

Higher Performance Subsystems
Higher Margins, Lower Life Cycle Costs

Space Propulsion Technology
Assessment Workshop

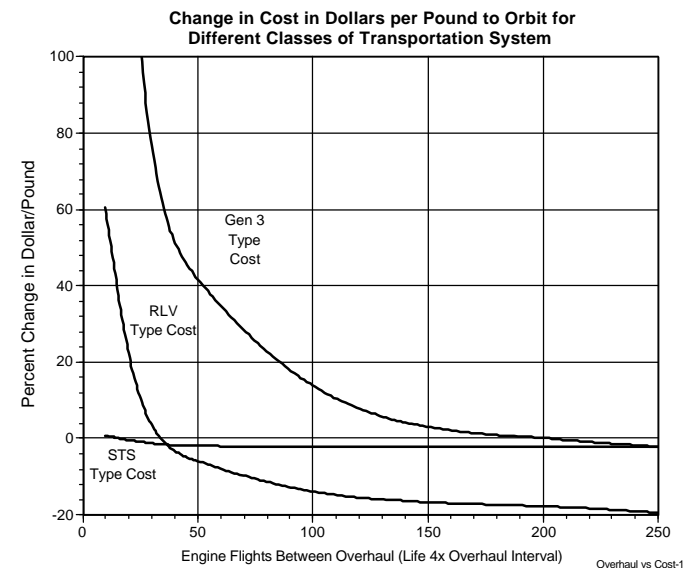
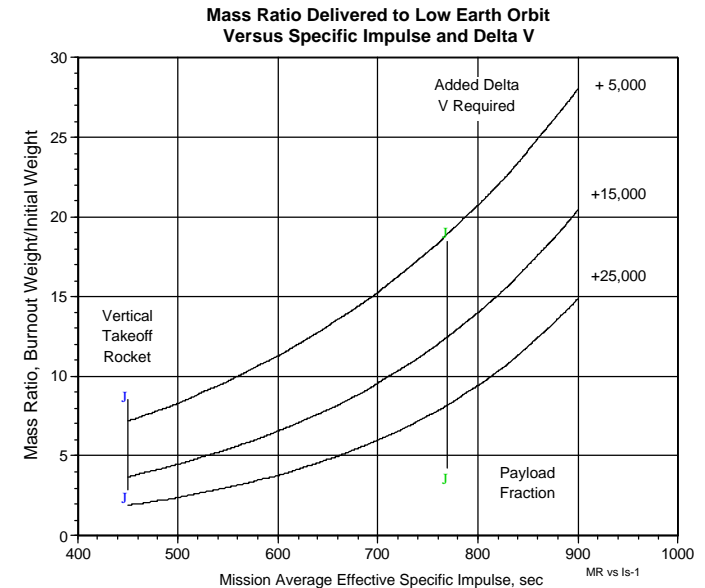
April 2001

Goal

Higher Performance Subsystems

Higher Margins, Lower Life Cycle Costs

- Higher performance means any net gain in specific impulse, engine life, lower operating, design, development, or production costs
 - Some technologies will improve some of these at the expense of others
- Goal is to have subsystems with higher performance
 - Higher specific impulse
 - More benign internal environments for the same specific impulse
 - Lower turbine temperatures
 - Lower pump pressures
 - These produce longer life and/or higher reliability or the margin to address development problems without compromising life
- Result is lower life cycle costs
 - More certain development
 - Longer overhaul intervals
 - Less maintenance

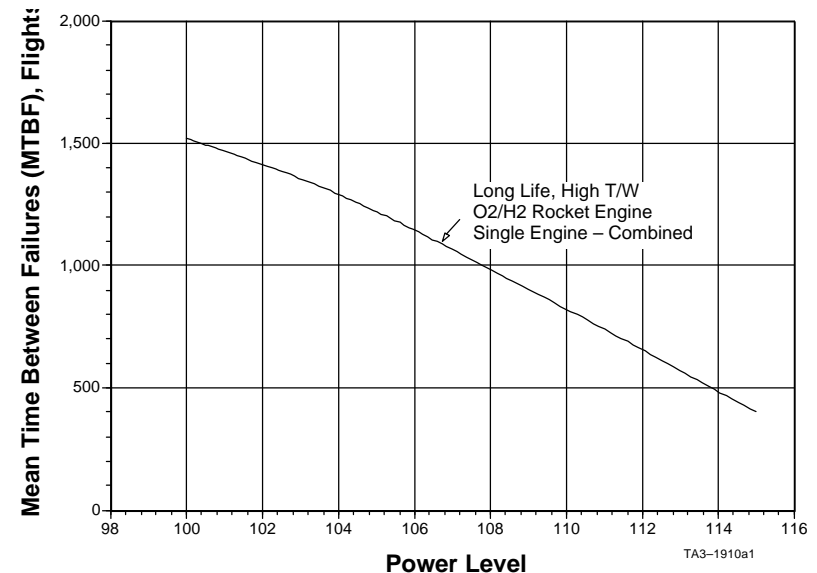
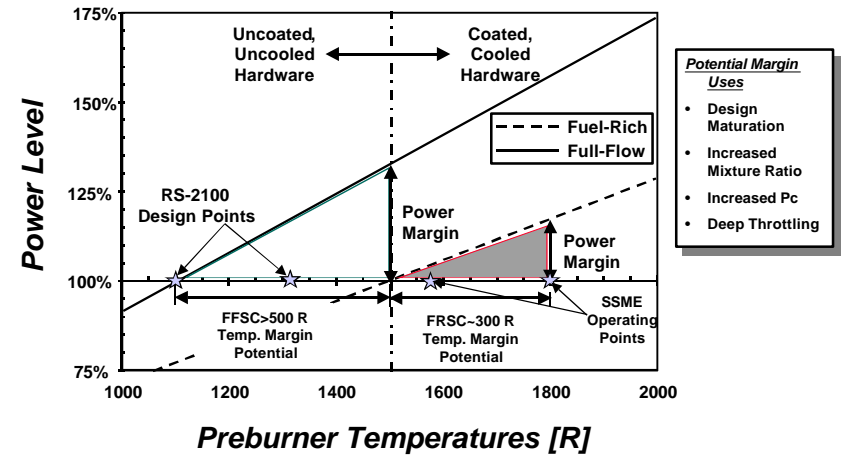


Potential Solutions

Higher Performance Subsystems

Higher Margins, Lower Life Cycle Costs

- Incorporate Lessons Learned from Past Engines
 - Failure Causes
 - Significant Number Thermally Induced
 - Design Fixes
- Design for Reliability and Robustness
 - Chose Cycle to Improve Margins and Reduce Failure Modes
 - Improves Life

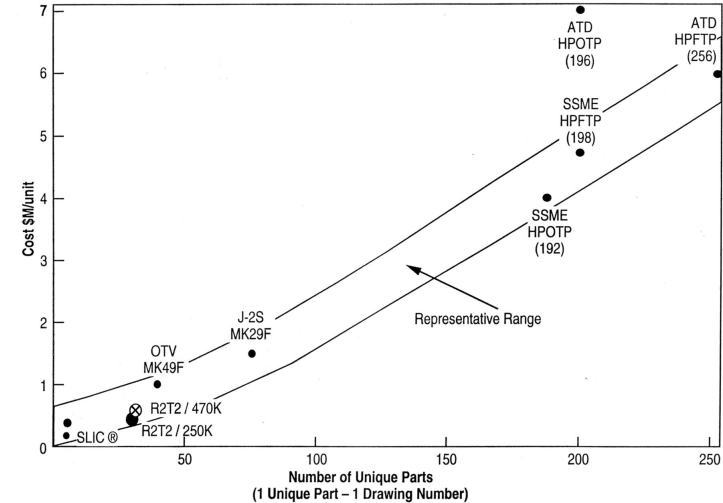


Potential Solutions (Cont'd)

Higher Performance Subsystems

Higher Margins, Lower Life Cycle Costs

- Design for Many Fewer Parts
 - IPD is demo for this type of turbopump
- Use Design to cost and other process improvements
- Test to Drive Out Failures (Engineering Confidence) Instead of Success Oriented Demonstrations (Statistical Confidence)
 - Early Focus on High Risk Areas
 - Complete Characterization of Operating Environment
 - Extensive Limits Testing Conducted at the Component Level
 - Early Introduction of HMS to Characterize HMS and to Preserve Test Assets



Technologies to Implement Solutions (TRLs)

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- Examples in MPS application
 - High Pressure Turbomachinery
 - Fluid Film Bearings
 - Low Temperatures
 - No Protective Coatings
 - Advanced Materials
 - Eliminate Seals and Purges
 - Main Combustion Chamber
 - Lower Wall Temperatures
 - Powerhead
 - Low Temperatures
 - System
 - Power Cycles for High Margins
 - Eliminate Purges and Fluid Systems
 - Eliminate Sheet Metal and Complexity

Cost to Mature Technology

Higher Performance Subsystems

Higher Margins, Lower Life Cycle Costs

\$100K	
\$500K	
\$1M	
\$5M	
\$10M	
\$30M	
\$50M	
\$100M	
\$500M	
\$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 such as EMAs and EHAs. The longer time is required for some of the less well defined technologies.