Historical Perspective and the Future of Composites for NASA Missions
Joint Composite & Advanced Materials Sustainment (JCAMS) Annual Meeting

John Vickers | Principal Technologist, Space Technology Mission Directorate | June 13, 2023

How We Explore… NASA Mission Directorates

Exploration Systems Development

Space Technology

Aeronautics Research

Space Operations

Science

SPACE TECHNOLOGY PORTFOLIO

EARLY STAGE INNOVATION AND PARTNERSHIPS

- Early Stage Innovation
  - Space Tech Research Grants
  - Center Innovation Fund
  - Early Career Initiative
  - Prizes, Challenges & Crowdsourcing
  - NASA Innovation Advanced Concepts

SBIR/STTR PROGRAMS

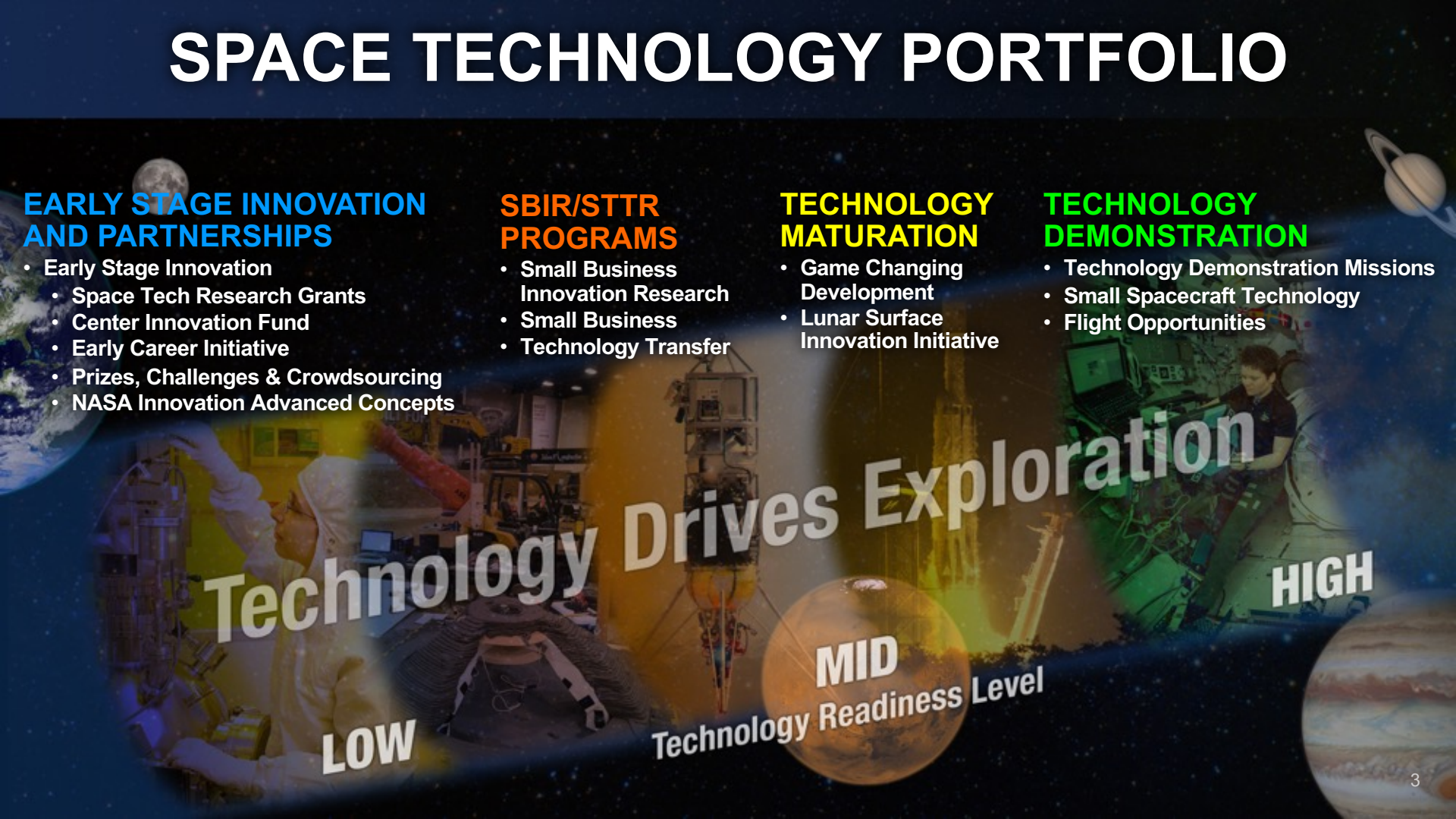
- Small Business Innovation Research
- Small Business
- Technology Transfer

TECHNOLOGY MATURATION

- Game Changing Development
- Lunar Surface Innovation Initiative

TECHNOLOGY DEMONSTRATION

- Technology Demonstration Missions
- Small Spacecraft Technology
- Flight Opportunities



Develop Technologies Supporting Emerging Space Industries

Priorities - Targeted advanced manufacturing outcomes aligned with space industry trends that will shape the course of research and development over many years

In-Space Manufacturing and Space Infrastructure

A catalyst for space infrastructure and economic opportunities
> 50% Mass reduction, > 99% 3D printer readiness.

1

3D Printing / Additive Manufacturing

Revolutionized product design and manufacturing
>50% Cost reduction, accelerated time to market

2

Digital Transformation Digital Twins and Artificial Intelligence

More intelligent and more accurate predictions and capabilities
>50% of physical resources replaced with virtual

3

Lightweight Composite Spacecraft

High high strength-to-weight ratio and dimensional stability
50% More payload, equipment, and experiments

4

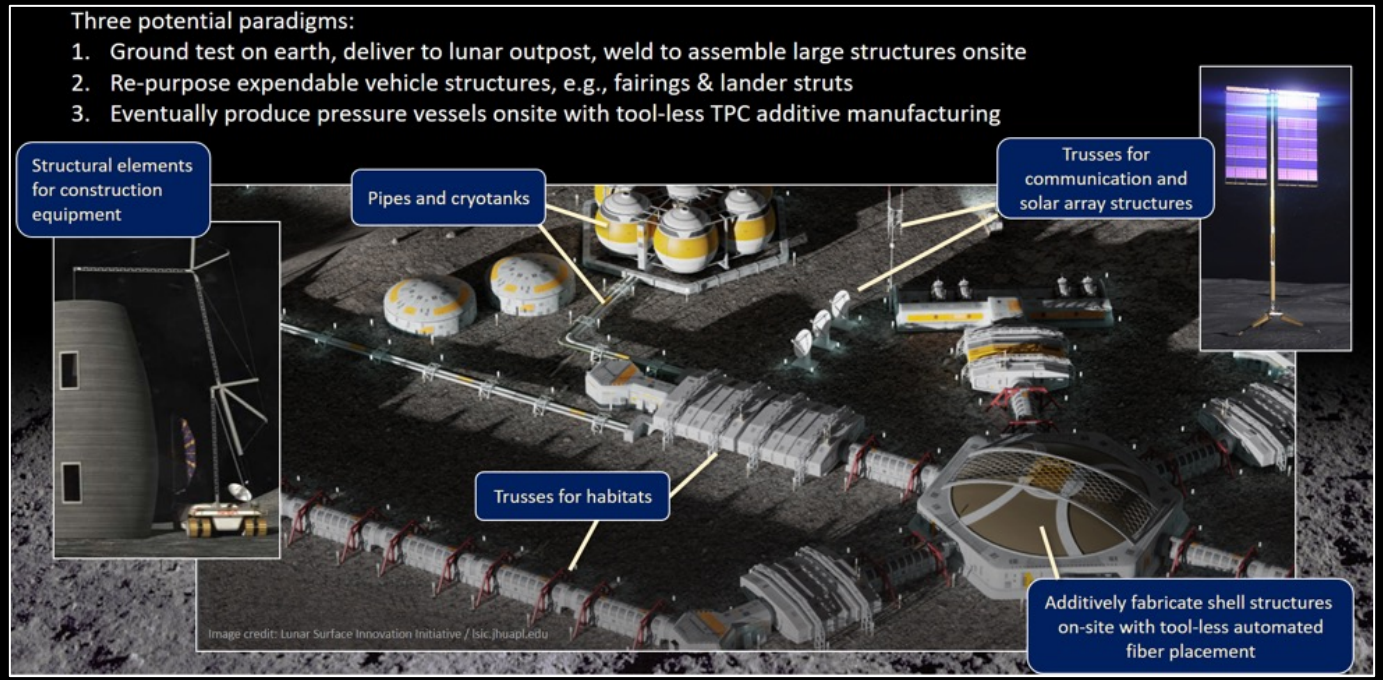
Back in Time Machine

NASA Composites Capability

Thermoplastic Composites

Thermoplastic Composites for In-space Applications

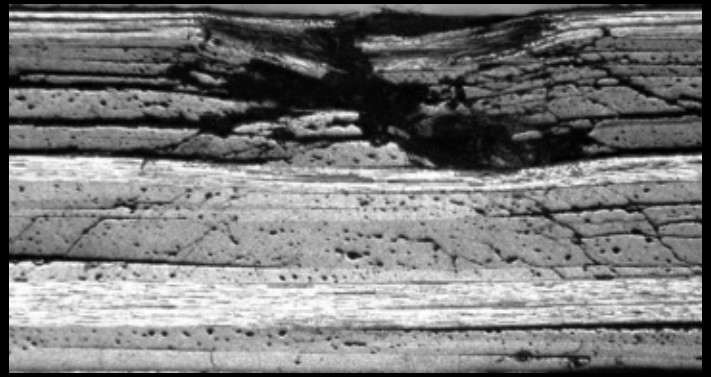
- NASA/STMD effort to develop thermoplastic composites manufacturing and joining technologies for eventual in-space/on-orbit applications.



Composite Motor Cases

Composite Motor Cases for SLS Solid Rocket Boosters

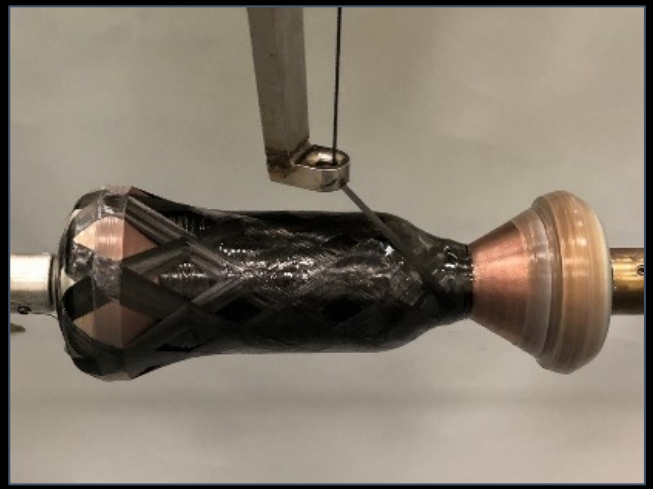
- NASA/Northrop Grumman joint effort to develop composite motor cases to replace Shuttle Program-heritage steel cases
- Notable accomplishments and ongoing tasks:
  - Carried out comprehensive damage tolerance assessments for IM7 and T1100 carbon fibers to aid in material down-select.
  - Developing improved manufacturing and test techniques to better characterize filament wound composites.
  - Working with Northrop Grumman to serve as a sub-scale development partner, which reduces risks for Northrop Grumman and SLS as a whole.



Overwrapped Thrust Chambers

Composite Overwrapped Thrust Chambers

- NASA/STMD effort to mature novel additive and composites manufacturing techniques to reinforce regen-cooled thrust chamber assemblies via composite overwraps.
- Notable accomplishments:
  - Developed manufacturing processes for 2k, 7k, and 40k combustion chamber hardware, where chambers were additively manufactured and overwrapped with carbon fiber composites.
  - Successfully hot fired 2k and 7k composite overwrapped combustion chambers.



SLS Payload Adapter

SLS Block 1B Payload Adapter

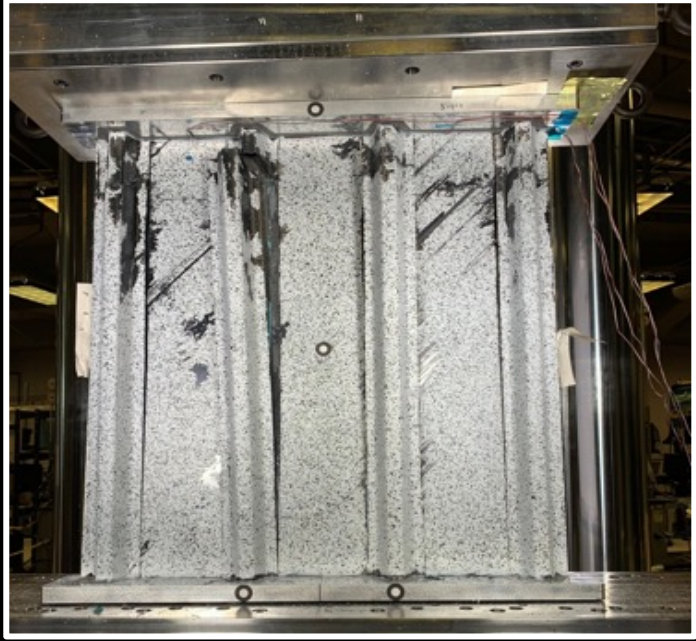
- NASA effort to produce Payload Adapter flight units for SLS Block 1B.
- Composite sandwich structure built in 8 segments.
  - T1100 carbon fiber used throughout the structure.
  - Automated fiber placement (AFP) used to lay up facesheets.
  - Segments joined together via adhesively bonded double strap joints (non-redundant, primary load path, fracture critical).

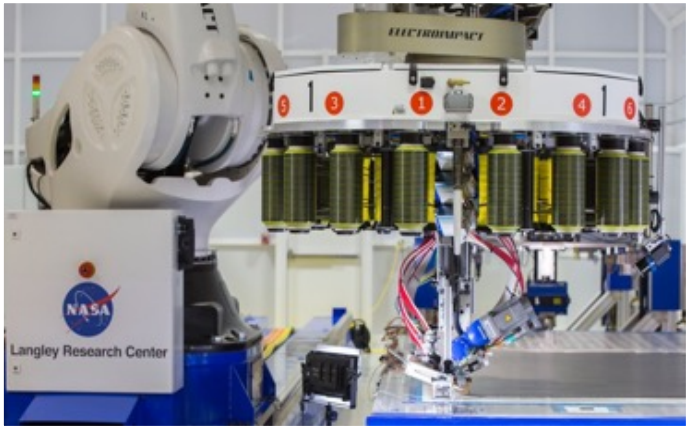
The James Webb Space Telescope's Backplane

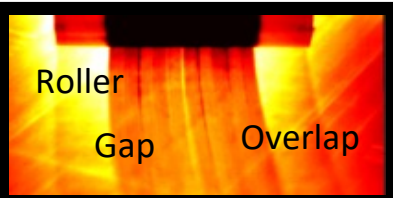
The backplane carries more than 2400kg (2 1/2 tons) of hardware, it performs at temperatures colder than -400°F (-240°C) with unprecedented thermal stability within 32 nanometers, which is 1/10,000 the diameter of a human hair!

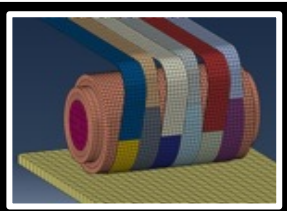
Mars 2020 Perseverance Rover & Helicopter Ingenuity

Remaining Competitive in Aircraft Manufacturing



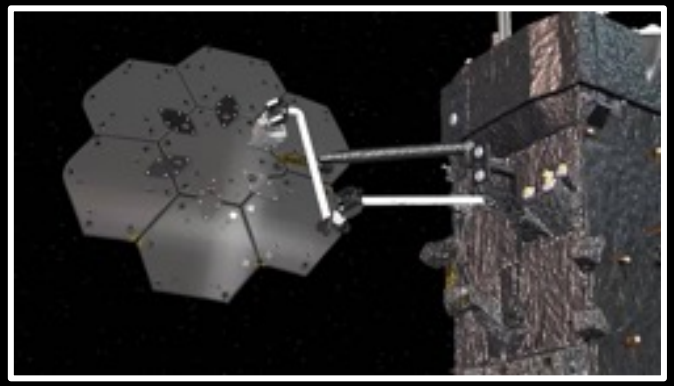




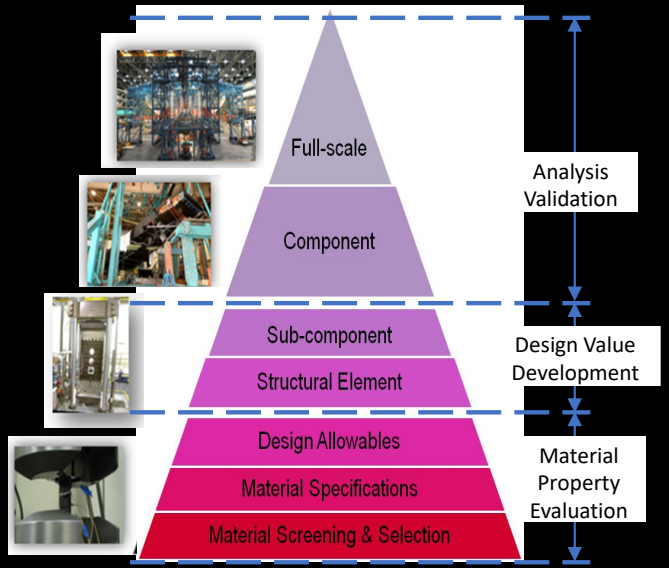


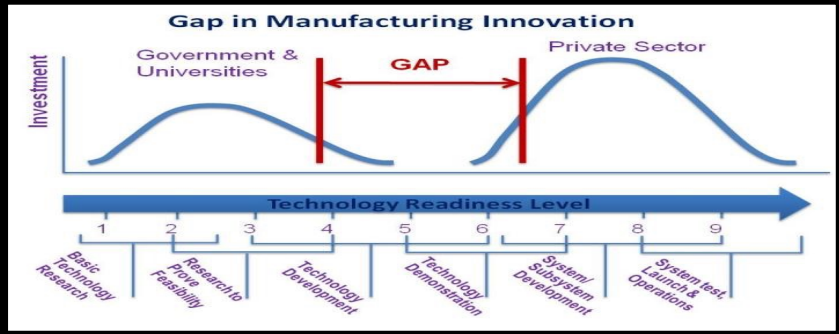
- Advanced Composites Project completed after a 5 year research effort and $170M investment
- Hi-Rate Composite Aircraft Manufacturing (HiCAM) (in formulation in FY21)
- Reducing time to develop & certify composite structures
- Partnerships between government, industry and academia

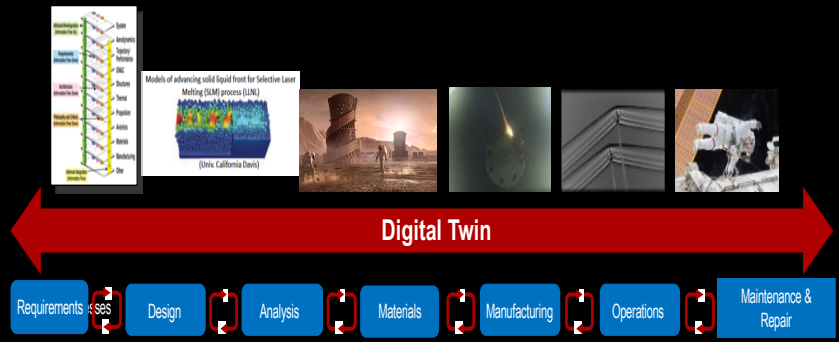
In-Space Manufacturing



Digital Manufacturing





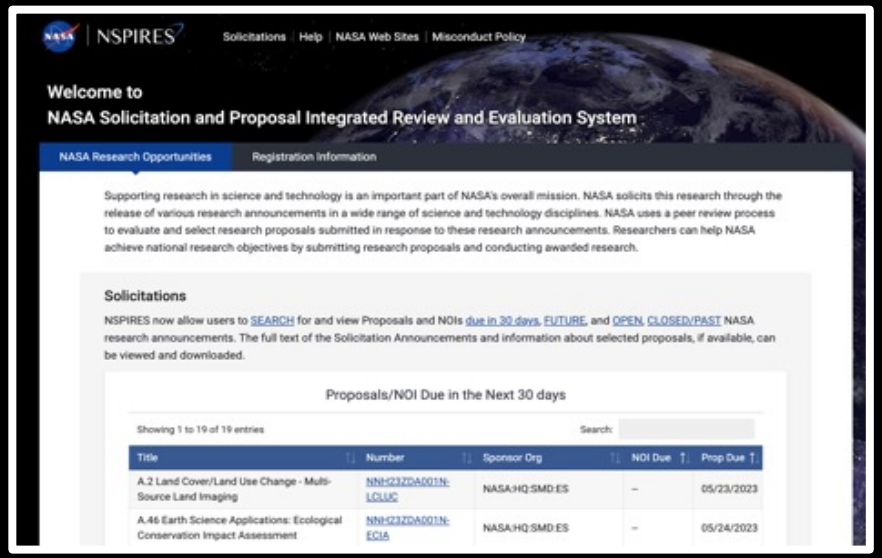


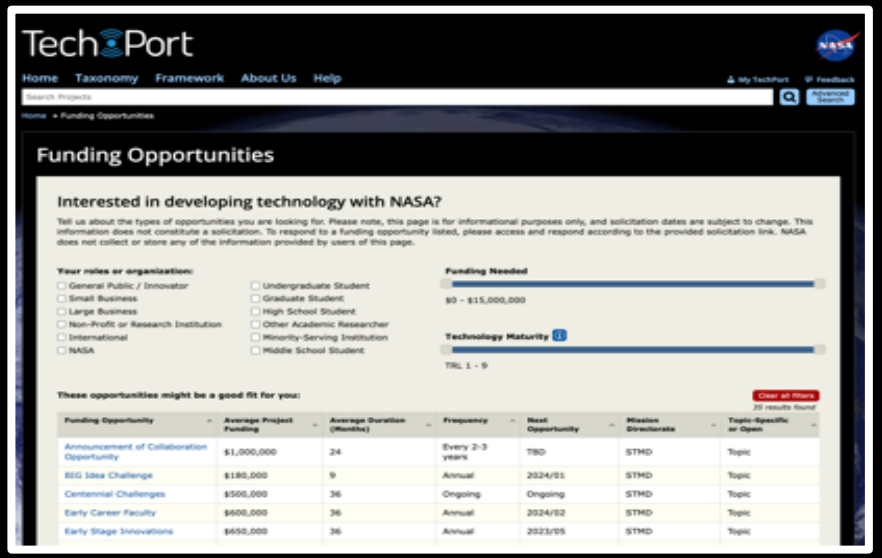
Product Development, Testing and Certification Today

"It takes too long and costs too much to certify aerospace structures" - Exhaustive testing done to support analysis

Funding Opportunities and Announcements

NASA's Notices of Funding Opportunities are located in the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) and TechPort (https://nspires.nasaprs.com) (https://techport.nasa.gov/home)






QUESTIONS?
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