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NASA COST MANAGEMENT HEARING—SCOLESE TESTIMONY

Christopher Scolese

Ms. Chairwoman and Members of the Subcommittee, thank you for the opportunity to appear today to discuss NASA's progress in managing the cost and schedule of the Agency's projects. NASA missions have allowed us to rove the surface of other planets, to send people to live and work in space, to improve our understanding of the Universe, and to better understand our Earth. NASA recognizes the importance of delivering missions on cost and on schedule, and developing clear and stable baselines for planning. We strive to continually improve our tools to identify issues so we can implement corrective action. Today, my testimony will outline NASA's progress to date and the actions the Agency is taking to continue to improve its performance. We are pleased that the Government Accountability Office (GAO) recognizes our efforts to mitigate acquisition management risk and lay a foundation to improve project cost and schedule performance.

FEDERAL RESEARCH AND DEVELOPMENT ENVIRONMENT

As one of the Federal government's research and development (R&D) organizations, NASA functions in an environment where we must accept and manage considerable risk and uncertainty. NASA develops scientific instruments, spacecraft, and new launch systems that redefine state-of-the-art. The Agency strives to standardize and reuse systems and capabilities where feasible. However, where we endeavor to achieve the next goal, develop the next technology, and make the next discovery, we venture beyond the realm of past experience and into an environment of uncertainty and higher risk. This is just one of the facts of life in an aggressive and exciting R&D environment.

Let me take a moment to share some examples with you, partially because they are illuminating, and partially because they show why people really love working at NASA.

The International Space Station (ISS), permanently crewed since November 2000, is being built by over a dozen nations. The ISS already has the American *Destiny* and European *Columbus* science laboratories on board and, with the flight of STS-127 later this year, the Japanese *Kibo* laboratory will be complete. Upon its completion next year, the ISS will have a mass of over 900,000 pounds and be a world-class research center for conducting experiments in life and materials sciences; it will also serve as a training ground for long-duration human space missions. The ISS has repeatedly demonstrated the ability of nations to work together on complex projects: with Station components being designed and built in different countries,

many were actually assembled for the first time in orbit. Now, international crews are operating, repairing, and utilizing the ISS for the benefit of the world. This kind of cooperation is essential if we are to continue to expand our reach beyond our planet. Research results have already improved medical science here on Earth: as you probably know, experiments conducted aboard the Space Shuttle and the ISS have been useful in demonstrating techniques for the development of salmonella vaccines. The ISS Program represents unprecedented international cooperation on a peacetime task of immense technical complexity.

In the past five years, NASA has landed three vehicles on the surface of Mars – each without human intervention. The planning and on-board capabilities to avoid obstacles make these landings some of the most difficult accomplishments imaginable. Think of shooting a basketball from Washington, DC, and making a perfect shot through a basketball hoop located at in Los Angeles without hitting the rim, while the rim is moving. The discoveries made by these rovers and their companion orbiters have changed our view of Mars. We now know that, at one time, Mars was indeed a wet planet, and our vehicles have found ice on its surface. More mysteries remain to be unlocked. The Mars Science Laboratory (MSL) is the next in the series of missions to Mars. MSL is significantly more complex than its predecessors, as it builds upon the lessons and discoveries they made to address the next level of scientific questions. As a result, the MSL vehicle is much larger -- about the size of a Mini-Cooper -- than the Mars Rovers *Spirit* and *Opportunity* -- roughly the size of a coffee table -- so it requires a new type of landing system.

The Nation and the world benefit from NASA's breakthrough research in Earth science and technology on a daily basis. This legacy began in April 1960 when NASA launched the world's first environmental satellite. The focus then was to improve weather forecasts. Our focus now is much more challenging. NASA conducts a comprehensive research program to advance fundamental knowledge on the most important scientific questions on the global and regional integrated Earth system. NASA presently operates 15 on-orbit Earth science missions, making measurements ranging from precision sea level through atmospheric chemistry and composition, and winds through ocean color and land vegetation, as well as ice cover and surface temperature. NASA’s robust research and analysis develops outstanding scientific advances that improve climate projections and provide societal applications. NASA has six missions in formulation and development, and is pleased to have a first-ever National Research Council Decadal Survey for Earth science and applications that establishes NASA’s priorities for satellite missions to study changes in the Earth’s climate and environment. Achieving simultaneity of NASA's outstanding measurements is a major challenge for progress in understanding the changing climate, its interaction with life, and how human activities affect the environment.

As you can imagine, the NASA and Earth science communities are saddened at the loss of a key Earth science asset when the NASA Orbiting Carbon Observatory satellite failed to reach orbit last week following launch. NASA immediately convened a Mishap Investigation Board to determine the cause of the launch failure. In addition, we are assessing options for its replacement. Although rare, these kinds of events demonstrate the need for flexibility in NASA’s ongoing portfolio.

The scientific and technical results across NASA’s portfolio are substantial, and often extraordinary. However, as we push the performance envelope on several fronts, NASA’s specific cost and schedule performance has, indeed, been less than desired in the past. It is

NASA's responsibility to maximize the value of the American taxpayer's dollars. We already have some tools in place, but we also have plans to incorporate additional tools and make better use of existing tools and processes to improve our delivery of missions on cost and on schedule.

POTENTIAL CAUSES OF COST GROWTH AND SCHEDULE DELAY

NASA puts great effort into managing the environment of uncertainty that naturally surrounds a project. Some uncertainties are within the realm of the project's control. Proposers can be overly optimistic in their efforts to provide the most attractive package in a competition. The cost savings assumed based on the use of "heritage technology" for spacecraft or instruments can be over estimated. New technology development can ultimately be much more challenging than anticipated. Sometimes inadequate time is planned for early engineering efforts and refinement of requirements. These are all areas within project accountability and the majority of this statement outlines the steps NASA has taken to address these issues.

I would like to digress for a moment to add a bit of "ground truth" on cost or schedule variances. NASA focuses a great deal of effort on measuring variations from plans and responding to trend patterns reported in monthly Baseline Performance Reviews, and in program and project reviews. NASA's renewed emphasis on the use of various tools such as Earned Value Management also help provide indications of problems early enough to take corrective action.

Reports of apparent cost growth can be misleading. If one measures project cost or schedule from the very earliest conceptual phase, as compared to measuring cost after the preliminary design is complete, the project typically appears to have incurred significant growth. NASA commits to project cost and schedule estimates at the completion of the preliminary design phase when technology readiness is better understood, preliminary designs are complete, and partner arrangements and industrial base considerations are better understood. This information provides a much better basis for estimating cost and schedule. While useful and necessary for the initial planning phase of a mission, early estimates are, at best, educated guesses made with preliminary conceptual information. As an example, although there remains plenty of room for improvement in the case of MSL, one of these early conceptual estimates quoted in the press for MSL was not even an estimate produced by NASA.

Other events can occur that are not within the control of the project, but are typically under the control, and within the accountability, of the overall program or the Agency. Owing to other stresses in the host program, funding flexibility to address problems may be inadequate, there may be inadequate validation of cost and schedule assumptions, or performance on one project may negatively affect others. This last point needs clarification. Not all projects that adversely impact other projects are poor performers. Sometimes they are stellar performers. For example, because on- orbit lifetime of a mission is difficult to predict from afar, projects already in operation that extend well beyond the original planned operational life may require more funding, resulting in the need to obtain resources from other sources, often projects in development. As an example, the Spirit and Opportunity

Rovers on Mars were planned for approximately 3 months of operation, but are now past 5 years of operations and are still returning valuable data. NASA also tries to estimate these costs and control impacts by having a group of independent experts periodically review these extraordinary missions to assess their value and the likelihood that they will operate until the end of the projected budget horizon. However, who could have guessed that the Terra Earth Science mission -- approaching its 10th anniversary -- would operate over twice its design life, or that the Voyagers -- at over 30 years in space -- would still be operational outside of our solar system?

Of course, some events occur that are not under the control of the project or the Agency, although we take measures to mitigate the attendant risk. In the case of the Solar Dynamics Observatory, national launch manifest priorities -- not project performance -- resulted in delays of about a year, with the attendant cost growth. In the case of the Glory project -- a first-of-a-kind Earth science mission -- the mission experienced unexpected problems due to a loss of contractor expertise, which is illustrative of challenges in the aerospace industrial base. Simply put, the number of capable suppliers has substantially contracted and the demand is such that the skills of the remaining suppliers are difficult to maintain. Contributions from our international partners can be late. Launch vehicle delays or price increases have also had significant impacts. External changes in budget profiles, including the unavoidable impacts of Continuing Resolutions, can also occur. Out of the ten NASA projects in the GAO QuickLook Report that exceeded the Congressionally-mandated cost and schedule thresholds, approximately half did so as a result of external factors; some with limited solution options open to NASA.

In an effort to better understand the extent to which our performance has been impacted by events that are beyond the control of the project and program, we have initiated a study of NASA and Department of Defense projects with the objective of being able to quantitatively separate internal and external growth. This will enable the Agency to better compare the results of a project's detailed cost estimate with the results of analytical cost estimates based upon historical performance. NASA currently anticipates completing this study by the end of calendar year 2009. We will keep the Congress informed of our progress in evaluating these factors.

HISTORICAL COST AND SCHEDULE STUDIES

Over time, various NASA organizations have studied cost and schedule growth after the fact. Most of the studies were focused on a specific question, or measured cost or schedule from different points in a project's life cycle. Additionally, the individual research tasks utilized different data, methods, and approaches, and thus are not directly comparable.

To provide a proactive means to control costs, NASA has implemented monthly reviews -- using common data set requirements and consistent data and analyses that are centrally coordinated -- to produce results that are comparable from project to project and from year to year. It is this data that is now reported both internally to NASA and to the Administration and externally to the Congress. The January 2009 update to the GAO High-Risk Series notes a number of these changes that have improved NASA's standard reporting.

Additionally, NASA is using the research on historical cost and schedule performance to identify areas that need to be addressed with corrections to tools or processes. A number of changes have been initiated that address common issues such as optimism in cost estimates and schedules, inadequate identification of risks, and unrealistic assumptions on technology maturity, along with external issues such as instability in funding, launch vehicle issues, and the performance of partners.

STEPS ALREADY TAKEN

The Agency has undertaken a number of actions to address cost and schedule growth through modifications to NASA's project lifecycle. These actions are also noted in the NASA High-Risk Corrective Action Plan, which the Agency developed in recognition of the complexity and cross- functional nature of the issues identified in the GAO High-Risk Series. While NASA continues to address the issues outlined in the GAO High-Risk series, we were pleased that the January 2009 update to the series highlighted the efforts we have made to improve NASA acquisition management.

Some actions that NASA has taken relate to the definition of a project life cycle that is now used by all space flight projects. Examples include:

- The project life cycle has six phases that each space flight project now must address. This is a change from the past, where different types of projects followed different paths, so that comparisons were more difficult to make, and most importantly, progress across NASA was difficult to assess.
- To ensure that we have an unbiased assessment of project performance and plans, NASA has implemented the use of Standing Review Boards to evaluate the project at each key decision point in the project's life cycle. The Standing Review Boards are composed of discipline experts who are independent of the project being reviewed. The Boards provide the Agency with independent advice on project design implementation, manufacturing plans, cost and schedule planning, risks, and margins. This change helps address past performance issues related to optimism, inadequate evaluation of technology maturity, heritage assumptions, etc.
- NASA commits to the project content, cost, and schedule baseline only after successful completion of the Key Decision Point C (KDP-C). At that point in the lifecycle, following the completion of the Preliminary Design Review, project management has a more thorough understanding of the technological maturity, complexity, and risk associated with the project. As a number of risks have been retired by that point, and the implications of the project requirements are better understood, the baseline established at KDP-C provides a more meaningful basis for measuring cost and schedule performance. Several NASA research efforts confirm that the Agency's cost and schedule performance is better when measured from the KDP-C gate than when measured from the earlier milestones.

RECENT ACTIONS

In January 2009, NASA adopted a new acquisition strategy policy, which improves its ability to manage performance risk (including the adoption of probabilistic cost and schedule estimating methods). Among its features, the new policy requires space flight and information technology projects and programs to develop joint cost and schedule probabilistic estimates. Probabilistic estimating provides NASA with an approach that fully integrates technical, cost, and schedule plans and risks to develop both an understanding of the sensitivity of parameters to each other and the most likely estimate. Using this approach allows NASA to understand and document how the mitigation of technical risks would enable an increase in the project confidence level. Conversely, the introduction of a budget reduction would have the effect of increasing technical and schedule risks and thus lower the confidence level for the project. The use of probabilistic estimates also generates baseline values that include funding to address impacts associated with contingencies and uncertainties, such as industrial base, partner performance and technology optimism.

The introduction of probabilistic joint cost and schedule estimating puts NASA on the leading edge of applying these techniques in both the Federal and space sectors. Because this estimating approach requires the employment of new tools and techniques, full implementation will take some time to deploy; we are currently estimating at least two years to develop the tools, training, and understanding across the Agency. Given the deployment and the typical project development cycle of 3-5 years, it is unlikely that NASA will be able to evaluate the impact of these changes for a few more years. The recent GAO QuickLook Report underlines the fact that it takes time to realize the results from policy and process changes. Further, as we implement this joint confidence level policy, we are looking back at existing projects in development to ascertain risks and make adjustments where prudent to improve our cost and schedule posture.

As noted earlier in this testimony, there have been issues with the consistency of historical data used for various cost research studies. In another recent action, NASA has taken steps to improve and bring consistency to the cost and schedule data collection that is now included in the Cost Analysis Data Requirement documents. This effort is also part of the NASA High Risk Corrective Action Plan. These documents serve to collect data in a standard format to allow us to assess performance on current projects and to provide a reference for future activities. At this time, NASA has completed detailed documentation on 38 historical projects and has captured data from 90 KDPs on current projects.

NASA is committed to using our tools and processes to identify issues and take corrective actions to address those issues. The steps that we have taken to standardize our project lifecycle, to utilize Standing Review Boards to provide focused assessments at Key Decision Points, the renewed emphasis on tools such as Earned Value Management, the institution of strengthened acquisition planning and monthly reviews, and the use of joint cost and schedule confidence levels in our decision making, have all moved NASA along a path towards improving our delivery of projects on time and within budget.

CONCLUSION

In closing, cost and schedule estimation and performance are extremely important, and the Agency has taken a number of steps in recent years that have been acknowledged in the January 2009 update to the GAO High-Risk Series. We understand and support transparency and accountability in NASA project cost and schedule assessment.

NASA is dedicated to the continuous improvement of its acquisition management processes and performance. There are many improvement efforts already in place, and others are underway. From these, we have developed -- and will continue to develop -- significantly improved NASA processes yielding results now and in the years to come.

I would be happy to respond to any questions you or the other Members of the Subcommittee may have.