

SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Engineering - Methods, Processes and Tools (2) (4B)

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ON COMING IN UNDER BUDGET AND ON PERFORMANCE

Abstract

A key System Engineering activity during any new space system development is the initial allocation, and subsequent re-allocation of key development resources. Historically, development resources have been allocated initially via expert judgment, usually by the Program Manager and Lead System Engineer. As portions of the development use more resources than initially allocated, reallocation of development resources becomes necessary. Typically, unused resources are set aside for this purpose, in the form of margins or reserves. Resource reallocation has also historically been via expert judgment. The problem arises in that most often the development ends up some combination of late, over budget, and/or not meeting technical performance requirements. The expert judgment process of reallocating key development resources has not worked well. A new study of 26 NASA space science mission instrument set developments determined that the average development cost was 73.77% over initial allocation. A new study of 28 NASA space science mission spacecraft developments determined that the average development cost was 46.04% over initial allocation. Current space science developments massively over budget include James Web Space Telescope. Twice in the history of space system development, on the Cassini Saturn orbiter and on the Terra Earth orbiter, barter-based key development resource reallocation was tried, with spectacular results. Science instrument development resources, including money, mass, power and data rate were completely allocated to all 12 Cassini instrument developments. No margin or reserve was held back on any resource. At the end of the four year Cassini science instrument development, all 12 instruments completed development on time, with a net cost growth of +0.9%, and a net mass growth of -7%. A similar key development resource reallocation barter process was used during the Terra science instrument development, with similar results, i.e., almost no development cost or mass growth over initial allocations. A Netlogo agent-based simulation was developed to simulate barter-based key development resource reallocation. The simulation was applied to the Cassini historical example, and predicted the actual cost growth attained within 0.15%, and the actual mass growth within 0.264%. The agent-based simulation was then used to develop 300 mythical sets of science instruments. The simulations predicted a mean cost growth of -3.365%. A bivariate inference on the means was performed, showing that significant statistical evidence exists to support a claim that expected cost growth using barter-based key development resource reallocation is less than expected cost growth using the historical industry standard expert judgment process.