, energy harvesting, wireless communication, etc.

The objective of this AVT-305 Specialist Meeting is to offer an opportunity for both sensor developers and military vehicle operators to discuss the current status and implementation of sensing technologies for military vehicle health management. The goal is to improve the readiness level of such technologies for integration within the new and legacy military platforms to improve mission availability and safety while reducing operational and maintenance costs. The Specialist Meeting will explore advancements in sensors and sensing systems for integrated vehicle health management and identify the benefits for application in military platforms for land, sea and air.

The following topics are covered by AVT-305:

- Advanced sensing technologies
- Multi-functional sensors
- Wireless sensors
- Embedded sensors
- Energy harvesting / self-powered sensors
- Long-term durability and reliability of sensors and sensor placements
- Sensor integration
- Sensor data acquisition, storage and processing
- Diagnostics and prognostics
- Implementation of sensors in new and legacy platforms
- Lessons learned, experiences, and best practices

Background

The mission of the Science & Technology Organization is to conduct and promote co-operative research and information exchange. STO consists of a three level organization: the Science and Technology Board, the Panels and the Technical Teams. The Applied Vehicle Technology (AVT) Panel, comprising more than 1000 scientists and engineers, strives to improve the performance, reliability, affordability, and safety of vehicles through advancement of appropriate technologies. The Panel addresses platform technologies for vehicles operating in all domains (land, sea, air, and space), for both new and ageing systems.

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AVT-305 Research Specialists' Meeting on Sensing Systems for Integrated Vehicle Health Management for Military Vehicles

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Programme

Wednesday, 12 December 2018

Joint Session AVT-305 & AVT-306

Chair: Afzal Suleman, Instituto Superior Tecnico, Portugal

- 11:00 KEYNOTE: Using Additive Technology To Enable Design and Manufacturing of Instrumentation Mohammed Ehteshami, General Electric, United States
 11:30 KEYNOTE: Test Cell Instrumentation Challenges Then and Now: AVT-126 to AVT-306 Robert Jackson, Inter-connect Plus Ltd, United Kingdom
 12:00 Welcome Remarks by AVT-305 Chairs
 12:05 Laser Deposited High Temperature Thin Film Sensors for Gas Turbines Dongfang Yang, Vladimir, Pankov, Linruo, Zhao, Prekash, Patnaik, National Research
- Dongfang Yang, Vladimir Pankov, Linruo Zhao, Prakash Patnaik, National Research Council Canada, Canada
- 12:30 LUNCH BREAK and END OF AVT-306

Session 1 – Modelling and Data Analysis

Chair: Marcel Bos, Netherlands Aerospace Centre, The Netherlands

- 14:00 Sensing Systems for Surface, Damage and Bonding Assessment for Lightweight Materials Tomasz Wandowski, Pawel Malinowski, Wieslaw Ostachowicz, Polish Academy of Sciences, Bartosz Puchowski, CreeYacht, Poland, Jochen Moll, Goethe University of Frankfurt am Main, Germany
- 14:30 Predictive Simulation of Guided Wave Structural Health Monitoring with Piezoelectric Wafer Active Sensors for Military Vehicle Applications Victor Giurgiutiu, University of South Carolina, United States
- 15:00 Computational Simulation and Experimental Validation of a Fiber-Optic Based SHM System Applied to a UAV Structure Alfredo Guemes, Antonio Fernandez-Lopez, Univ Politecnica Madrid, Malte Frovel, Jose Maria Pintado, INTA (Spanish Aerospace Research Center), Spain
- 15:30 COFFEE BREAK

Session 2 – Sensor Integration

Chair: Shashank Pant, National Research Council, Canada

- 16:00 Structure Conformable Eddy Current Coils for In-situ Crack Detection Catalin Mandache, Shashank Pant, Muzikur Khan, Marc Genest, National Research Council Canada, Canada
- 16:30 Fibre Optic Sensor Embedding in Metals Using Low Cost TIG Welding and High Precision Laser Brazing Tania Grandal, Sergio Fraga, Gemma Castro, Esteban Vazquez and Ander Zornoza, AIMEN Technology Center, Spain
- 17:00 Observation of Damage Accumulation Under In-Plane Shear Loading Cagatay Yilmaz, Cagdas Akalin, Murat Buyuk, Mehmet Yildiz, Sabanci University, Ibrahim Gunal, KNRTU-KAI named after A.N. TUPOLEV, Hakan Celik, Yonca-Onuk JV Shipyard,Turkey, Afzal Suleman, University of Victoria, Canada

Thursday, 13 December 2018

Session 3 – Structural Health Monitoring Chair: Prakash Patnaik, National Research Council, Canada

08:30	KEYNOTE: Challenges for SHM Reliability and Application in Aerospace Industry Christian Stolz, Christoph Meisner, Airbus Defence and Space, Germany
09:30	SHM System Design Tool for Damage Detection and Probability of Detection Frank Grooteman, Netherlands Aerospace Centre, The Netherlands
10:00	Hull Stress Monitoring and Load Prediction Systems Geir Sagvolden, Karianne Pran, Light Structures, Norway
10:30	COFFEE BREAK

Session 4 – Diagnostics and Prognostics Chair: Roland Lang, Airbus, Germany

- 11:00 A Novel Approach to Integrated Vehicle Health Management George Vachtsevanos, GaTech, Kimon P. Valavanis, University of Denver, United States
- 11:30 Listening to Corrosion Axel Homborg, Netherlands Defence Academy, T. Tinga, University of Twente, J.M.C. Mol, Delft University of Technology, The Netherlands
- 12:00 Vibration-Based Fault Detection in Railway Suspensions Under Variable Operating Conditions Via a Stochastic Functional Model BasedMmethod Tryfon-Chrysovalantis Aravanis, John Sakellariou, Spilios Fassois, University of Patras, Greece
- 12:30 LUNCH BREAK

Session 5 – Sensor Implementation

Chair: Henk Jan ten Hoeve, Netherlands Aerospace Centre, The Netherlands

- 14:00 New Developments in the Health Monitoring of Aircraft Structural and Dynamic Components Marcel Bos, Carlo Rens, NLR - Netherlands Aerospace Laboratory, The Netherlands
 14:30 Sensing of Structural Damage with OBR Based Fibre-Optic Networks Kaspar Lasn, Erik Sæter, Andreas T. Echtermeyer, Norwegian University of Science and Technology, Norway
 15:00 Ageing Fighter – Bomber Aircraft Durability Tests and Operational Load Monitoring to Support Life Extension Program Artur Kurnyta, Piotr Reymer, Michał Dziendzikowski, Marcin Kurdelski, Andrzej Leśniczak, Air Force Institute of Technology, Poland
- 15:30 COFFEE BREAK

Session 6 – Technical Evaluation / Closing Session

Chair: Prakash Portugal	Patnaik, National Research Council, Canada and Afzal Suleman, Instituto Superior Tecnico,
16:00	AFRL Perspective on Structural Health Monitoring for USAF Fixed Wing Aircraft Eric Lindgren, Air Force Materiel Command, Wright-Patterson AFB, United States
16:30	Technical Evaluation Report Loris Molent, Defence Science & Technology Group, Australia

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17:30 END OF AVT-305

Science and Technology Organization in NATO

In NATO, Science & Technology (S&T) is defined as the selective and rigorous generation and application of state-ofthe-art, validated knowledge for defence and security purposes. S&T activities embrace scientific research, technology development, transition, application and field-testing, experimentation and a range of related scientific activities that include systems engineering, operational research and analysis, synthesis, integration and validation of knowledge derived through the scientific method.

In NATO, S&T is addressed using different business models:

- The Collaborative business model where NATO provides a forum where NATO Nations and partner Nations elect to use their national resources to define, conduct and promote cooperative research and information exchange.
- The In-House delivery business model where S&T activities are conducted in a NATO dedicated executive body, having its own personnel, capabilities and infrastructure.

The Science and Technology Organization - STO

The mission of the NATO STO is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO Nations and partner Nations, by:

- Conducting and promoting S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives;
- Contributing to NATO's ability to enable and influence security- and defence-related capability development and threat mitigation in NATO Nations and partner Nations, in accordance with NATO policies;
- Supporting decision-making in the NATO Nations and NATO.



AVT-305 Research Specialists' Meeting

Acknowledgement

The Applied Vehicle Technology Panel expresses its thanks to Greece for the invitation to hold this meeting in Athens and for the facilities and personnel, which make this meeting possible.