

The background of the entire slide is a composite image. The upper portion shows a deep space scene with a large, detailed Earth's moon on the left, a smaller reddish planet (Mars) in the upper left, and a small spacecraft with a bright blue engine glow moving towards the right. The lower portion shows a silhouette of a person's head and shoulders on the right, looking out over a dark, hilly landscape under a twilight sky with orange and yellow clouds.

EXPLORESpace TECH
TECHNOLOGY DRIVES EXPLORATION

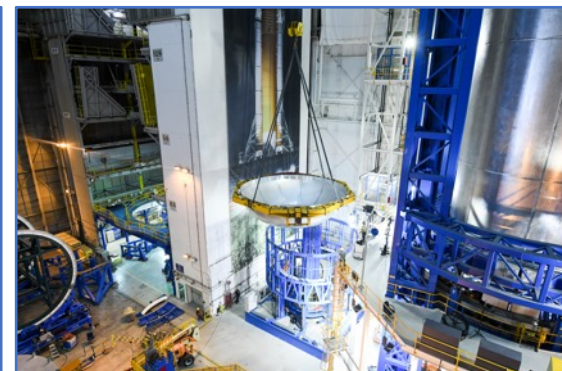
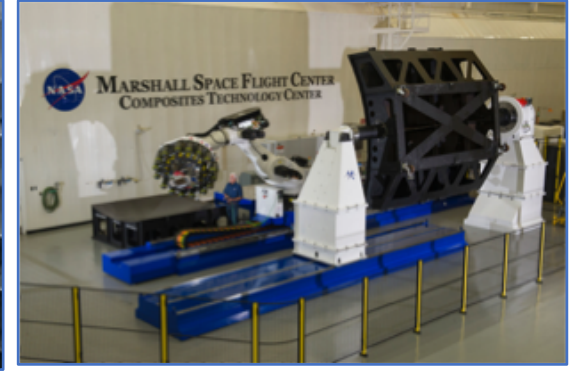
Advanced Manufacturing Technology

John Vickers, Principal Technologist | 05.23.19

NASA Manufacturing is...

Technology Challenges

- ✓ In-space/on-orbit manufacturing
- ✓ Additive Manufacturing
- ✓ Composites
- ✓ Metals Processes
- ✓ Advanced Materials
- ✓ Digital Manufacturing (e.g. process modeling)
- ✓ *and more... (e.g. NDI)*



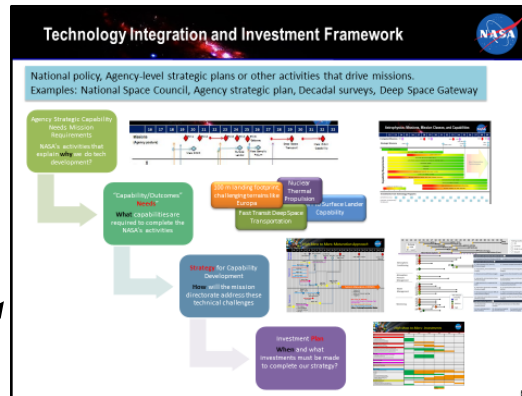
Infusion / Cost / Performance / Transformative / Crosscutting

NASA Technology Strategy & Roadmaps

TA 12: Materials, Structures, Mechanical Systems, and Manufacturing

12.0 Materials, Structures, Mechanical Systems, and Manufacturing	Goals: Develop materials to increase multi-functionality and reduce mass and cost (radiation protection/mass reduction challenges). Provide innovative designs and tools for robustness and superior structural integrity for deep space and science missions (reliability/mass reduction challenges). Design and develop robust, long-life mechanisms capable of performing in the harsh environments (reliability challenge). Advance new processes and model-based manufacturing capabilities for more affordable and higher performance products (mass reduction/affordability challenge).
12.1 Materials	Sub-Goals: Design materials that have multiple tailored functions to meet specific mission needs.
12.2 Structures	Sub-Goals: Develop lightweight, robust, multifunctional, smart structures that are reliable and predictable.
12.3 Mechanical Systems	Sub-Goals: Improve life and reliability of mechanisms to extend the life of space missions. Improve the precision alignment capability of mechanisms to extend the capability of deployable structures.
12.4 Manufacturing	Sub-Goals: Develop innovative physical manufacturing processes combined with the 'digital thread' that integrates modern design and manufacturing.

MD Strategic Technology Frameworks



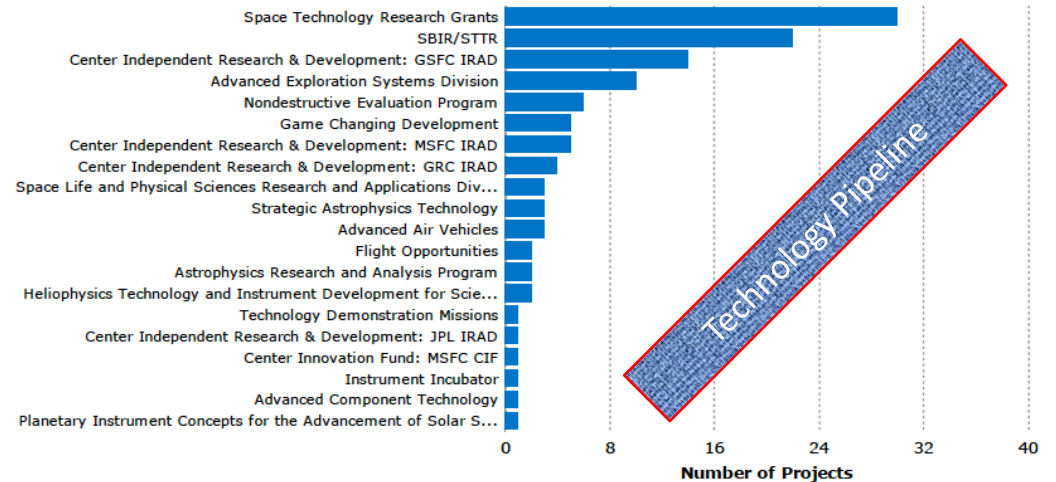
2015 NASA Technology Roadmaps



2020 NASA Technology Taxonomy



Manufacturing Technology Report 117 Active, 59 Partnerships, \$702M



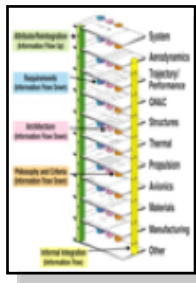
Digital Transformation

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...*



Models of advancing solid liquid front for Selective Laser Melting (SLM) process (LLNL)
(Univ. California Davis)

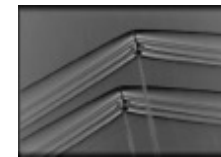
NASA's 3D-Printed Habitat Challenge
Credits: Team SEArch+/Apis Cor



NASA Laser Powder Bed AM



Supersonic Shock Interaction



Astronaut Scott Kelly on a Spacewalk



Digital Twin

Requirements



Materials



Design



Analysis



Manufacturing



Operations



Maintenance & Repair

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

National & Global Alignment

Manufacturing USA – National Network of Manufacturing Institutes



- ✓ U. S. MATERIALS GENOME INITIATIVE / National Nanotechnology Initiative
- ✓ UK Catapult Centers
- ✓ Fraunhofer Institutes, Others....



STRATEGY FOR AMERICAN LEADERSHIP IN ADVANCED MANUFACTURING

A Report by the
SUBCOMMITTEE ON ADVANCED MANUFACTURING
COMMITTEE ON TECHNOLOGY
of the
NATIONAL SCIENCE & TECHNOLOGY COUNCIL

October 2018

- ✓ Develop and transition new manufacturing technologies
- ✓ Educate, train, and connect the manufacturing workforce
- ✓ Expand the capabilities of the domestic manufacturing supply chain



Thank You

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