Johnson Space Center

Advanced Mating System Development for Space Applications

An Overview

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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.*

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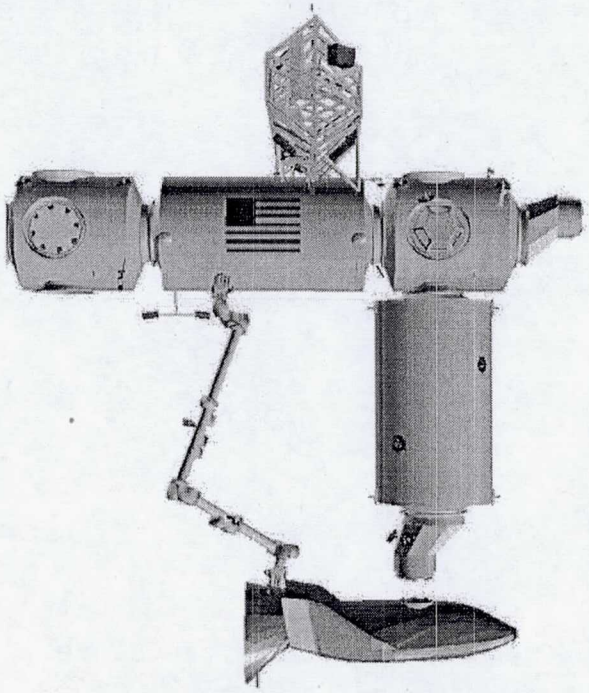
Background

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.

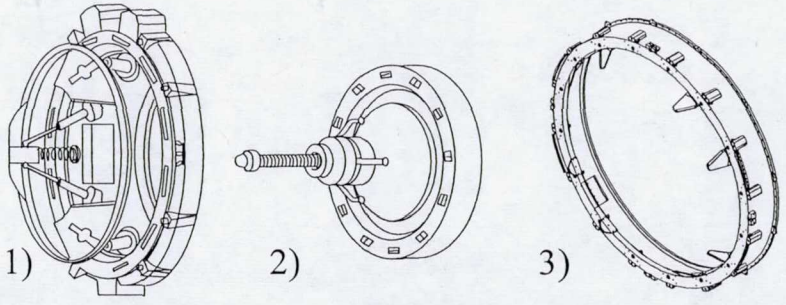


RMS Berthing Illustration

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."



Depictions of ISS Mating Systems

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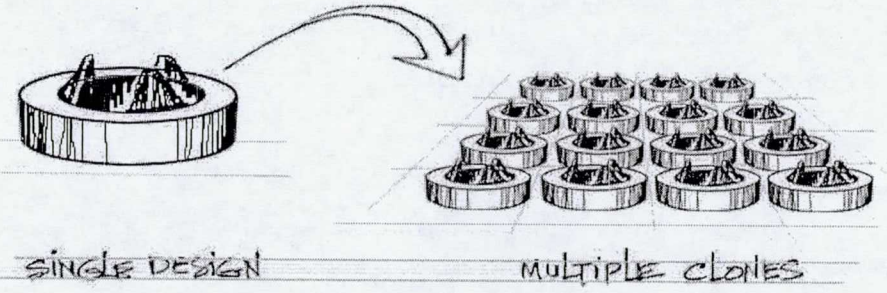
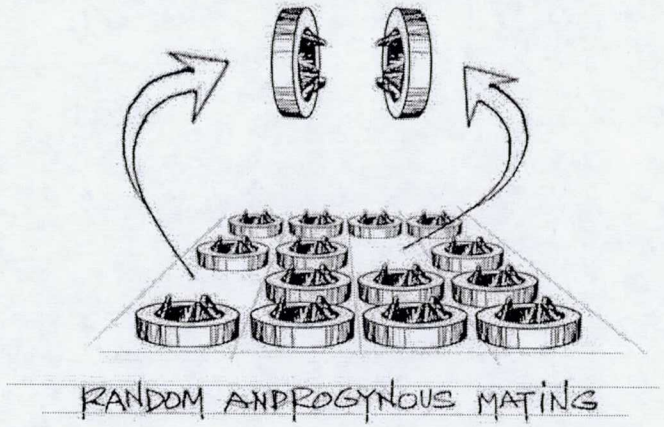
Background

- 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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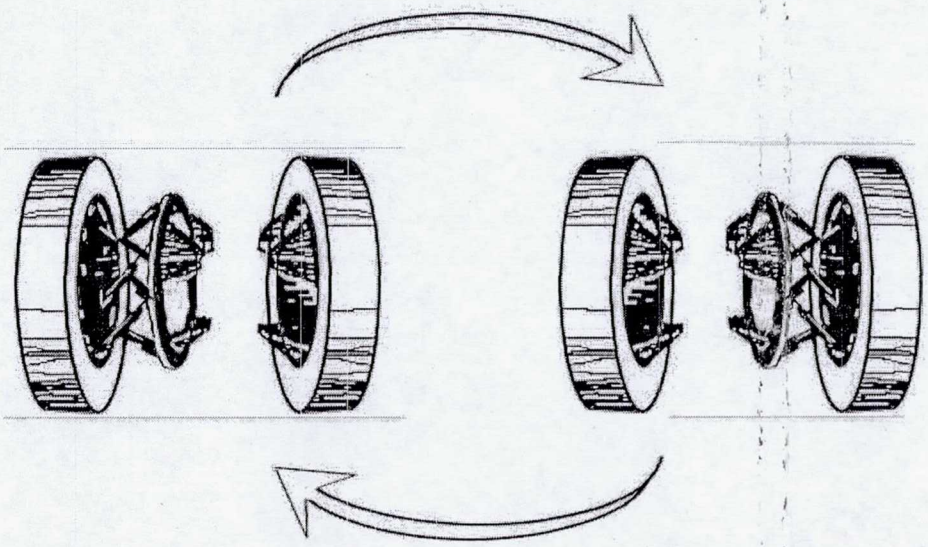
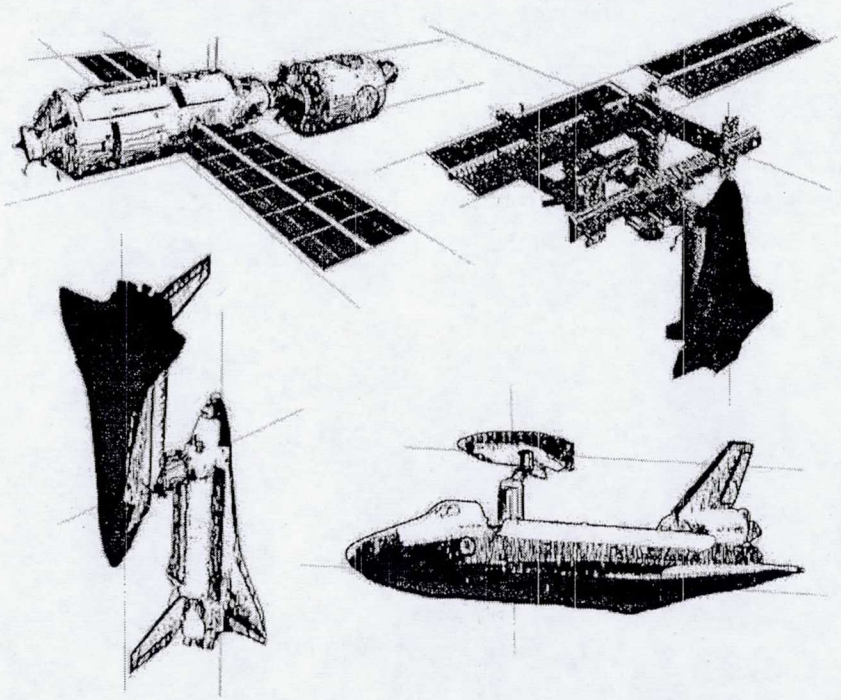


FUNCTIONAL REVERSIBILITY

RECONFIGURABILITY



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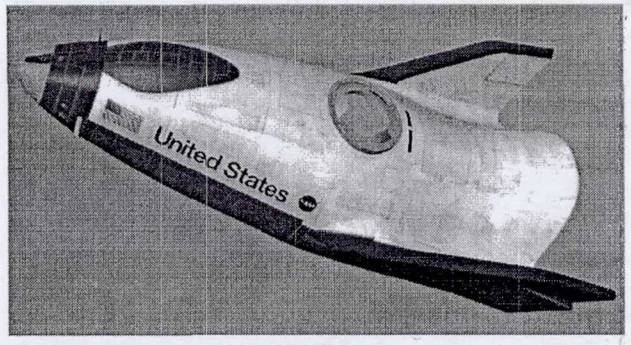
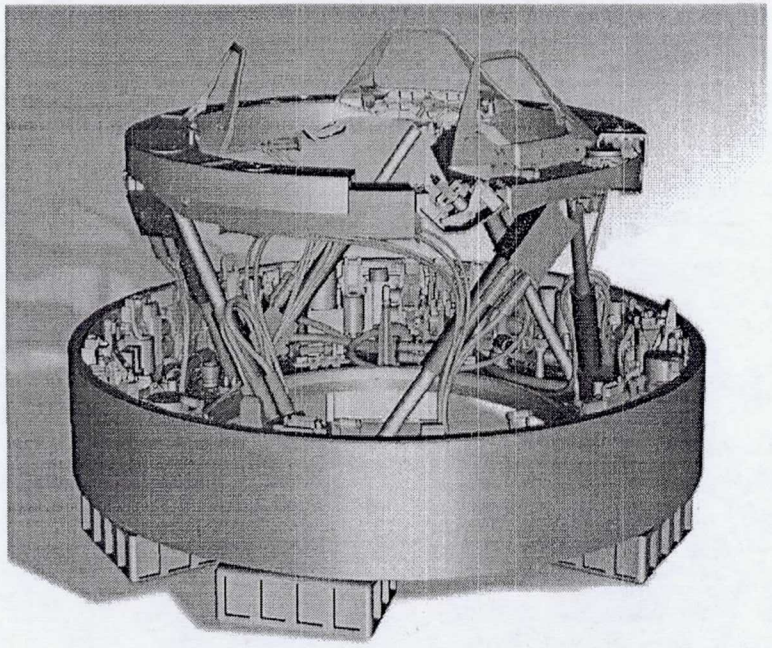
Background

- 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

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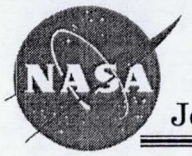

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Seal Work

- "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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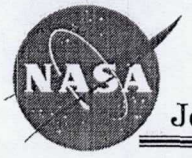

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Seal Testing Conclusions

- Seal Testing Conclusions to go here.

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