Welcome to

Advanced Textiles EXPO

ORGANIZED BY ATA

Advanced Textiles – A New Frontier and New Opportunities

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Customer Solutions and Business Development Lead

Introduction

- Space offers a unique environment for advanced material design and testing

Objectives

- Understand the opportunity to utilize space for advanced textile design and testing
- Learn about the unique challenges and opportunities of the space environment
- Understanding how the space environment has accelerated textile design, development & testing
- Understand why advanced textiles are important to US competitiveness both on earth and in space.

Why Test/Manufacture Textiles in Space

- Unique Attributes of the Space Environment
  - Microgravity, Radiation, Atomic Oxygen, Extreme Temperatures, Harsh Environment, Vacuum & Lack of Contamination

- Space-Based Applications
  - Verification of performance in space
  - Accelerate Technology Readiness Level (TRL)

- Terrestrial Applications
  - Using accelerated aging of space environment
  - Testing in a harsh environment
  - Provide proof of reliability and durability

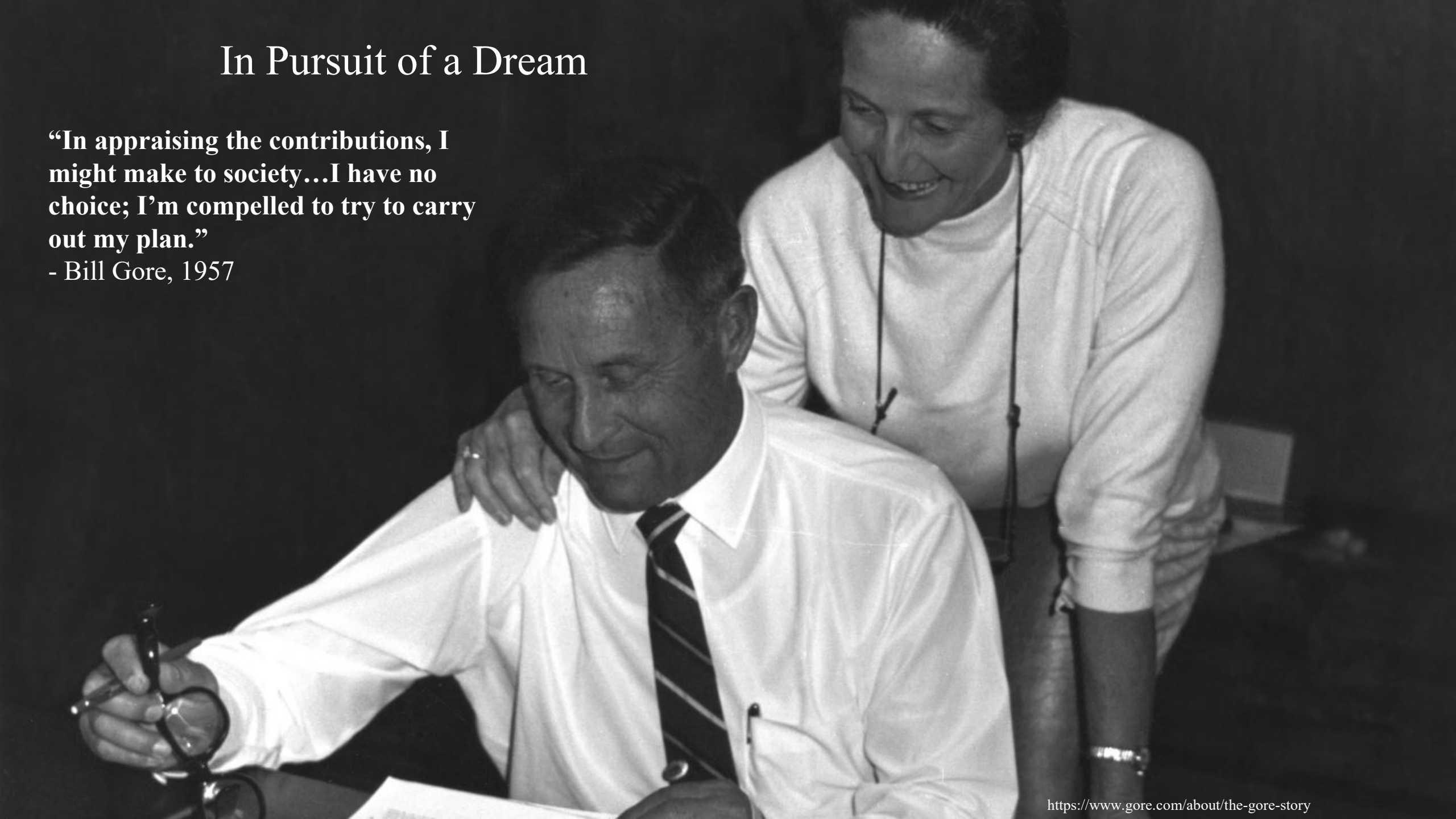
- Manufacture textiles in space
  - Next-generation consumer textiles – more comfortable, durable, and sustainable
  - Design new materials and create new markets

- Unique Market Opportunity – space, aerospace, automotive

Jason M. F. Smith | Customer Solutions & BD Lead | Nov. 2, 2023

In Pursuit of a Dream

“In appraising the contributions, I might make to society…I have no choice; I’m compelled to try to carry out my plan.”
- Bill Gore, 1957



https://www.gore.com/about/the-gore-story

Photo courtesy of NASA
https://www.gore-tex.com/blog/break-points-2

1981 - OUTFITTING THE ASTRONAUTS

Gore fiber is used in space suits designed for astronauts on the Columbia, NASA's inaugural space shuttle mission.

To The Edges of the World – An international expedition team in Antarctica wears GORE-TEX outerwear

They are ideal for a wide variety of applications and industries, including the following:

- protective outerwear
- military, safety, and protective services gear
- aerospace
- electronics
- geotextiles
- marine
- transportation applications
- industrial equipment covers
- wire harnesses
- electrical cable insulation

https://www.gore.com/products/categories/fabrics

NASA ASTRONAUT - Megan McArthur - Bachelor of Science in Aerospace Engineering from University of California, Los Angeles, 1993
Ph.D. in Oceanography from University of California, San Diego, 2002.

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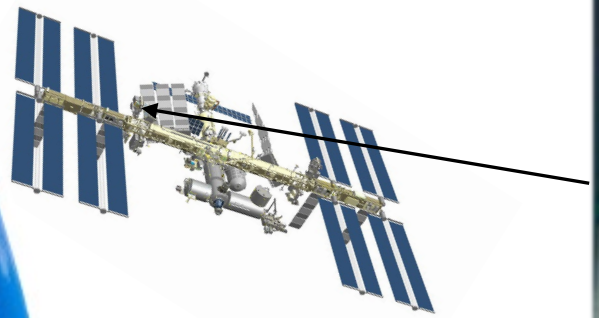
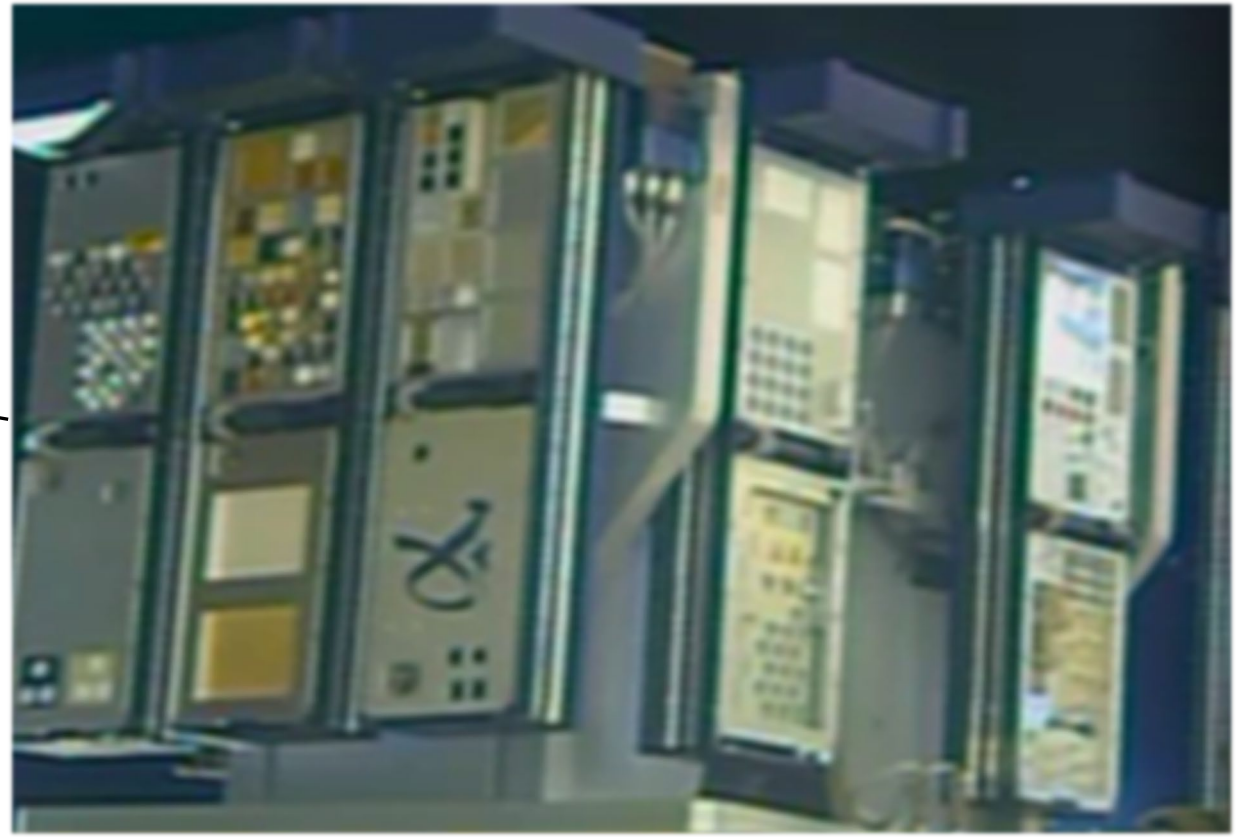
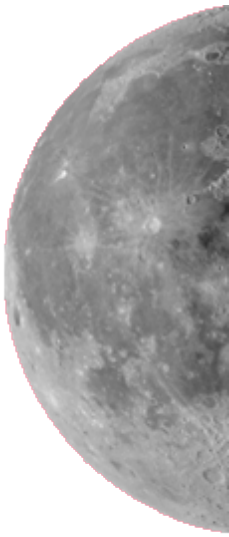
Space Testing as a Service (STaaS™)

Commercial service for advancing technologies and performing experiments.

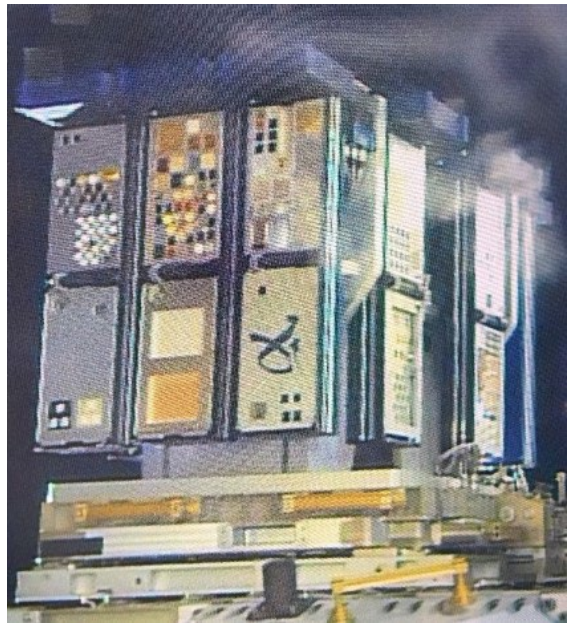
MISSE-Flight Facility



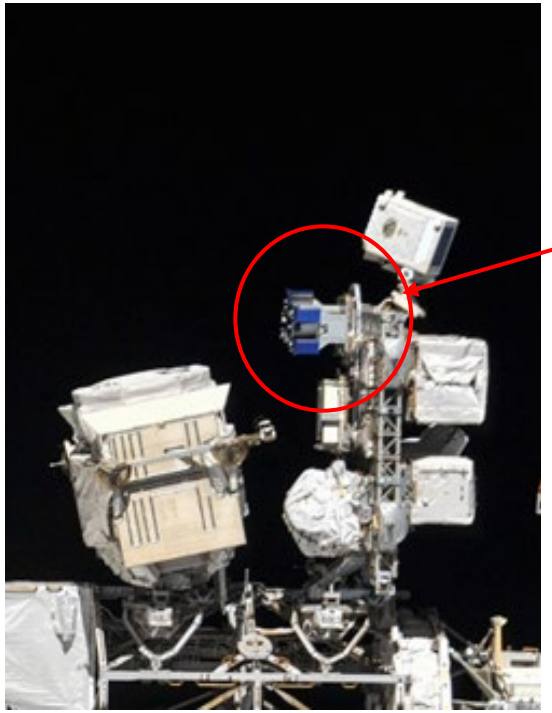


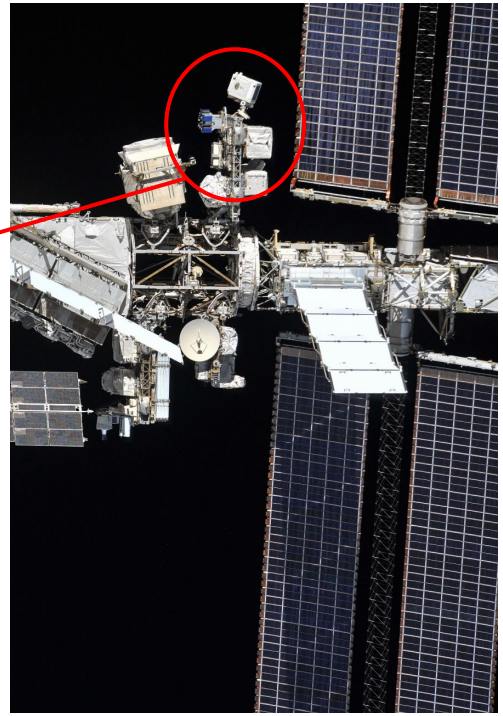


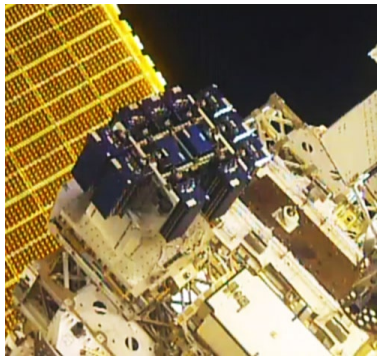
MISSE On Orbit

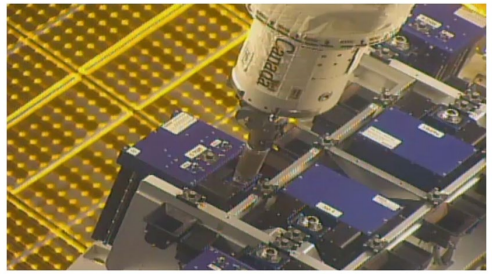


Side View
Open Carriers (top)

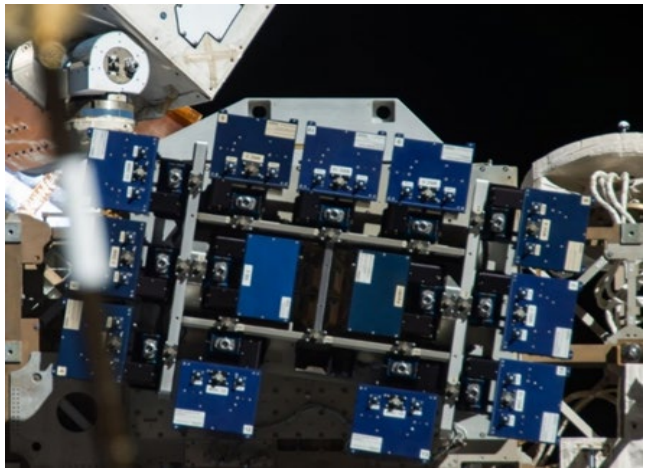


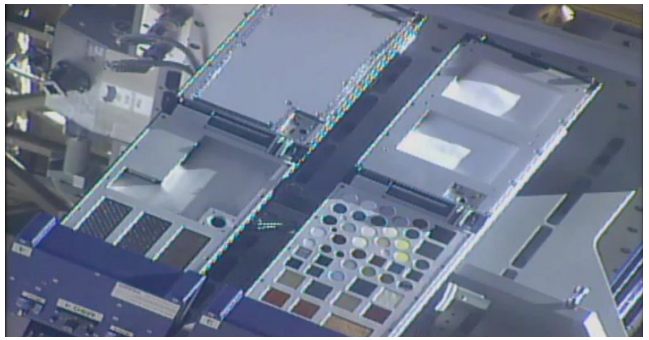


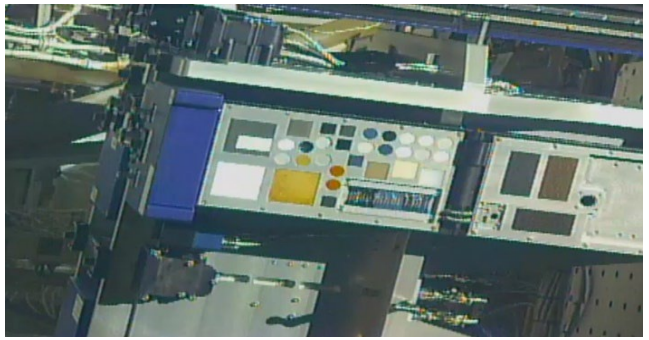




Closed carriers
robotically installed








Canada

Understanding the Unique Attributes, Challenges and Opportunities of the Space Environment

- **Vacuum:** Without air pressure to support them, materials can expand or contract. Advance Materials/Textiles with plastics components can become brittle and lose their strength. By working in vacuum, you can improve the strength and toughness of textiles.
  - **NanoTex** is using vacuum to apply a durable water-repellent coating to textiles.
- **Radiation:** The sun emits a constant stream of radiation, including high-energy particles called protons and neutrons. These particles can damage materials, causing them to become brittle and lose their strength.
  - Crosslinking: Radiation can be used to crosslink polymer chains in textiles, which can improve their strength, toughness, and durability.
  - **Acrylatech**, is using radiation to cure UV-curable adhesives and inks on textiles to create durable and attractive finishes

Understanding the Unique Challenges and Opportunities of the Space Environment

- **Temperature:** In the vacuum of space and in the LEO environment, temperatures usually range from -60 degrees Celsius to +80 degrees Celsius. This can put a lot of stress on materials, and it can also cause them to degrade over time.
    - **Researchers at the University of California, Los Angeles:** using extreme temperatures to create new types of ceramic textiles. These textiles could be used in a variety of applications, such as aerospace, automotive, and industrial.
- **Microgravity:** Microgravity can have several effects on materials, including changing their mechanical properties and making them more susceptible to damage from radiation.
    - **Space Fluidics** is using microgravity to develop new textile coatings with enhanced antimicrobial activity. These coatings could be used to create textiles that are more resistant to the growth of bacteria and other microbes.

Understanding the Unique Challenges and Opportunities of the Space Environment

- **Lack of Contamination:** There is no dust or dirt to contaminate textiles = Improved purity. This has led to the development of new textile materials that are more easily cleaned, sterilized ad more electrical conductivity
    - **Tethers Unlimited** is developing a new type of solar sail that is made from a thin film of metalized polymer. This solar sail is designed to be deployed in space and to use the power of sunlight to propel spacecraft. The lack of contamination in space is essential for ensuring that the solar sail is able to reflect sunlight efficiently and that it does not degrade over time. Much like Gore-Tex application, there is a possibility to utilize material terrestrially.
- **Atomic Oxygen (AO):** It is a major challenge for the space environment because it can damage materials, including textiles. (Oxidation, Delamination, Crazing)
    - **Researchers at the University of California, Berkeley** are using AO to create new types of self-cleaning textiles. These textiles are coated with a thin layer of AO-responsive material that changes its surface properties when exposed to AO. This allows the textiles to repel dirt and other contaminants.

The Space Environment has accelerated Textile Design, Development & Testing

- **Inflatable Space Structures:** Inflatable space structures that are made of lightweight, strong textiles.
- **Radiation-Resistant Textiles**: Are resistant to radiation.
- **Temperature-Resistant Textiles: C**an withstand extreme temperatures.
- **Self-Cleaning Textiles:** Textiles that have the ability to self-clean.
- **Medical Textiles:** Used for medical applications both terrestrially and in space

Jason M. F. Smith | Customer Solutions & BD Lead | Nov. 2, 2023

Materials Used In-Space Examples

Kevlar is used in spacesuits and debris shielding

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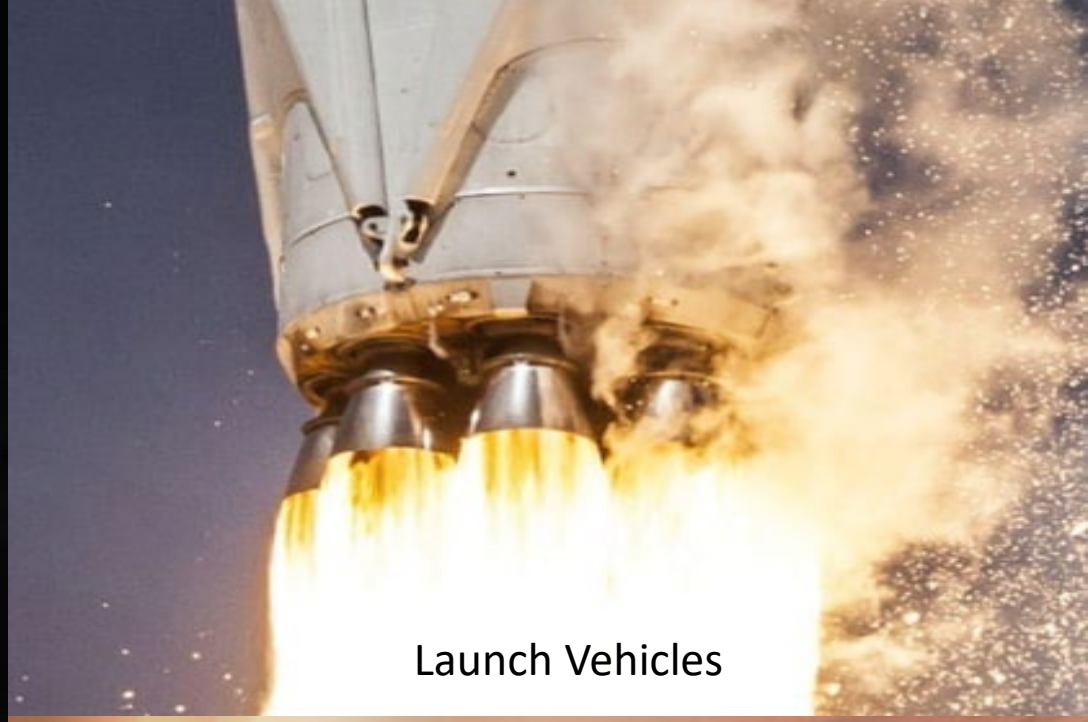
https://www.dunmore.com/products/aluminized-nextel-fabric.html

"Nextel: A High-Performance Textile for Space." NASA, NASA, 2023, www.nasa.gov/mission_pages/science/spinoff9_nextel_f.html



Launch Vehicles

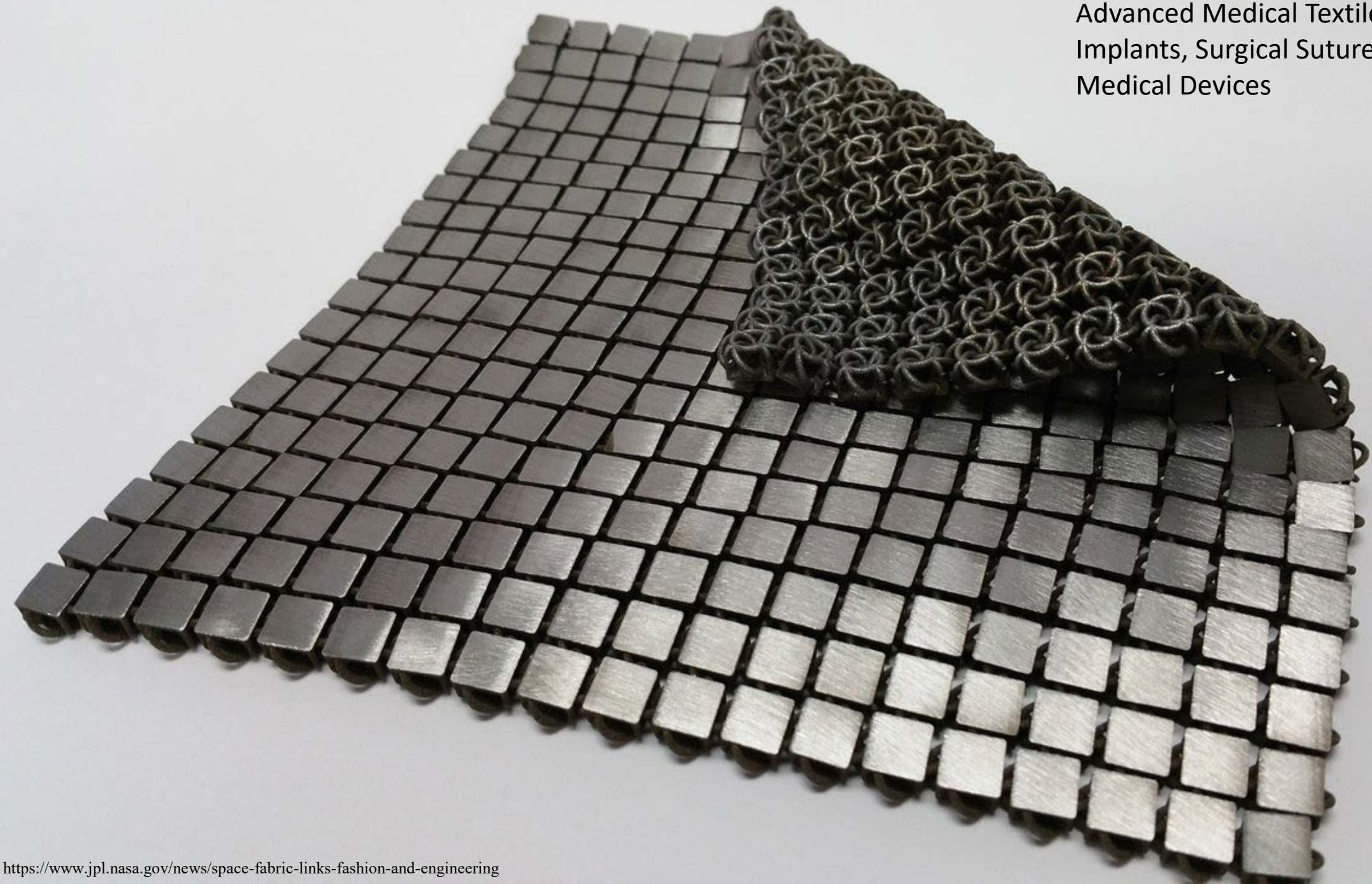
Inflatable Heat Shield

Credit: NASA

https://www.nascar.com/

Photonic Textile Could Self-Clean in Space." Phys.org, Phys.org, 15 Feb. 2023, phys.org/news/2023-02-photonic-textile-self-clean-space.html.

Advanced Medical Textiles – Medical Implants, Surgical Sutures and Medical Devices



https://www.jpl.nasa.gov/news/space-fabric-links-fashion-and-engineering

Additional commercial applications examples of In-Space design, development and testing of advanced textiles


Health, Medicine
and Biotechnology

“Humanity’s instinctive will to explore draws modern civilization towards evermore extreme environments. Alas, until it is possible to substantially alter the human body, the humble textile will continue to serve as a boundary—a second skin— for the arctic explorer, for the deep-sea diver, and indeed for the astronaut” – Juliana Cherston Ph.D.

https://spectrum.ieee.org/e-textiles-for-space

earth-orbit-from-sensate-skins-

https://www.expedia.com/O2-Arena-Greenwich.d6057080.Vacation-Attraction

Identifying the Specific Need of Your Application

The specific needs of your application will depend on the type of material you are developing. Things to consider

- Considerations:
  - The environment in which the material will be used
  - The load that the material will be subjected to.
  - The desired lifespan of the material.
  - The properties that the materials need to have.

  - Once you have identified the specific needs of your application, you can start to look for materials that are well-suited to those needs.
  - Available Resources:
    - materials databases, research papers, and expert consultants.

Consider a Portfolio of Methods for Testing

- **Ground-based testing:**
  - Simulating the conditions of space, such as the vacuum, radiation, and temperature extremes.
- **Computer simulations:**
  - Modeling the behavior of textiles in space, and it can be used to predict how textiles will respond to different conditions.
- **Space-based testing:**
  - Testing is done on space-based platforms, such as the ISS, and it allows researchers to test materials in the actual environment of space.

Collaboration with Experts

- **Universities and research institutes:** NC STATE University - Textile Technology
- **International organizations:** These organizations, such as the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA), have resources and expertise that can be invaluable for your research.
- **Conferences and workshops:** These events are a great way to meet other researchers in the field and to learn about the latest advances in material design and testing in space.
  - The International Conference on Advanced Materials for Space Applications is a biennial conference that brings together researchers from around the world to discuss the latest advances in this field.
- **Commercial Resources:** Commercial Space Testing Services

Commercial Space Testing: Contact Commercial Providers

- **Ways to Access Space Testing**
  - Contact NASA directly
  - Contact the ISS National Lab
    - Funding opportunities for research
  - Contact Commercial Providers for the International Space Station (ISS)
    - Aegis Aerospace
    - Axiom
    - Nanoracks

For Space Testing That is Easy, Rapid, Turnkey

Contact Commercial Providers

Flight Articles Returned

On Orbit Operations Data Delivered

Carriers Delivered Launch

Carrier Integration Certification Testing

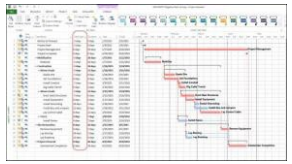
5 Months Before Launch

Deliver Flight Articles

NDA, Questionnaire, Quote

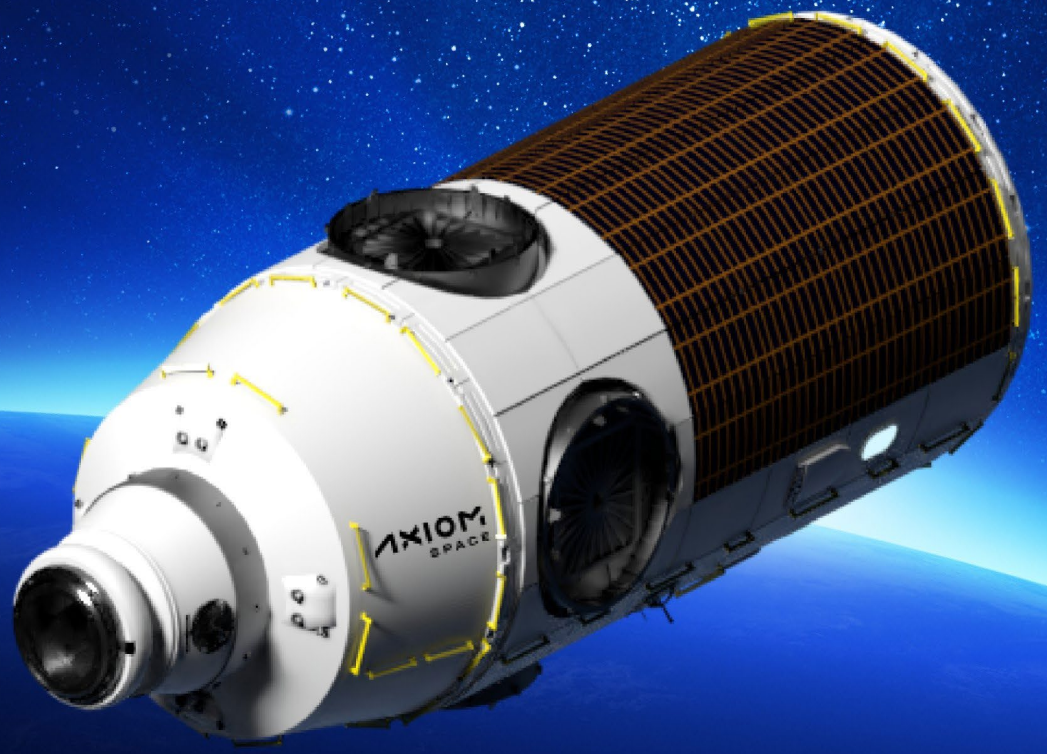
Purchase Order Contract

NASA Integration Process Safety Approval Process




AEGIS
AEROSPACE
AEGIS
AEROSPACE

AXIOM SPACE



Matt Ondler President & Chief Technology Officer – “Fifteen to twenty years from now were going to be surrounded by objects that we can’t imagine how we lived without that were manufactured in space.”

AxH1 | 2024

The Axiom Hub module, containing living quarters for four crew members and volume to accommodate research and manufacturing applications, is the nucleus of future human activity in Earth’s orbit. Each personal crew quarter is equipped with a large Earth-viewing window and touch-screen comms panel. A docking adapter allows visiting vehicles to dock to the Axiom Station; four radial ports on the Hub provide for the addition of future modules and increase the station's docking capability.

Advanced Textiles are Important to US Competitiveness both on Earth and in Space

Conclusion:

- Advanced materials research and development is essential to the future of the US economy.
- The United States is currently a leader in advanced materials research and development.
  - To maintain its leadership, the US needs to:
    - continue to invest in advanced materials research and development.
    - capitalize on the unique Low-Cost access to space via the ISS technology platform to drive game changing innovation and products that benefit mankind terrestrially.
- Advanced materials can also play a role in addressing some of the world's most pressing challenges.
- Advanced Textiles provide the opportunity for new job and industry creation

Topics Covered Today

- Utilizing space for advanced textile design and testing
- Learned about the Unique Challenges and Opportunities of the Space Environment
- Covered How the Space Environment has accelerated Textile Design, Development & Testing
- Why advanced textiles are important to US competitiveness both on earth and in space.

Who is the next Bill Gore?

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Thank You!


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See You Next Year
Sept. 24–26, 2024
Anaheim, California

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