

Advanced Manufacturing: An Extraordinary Technology Ecosystem

National Aeronautics and
Space Administration



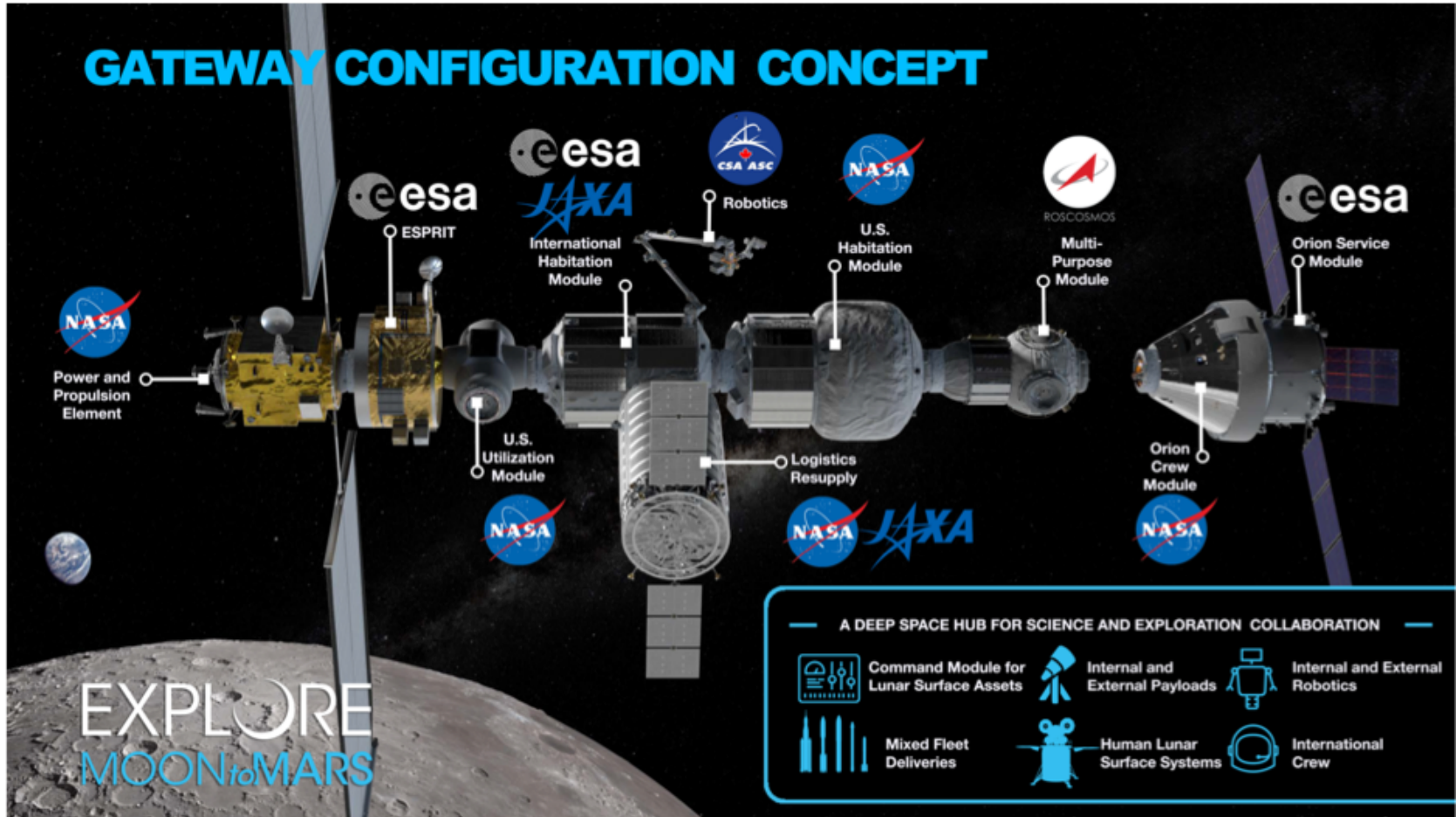
John Vickers
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Space Technology
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Made for Space Workshop
May 2-3, 2019

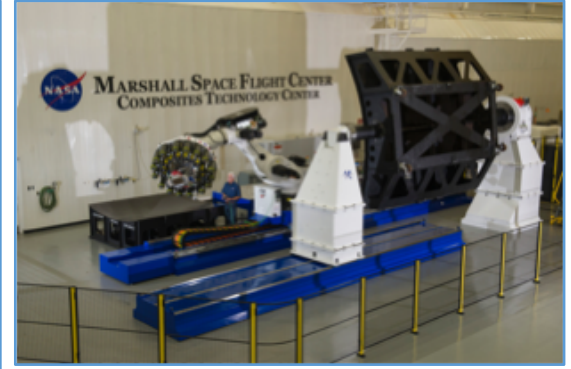
**The MTC Advanced
Manufacturing Centre**
Coventry, UK

“The Future of Manufacturing”

Returning to the Moon in Five Years



NASA Manufacturing is...



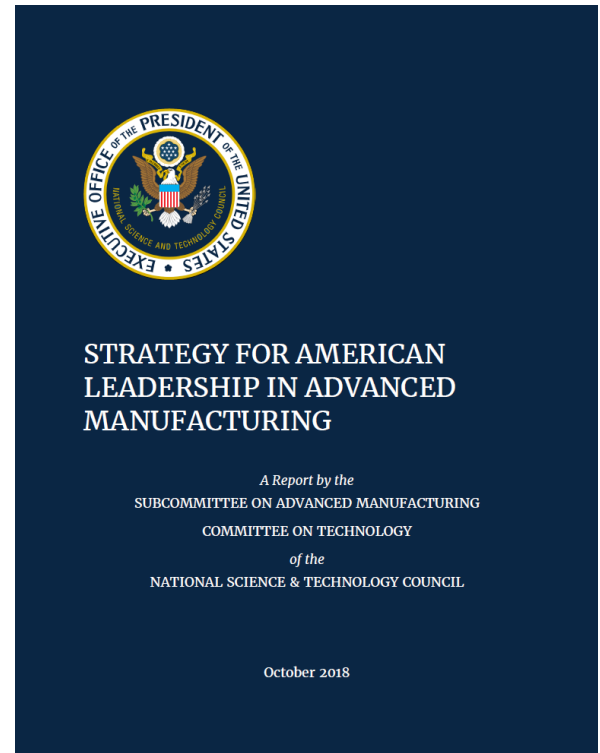
The Space Launch System





Goals

1. **Develop and transition new manufacturing technologies** – 5 Objectives with 15 priorities
2. **Educate, train, and connect the manufacturing workforce** – 4 Objectives with 9 priorities
3. **Expand the capabilities of the domestic manufacturing supply chain** – 4 Objectives with 11 priorities



<https://www.whitehouse.gov/wp-content/uploads/2018/10/Advanced-Manufacturing-Strategic-Plan-2018.pdf>

Digital Transformation

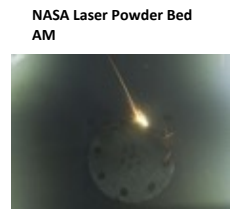
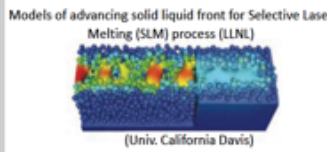
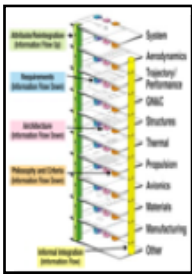


Desired Future State

- Data Can Be Integrated and Automatically Couple the Virtual and Physical
- Digital Twin – Digital representation of a physical process/system/object
- Digital Thread – Communication framework that allows a connected data flow

Digital Transformation Major Trends

- ✓ Industry 4.0
- ✓ MGI/ICME
- ✓ Digital Twin / Digital Thread
- ✓ Big Data / Data Analytics
- ✓ AI / VR / AR
- ✓ Robotics / Autonomous Systems
- ✓ Model-based Engineering (MBx)
- ✓ 3D Printing
- ✓ Discipline Physics-based Models
- ✓ Integrating Science / Engineering
- ✓ Biomimetics
- ✓ Collaboration environments
- ✓ *And more...*



Digital Integration Allows Predictive, Detective, and Corrective - Real Time Accurate Decisions

Additive Manufacturing at NASA



Launch Vehicles

- Design process culture shift
- Industrial base development
- Technology infusion for cost and schedule savings
- Large volume AM expands application
- Certification for flight

In-space

- On-orbit manufacturing
- Recycling for new feedstock
- Reduced necessity for spares
- Non-conventional electronics for space flight applications

Extraterrestrially

- Surface construction and manufacturing
- In-situ resource utilization

Significant Progress Made — Significant Challenges Remain

Sustainable Exploration Links Discovery, Science and Commerce



The object of your mission is to explore the Missouri river...and its communication with the waters of the Pacific ocean.... for the **purposes of commerce.**

Thomas Jefferson, 1803



The Next Generation



Systems Thinking, Entrepreneurship, Cultural Agility, Critical Thinking

Joseph E. Aoun, "Robot-Proof, Higher Education in the Age of Artificial Intelligence"



Thank You

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