



Science and Technology Organization
Collaboration Support Office

Neuilly-sur-Seine – France

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Collaboration Support Office
Applied Vehicle Technology Panel

AVT-384 Research Specialists' Meeting on

Novel Materials and Manufacturing in Military Vehicle Design Koblenz, Germany

16 - 18 October 2024

This Research Specialists' Meeting is open to NATO Nations and Enhanced Opportunity Partners (EOP)

Theme and Topics

This Research Specialists' Meeting (RSM) will be held in conjunction with the 54th AVT Panel Business Meeting (PBM) with the objective to engage in discussions about the state-of-the-art of novel materials and manufacturing techniques in military vehicle design, identify technology gaps impeding progress, and foster meaningful collaborations between interested parties. By incorporating materials and manufacturing into modern design practices NATO's ability to maintain a technological advantage over adversaries will be preserved with the ability to complete swift design updates responding to changing battlespace needs or the introduction of new materials or processes. Anticipated topics of discussion span ground, sea, air, and space applications and may include:

- Integration of Novel Materials into design frameworks and agile manufacturing, including: characterization, experimental techniques, high temperature materials, metamaterials, multiscale materials, smart materials, and architected/hierarchical materials;
- Integration of Novel Manufacturing capabilities, including agile manufacturing, reconfigurable processes, additive manufacturing, and implications on initial operating capability timelines
- Developments in Novel Design methods including multidisciplinary design and optimization (such as gradient-based techniques), integration of material design and manufacturing constraints, and AI/ML based generative design methods.

In recent years advances in gradient-based optimization techniques, novel materials, and new manufacturing methods have provided designers with materials capable of both complex geometries and idyllic smooth gradations as well as the ability to quickly fabricate them. The design community now finds itself behind in the development of tools and models to take advantage of these opportunities. To that end, efforts across the community are underway to bridge this gap, enabling new opportunities to take advantage of the unique qualities of these new materials and manufacturing techniques.

The integration of novel materials and manufacturing into design processes will yield several benefits. Historically three factors have decided near peer conflicts: technological advantages, logistics, and intelligence. At a conflict's onset it is unlikely fielded systems will be optimized for the evolving battlespace. Implementing just-in-time design practices requires novel material design and manufacturing strategies as early as possible. NATO will maintain a technological advantage throughout future conflicts with the ability to quickly include new materials and manufacturing requirements and timelines into designs.



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Keynote Speakers

Mr. Alexander L. Carrere, Senior MDAO Engineer at Boeing Research & Technology, USA

Mr. Alexander Carrere is a Senior Multidisciplinary Design Analysis and Optimization (MDAO) engineer in Boeing Research and Technology (BR&T) focused on developing, tailoring, and applying a wide variety of MDAO models to design advanced platforms across Boeing. He is a Boeing Designated Expert in MDAO and has worked as the MDAO study lead on a variety of derivative and clean sheet vehicle design projects that include F-18, T-7a, MQ-25a, X-65, Blended Wing Body, and small missiles. He is a member of the AIAA Multidisciplinary Design Optimization (MDO) Technical Committee.

Dr. Richard M. Kearsy (Rick), Director R&D, Aerospace Research Centre, National Research Council of Canada (NRC)

Over the past 8 years, as Director R&D for both the Structures and Materials Performance Lab and the Aerospace Manufacturing Research Centre of NRC, Dr. Kearsy has been leading a team of more than 100 scientists and technicians in the design, development, and certification of materials and structures for aerospace applications. With over 30 years' experience in the field, he has gained practical & professional experience by supporting research at the national & international levels, including cutting edge research with Defence partners, large OEM clients, numerous SME's and MRO's, and an extensive list of colleagues within academia and International Research Organization cadre. Fundamental research activities involve the design and fabrication of high temperature materials systems, risk assessment and residual life assessment of critical airframe and engine components, and the development of digital twin and physics-based deformation modelling methods.

Dr. Mark D. Benedict, Senior Scientist, Advanced Manufacturing, Air Force Research Laboratory, USA

Mark D. Benedict, a member of the scientific and professional cadre of senior executives, is the Senior Scientist for Convergent Digital Manufacturing, Materials and Manufacturing Directorate, Air Force Research Laboratory, Wright-Patterson AFB, Ohio. He serves as the principal scientific authority and independent researcher in the research, development, adaptation, and application of advanced manufacturing and is a recognized expert on additive manufacturing process modeling, machine development, data management, and airworthiness qualification/certification. In his prior role as America Makes Chief Technical Advisor he was integral to the planning, requirements definition, selection, and execution of the \$446M technical portfolio that America Makes has in the area of convergent manufacturing over the last decade.



Programme

DAY 1, Wednesday, 16 October 2024, 1400-1730

Session 1: Materials in Military Vehicle Design

Chairs: Mr. Robert MATHERSHAW and Dr. Rafael LUTERBACHER

- 1400** **Welcome and Introduction**
- 1430** 1 **KEYNOTE: The State of the Art in Materials in Military Vehicle Design**
Dr. Richard M Kearsey
Director R&D, Aerospace Research Centre, National Research Council of Canada, CAN
- 1530** **Coffee Break**
- 1600** 2 *Characterization of Additively Manufactured Ceramic Composite for Passive to Active Oxidation in High Enthalpy Flow*
Dr. Joseph El Rassi
 von Karman Institute for Fluid Dynamics (USA)
- 1630** 3 *Plasticity Modelling of Titanium and Steel Alloys Fabricated via Powder Bed Fusion and Material Extrusion: A Phenomenological Constitutive Approach*
Prof. Kyriakos I. Kourousis
 University of Limerick (IRL)
- 1700** 4 *Platform Signature Research at TNO: A Comprehensive Framework Combining Novel Materials, Novel Design Methods, and Novel Manufacturing Techniques*
Dr. Arthur J Vromans
 Netherlands Organisation for Applied Scientific Research – TNO (NLD)
- 1730** **End of Day 1**

DAY 2, Thursday, 17 October 2024, 0800-1730

Continuation of Session 1: Materials in Military Vehicle Design

Chairs: Mr. Robert MATHERSHAW and Dr. Rafael LUTERBACHER

- 0800** 5 *High Temperature Materials and Thermal Protection for Hypersonic and Space Vehicles – View and Needs From Dassault Aviation*
Ing. Benoit Berton
 Dassault Aviation (FRA)
- 0830** 6 *Development of Carbon-Polyimide Powder-Coated Semi-Preg for High Temperature Composite Applications*
MSc. Ronald Klomp-de Boer
 Netherlands Aerospace Centre (NLR)



0900 7 *High and Ultra High Temperature Ceramic Matrix Composites for Hypersonic Systems*
Dr. Mario De Stefano Fumo
Italian Aerospace Centre (ITA)

0930 **Panel Discussion**

1030 **Coffee Break**

Session 2: Design Methods of Military Vehicles

Chairs: Dr. Erdem ACAR and Mr. Selvan THAMIZHIRAI

1100 8 **KEYNOTE: The State of the Art in Design of Military Vehicles**
Mr. Alexander Carrere
Senior MDAO Engineer at Boeing Research and Technology, USA

1200 9 *Novel Design and Manufacturing Technologies for Future Military Aerostructures From an OEM Perspective*
Dr. Klaus Müller
Airbus Defence and Space (DEU)

1230 **Lunch**

1400 10 *Additive Manufacturing of Metamaterials, Vibration Mitigation, and Metals Replacement*
Dr. Juan Garcia-Martinez
Instituto Nacional de Técnica Aeroespacial “Esteban Terradas” – INTA (ESP)

1430 11 *Multiscale Materials in Topology Optimized Vehicle Design*
Dr. Richard V Beblo
Air Force Research Laboratory (USA)

1500 **Panel Discussion**

1530 **Coffee Break**

1600 **Panel Discussion**

1730 **End of Day 2**



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DAY 3, Friday, 18 October 2024, 0800-1230

Session 3: Manufacturing Technologies in Military Vehicle Design

Chairs: Dr. Richard BEBLO and Dr. Prakash PATNAIK

- 0800** 12 **KEYNOTE: The State of the Art in Manufacturing of Military Vehicle Design**
Dr. Mark Benedict
Senior Scientist, Advanced Manufacturing, Air Force Research Laboratory, USA
- 0900** 13 *Perspectives on 3D Printing of Advanced Ceramic and Metallic Materials*
Dr. Priti Wanjara
National Research Council of Canada (CAN)
- 0930** 14 *Manufacturing of Ceramic Matrix Composites for Hypersonic Systems Using Automated Fibre Placement*
Dr. David King
National Composites Centre (UK)
- 1000** 15 *The Relationship Between Fatigue Life and the Micro and Meso Structure of Additively Manufactured Materials*
Dr. Emiel Amsterdam
Royal Netherlands Aerospace Centre (NLD)
- 1030** **Coffee Break**
- 1100** **Panel Discussion**
- 1200** **Conclusion and Best Paper Award**
- 1230** **End of Day 3**



Science and Technology Organization in NATO

In NATO, Science & Technology (S&T) is defined as the selective and rigorous generation and application of state-of-the-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.
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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-384 Research Specialists' Meeting

Acknowledgement

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