Establishing a Resilient Flagships Science Program

Francesco Bordi[*a], Debra L. Emmons[a], Mark Clampin[b], Stephen A Shinn[c], Robert E. Bitten[a]*
[a]The Aerospace Corporation, El Segundo, CA, USA 90245; [b]NASA Goddard Space Flight Center, Greenbelt, MD USA 20771; [c]NASA Headquarters, Washington, DC, USA 20546

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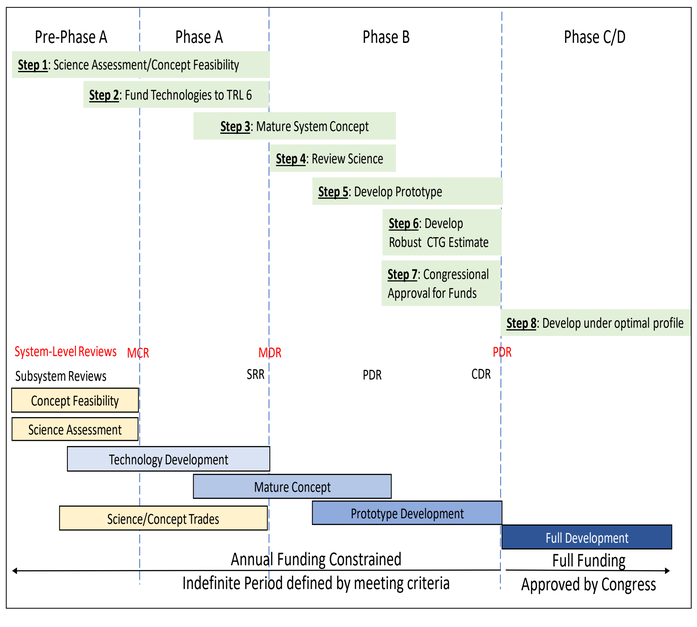
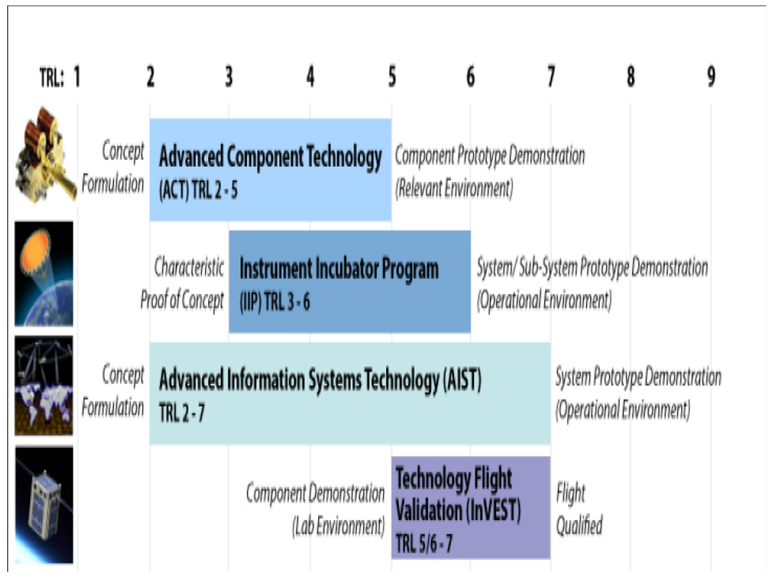
INTRODUCTION

We are at a crossroads today with large and complex missions, known as flagships: while much has been achieved to lower their size, weight, and power demands, there are science questions that cannot be answered but through the exquisite measurements characteristic of flagships. We need an approach to a resilient flagships program for science:
One, conduct an assessment of the fundamental science questions and concept feasibility study to define the core science requirements (those that, if not met, render the mission unnecessary), and the corresponding technology challenges.
Two, fund technologies to TRL 6, including systems engineering and system integration approaches, and also ways to determine the impact of science requirements on the mission concept (complexity, cost, schedule).
Three, mature the system concept prior to prototyping of manufacturing and test activities.
Four, review science requirements in light of systems level interactions that are driving complexity, cost and schedule, and re-scope accordingly.
Five, after the technology development is complete, develop a prototype of the system to resolve implementation issues.
Six, establish a not-to-exceed annual funding level that continues until a prototype is complete. As prototype development is nearing completion, provide a realistic estimate of the scope of remaining work.
Seven, obtain Congressional approval for all remaining development funds (similar to the approach for Navy capital ships).
Finally, develop and deploy the mission following an optimal funding profile.
When evaluating contracting approaches, it is important to contemplate a NASA Center serving as prime and evaluate contractors' abilities to execute one-off payload elements

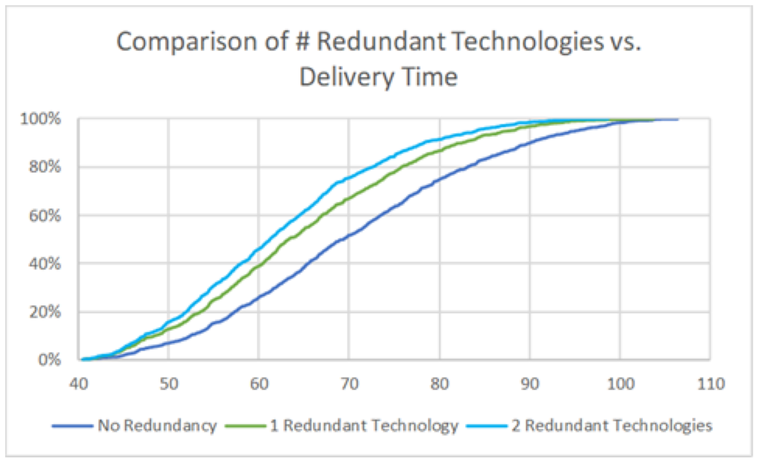


Proposed Approach to Developing and Funding Flagship Missions

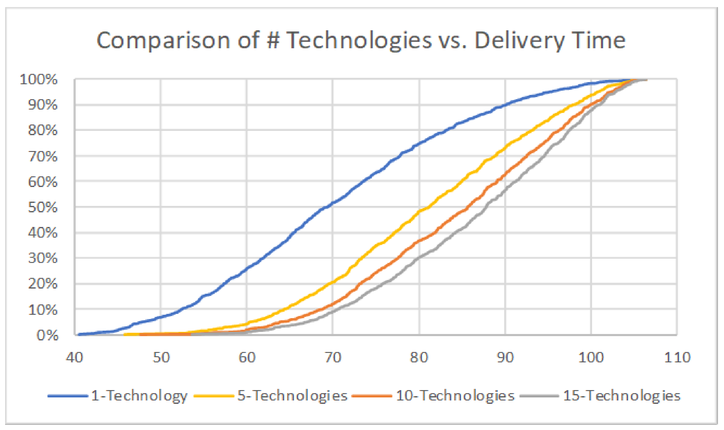
TECHNOLOGY DEVELOPMENT



TRL Ranges for Technology Development



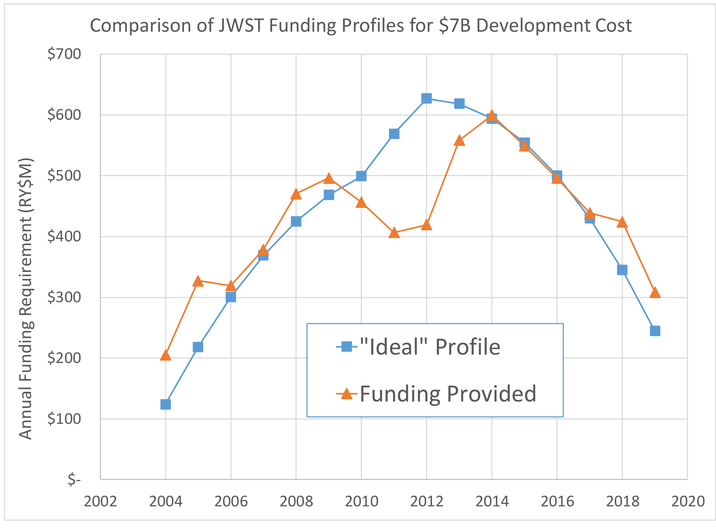
Impact on Delivery Time of having redundant technologies



Impact on Delivery Time of Multiple technologies needing Maturation

FUNDING PROFILE

An illustration of how the impact of the funding profile on the potential cost of JWST, The Aerospace Corporation presented an analysis that estimated an "ideal" funding profile vs. the actual funding profile made available to JWST based on historical funding profiles. The figure shows the results of the analysis and shows the significant decrease in funding after PDR that JWST experienced compared to the ideal funding profile that increases through CDR and into the first part of I&T. Based on other analysis conducted, the penalty associated with this reduced funding profile during time of need is on the order of $1B. This example demonstrates that it's imperative to establish a robust baseline estimate and to fund it relative to an optimal funding profile.



Comparison of Actual vs. Ideal Funding Profile

SUMMARY

Large flagship missions are necessary to achieve the exquisite science goals articulated in the National Academies Decadal Surveys. We have discussed here and approach to establish a resilient Flagship Program, the salient characteristic of which is an extended initial phase where a digital twin of the flagship is built and used to trade scientific requirements versus complexity (including mission integration), cost and schedule, and to establish a technical and programmatic baseline from which an optimal funding profile can be derived and established by the mission sponsors.