

Simplified Mating Operations

Space Propulsion Technology
Assessment Workshop

April 2001

Current Baseline

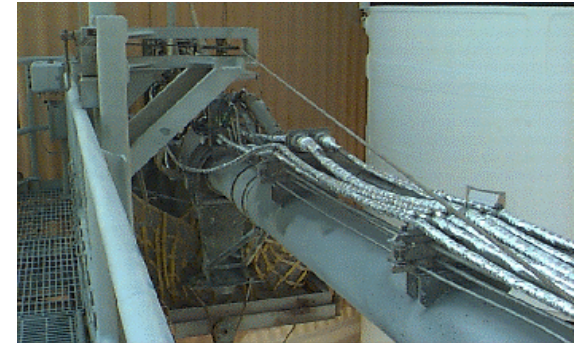
Simplified Mating Operations

- The STS has over 100 umbilicals
- Most critical umbilicals have pyro disconnects
 - Only replaced near flight time
 - Hazardous mechanisms require stopping other work and serial processing
- Must be cleaned after launch
 - Currently most are cleaned by disassembly, cleaning, refurbishment, reassembly, and verification
- In general
 - Days to refurbish
 - Expendable hardware
 - Days to install
 - Days to checkout
 - Example: 6 shifts (approximately 75-100 hours) per GUCP for fluids only
 - Highly manual operations
 - Many serial operations
 - Checkout part of system, reconfigure, checkout remaining
- To save weight, hardware on ground instead of vehicle requiring additional interfaces
 - Sensor, valve actuation

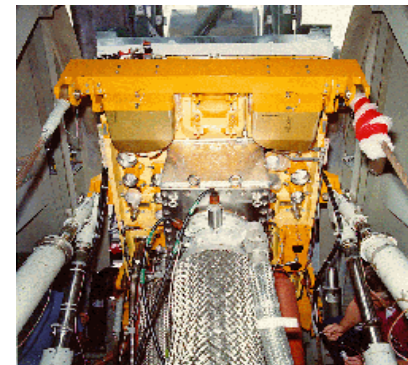
Potential Solutions

Simplified Mating Operations

- Lower number of umbilicals
 - Even for same number of connections, run many more through each connection
 - Lowers number of umbilicals
 - Combine services
 - Distribute internally
 - Lowers number of connections
 - Do both
 - Combine systems and/or propellants
 - e.g., combined OMS/RCS
 - Lowers number of connections and number of umbilicals
- Eliminate use of pyros
- Develop method to clean in the field without disassembly
 - Or very simple replacement of unclean part



Shuttle H2
Vent Arm



Shuttle LOX T-0 Interior View

Technologies to Implement Solutions (TRLs)

Simplified Mating Operations

- Standardize, to extent practical, umbilical interfaces (3)
 - Standard electrical plug
 - Standard power
 - Same outside shape and size
- Develop vision and/or self aligning mating and sealing system (2/3)
 - Tolerant to
 - Torque
 - Lateral and rotational displacement
 - Temperature change
- Bring health management to the mating plane (2/3)
 - Verification of mating integrity
 - Operations and leak checks of umbilical
 - Verification of disconnect
 - Maintenance needs
 - Goal is only maintenance by exception (except cleaning)

Technologies to Implement Solutions (TRLs) (Cont'd)

Simplified Mating Operations

- Mechanical/electrical disconnect design (2/3)
 - Examples, springs or shape memory alloys, pneumatic collets (3)
 - Electromagnetic coupling (3/4)
 - Both the umbilical and the vehicle mating site designed together for load transfer
- Minimize need to clean and improve implementation (2/3)
 - Closing and opening shutter
 - Design opening of shutter as part of mating operation
 - Cleaning method at site without disassembly
 - Use health management system for varification
 - Line replaceable umbilical end
 - Old one cleaned and refurbished or disposed
- Eliminate large number of hydraulic and pneumatic interface connections by using
 - EMAs (5)
 - Also requires low torque values
 - Electro hydrostatic actuators (EHAs) for high torque applications, e.g., TVC actuators (4/5)
 - Self-contained hydraulics
 - Now only power across interface
 - Could be only one umbilical if supplying to main internal power system

Cost to Mature Technology

Simplified Mating Operations

\$100K	
\$500K	
\$1M	
\$5M	
\$10M	
\$30M	
\$50M	
\$100M	
\$500M	

The lower number to address just a few of the technologies and only part of the problem. The higher amount to address the broad range of technologies and the full range of the problem.

6 Mo	
1 Yr	
18 Mo	
2 Yr	
3 Yr	
4 Yr	
5 Yr	
5 Yr+	

The shorter time for the well developed solutions. The longer time is required for some of the less well defined technologies.