

Risk-based Approach for Estimating the Cost of New Technology

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SESSION: Technology Maturation, Transfer and Utilization

Estimating the cost of developing a new, advanced technology is inherently difficult. Herein, by new technology we define the technology to be sufficiently novel and break-through that there is little or no basis for cost estimation based on prior generation developments. For NASA, the success of mid- to far-term (launch 2010 to 2016 and beyond) complex space missions relies on making significant and effective up-front advanced technology investments now. The need for accurate cost projections is accentuated further in an environment of competition, changing capital budgeting constraints, rapid technological change and options not only for technology development investment but also for acquisition.

In a technology-driven mission enterprise, infusion of advanced enabling technologies yields a competitive advantage. Understanding the impact of new technologies on cost, schedule and mission risk is critical. Cost uncertainty reduces the credibility and sustainability of new technology programs and the likelihood of technology infusion into complex space missions. This in turn compromises future missions and the science return on technology investments.

We shall present the architecture and pilot implementation of a preliminary model for estimating the cost of maturing a new technology, beyond proof-of-concept. After proof-of-concept, we consider technology maturation to be synonymous with risk retirement. The cost estimation is based on an accepted and quantifiable level of technology maturation risk. The intent is also to use this cost model in trade studies using risk-based design (RBD). Understanding the cost structure of new technologies enables buying down risk with cost, and helps ensure that baselined technologies indeed are infused into flight.

The methodology to be presented consists of initially assessing the maturity level of the technology. For this, a Technology Infusion and Maturity Assessment (TIMA) is undertaken using the lifecycle risk management decision-support software tool – *Defect Detection and Prevention* (Cornford, SL, MS Feather, KA Hicks, IEEE 2001) developed for NASA space mission systems. The TIMA requires an understanding of a target (sub)system design in which the technology will be embedded. This same tool is being piloted for RBD in support of Mars Smart Lander and thus offers a consistent framework for the technology assessment and the transition into a given design.

The TIMA prescribes a set of risk retirement steps that can be selected based on available resources and on their considered effectiveness against principal risks at a given phase of the development. From this, a work breakdown structure (WBS) is established for the accepted level of residual risk and for a desired

functionality or utility (i.e. specified set of technology requirements). The proposed cost model is analogous to current financial engineering techniques and market portfolio analysis using time dependent stochastic (Wiener) processes and Monte Carlo simulation. Interdependencies between WBS elements in terms of risk and cost are modeling alternately by incorporating schedule risk.

Integration of this cost model with the technology assessment yields what we refer to as a risk-based WBS approach to estimating the cost of new technology maturation. The proposed cost model, together with a highly structured risk assessment, offers a very powerful approach. Results from a pilot of a compact holographic data storage technology, and technologies that are being considered for the Mars Smart Lander will be presented, along with plans for model validation.

Biographies

DM Tralli has an MBA in Technology Management from the Peter F. Drucker Center of the Claremont Graduate School, a PhD in Geophysics from the University of California at Berkeley and a B.S. in Physics from the University of Southern California. He has been with the Jet Propulsion Laboratory since 1986. Tralli is currently in the Systems Division as program architect for the Strategic Systems Technology Program of the Office of Chief Technologist. His areas of responsibility include systems technology development, infusion and risk-based design.

KA Hicks has a B.S. in Computer Science and Engineering from The University of Laverne. He has been with JPL since 1985 where his primary responsibility has been infusing new advanced technologies into flight projects. Hicks is currently a technologist in the Strategic Systems Technology Program Office where he is responsible for piloting new RBD tools and processes on ongoing tasks to determine their effectiveness.

G. Fox has a PhD in Applied Physics and Economics from the California Institute of Technology, and MS and BS in Mathematics also from the California Institute of Technology. He has been at the Jet Propulsion Laboratory since 1980. Fox is in the Cost/Risk and Systems Analysis Group of the Systems Division.

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