ASCEND™

www.ascend.events

A Protoflight Lightweight Surface Manipulation System to Enable High-Load, Long-Reach Lunar Surface Operations

Thomas C. Jones

Structural Mechanics and Concept Branch

NASA Langley Research Center

11/16/21



This material is a work of the U.S. Government and is not subject to copyright protection in the United States.

Introduction: The Need for a New Class of Offloading Device

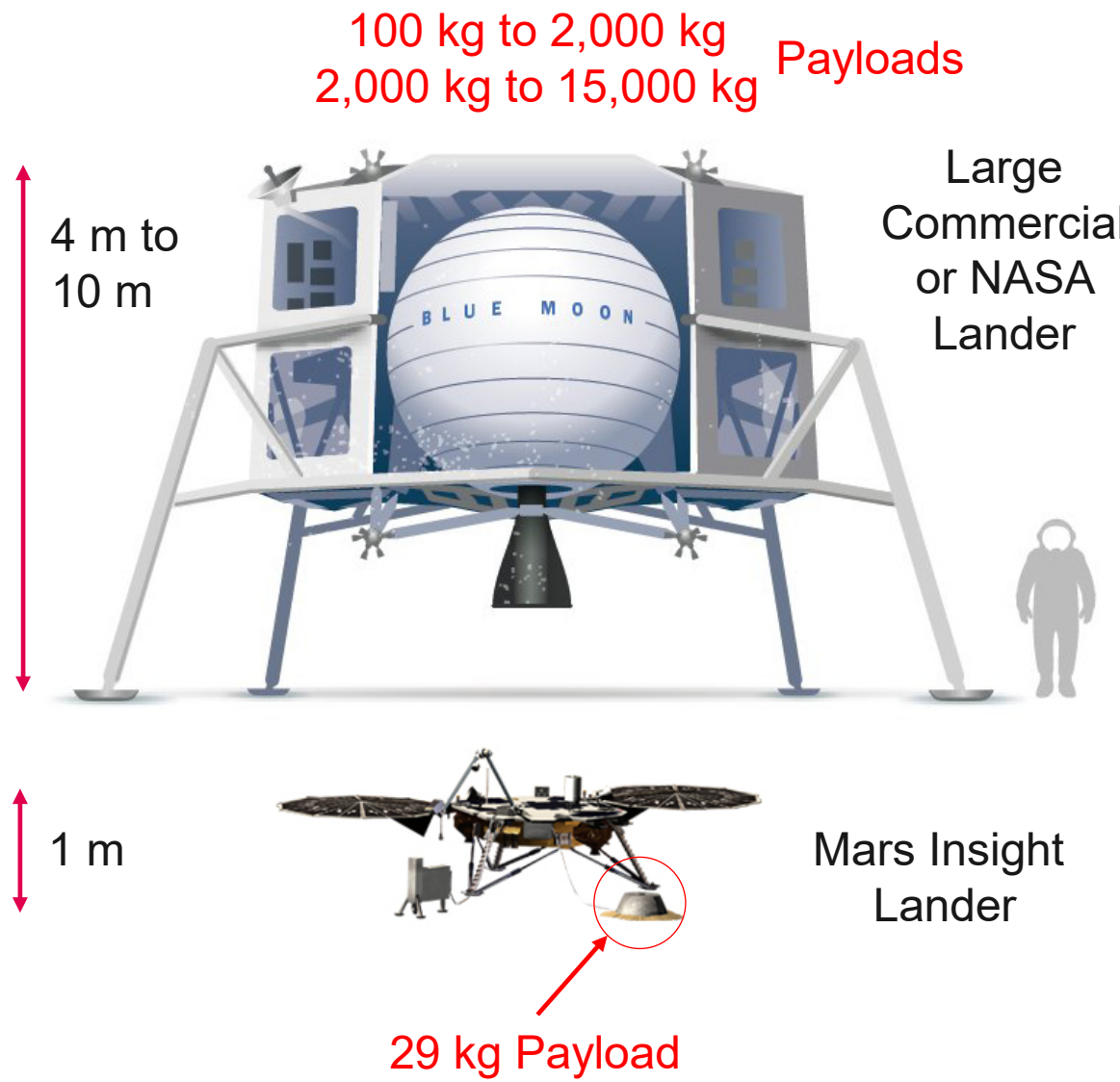
Background: NASA Artemis program seeks to use the Moon as a proving ground to develop the technologies to support sustainable, long-term habitation and exploration

The Problem: NASA and commercial landers require a robust approach to offloading and maneuvering payloads in a wide range of masses, sizes, and shapes

State of the Art: Planetary-surface serial manipulators do not scale to heavy payloads / long reach

- All prior payload positioning on Moon / Mars performed by small robotic arms (0.75 m to 2.2 m reach)
- Payload mass and size, reach required, and height and size of lander, are all significantly greater for large commercial and NASA landers

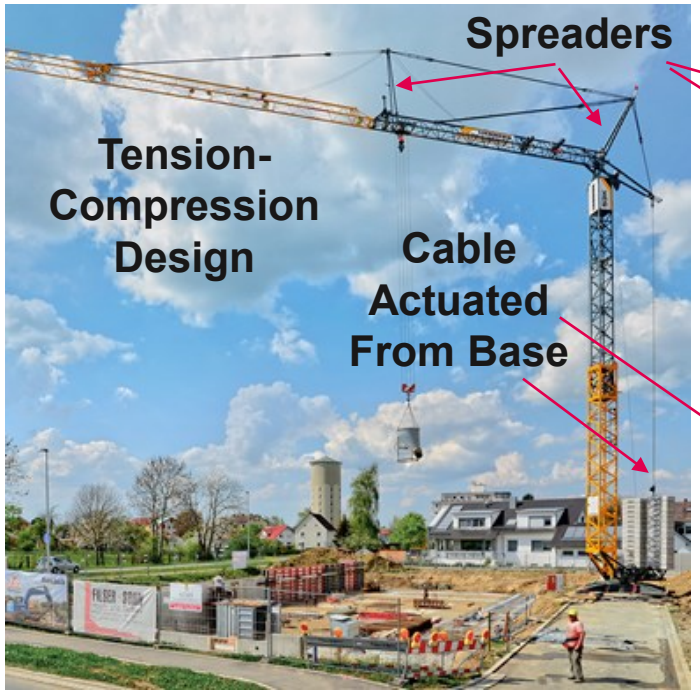
Need: A new class of heavy lift, long-reach offloader



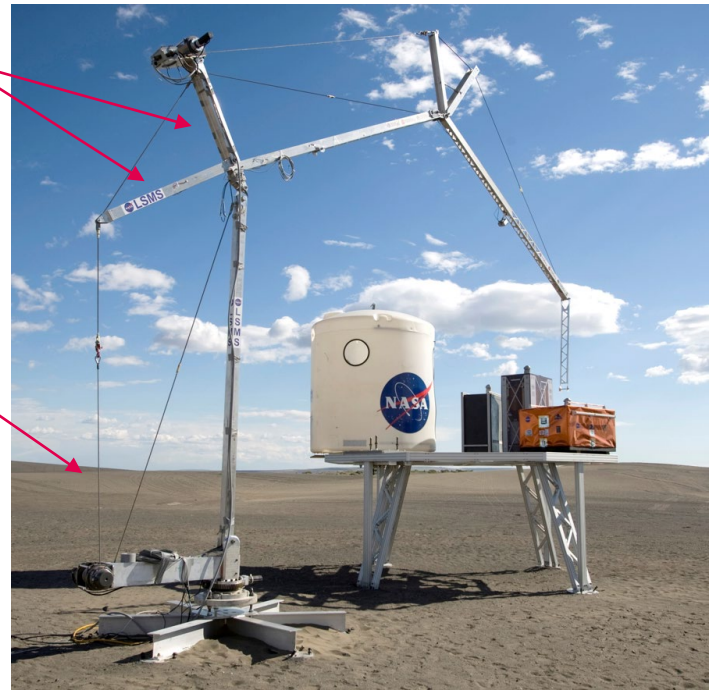
The Lightweight Surface Manipulation System (LSMS)

The Solution:

A lightweight, high-load, long-reach manipulator that combines the structural efficiency and robustness of commercial cranes, with the enhanced dexterity and multi-functionality of a deployable robotic arm



Structurally Efficient Crane

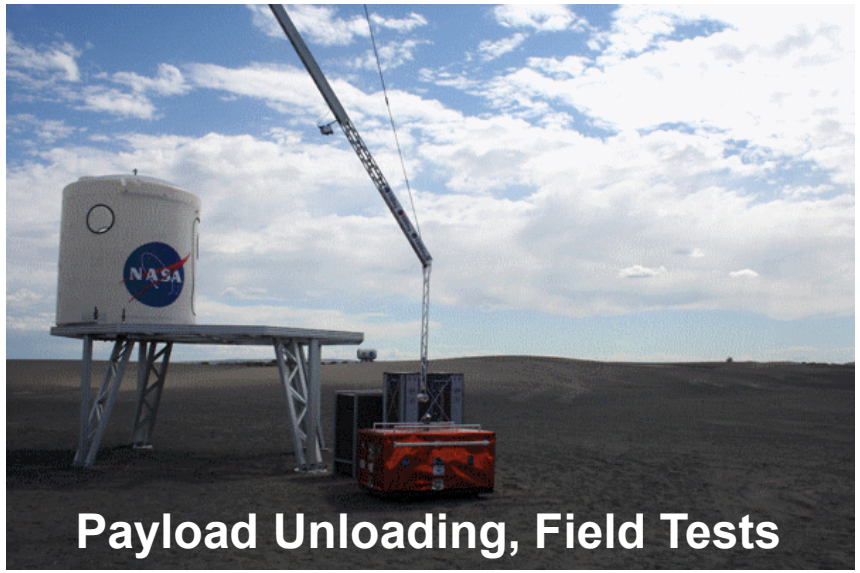


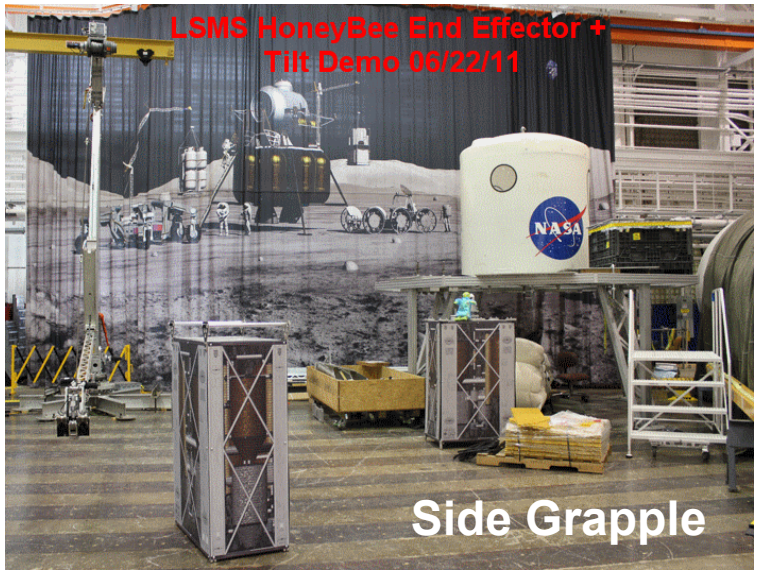
LSMS Prototype

LSMS Design Approach:

- **Scalability**
  - Apply architecture to different missions
- **Versatility**
  - Multiple functions beyond offloading
- **Robustness**
  - Reliable, simple, maintainable
- **Minimize Impact on Lander**
  - Low system mass / small footprint
- **Minimize impact on payload**
  - Use same attachment points and approach used in ground handling
- **Move Slowly**
  - Higher gearing, smaller actuators, reduce dynamic loading, lower risk
- **Simplify Fabrication**
  - Use heritage hardware, lightweight metallic structure

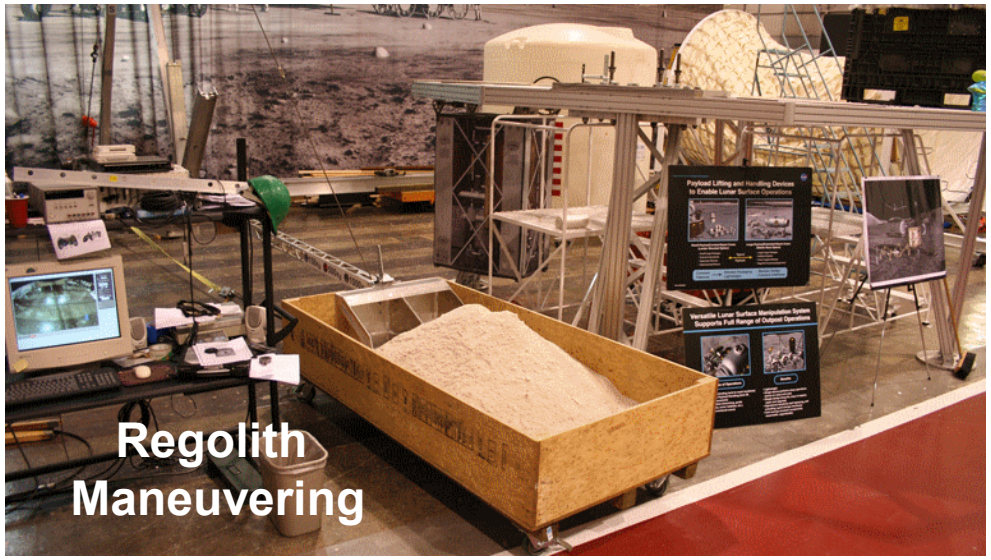
Heritage: Prior Testing with Prototype LSMS

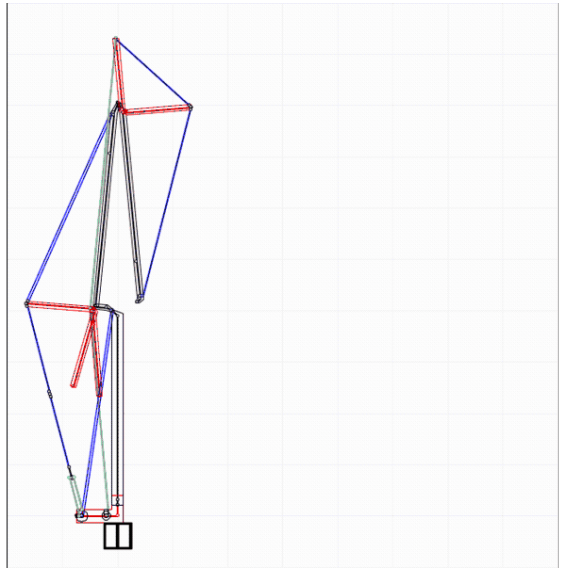






- 14 years of design heritage and testing of 1000 kg (lunar) tip mass capable prototype LSMS
- Multiple payload handling approaches, and end-effector tools demonstrated



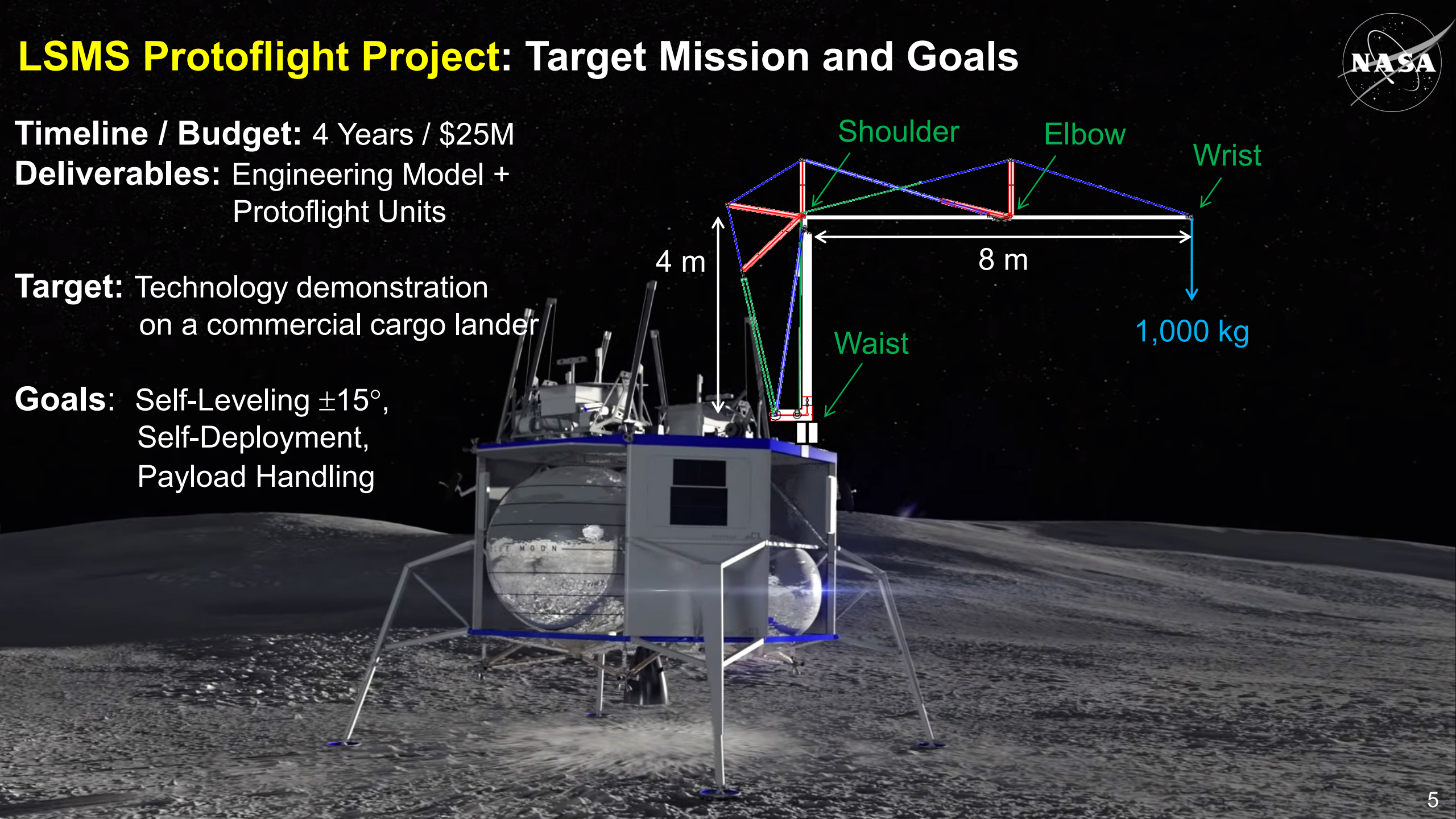


LSMS Protoflight Project: Target Mission and Goals

Timeline / Budget: 4 Years / $25M
Deliverables: Engineering Model + Protoflight Units

Target: Technology demonstration on a commercial cargo lander

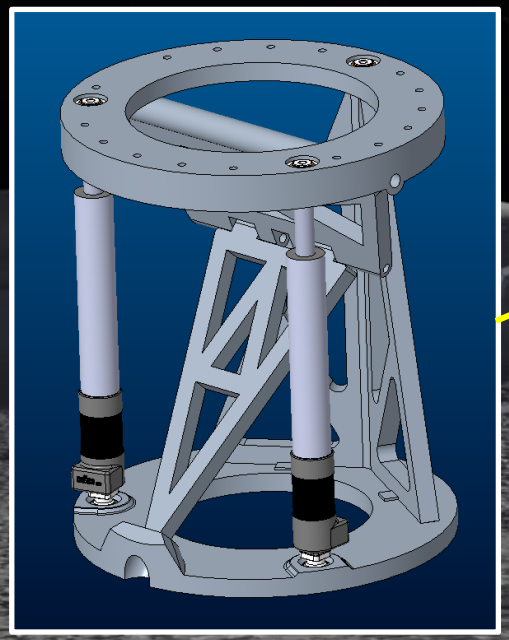
Goals: Self-Leveling ±15°, Self-Deployment, Payload Handling

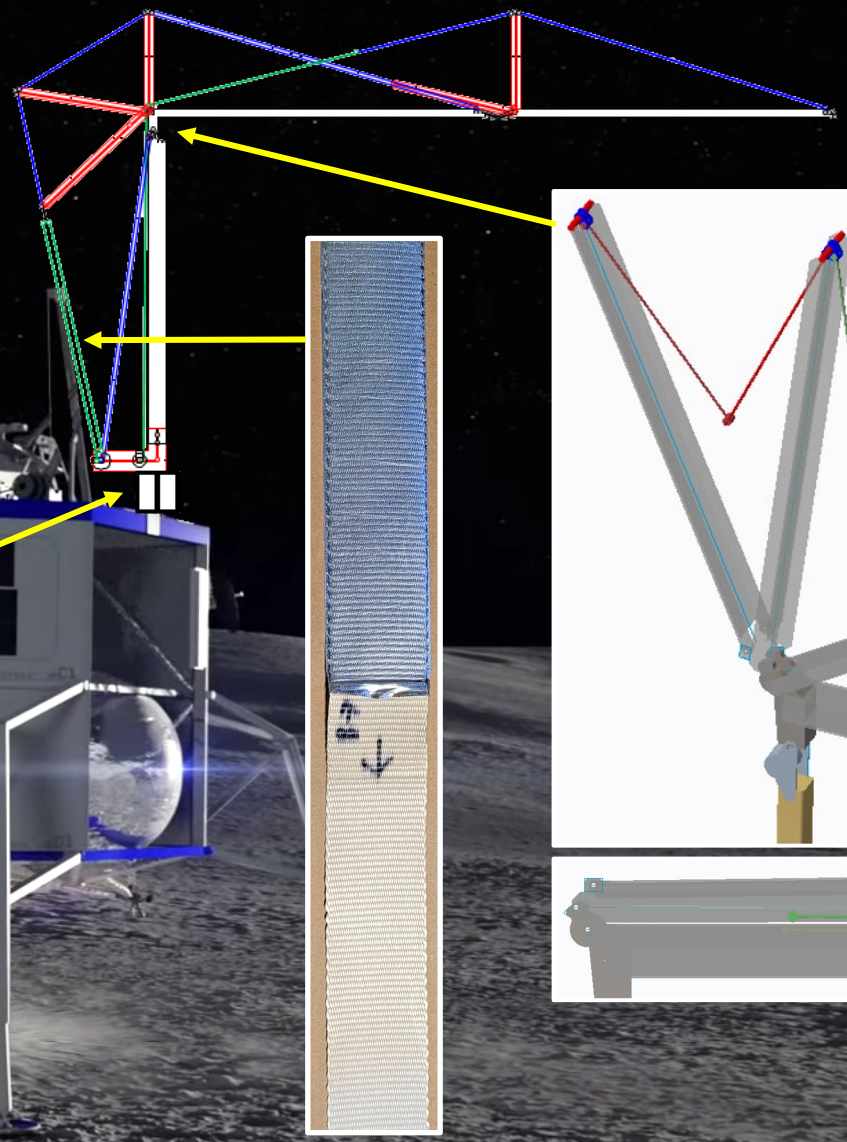


LSMS Protoflight Project: Target Mission and Goals

Major design differences with Protoflight LSMS:

- Actuated leveling base
- Packaging and deployment
- Coated Vectran™ webbing used in place of cables





Thank You



ASCEND

#ascendspace


ASCEND™
LIVE
Las Vegas
15–17 Nov. 2021
ONLINE
EVERYWHERE
8–10 + 15–17 Nov. 2021
LIVE
Washington, DC
15 Nov. 2021
www.ascend.events
Powered by AIAA