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Logistics and Manufacturing under Attack

Virtual Workshop on June 2-4, 2021

https://www.nationalacademies.org/our-work/logistics-and-manufacturing-under-attack-a-workshop.

Presented by the National Academies' Defense Materials, Manufacturing and its Infrastructure Standing Committee (DMMI)

Chair DMMI **Haydn Wadley**, UVA; Workshop Chair **Angus Kingon**, Brown University

Under the auspices of the National Materials and Manufacturing Board (NMMB)

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The ability to make and repair equipment in current operational environments is increasingly vulnerable to disruptions in global supply chains and to attacks. Join the National Academies for a virtual workshop on **June 2-4, 2021** to discuss the latest in advanced manufacturing technologies and their future logistical considerations. Topics discussed will include additive manufacturing of large structures, supply and manufacturing in space, and critical systems supply and repair. Speakers will also address failure prediction tools, supply chain issues, and the challenges of applying sophisticated materials science and engineering at point of need.

Register to attend at http://dmmi.eventbrite.com

Agenda

Day 1: Additive manufacturing of large structures June 2, 2021 Co-chairs: Thomas R. Kurfess (Oak Ridge National Laboratory) and Pablo Zavattieri (Purdue University)		
11:00 am ET /8:00 am PT	Welcome, DMMI Introduction, and Day 1 Introduction	15 min
	Session 1: State of the Art and Beyond 3D Printing Introductions by Thomas Kurfess, Moderated by Pablo Zavattieri	
11:15 am ET /8:15 am PT	**Henrik Lund-Nielsen,** COBOD International A/S 3D Concrete Printing Technology for Construction Applications Discussion	20 min 10 min
11:45 am ET /8:45 am PT	**Brian Post**, Oak Ridge National Laboratory SkyBAAM: Portable Infrastructure Scale 3D Printing Discussion	20 min 10 min
12:15 pm ET /9:15 am PT	**Amy Marks**, Autodesk Industrialized Construction: Transformation Framework for the New Possible Discussion	20 min 10 min
12:45 pm ET /9:45 am PT	**Break**	10 min
12:55 pm ET /9:55 am PT 1:35 pm ET /10:35 am PT	**Session 2 Panel Discussion:** **Peter Stynoski**, U.S. Army Corps of Eng. Remote 3D Printing and deployment **Scott Jones**, NIST Metrics **Julieta Moradei**, Hometeam Ventures Bringing breakthrough technologies to one of the world's largest — but least innovative— industries **Jan Olek**, Purdue University 3D Printing in Construction: Technical Challenges and Research Needs **Q+A and General Discussion** Introductions by Pablo Zavattieri and Moderated by Thomas Kurfess	10 min 10 min 10 min 10 min 60 min
2:35 pm ET /11:35 am PT	**Break**	10 min

2:45 pm ET /11:45 am PT	**Michael Dosier,** BioMASON Biotechnology in construction Discussion	20 min 10 min
3:15 pm ET /1:15 pm PT 3:35 pm ET /12:35 pm PT	**Session 3 Panel Discussion:** **Bing Tian,** The Quikrete Companies Uses of Recycled Materials for Remote 3D Printing **Diana Hun,** Oak Ridge National Laboratory Toward Net Zero Carbon Concrete **Q+A and General Discussion** Introductions by Thomas Kurfess and Moderated by Pablo Zavattieri	10 min 10 min 30 min
4:05 pm ET /1:05 pm PT	**Adjourn Day 1**	

Day 2: Repair and Supply of Systems and Subsystems **June 3, 2021** Co-chairs: Angus Kingon (Brown University) and Dave Aspnes (NC State University)		
11:00 am ET /8:00 am PT	Welcome, Introductory remarks	15 min
	Session 1: Advances in Asset Monitoring Introductions by Angus Kingon, Moderated by Dave Aspnes	
11:15 am ET /8:15 am PT	**Brant Simmons,** GE Aviation Reflections on Jet Turbine Engines: Lifetime Prediction and Asset Availability Discussion	20 min 10 min
11:45 am ET /8:45 am PT	**Gary W. Rogers,** Roush Industries Advances in system monitoring: Lessons from the automobile industry Discussion	20 min 10 min
12:15 pm ET /9:15 am PT	**Break**	15 min
	Session 2: Issues and Opportunities in Supply Introductions by Angus Kingon, Moderated by Dave Aspnes	
12:30 pm ET /9:30 am PT	**Craig Gravitz,** The Defense Logistics Agency Current status and opportunities for innovation Discussion	20 min 10 min
1:00 pm ET /10:00 am PT	**Robert Handfield,** NCSU The LIVING supply chain: Creating real time analysis Discussion	20 min 10 min
1:30 pm ET /10:30 am PT	**Nancy Stoffel,** GE Research Flexible Hybrid Electronics: Opportunities in Sensing, Monitoring and Communications Discussion	20 min 10 min
2:00 pm ET /10:50 am PT	**Break**	10 min

2:10 pm ET /11:10 am PT	**Session 3 Panel Discussion: Innovations and Opportunities in Asset Monitoring and Supply**	
	Mike Maloney, retired, Pratt and Whitney Case Study: lessons from gas turbine jet engine monitoring and maintenance	15 min
	Geoff Joseph, Roush Industries Applying lessons from automobile vehicle monitoring to the defense industry	15 min
	Walter Yund, General Electric Supply chain reliability analytics	15 min
	Eric Forsythe, U.S. Army Research Lab and NextFlex DoD Investment in Hybrid Electronics Industrial Base	15 min
3:10 pm ET /12:10 pm PT	**Q+A and General Discussion** Introductions by Dave Aspnes and Moderated by Angus Kingon	60 min
3:55 pm ET /12:55 pm PT	**Adjourn Day 2**	

Day 3: Logistics and Manufacturing in Space **June 4, 2021** Co-chairs: Rosalind Lewis (Aerospace Corp) and Haydn Wadley (University of Virginia)		
11:00 am ET /8:00 am PT	Welcome, Introductory remarks	5 min
Day 3 Overview of the Challenges Introductions by Rosalind Lewis, Moderated by Haydn Wadley		
11:05 am ET /8:05 am PT	**Kara Cunzeman,** Aerospace Corporation The space logistics challenge Discussion	30 min 15 min
11:50 pm ET /8:50 am PT	**Break**	10 min
Session 1: Logistics in cis-lunar space Introductions by Haydn Wadley, Moderated by Rosalind Lewis		
12:00 pm ET /9:00 am PT	**Tom Spilker,** Orbital Assembly Corporation Long-Duration Operations in Cis-Lunar Space: Needs, Hurdles, and Opportunities Discussion	20 min 10 min
12:30 pm ET /9:30 am PT	**Gordon Roesler**, Robots in Space LLC A National Space Logistics System Discussion	20 min 10 min
1:00 pm ET /10:00 am PT	**Dennis Bushnell,** NASA Langley Research Center In-Situ Resource Utilization For "OSAM" Logistics And Space Development Discussion	20 min 10 min
1:30 pm ET /10:30 am PT	**Danette Allen,** NASA Autonomy and dexterous robots Discussion	20 min 10 min
2:00 pm ET /11:00 am PT	**Justin Kugler,** Made in Space Space-based materials synthesis/manufacturing Discussion	20 min 10 min
2:30 pm ET /11:30 am PT	**Break**	15 min

2:45 pm ET /11:45 am PT 3:15 pm ET /12:15 am PT	**Session 2 Panel Discussion: Future of Space Logistics** **Andy Kwas,** Northrop Grumman Innovation In On-Orbit Servicing **Rob Hoyt,** Tethers Unlimited, Inc. Building an In-Space Supply Chain **William Carter,** DARPA DSO Lunar resource utilization **Q+A and General Discussion** Introductions by Rosalind Lewis and Moderated by Haydn Wadley	 10 min 10 min 10 min 45 min
4:00 pm ET /1:00 pm PT	**Conclude the workshop** Moderated by Haydn Wadley, DMMI Chair and Angus Kingon, Workshop Chair	30 min
4:30 pm ET /1:30 pm PT	**Adjourn Day 3**	

Day 1: Additive manufacturing of large structures

Co-chairs:
Thomas R. Kurfess (Oak Ridge National Laboratory) and Pablo Zavattieri (Purdue University)

Adapting the methods of 3D printing for much larger structures, such as bridges, is increasingly being investigated. Recent reports include the printing of metal, concrete and concrete-like structures with significant potential consequences for humanitarian and stabilization operations. This workshop session will investigate the present-state-of-the-art of these macro-scale approaches to additive manufacturing, and explore new methods that can be developed to solve logistical problems at forward operating bases in jungle, mountainous and arctic environments, and when these locations are vulnerable to attack by a near peer adversary. This session will also discuss the opportunity to incorporate indigenous materials, and waste materials (such as discarded packaging), with the attendant challenge of rapid testing and qualifying of unique materials, while also discussing the possibilities of failure prediction, supply chain implications, and supply logistics. While there are active programs on AM of mesoscale structures (such as vehicle parts), this element of the workshop will extend the potential application to larger structures such as bridges, housing, piers, and runways, as well as large space structures. The context for the initial discussions will be focused on the Asia-Pacific region where peer adversary warfare may be envisaged.

Day 2: Supply of Systems and Subsystems

Day 2 Co-chairs: Angus Kingon (Brown University) and Dave Aspnes (NC State University)

Military systems - particularly electronic systems - are complex and vulnerable to degradation in extreme operating environments (the jungle environments of Asia and South America, the dusty environments of the Middle East, the extreme temperatures of the Polar Regions). At the same time, the repair of individual components of the system at a forward operating base or under threat conditions is typically unfeasible. Thus, asset monitoring and improved prediction of failure and maintenance assumes increased importance if operational capability is to be maintained. We posit that there are new lessons to be learned from advanced industries (e.g., monitoring from aircraft engine producers, or supply chain from Amazon) that could be more widely applied in DoD scenarios, particularly to improve operational capability under hostile conditions. We also assume that there are lessons to learn that potentially have broad applications regarding the monitoring of components and failure prediction (not only while in use, but also in storage and during supply), and that these methods could be combined with the advanced prediction methods.

Finally, the DoD has invested in building a flexible hybrid electronics capability through programs such as the NextFlex Consortium. Can this capability be advanced to provide for microsystem needs in shortened timeframes and limited production volumes to meet immediate or short-term needs of forward forces and forward bases? How would these microsystem needs be identified, and matched to the production capabilities?

Day 3: Logistics and Manufacturing in Space

Day 3 Co-chairs: Rosalind Lewis (Aerospace Corp) and Haydn Wadley (University of Virginia)

The cost of lifting payloads from the deep gravitational potential well of earth into low earth orbits - and eventually the entire cis-lunar space environment - is steadily decreasing with the advent of commercial launch systems, but the cost of material deployment to the near-lunar environment remains very high. Furthermore, the limited dimensions of fairings into which satellites and supplies are packed has not been overcome, and these two challenges remain dominant factors limiting the deployment of large platforms and their sustainment via space logistics. Satellites in current constellations have not been designed for re-supply (i.e. refueling/repair), but this may now be changing since the on-orbit servicing, assembly, and manufacturing (OSAM) of satellites is receiving increasing attention. However, this will require the development of new approaches which can incorporate increasingly autonomous robotic systems with human-like dexterity and tactile sensing, and latency beyond current robotic capabilities.

The very large and rigid structures required for shields, antennae, and solar panels present special challenges: the sizes imply that they must be unfurled, assembled, or even manufactured in space, and the trade-offs among these options remain to be understood. The manufacturing of composite components in space is at an initial stage of investigation. The lack of gravity allows the design of structures that would not function on earth, while the high vacuum of space may enable the use of novel materials such as beryllium (whose toxicity limits its terrestrial applications) and manufacturing processes (the solidification of reactive metals or the more rapid synthesis of bio-pharmaceuticals) but presents many design and testing challenges. What other unique advantages are there to manufacturing in space?

Capabilities developed for OSAM may also enable the construction of much larger space structures aided by novel approaches to the orbital manufacture and novel techniques to stabilize vibration of the platforms. As extra-terrestrial civilian missions to create transiently inhabited bases on the Moon and Mars are now being articulated, opportunities to use the lunar environment for storing, servicing, making components and fuels on the lunar surface or in low lunar orbits where escape from the weak potential energy well simplifies logistics may emerge, and will therefore also be explored in the workshop. The workshop will ask: could large-scale AM techniques be employed to build a lunar base? The use of lunar indigenous materials and the salvaging of components/materials from discarded satellites in graveyard orbits also represent interesting concepts for further investigation in the workshop.