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Valuation of Technology Development using a Novel Workflow Approach to Compound Real Options

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The results of a technology infusion and maturity assessment (TIMA) are used to construct a workflow for development of a miniaturized sun sensor engineering model (EM). The work decomposition using a TIMA replaces a traditional work breakdown structure and consists of activities designed to retire identified risks to attaining the requirements of a targeted future mission. Discounted cash flow (DCF) analysis then provides the expected economic value of the planned development, with anticipated future cost savings compared to acquisition of commercially available units.

This same workflow is used for a strategic valuation by representing the EM development as a series of compound real options, capturing decisional flexibility from uncertainties in the targeted application and development domains of the technology. Compound options are options in which the underlying security (i.e. real asset herein) is another option. At each node in the workflow, a positive decision was implied to proceed to the next work element; from an options perspective however, the developer has the right but not the obligation to make the next investment. Under assumptions of zero volatility, the real options approach equates to decision tree analysis, hence characterization of workflow as an executed decision tree path within the TIMA. Using a Black-Scholes option pricing model, planned expenditures and work durations, their likelihoods of success and volatilities, and proxy net present value of future cash flows (i.e. cost savings) are modeled as lognormal or otherwise simple probability distribution functions. Volatility captures market influences over a given period of time. Here, volatility intends to encompass influences due to program management, human and organizational factors, specialized manufacturing and testing facilities availability and usage, competitive landscape, supplier/vendor relationships, mission readiness and other such factors beyond unique developmental risks.

This simple case study suggests where financial modeling might improve current processes and tools for technology risk management, infusion planning, and new technology cost estimation and program-level portfolio management. Noting the perspectives of a task or project manager (i.e. value investor) and a technology program manager (i.e. growth investor), total valuation allows for strategic decision-making with economic R&D planning and execution. While this is not the first application of real options in the NASA technology domain, it is the first attempt to drive valuation with workflow representing an optimum point on the cost-benefit Pareto front of TIMA development alternatives – where benefit is the aggregated percentage of targeted mission requirements attainment (i.e. measure of risk level). This approach could be used to explore the development trade space by incorporating strategic value into benefit. Results of Monte Carlo simulations are shown, including sensitivity analyses and characterization of uncertainty and volatility. The EM development is approximately $800K over two years. DCF and option values are expectedly dominated by assumptions of uncertainty; nonetheless, the latter preliminarily yields an overall value distribution that can exceed DCF by up to $40K in some cases, though typically is below $10K, for this relatively small development effort.