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Source of Acquisition
NASA Johnson Space Center

Advanced Mating System Development for Space Applications

An Overview



Introduction

- Purpose: *present for discussion work needed in the area of space flight sealing.*
- Technical Area of interest: *Dynamic Interface Seal for use on space mating systems in support of a “fully” androgynous mating interface*
- Design Concept: *To provide a “fully” androgynous mating system will require a Seal-on-Seal Interface.*



Background

Terminology

Mating is a generic term used to describe the act of bringing two space vehicles together using an interface mechanism to capture and hold the vehicles together in support of on-orbit assembly and/or crew/cargo transfer.

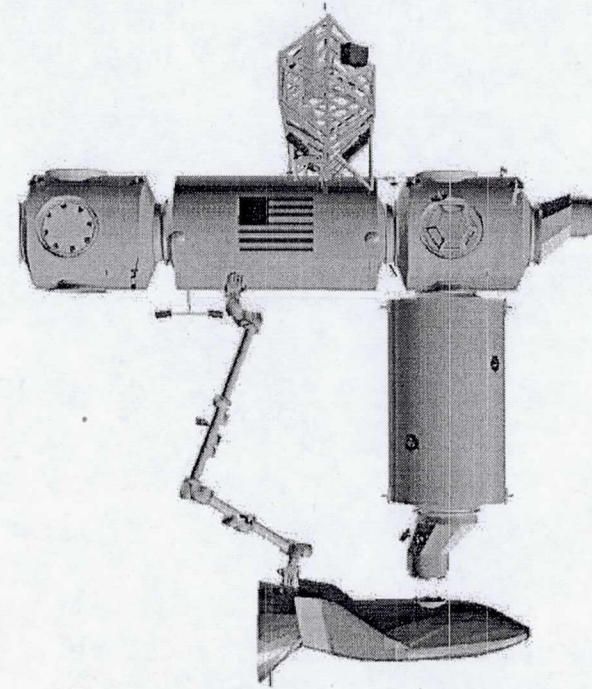
Berthing refers to mating operations where a module/vehicle is placed onto the mating interface using a Remote Manipulator System-RMS.

Docking refers to mating operations where an active vehicle flies into the mating interface.

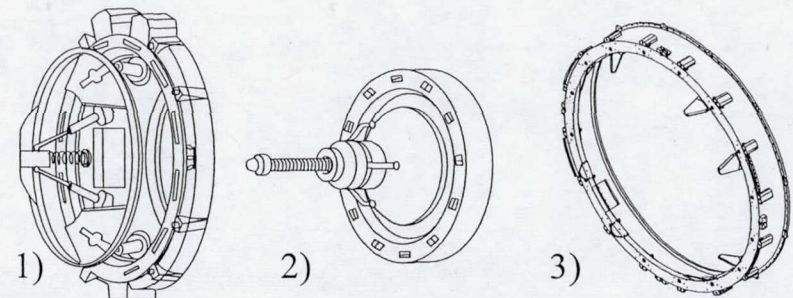
Existing mating systems:

- 1) Modified Russian APAS for Docking the Shuttle to ISS
- 2) Russian Probe & Drogue for Docking the Soyuz/Progress to ISS
- 3) US Common Berthing Mechanism (CBM) used for Module to Module/MPLM/HTV (ISS)

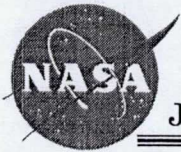
“None of these systems meet the requirements for a long duration, Crew Exploration Mission.”



RMS Berthing Illustration

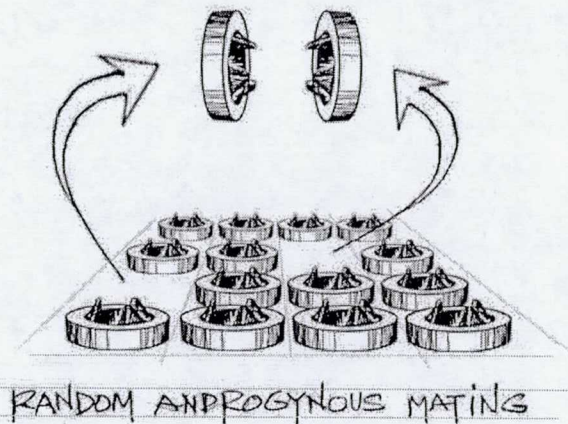
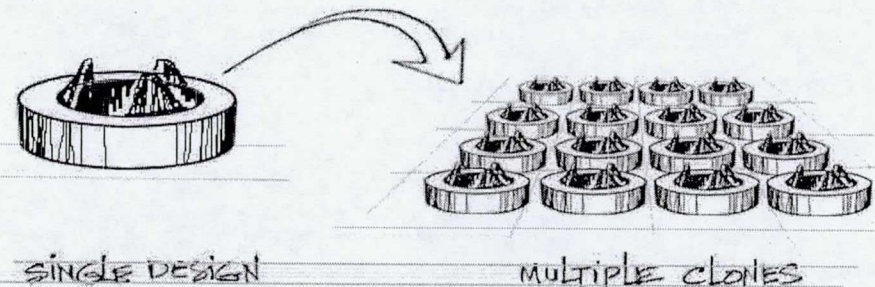


Depictions of ISS Mating Systems



Background

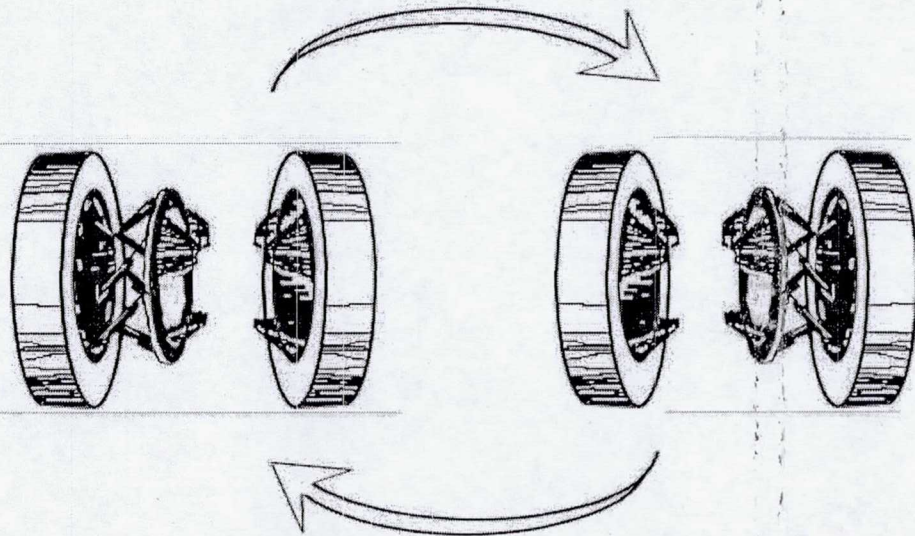
- The Structural Engineering Division at the JSC has had an internal, next-generation, mating system development activity ongoing since the mid-1980's
- This effort has resulted in the advocacy of developing a standard multipurpose interface for use with all modern modular space architecture.
 - No unique active or passive mechanisms;
 - Support both Docking and Berthing operations;
 - On-orbit assembly or AR&C;
 - Useful for Crew Transfer and Crew Rescue to ISS;
 - Landers, Nodes, & Modules supporting crew exploration;
 - Provide maximum flexibility in inter-connectivity "one system—many uses!"
 - System Level Redundancy
 - On-orbit Re-configurability





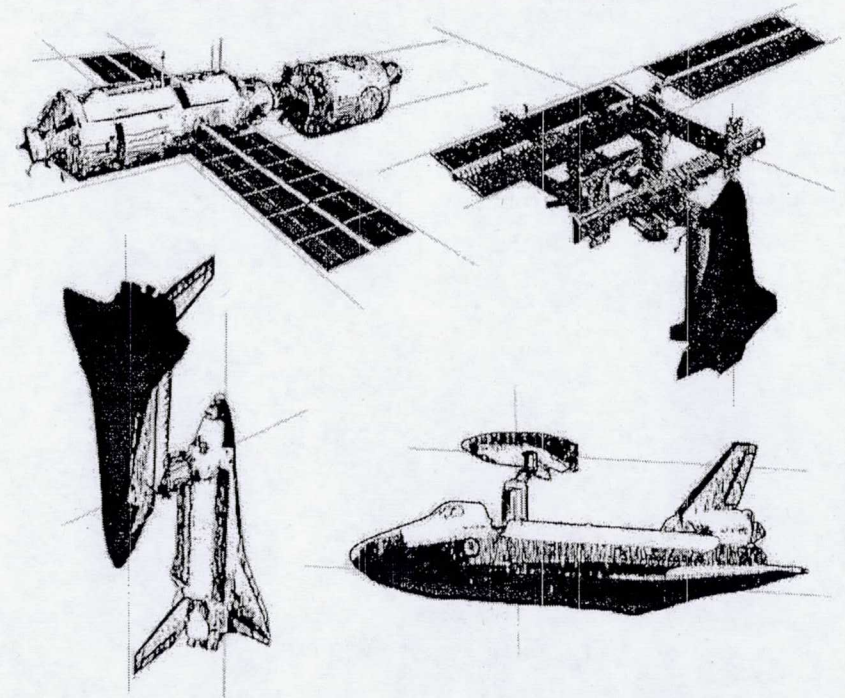
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Background



FUNCTIONAL REVERSIBILITY

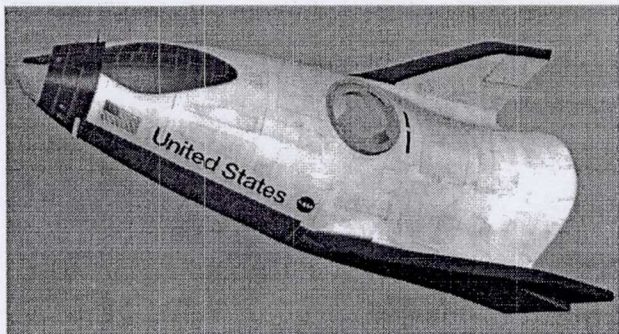
RECONFIGURABILITY



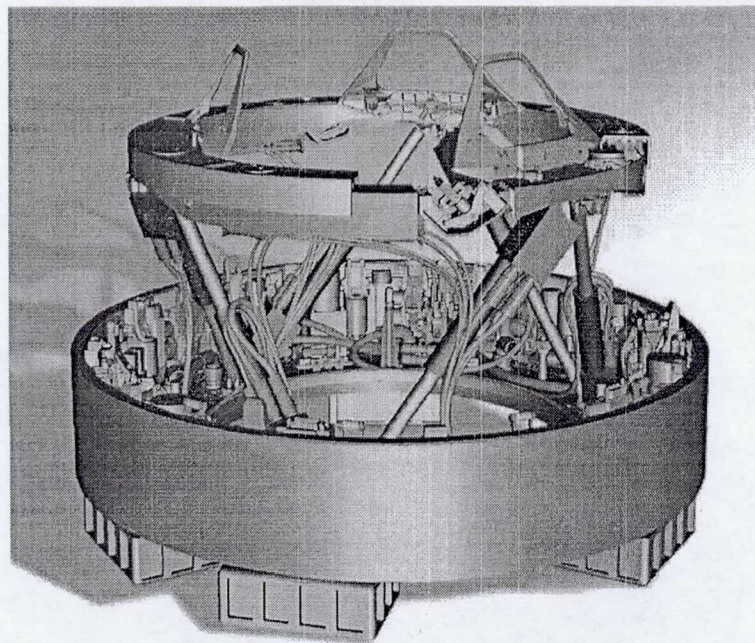


Background

- Recent efforts supporting the X-38 Program enabled development of a “fully” androgynous interface design
 - Low Impact Docking System-LIDS
 - Full-scale engineering development unit-EDU sized for crew transfer (32” dia)
 - Fully androgynous, integrated, ground based system to show TRL 4 maturity
 - Uses electromagnets & closed-loop force-feedback sys. for soft-capture
- “Fully” androgynous design means “Seal-On-Seal”-SOS
 - SOS not the current implementation standard
 - We typically use the seals on the “visiting” half
 - Cover the seals during exposed periods (CBM)
- Have some limited SOS experience
 - Apollo-Soyuz Test Program (ASTP)
 - APAS (Russian design originally has SOS)
 - LIDS—began some early SOS development



Artist Image of X-38 Crew Return Vehicle



CAD Image of LIDS EDU Design



Seal Work

- “Seal-On-Seal” development
 - 2001 a small development effort was initiated to begin determine the feasibility of a seal-on-seal interface and investigate:
 - leak rate
 - seal load force
 - adhesion behavior
 - Using some of the historical ASTP seal data, the seal vendor selected two cross-sections each of two different materials
 - Elliptical Crown Section and Flat Top section
 - S383-70 and S1853-50 Silicon materials

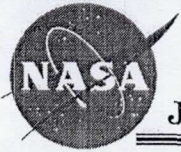
Figure of Cross-sections to go here



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Seal Testing

- Seal testing descriptions and results to go here.



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Seal Testing Conclusions

- Seal Testing Conclusions to go here.