
RoboGlove
GM
NASA
A Successful Public-Private Collaboration

Background

The Human Grasp Assist (RoboGlove) idea was conceived in 2009 by GM and NASA during the development of Robonaut 2.

RoboGlove leverages technology from this GM-NASA collaboration for use in a wearable grasp augmentation robot.

- Tendon Actuation
- Distributed Controls
- Touch Sensing
- Specialized Soft Goods

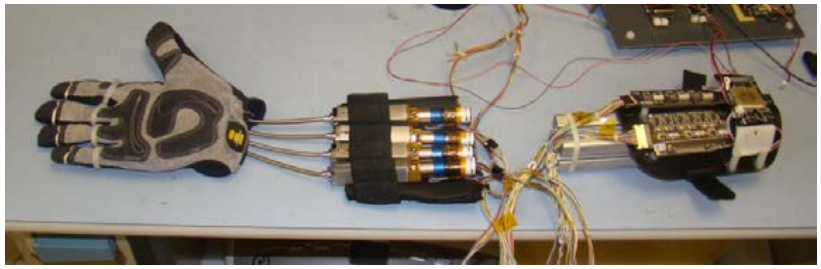
Multiple patents granted since 2012.

Motivation

To reduce grasping fatigue in tasks that require high repeated or prolonged grasping effort.

Reducing grasping fatigue has the potential to prevent fatigue related injuries, speed recovery from such injuries, and/or increase productivity in demanding applications.

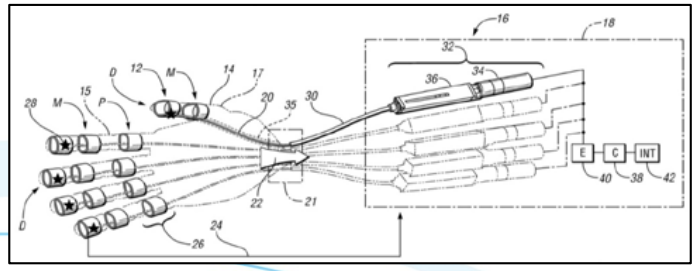
Development History



Proof of Concept – March 2011
Constructed with Robonaut hardware

Version 2 – October 2012

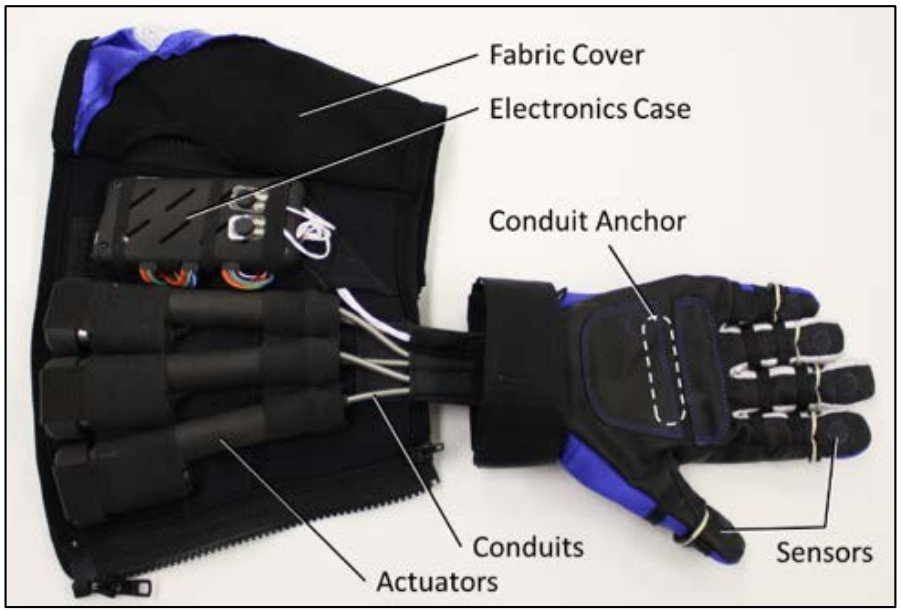
2009 **2010** **2011** **2012** **2013**

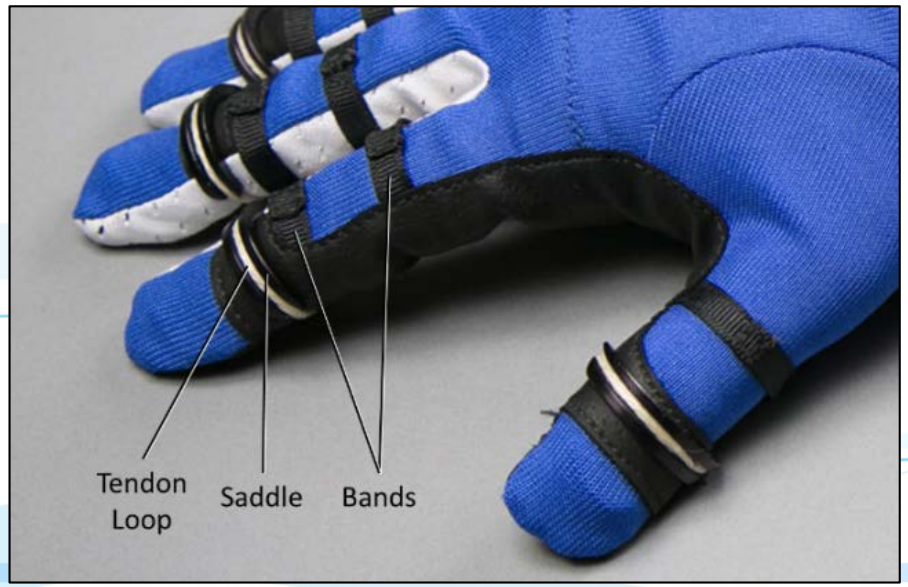


Concept – June 2009
Based on Robonaut finger actuation system

Version 1 – September 2011
Customized soft goods, electronics, and actuators

RoboGlove





Technology

- Forearm mounted electric actuators
- Synthetic tendons
- Force sensors across fingers
- Embedded processing and control

Design Features

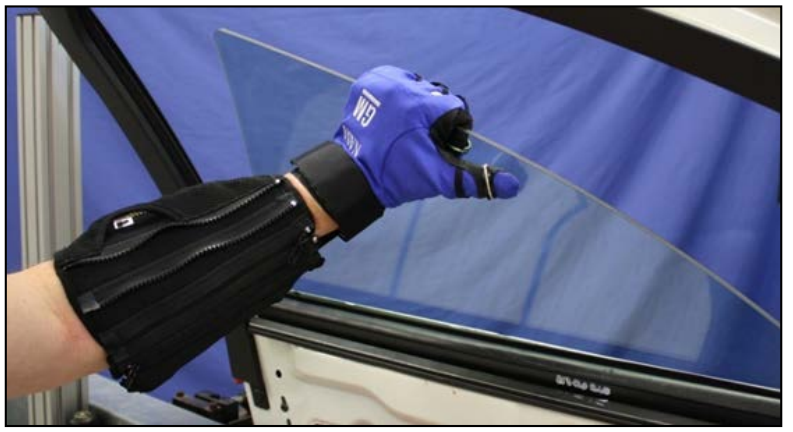
- Multiple hand and forearm sizes
- User-selectable grasp modes
- Tunable sensor thresholds and state transition triggers

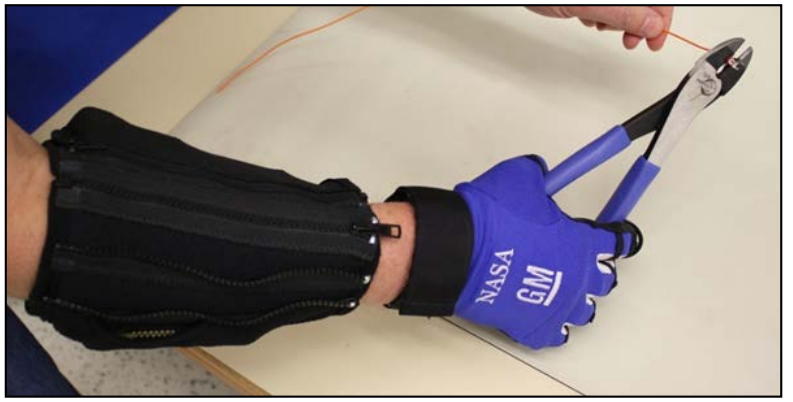
Internal Trials

The following tasks have been identified as potential applications for RoboGlove

1. Door glass install (trial date: 11/12/12)
2. Crimping (trial date: 12/5/12)
3. Weather strip install (trial date: 12/5/12)
4. Power tool grasping (various applications)
5. Snap-in trim install
6. Stamping/die pulls, where tongs are used
7. Mallets in GA
8. Skiving in Paint Shop
9. Stoning in Stamping and at Design Center
10. Casting plant core lifting

Early trials showed only moderate success due to poor glove fit





Commercialization Strategy

Transfer the technology to a supplier that will continue the development, manufacture, and support of a commercial version of the device for GM to purchase.

We have agreed to a license with **Bioservo** to further develop and market GM-NASA RoboGlove technology.

SEM – Soft Extra Muscles for you

BIOSERVO

- Bioservo Technologies is a small Swedish company funded by venture capital.
- They have separately developed a similar product to RoboGlove called the SEM Glove (SEM = Soft Extra Muscle).
- Primary market of interest is biomedical and rehabilitation.
- Bioservo has one US patent and at least one pending application for their technology.

The GM – Bioservo Partnership

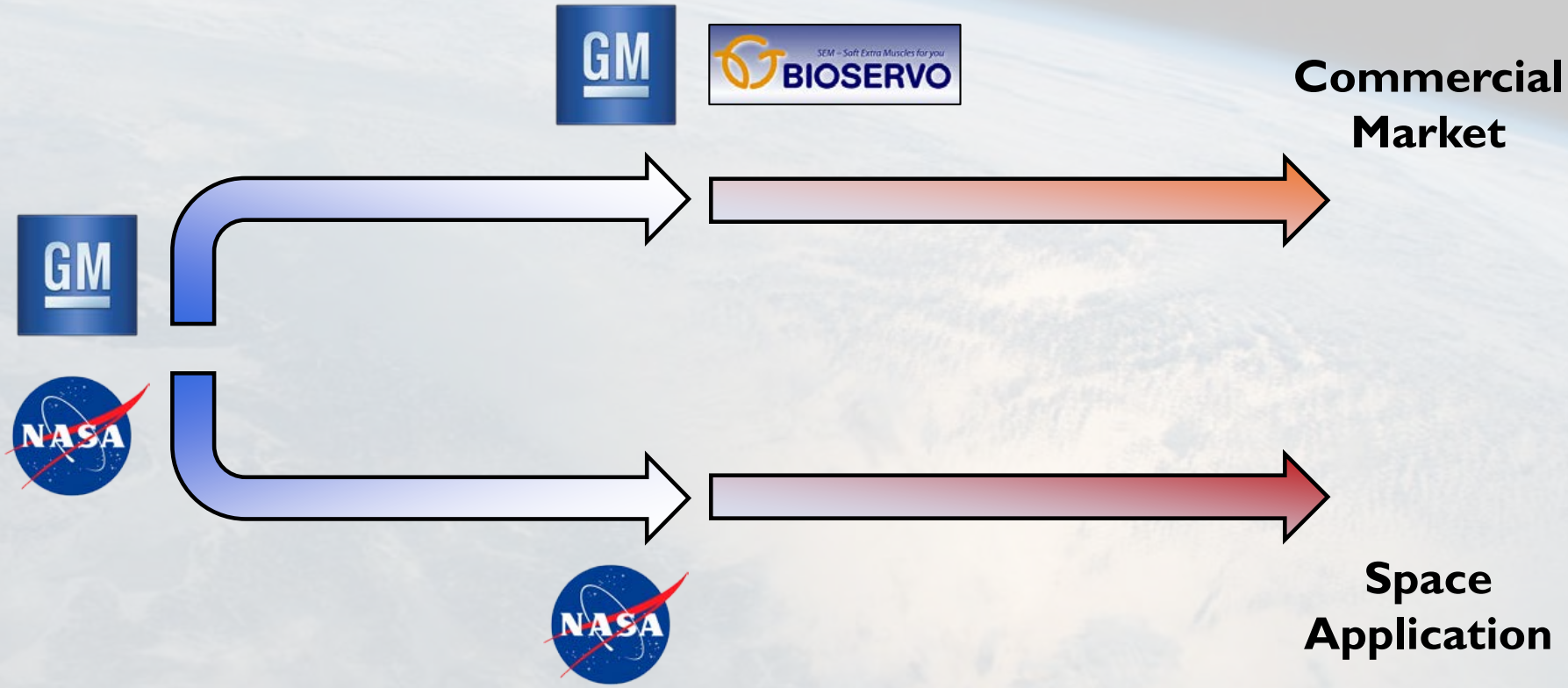
Benefits

- Combining IP will result in a better product for both parties
- Bioservo's background in biomedical research complements GM's interest in manufacturing
- Bioservo has already developed relationships with multiple potential suppliers for GM

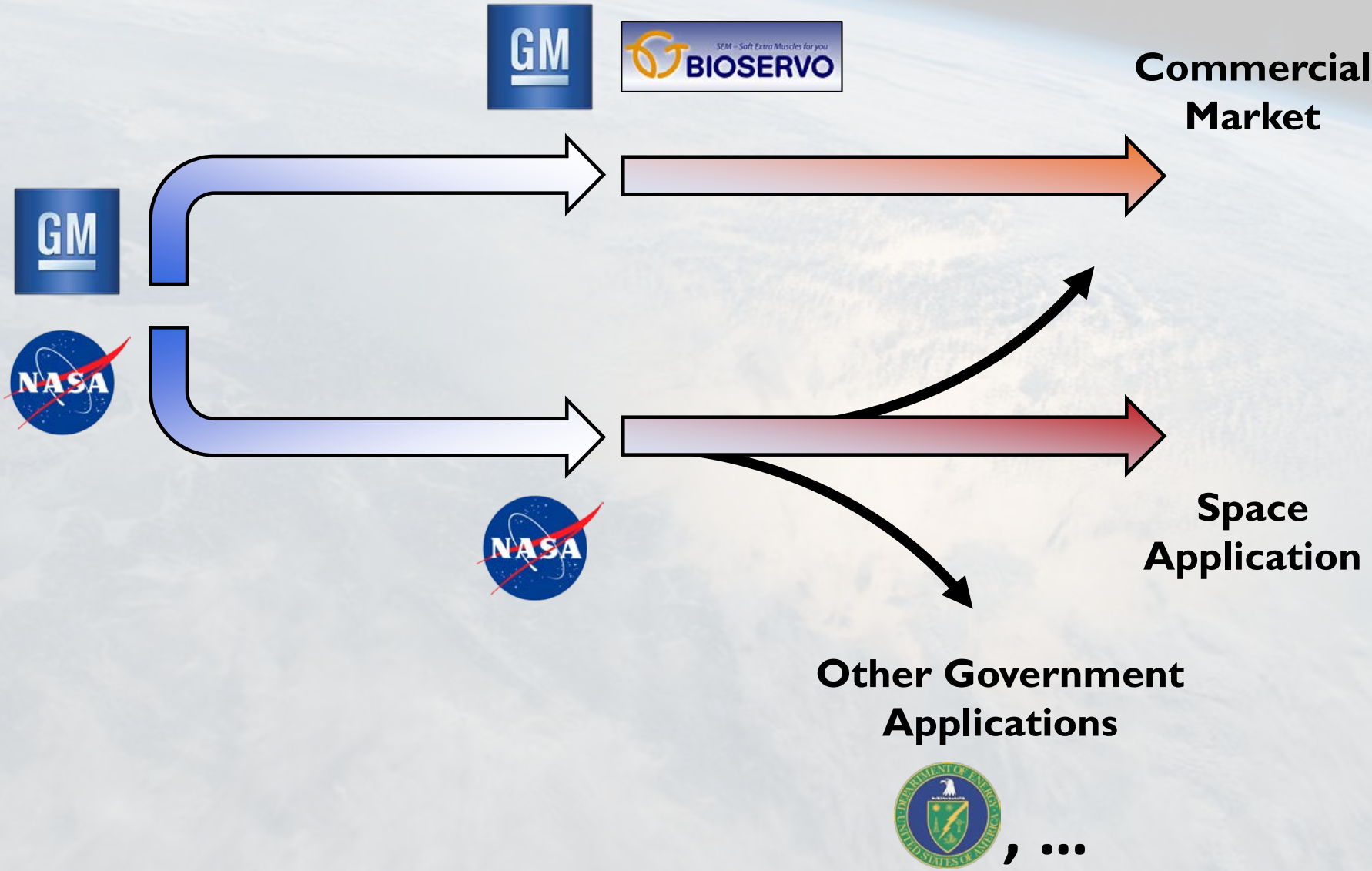
The Going Forward Plan

- Technology transfer between GM and Bioservo
- GM and Bioservo participate in development of a new (combined) product
- Royalties on sales of the new product are paid to GM and NASA

Technology Development Pipeline



Technology Development Pipeline



The Science of Safety

Synergy in the NASA and DOE missions

- Hazardous, high risk environments
- Remote operations
- Specialized protective equipment

Crew/workforce safety and health is the top priority

Wearable robotic technologies could be key mission enablers

The Science of Safety

Robotic tests and demonstrations at the Portsmouth Gaseous Diffusion Plant in Piketon, OH

- Workforce operated robots
- A "proof of application" event

RoboGlove used by workforce personnel in conjunction with tools common to the D&D efforts at the plant


AVT
Makita


DEWALT
20V MAX


The greate casualty
is being rgotten.
DEWALT

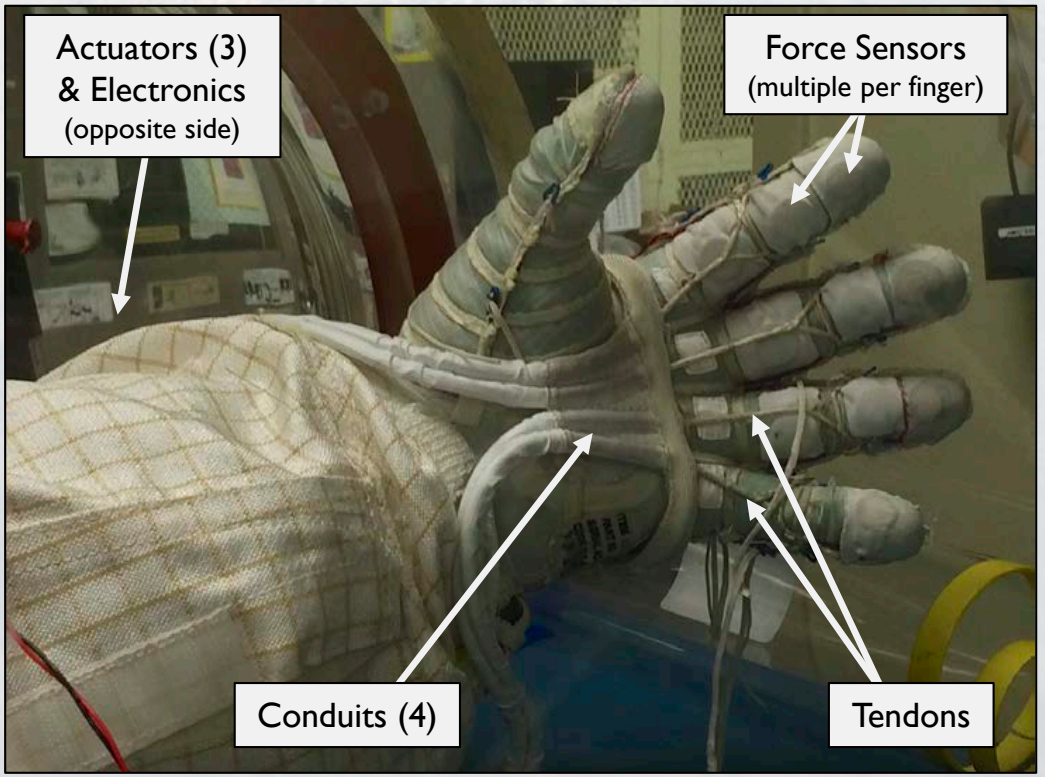
Space Suit RoboGlove

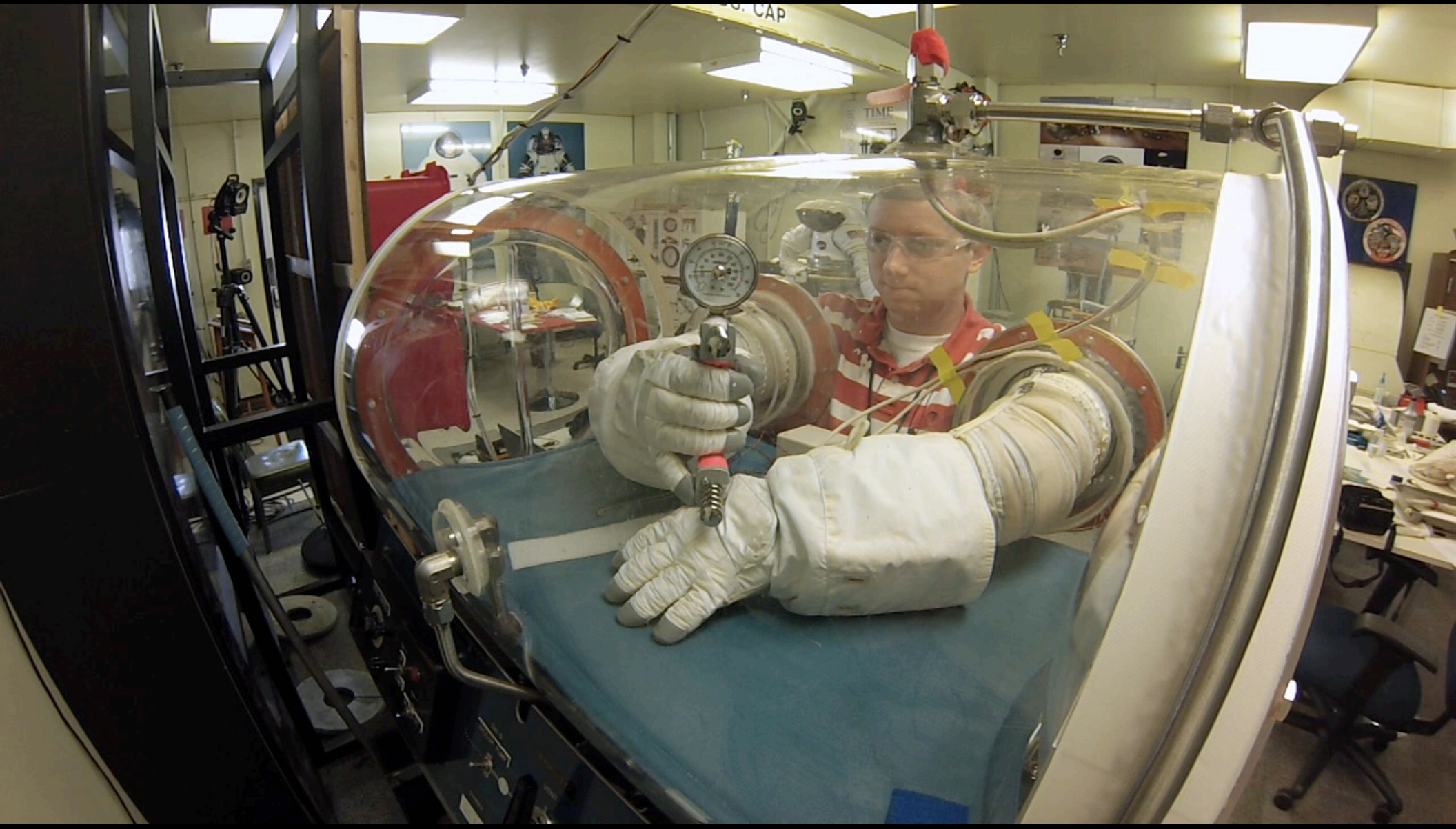
Hand fatigue is an issue when working in bulky, pressurized spacesuit gloves

Integrating RoboGlove technology into the glove provides roughly 10 lbs of continuous grip strength augmentation

Technology advancements:

- New tendon routing and termination techniques
- New sensor layup
- "Powered Steering" control





Quantitative Assessments

Ongoing Tests

- Grip Strength (static and dynamic)
- Dexterity Tasks (timed assessments)
- Subjective Fatigue
- Neuromuscular Effort (EMG-based measurements)

Performance analysis and resulting targeted design improvements will feed into future RoboGlove iterations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