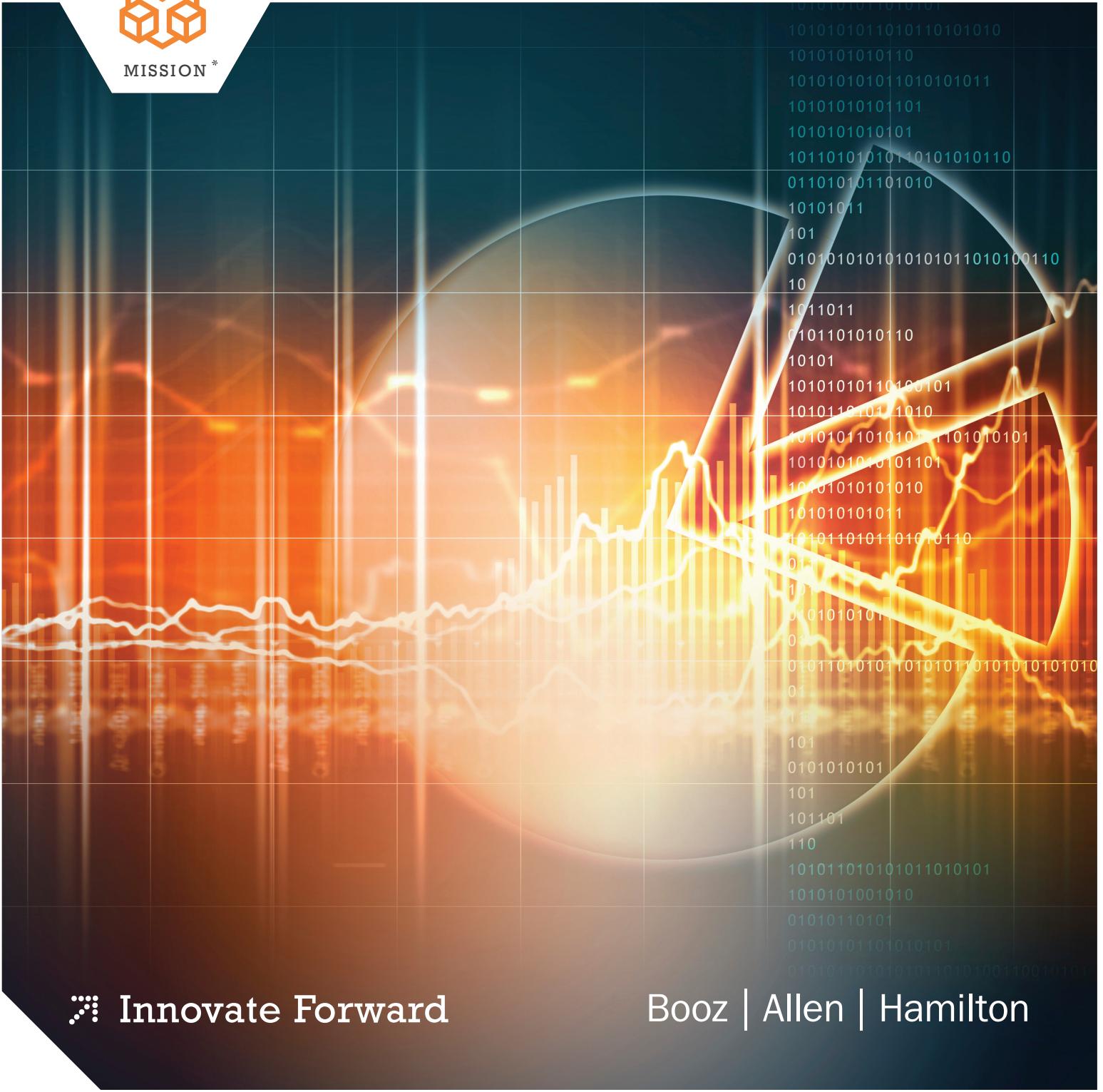


Analytical Program Management

Integrating Cost, Schedule, and Risk



MISSION *



Innovate Forward

Booz | Allen | Hamilton



One of the greatest challenges in managing complex programs is the lack of integration of schedules, budgets, cost estimates, and risk. Schedule growth almost always implies cost growth; cost growth almost always implies schedule growth; and risks identified as part of the risk management process often lead to cost and schedule growth. Despite the interconnection of these disciplines, it is rare when cost estimates, schedules, and risk registers become fully integrated artifacts.

Analytical Program Management (APM) is a methodology pioneered by Booz Allen Hamilton that fully integrates cost, schedule, and risk. We've apply this methodology to highly complex programs, such as NASA's James Webb Space Telescope (JWST) and Landsat Data Continuity Mission (LDCM). APM ensures a program has compatible artifacts and allows program managers to immediately determine the impacts of one area of growth on the other. In addition, because the cost estimate and risk register are fully integrated with the schedule, the secondary and tertiary effects of risks are revealed. This provides a far more complete view of critical risks that can affect a project's cost and schedule, and enables program managers to proactively manage those risks with an eye toward reducing cost and schedule growth.

Booz Allen's Monte Carlo simulation tool, Polaris™, calculates the risk-adjusted cost estimate and schedule, allowing program managers to create a budget for their programs using statistical confidence levels and identify the near-critical paths in the schedule that should be closely monitored. Polaris™ also identifies the lead sources

of cost and schedule risk allowing program managers to identify in real-time actions they can take—accelerating tasks, mitigating risks, or removing scope—to give their program the greatest opportunity to finish on-time and budget.

Booz Allen's Analytical Program Management Methodology

By combining standard program artifacts—such as an integrated master schedule (IMS), a risk register, and a cost estimate—into a single analytic model, APM removes the roadblocks for project integration. The IMS serves as the foundation for the APM analysis, with uncertainty bounds placed on activity durations. The uncertainty bounds identified within the cost estimate are connected to the IMS through a shared Work Breakdown Structure (WBS). The cost estimates should be an unbiased estimate of what the program will cost to complete and should include management reserves to cover potential risks. If the cost estimate was developed independently from the IMS, the budget may also be used. In this case, the cost estimate is likely to already contain the cost impacts of the schedule risk. The risk register is mapped to specific activities within the IMS. The combination of these three artifacts is what Polaris™ uses to create an integrated program analysis. Polaris™ combines cost and schedule risk analysis into a single, coherent output that visualizes the relationship between cost and schedule.

Exhibit 1 • APM Is an Integrated Analysis of Cost, Schedule, and Risk

Source: Booz Allen Hamilton

Polaris™ runs a cost-loaded, schedule-based, risk analysis simulation that accomplishes the following:

- Exposes the downstream effects of risks
- Enables risk-based management of subcontracts; mitigates cost growth from change orders
- Shows the probability that each task will appear on the critical path
- Reveals the range of potential costs for any schedule outcome and vice versa
- Empowers PMs to set reserves based on confidence levels
- Defends budgetary and scheduling decisions
- Predicts the impact of each task and risk on cost and schedule, including the secondary and tertiary risk impacts
- Facilitates PMs to immediately quantify the cost and schedule impacts of scope or requirements changes

The Impact of Polaris™ on APM

One of the challenges in performing integrated cost and schedule risk analysis is the time required to run simulations. Industry-standard risk analysis tools have run-times of minutes or hours, prohibiting their use as

real-time decision-making models because they cannot be rerun during meetings.

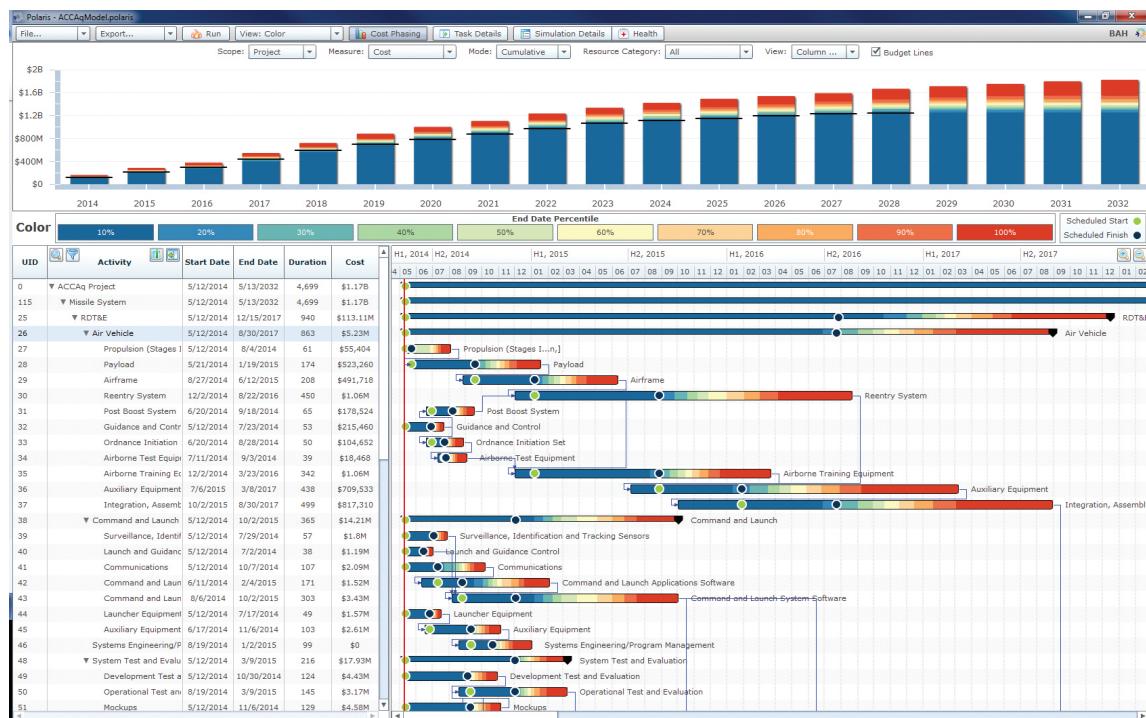
Polaris™ is a new software tool for performing APM, and was built to address user issues with the industry-standard tools. In particular, Polaris™ seeks to achieve the following goals:

- **Improved Software Runtime Performance.** Ensures that program managers do not need to plan around the software's performance
- **Simplicity.** Streamlines sophisticated analysis into easy-to-perform functions
- **Learnability.** Guarantees new users can easily learn the interface for rapid analysis

Analyses are no longer performed and viewed separately, but rather are integrated and optimized. This opens the lines of communication among cost, schedule, and risk management staff by providing a common dashboard for analysis. The result is better estimating and program management. APM also differs from traditional risk analysis by ranking risks based on their quantified impacts on the projects through simulation, as opposed to a likelihood multiplied by a consequence factor.



Exhibit 2 • Polaris™ Calculates Probabilistic Cost and Schedule Estimates



Source: Booz Allen Hamilton

Exhibit 3 • Polaris™ Uses Rapid Monte Carlo Simulation to Analyze All Programmatic Outcomes



Source: Booz Allen Hamilton

NASA's James Webb Space Telescope—A New Generation of Space-based Observation



Source: www.NASA.gov

Case Study: James Webb Space Telescope

Better Software Performance Improves Analysis and Decision-Making Ability

NASA deployed Polaris™ across the organization for any NASA analyst to use on any program. In one example, Booz Allen Hamilton assisted NASA with Polaris™ to support creating risk-adjusted cost and schedule estimates for the James Webb Space Telescope (JWST), NASA's flagship science program. Booz Allen worked with NASA to develop the program's first integrated schedule, overlaid with costs and a quantified risk register, which was analyzed using APM techniques. The Polaris™ engine could re-run the model instantaneously, which provided substantial flexibility in exploring scenarios for program planning. The analysts could run models live in meetings, and this unprecedented responsiveness prevented delays in review and decision making by Congress.

Conclusion

APM provides a first of its kind—a structured framework for integrating cost estimates, schedules, and risk registers. This analysis ensures that these artifacts are compatible and result in a cohesive analysis. When APM is applied with Polaris™, program managers can rapidly consider various actions to ensure their programs fit within a constrained budget and schedule. This type of analysis is mandated by policy for NASA budgeting and planning, but it is quickly gaining traction in areas such as defense, aerospace, shipbuilding, oil and gas, mining, construction, and other industries that require cutting-edge estimating tools and techniques.

APM provides a first of its kind—a structured framework for integrating cost estimates, schedules, and risk registers.

About the Authors

Eric Druker has 8 years of experience performing cost and schedule risk analysis for a varied range of DoD, Intelligence, and Civilian agencies. He is currently employed as a Senior Associate with Booz Allen's Strategic Innovation Group leading the firm's RealTime Analytics modeling and simulation capability. Eric has twice been named National Cost Estimator/Analyst of the Year (for Technical Achievement—2009 and Education—2013) by the International Cost Estimating & Analysis Association (ICEAA). As an author of over a dozen industry papers, including two best paper awards, he is an internationally recognized expert in cost estimating and risk analysis and has been a invited speaker or panelist at conferences including, but not limited to, Department of Defense Cost Analysis Symposium (DoDCAS), Naval Postgraduate School's Acquisition Research Symposium (NPS-ARS), Space Systems Cost Analysis Group (SSCAG) Meeting, Australian Department of Defence Cost Analysis Symposium and NASA's Project Management Challenge. Eric's works are also cited in the GAO's Cost Estimating & Assessment Best Practices guide.

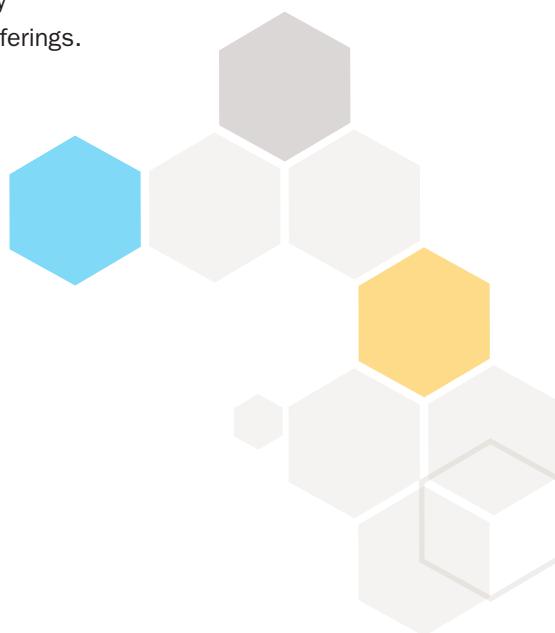
Graham Gilmer is a member of the Booz Allen Hamilton's Analytic Tools team in Washington D.C.—a leading provider of decision support software for the firm's Federal and Commercial clients. He has nearly a decade of experience supporting the Department of Defense and other US Government agencies. Graham graduated from Stanford University with a Bachelor's of Science in Management Science and Engineering, and his background includes experience in Operations Research, Portfolio Management, and Modeling & Simulation. He has been one of the team leads for the firm's RealTime Analytics service offering, generating the Polaris™ and Argo™ software tools prevalent on dozens of engagements across the firm. He has also been heavily involved in the development of Helios™, the firm's next-generation systems engineering and program management platform. Graham was a 2009 Booz Allen Excellence Award winner for Innovation for his modeling work on the US Navy Design for Affordability engagement, as well as a 2012 BEA finalist for the RealTime Analytics suite of offerings.

Eric Druker

Senior Associate
druker_eric@bah.com
314-368-5850

Graham Gilmer

Senior Associate
gilmer_graham@bah.com
202-898-3385





MISSION *

Principal Offices

Huntsville, Alabama	Red Bank, New Jersey
Montgomery, Alabama	New York, New York
Sierra Vista, Arizona	Rome, New York
Los Angeles, California	Fayetteville, North Carolina
San Diego, California	Cleveland, Ohio
San Francisco, California	Dayton, Ohio
Colorado Springs, Colorado	Philadelphia, Pennsylvania
Denver, Colorado	Charleston, South Carolina
District of Columbia	Houston, Texas
Pensacola, Florida	San Antonio, Texas
Sarasota, Florida	Abu Dhabi, United Arab Emirates
Tampa, Florida	Alexandria, Virginia
Atlanta, Georgia	Arlington, Virginia
Honolulu, Hawaii	Chantilly, Virginia
O'Fallon, Illinois	Charlottesville, Virginia
Indianapolis, Indiana	Falls Church, Virginia
Leavenworth, Kansas	Herndon, Virginia
Radcliff, Kentucky	McLean, Virginia
Aberdeen, Maryland	Norfolk, Virginia
Annapolis Junction, Maryland	Stafford, Virginia
Lexington Park, Maryland	Seattle, Washington
Linthicum, Maryland	
Rockville, Maryland	
Troy, Michigan	
Kansas City, Missouri	
Omaha, Nebraska	

The most complete, recent list of offices and their addresses and telephone numbers can be found on www.boozallen.com

About Booz Allen

Booz Allen Hamilton has been at the forefront of strategy and technology consulting for nearly a century. Today, Booz Allen is a leading provider of management consulting, technology, and engineering services to the US government in defense, intelligence, and civil markets, and to major corporations, institutions, and not-for-profit organizations. In the commercial sector, the firm focuses on leveraging its existing expertise for clients in the financial services, healthcare, and energy markets, and to international clients in the Middle East. Booz Allen offers clients deep functional knowledge spanning consulting, mission operations, technology, and engineering—which it combines with specialized expertise in clients' mission and domain areas to help solve their toughest problems.

The firm's management consulting heritage is the basis for its unique collaborative culture and operating model, enabling Booz Allen to anticipate needs and opportunities, rapidly deploy talent and resources, and deliver enduring results. By combining a consultant's problem-solving orientation with deep technical knowledge and strong execution, Booz Allen helps clients achieve success in their most critical missions—as evidenced by the firm's many client relationships that span decades. Booz Allen helps shape thinking and prepare for future developments in areas of national importance, including cybersecurity, homeland security, healthcare, and information technology.

Booz Allen is headquartered in McLean, Virginia, employs more than 23,000 people, and had revenue of \$5.76 billion for the 12 months ended March 31, 2013. For over a decade, Booz Allen's high standing as a business and an employer has been recognized by dozens of organizations and publications, including *Fortune*, *Working Mother*, *G.I. Jobs*, and *DiversityInc*. More information is available at www.boozallen.com. (NYSE: BAH)

Booz | Allen | Hamilton