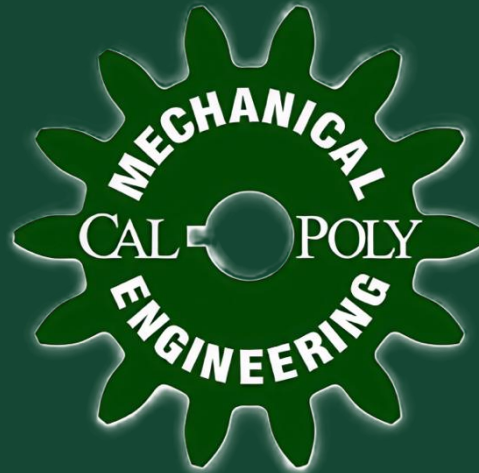


Cryogenic quick connect

CQC

Sponsor: Dr. John Chen

Coach: Rick Lasko



CAL POLY

| Student Developed Presentation

Development Team



Thomas Breen



Monica Herrington



Ethan Hook



Vianca Nerona



Colin Wall



Griffin Vernon

Project Scope

- Design a method for fluid transfer
- System must account for:
 - Reduced gravity
 - Regolith contamination
 - Temperature fluctuations
 - Ergonomical use
- Application on lunar and Martian surface
- Design for shareholders
 - Manufacturing
 - Astronauts

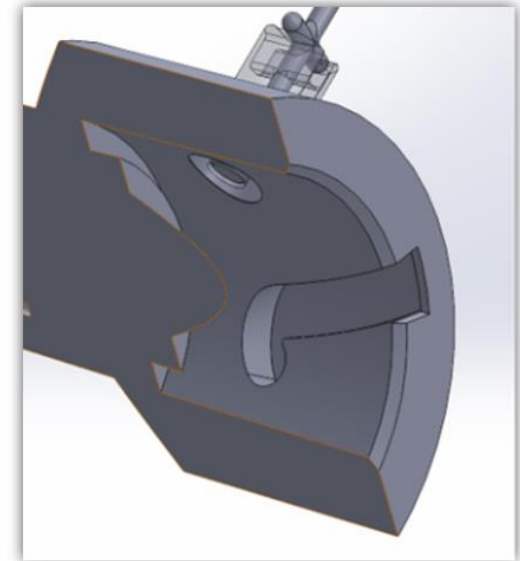
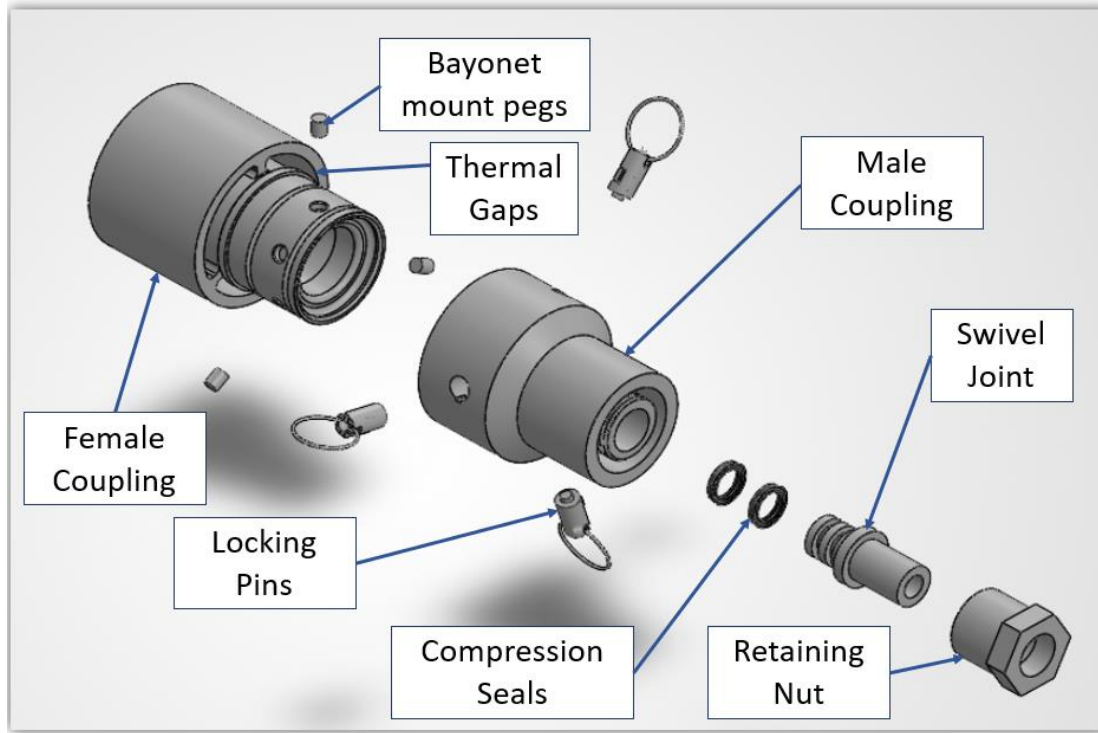


Background Research

- No existing standardized fluid coupling for lunar surface asset interfaces
- NASA's CryoMag coupler demonstrated feasibility of low-force, self-aligning cryogenic connections
- Interface standardization reduces astronaut training burden and operational complexity
- NASA human factors standards define maximum one-handed connection force limits for EVA operations
- Redundant locking mechanisms identified as critical for preventing accidental disconnection under pressure



Design

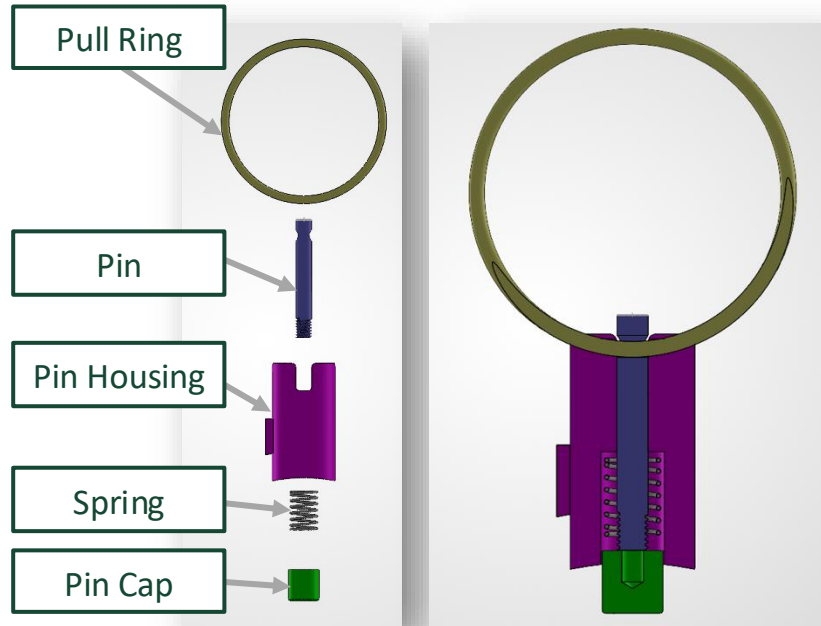


View of Bayonet Locking Channel

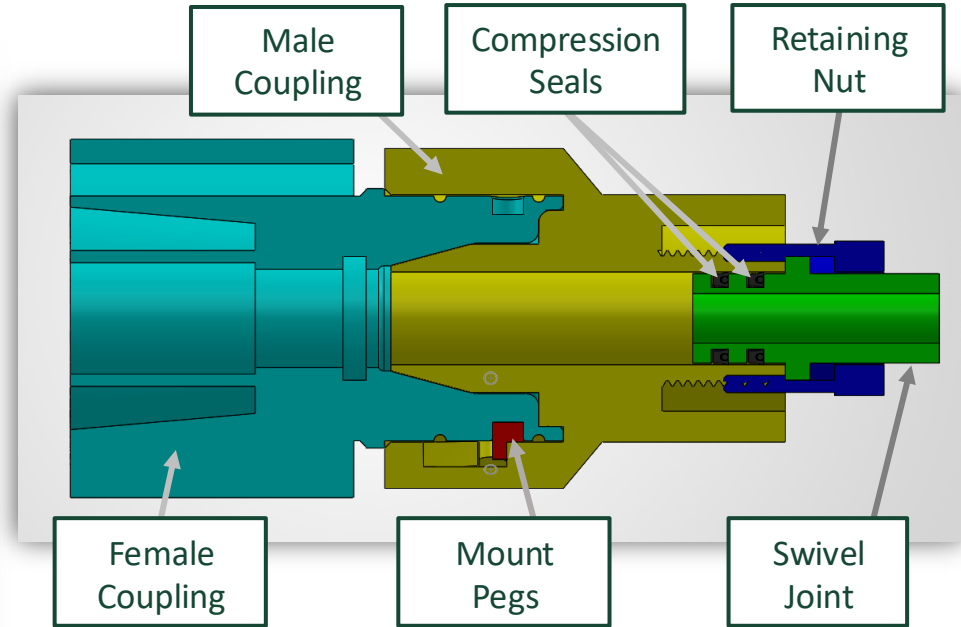


Design

Locking Pin Assembly



Coupling Assembly



Design Specifications

- Core Components

 - Male Connector Mounted on Asset
 - Female Connector for Hand Use

- Sub Systems

 - Locking Pin Assembly
 - Hose Mounting Attachments
 - Direct Flow
 - 90 Elbow

- Consumables

 - Springs
 - 2 inch PTFE O-Rings

- Materials

 - Stainless Steel
 - Titanium Alloy



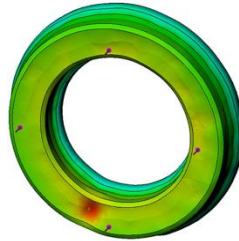
Modeling Results

Hydraulic Performance

Hydraulic Performance Results	
Fluid	ΔP [psi]
	Result
Water (20°C)	0.374
Liquid Oxygen (-183°C)	0.331
Liquid Hydrogen (-253°C)	0.021
Sludge (2% Solids)	0.862

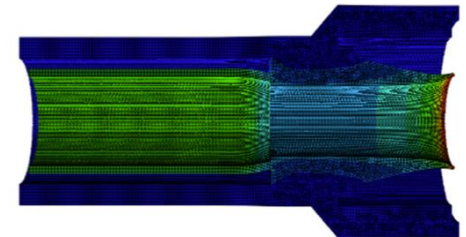
Axial Force & Seal Compression

Seal Compression Test Results		
Parameter	Target	Result
Axial Compression Load	-	2.52 kN
Max Seal Displacement	<1.25 mm	0.376 mm



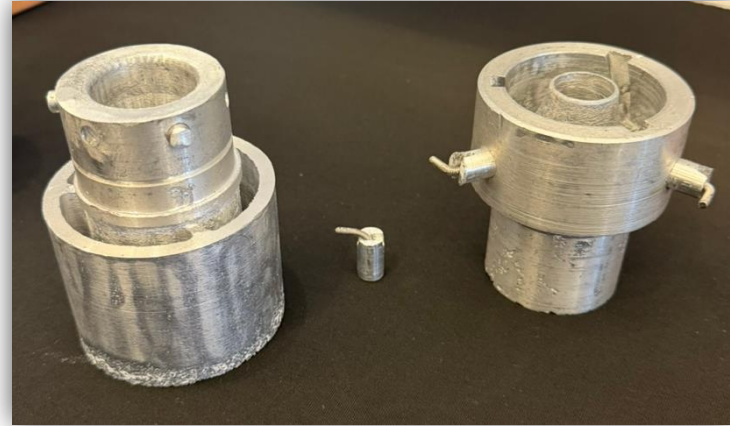
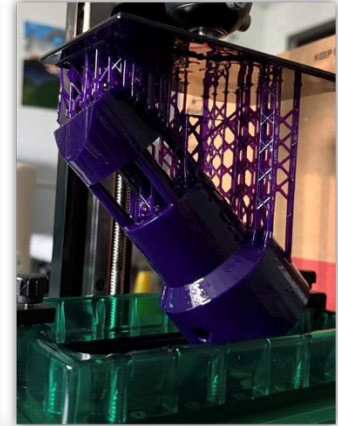
FEA Coupling Structure

FEA Pressure Test Results		
Parameter	Target	Result
Max Von Mises Strength	-	73.3 GPa
Material Yield Strength	-	193 GPa
Factor of Safety	≥ 4	≈ 5
Max Displacement	<0.635 mm	3.8 μ m

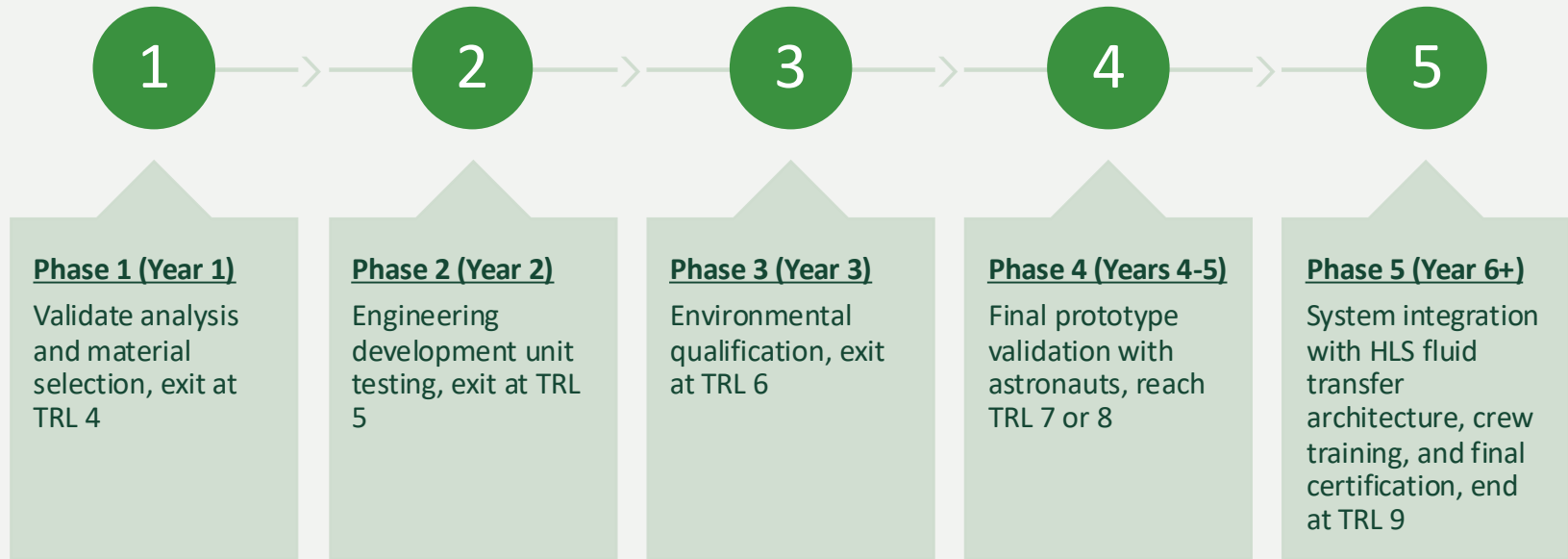


Manufacturing

- Current Prototype:
 - Male and Female Connectors cast using lost PLA
 - Post machining to meet tolerances
 - Pin Assembly Manufactured using CNC processes
 - Parts Sourced from McMaster Carr
- Improved Methods
 - 3-D Metal Printing
 - Improved Investment Casting



Path-to-Flight Plan



Risks and Concerns

- Bayonet locking force
- Thermal cycle degradation
- Cryogenic seal and mechanism performance
- Dust mitigation
- Ergonomic grip



Summary

- Bayonet locking with redundant pins mechanism ensures fail-safe connection
- Conical interface enables reliable mating for suited astronauts and robotic systems
- Standardized plug-and-play architecture simplifies operations
- Thermal gap and vacuum insulation preserve fluid integrity in cryogenic conditions

