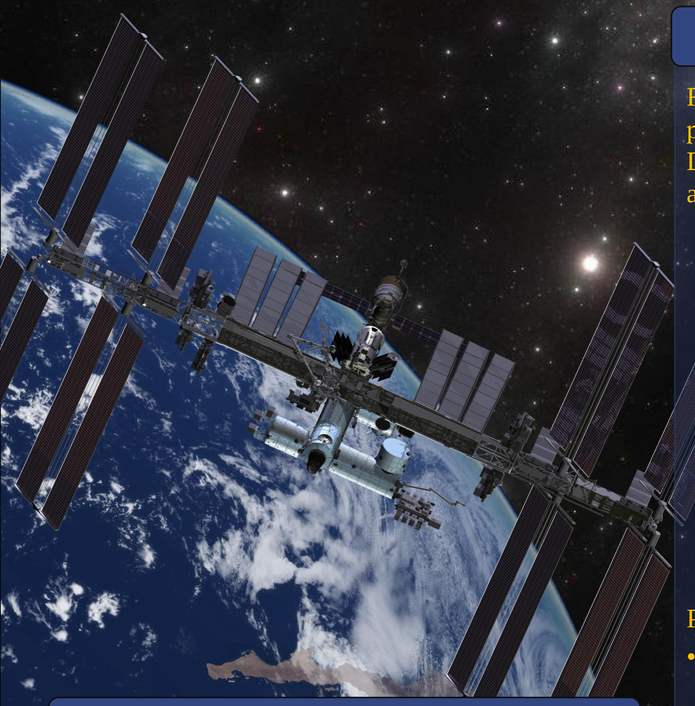
Parametric Mass Reliability Study

James Holt • Safety & Mission Assurance

NC4 – Space Exploration Division, Risk & Reliability Analysis Branch



Abstract

The International Space Station (ISS) systems are designed based upon having redundant systems with replaceable orbital replacement units (ORUs). These ORUs are designed to be swapped out fairly quickly, but some are very large, and some are made up of many components. When an ORU fails, it is replaced on orbit with a spare; the failed unit is sometimes returned to Earth to be serviced and re-launched. Such a system is not feasible for a 500+ day long-duration mission beyond low Earth orbit.

The components that make up these ORUs have mixed reliabilities. Components that make up the most mass—such as computer housings, pump casings, and the silicon board of PCBs—typically are the most reliable. Meanwhile components that tend to fail the earliest—such as seals or gaskets—typically have a small mass.

To better understand the problem, my project is to create a parametric model that relates both the mass of ORUs to reliability, as well as the mass of ORU subcomponents to reliability

Project Goals

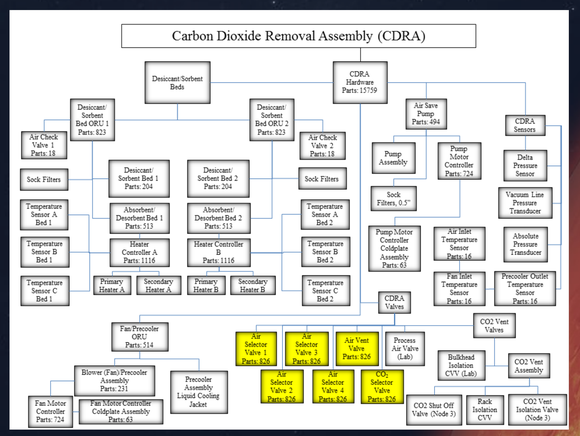
For my project, I have chosen to continue the previous intern's work of analyzing the Carbon Dioxide Removal Assembly (CDRA) and associated ORUs

Valve Selector ORU

CDRA Assembly

Process:

- Break down the CDRA to create a Master Equipment List (MEL)
- On the MEL, include mass and mean time between failure (MTBF) for each component
- Relate ORU mass to ORU reliability
- Relate subcomponent mass to subcomponent reliability
- Use data to perform a logistics/reliability study based on a 500-day mission

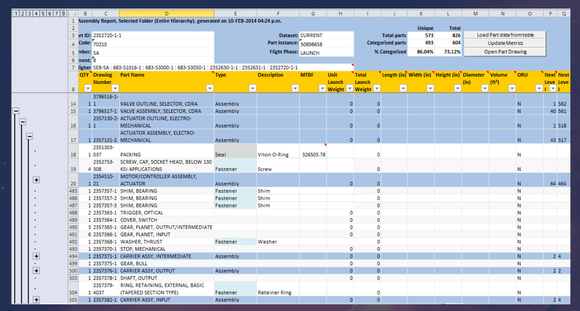


CDRA Hierarchy

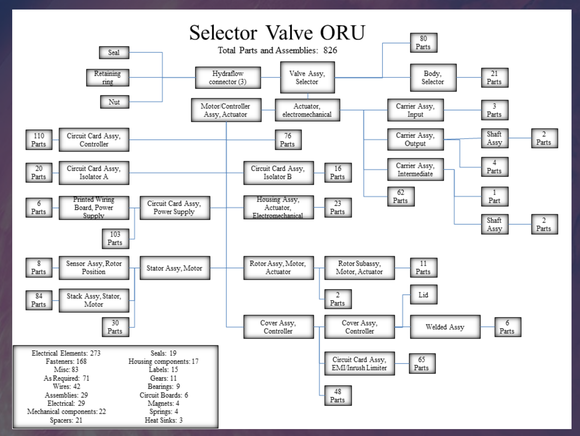
Approach

To develop a MEL below the ORU level, I used data from the space station Vehicle Master Database (VMDB) utilizing the "Search Parts, IPL Data, and Engineering Resources" (SPIDER) tool. SPIDER allows a user to find an assembly on the space station, and download a hierarchal spreadsheet of assemblies, parts, and drawing numbers. However this data lacks mass and MTBF values—these will need to be estimated separately.

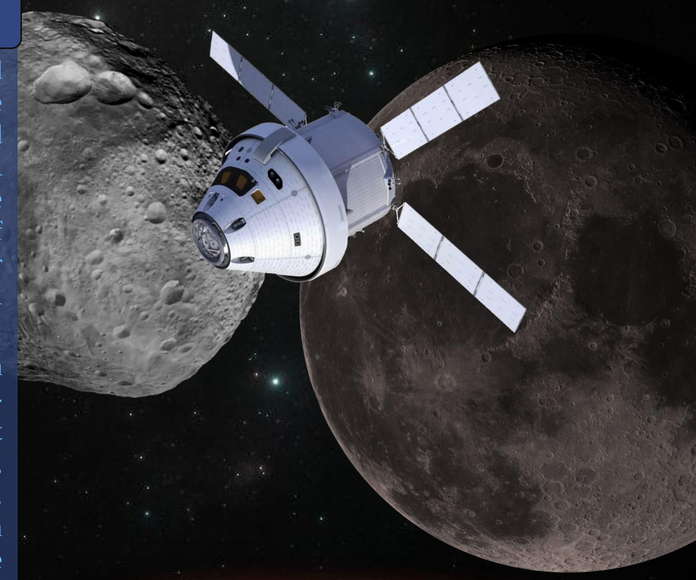
To make this data more useable, I am developing a Visual Basic program to put the data into an easier-to-read format, import mass and MTBF data about commonly used parts from a user-created catalog, and collect metrics and run calculations on the data. Such metrics include the number of parts in each category, the masses of each category, and the percentage breakdown. Non-commonly used parts will have to have this data manually input directly onto the MEL.



Selector Valve ORU MEL from SPIDER



Selector Valve ORU Hierarchy created from MEL



Future Plans

Because of the amount of data involved, this is an ambitious project which will be continued into the summer. Future steps include:

- Refining the Visual Basic program
- Improving ease of use
- Adding functionality to generate histograms from data
- Writing a user manual
- Continuing to collect and estimate mass and MTBF data
- Adding more entries to the commonly used parts catalog
- Completing the study once adequate data is available

Acknowledgements

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