

Analytical Program Management: Integrating Cost, Schedule, and Risk



Analytical Program Management (APM) Outline

- ▶ Integration of Cost, Schedule, and Risk Management Activities
- ▶ NASA's Approach to Analytical Program Management
- ▶ What goes into APM Analysis?
- ▶ Questions Addressed by APM
- ▶ Analytical Program Management Modeling
- ▶ Actionable Analysis and Insights Provided by APM Modeling
- ▶ Demonstration of APM Modeling

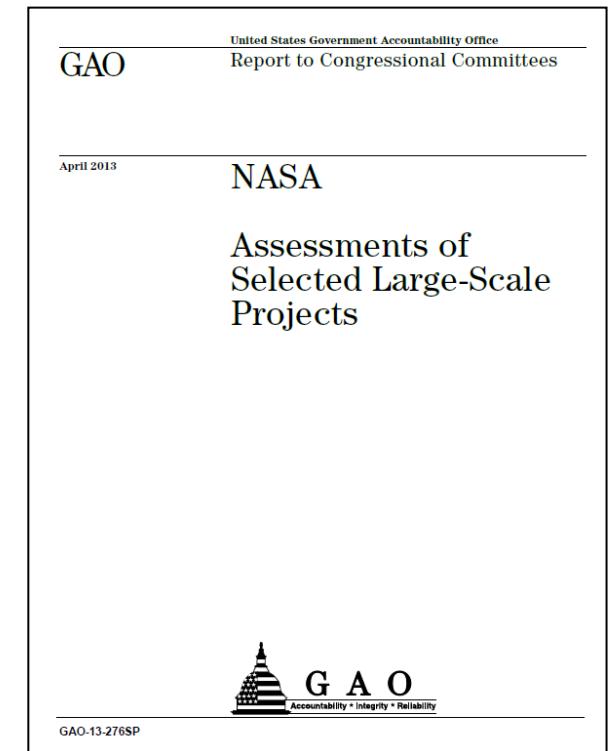
Cost, Schedule and Risk Activities Are Rarely Integrated on Programs

- ▶ Cost, schedule and risk management activities are typically not integrated on programs; oftentimes these teams have little interaction outside of program reviews
- ▶ This lack of integration has tangible consequences
 - When cost growth is identified, it almost always implies schedule growth
 - When the schedule growth is identified, it almost always implies cost growth
 - When risks are identified, they almost always imply both cost and schedule growth
 - *Program managers lose their opportunity to mitigate cost and schedule growth when these functions aren't integrated*
- ▶ The lack of tools for producing integrated artifacts has stood for years as a roadblock for integration
- ▶ Analytical Program Management (APM) provides a framework for integrating cost, schedule and risk using *existing artifacts* to produce a cohesive analysis

APM produces actionable analysis allowing PMs to proactively manage cost and schedule

NASA's Approach to Analytical Program Management

- ▶ Integrated cost/schedule estimation has gained significant momentum recently
 - NASA is leading the way in the development of this methodology, which they have labeled Joint Confidence Level (JCL) Analysis
 - NASA Policy Directive mandates that programs are baselined at the “70 percent confidence level” using a “joint cost and schedule probability distribution”¹
 - The goal was to provide stronger assurance that NASA can meet cost and schedule targets²
 - A recent GAO report cites the dramatic effects of NASA’s policy stating “Average development cost growth and schedule delay for the current portfolio have decreased to about a third of their 2009 level.”³
- ▶ While the methodology has made substantial strides, the cost and schedule communities must overcome political and technical obstacles before full adoption



¹ – NPD 1000.5 - <http://www.hq.nasa.gov/office/codeq/doctree/10005.htm> - January 15, 2009

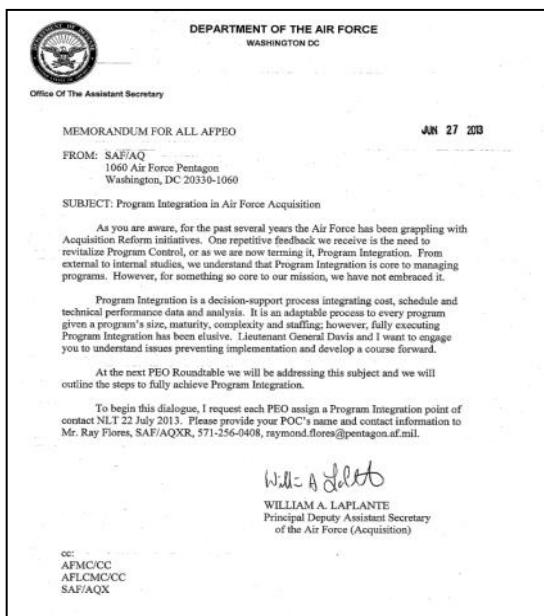
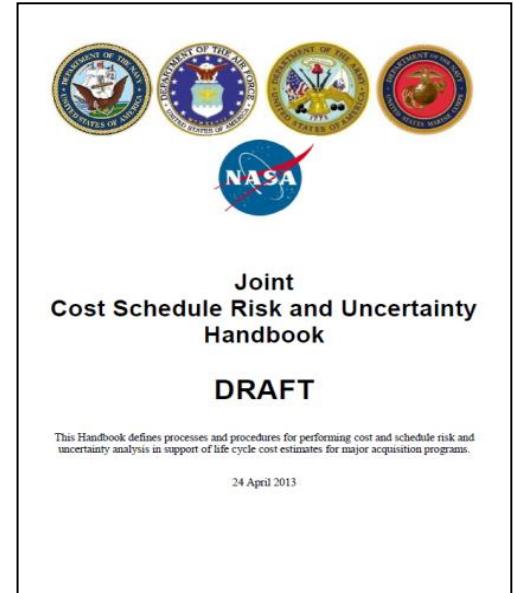
² – JCL Status Report - http://www.nasa.gov/pdf/421542main_JCL%20Status%20Report-2010%20Feb.pdf – February 2010

³ – GAO Report – “NASA – Assessments of Selected Large-Scale Projects” - <http://www.gao.gov/products/GAO-13-276SP> - April 2013



Movement by DoD to Integrate Cost, Schedule, and Risk

- ▶ Various programs from each Service have shown independent efforts to perform APM / JCL analysis, but so far no policy or guidelines have emerged to mandate the approach
- ▶ In 2013, the Naval Center for Cost Analysis (NCCA) led the publication of the Draft *Joint Cost Schedule Risk and Uncertainty Handbook*, which provides basic approaches and recommendations for APM / JCL

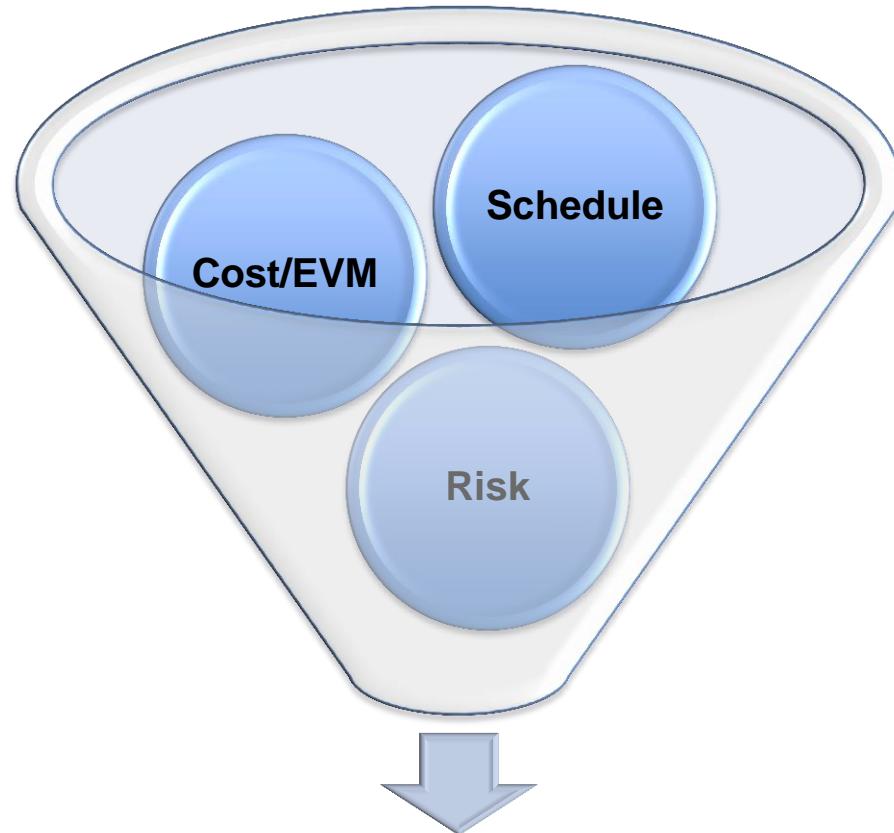


- ▶ Additionally, the Air Force has released a memo initiating a PEO roundtable for a decision-support process around “Program Integration” of cost, schedule, and technical performance

What Goes Into Analytical Program Management?

- ▶ Polaris analysis is performed by existing program staff using the following artifacts
- ▶ The ***program schedule*** (IMS or higher-level schedule) with uncertainty bounds on task durations
 - Program schedule is the backbone to which cost and uncertainty/risk are applied
 - Uncertainty bounds can be applied at the parent or child level and informed by EVM data
- ▶ The ***cost estimate*** with uncertainty bounds that map to the schedule at any level
- ▶ The ***quantified risk register*** (probabilities, cost and schedule impacts) where each risk is mapped to a task in the IMS

Polaris uses existing program artifacts or acts as a catalyst for their production



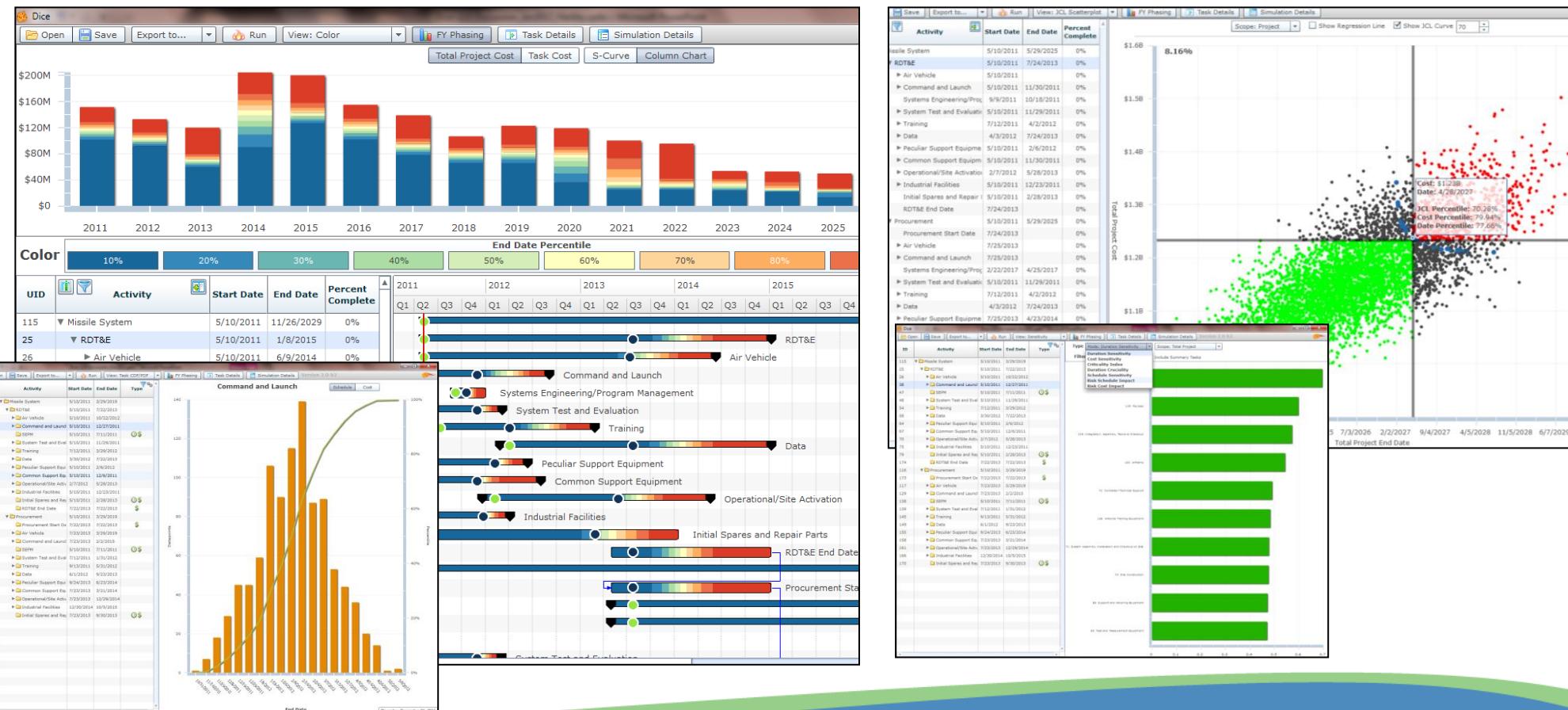
Integrated Program
Analysis

Questions Addressed by Analytical Program Management

- ▶ What risks have the greatest effect on my cost and schedule?
 - What are the primary, secondary, tertiary...impacts of these risks?
 - What is my optimal mitigation strategy and how much will it decrease my cost and schedule risk?
- ▶ How will schedule growth impact my costs? How will cost growth impact my schedule?
 - What are my potential critical paths?
 - How can I manage the cost impacts of change orders on contracts/subcontracts?
- ▶ How much management reserve do I need, where do I need it, and in what years?
- ▶ What action can I take to reduce cost and schedule risk?
- ▶ How can I best manage my portfolio of programs? Which combination has the best chance of providing maximum capability on time and on cost?

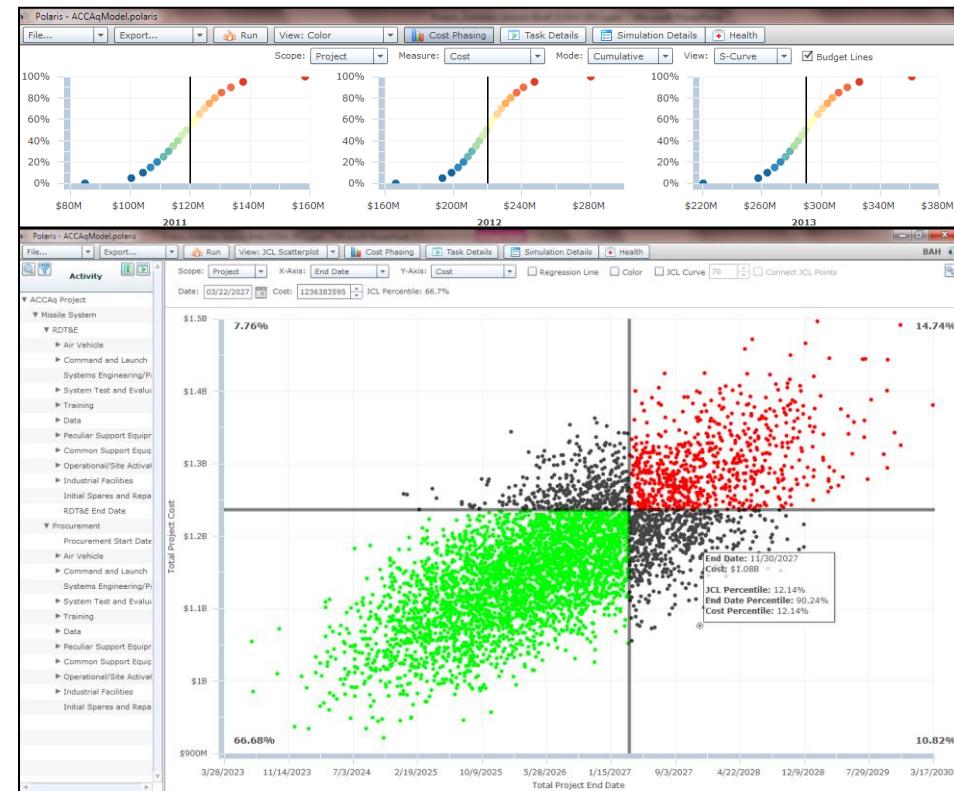
Analytical Program Management Modeling

- ▶ Booz Allen collaborated with NASA to build a standardized process and tool
 - The result is an Adobe Flex-based decision tool called “Polaris”, which integrates cost, schedule, and risk artifacts



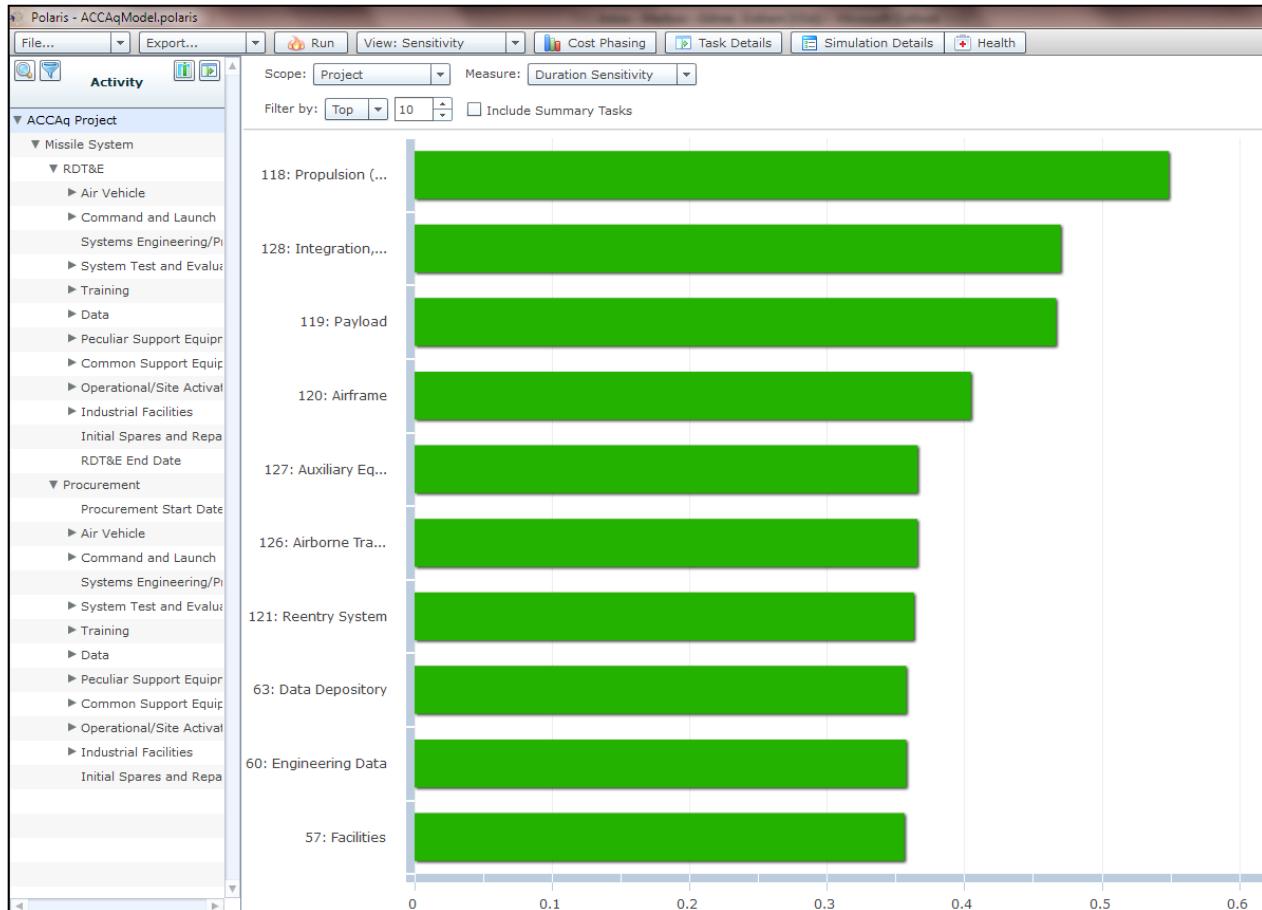
APM Provides Unparalleled Insight Into the Relationships Between Cost, Schedule and Risk

- ▶ Modeling provides a range of potential cost and schedule outcomes
 - Includes range of costs by year
- ▶ Allows PMs to set reserves based on *confidence levels* – required by DoD/IC/NASA
- ▶ Shows relationship between cost and schedule
 - Reveals the range of potential costs for any schedule outcome and vice versa
- ▶ All analysis is provided at every level of cost and schedule
 - Enables risk-based management of subcontracts; mitigates cost growth from change orders
- ▶ Standardized outputs allows combination of multiple programs into a portfolio-based analysis

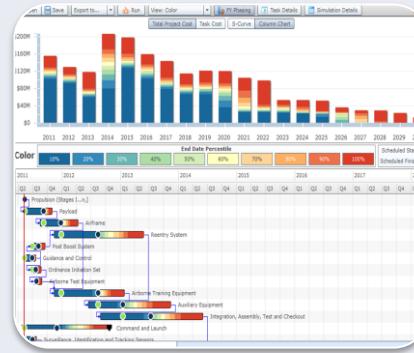
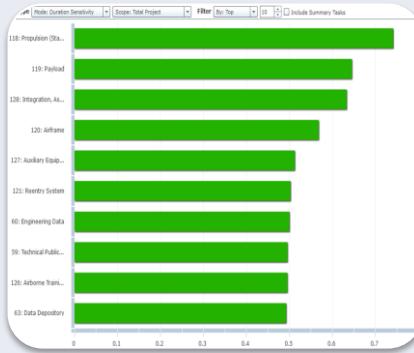
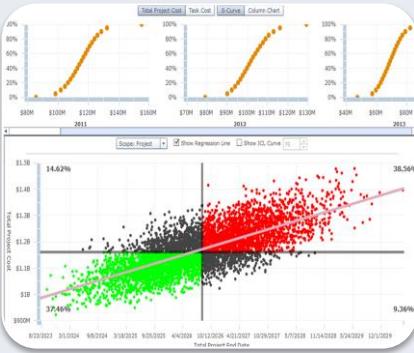
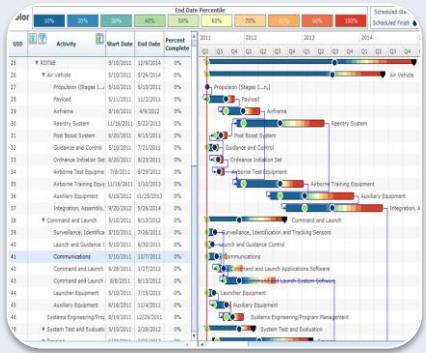


APM Provides Actionable Analysis Used to Prevent Cost and Schedule Growth

- ▶ Most risk management methods use a simple likelihood x impact metric to rank risks
 - This ignores downstream risk effects
- ▶ APM reveals the impact of each task and risk on cost and schedule
 - ...including secondary and tertiary risk impacts
 - E.g.: risks creating a new critical path or causing standing-army cost impacts elsewhere in the schedule
- ▶ Modeling also shows a probabilistic critical path
 - Shows the probability that each task ends up on the critical path



APM Provides Quality Insights and Analysis



Schedule Risk Analysis

- APM modeling includes schedule health check and schedule risk analysis features with industry leading run-times
- APM calculates the probabilistic critical path, providing insight into potential program choke points

Integrated Cost & Schedule Risk Analysis

- APM integrates schedules, cost estimates and risk registers into a single analysis
- APM quantifies the relationship between cost and schedule revealing the cost impacts of schedule growth and vice versa

Analytical Program Management

- APM performs real-time scope and requirements trade-off analysis allowing managers to design an architecture that fits into a constrained budget
- APM identifies lead sources of cost and schedule risk

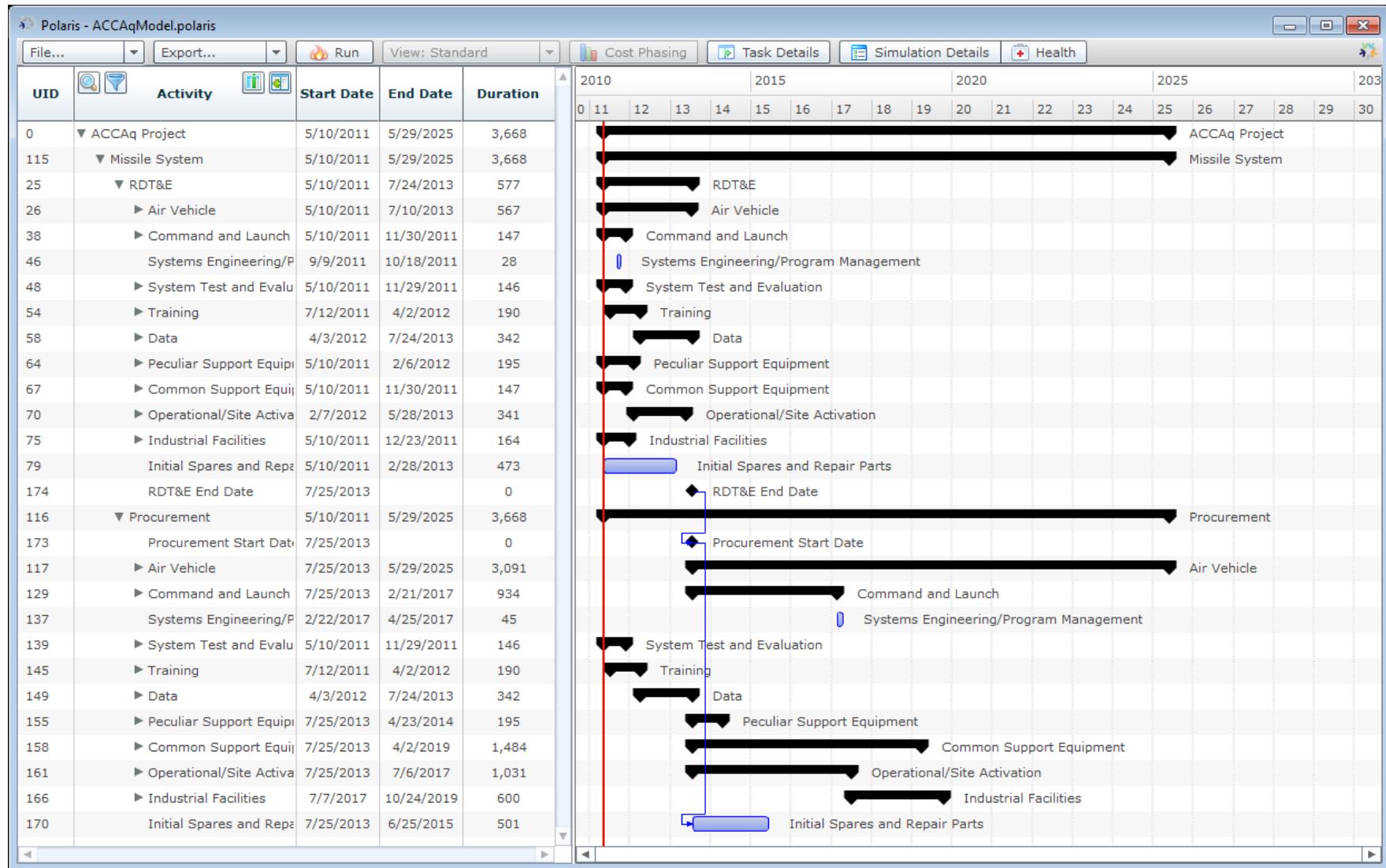
Portfolio Optimization

- APM looks across a portfolio of programs and allows real-time capability/program trade-off analysis enabling decision makers to quickly optimize their portfolio to provide maximum capability within a constrained budget

Demonstration of APM Modeling

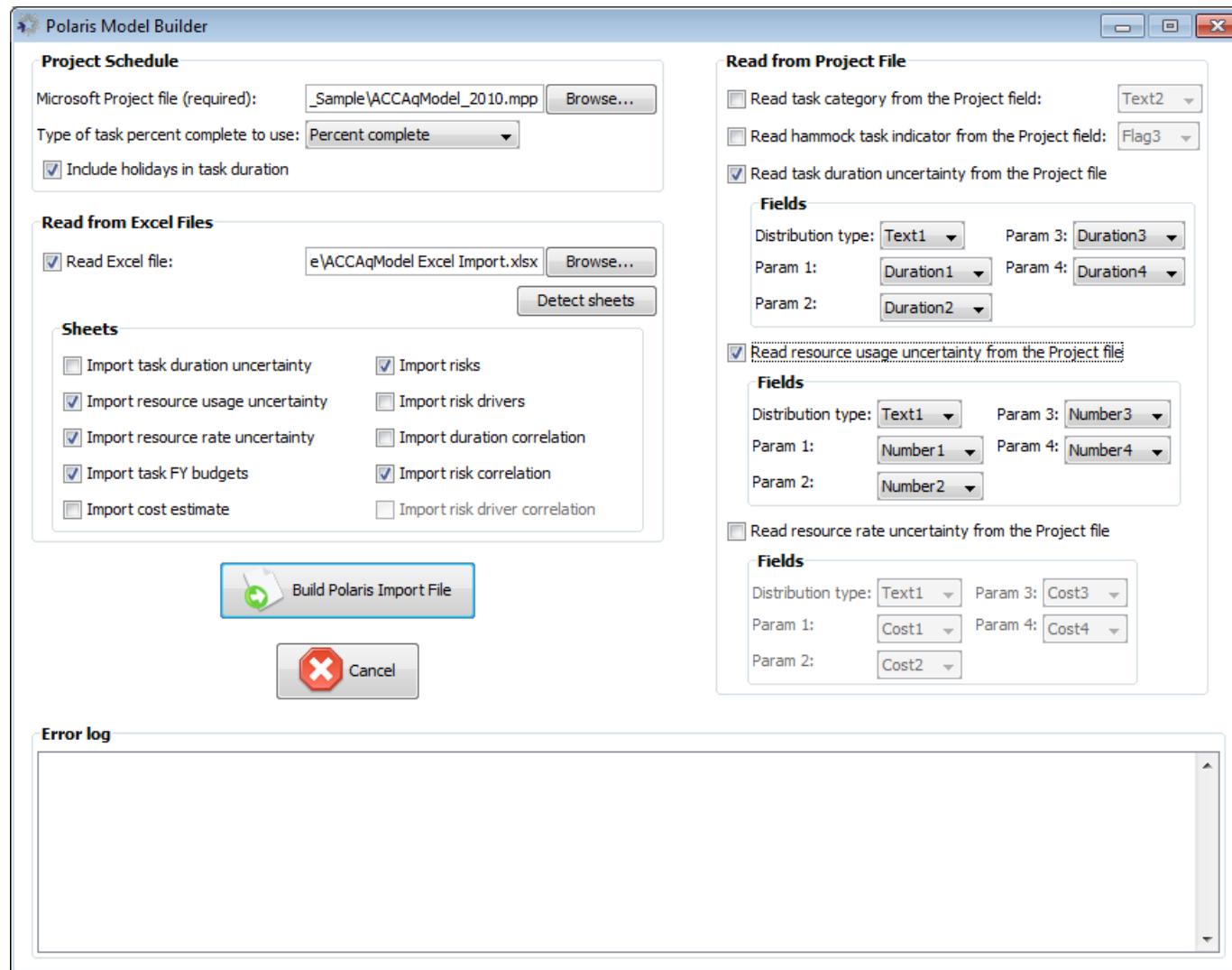
Initial View

- ▶ Analysis is schedule-based, begins with a Gantt chart environment



Data Import

- Quick import of schedule, cost, and risk data from Microsoft Project and Excel



Entering Uncertainty

- Schedule and cost uncertainty can be entered in Project, Excel, or the model

Polaris - ACCAqModel.polaris

File... Export... Run View: Standard Cost Phasing Task Details Simulation Details Health

Task Details: Propulsion (Stages I...n,)

Uncertainty Info Budget

Task Constraint

Work days per week: 5

Constraint Type: As Soon As Possible

Duration Uncertainty

Triangular - Min:7 Mode:9 Max:14

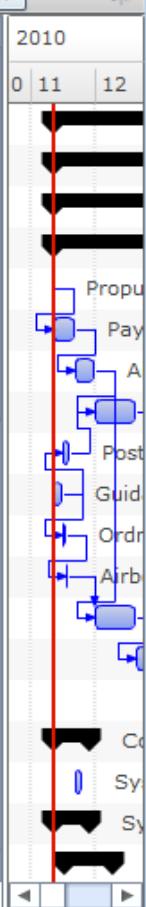
Resource Utilizations

Uniform - Min:80 Max:130 Resource: D_FTE

Planned: 10
Uncertainty Type: Uniform
Min: 80
Max: 130
Resource: D_FTE
Phasing: Uniform

UID	Activity	Start Date	End Date	Duration
0	ACCAq Project	5/10/2011	5/29/2025	3,668
115	Missile System	5/10/2011	5/29/2025	3,668
25	RDT&E	5/10/2011	7/24/2013	577
26	Air Vehicle	5/10/2011	7/10/2013	567
27	Propulsion (Stages I)	5/10/2011	5/10/2011	1
28	Payload	5/11/2011	9/6/2011	85
29	Airframe	9/7/2011	12/23/2011	78
30	Reentry System	12/26/2011	8/14/2012	167
31	Post Boost System	6/28/2011	8/5/2011	29
32	Guidance and Contr	5/10/2011	6/27/2011	35
33	Ordnance Initiation	6/28/2011	7/20/2011	17
34	Airborne Test Equip	7/21/2011	7/25/2011	3
35	Airborne Training Eq	12/26/2011	8/14/2012	167
36	Auxiliary Equipment	8/15/2012	1/15/2013	110
37	Integration, Assemb	1/16/2013	7/10/2013	126
38	Command and Launch	5/10/2011	11/30/2011	147
46	Systems Engineering/P	9/9/2011	10/18/2011	28
48	System Test and Evalu	5/10/2011	11/29/2011	146
54	Training	7/12/2011	4/2/2012	190

2010
0 11 12



Risk Register

- ▶ Import a complete risk register from Excel or add and edit risks within the tool

Screenshot of the Polaris - ACCAqModel.polaris software interface, showing the Risk Editor and Risk Impact Editor.

Risk Editor:

UID	Risk Name	Probability of Occurrence	Description	Enabled
1	J2-X Engine Development	50%	If the J2-X engine does not pass acoustic testing then additional develc	<input checked="" type="checkbox"/>
2	Coms System Development	75%	If the coms system interferes with guidance and control then additiona	<input checked="" type="checkbox"/>
3	Rentry System Redesign	40%		<input checked="" type="checkbox"/>
4	Software Potential Growth/Redesign/	50%		<input checked="" type="checkbox"/>
5	Test Equipment Single Point Failure	10%		<input checked="" type="checkbox"/>
6	Lack of Airframe Strength Verificatior	75%		<input checked="" type="checkbox"/>

Risk Impact Editor:

Impact Name	Task	Opportunity	In Parallel	Type
Software Impact 2	43 - Command and Launch S	<input type="checkbox"/>	<input type="checkbox"/>	
Software Impact 1	42 - Command and Launch A	<input type="checkbox"/>	<input type="checkbox"/>	

Impacts: Add Remove

Duration Impact: Triangular - Min:29 Mode:35 Max:49

Uncertainty Type: Triangular

Min: 29

Mode: 35

Max: 49

Correlation

- Add correlation to the uncertainty model either by entering in a blanket correlation or specifying correlation between different tasks or categories of tasks

Polaris - ACCAqModel.polaris

File... Export... Run View: Standard Cost Phasing Task Details Simulation Details Health

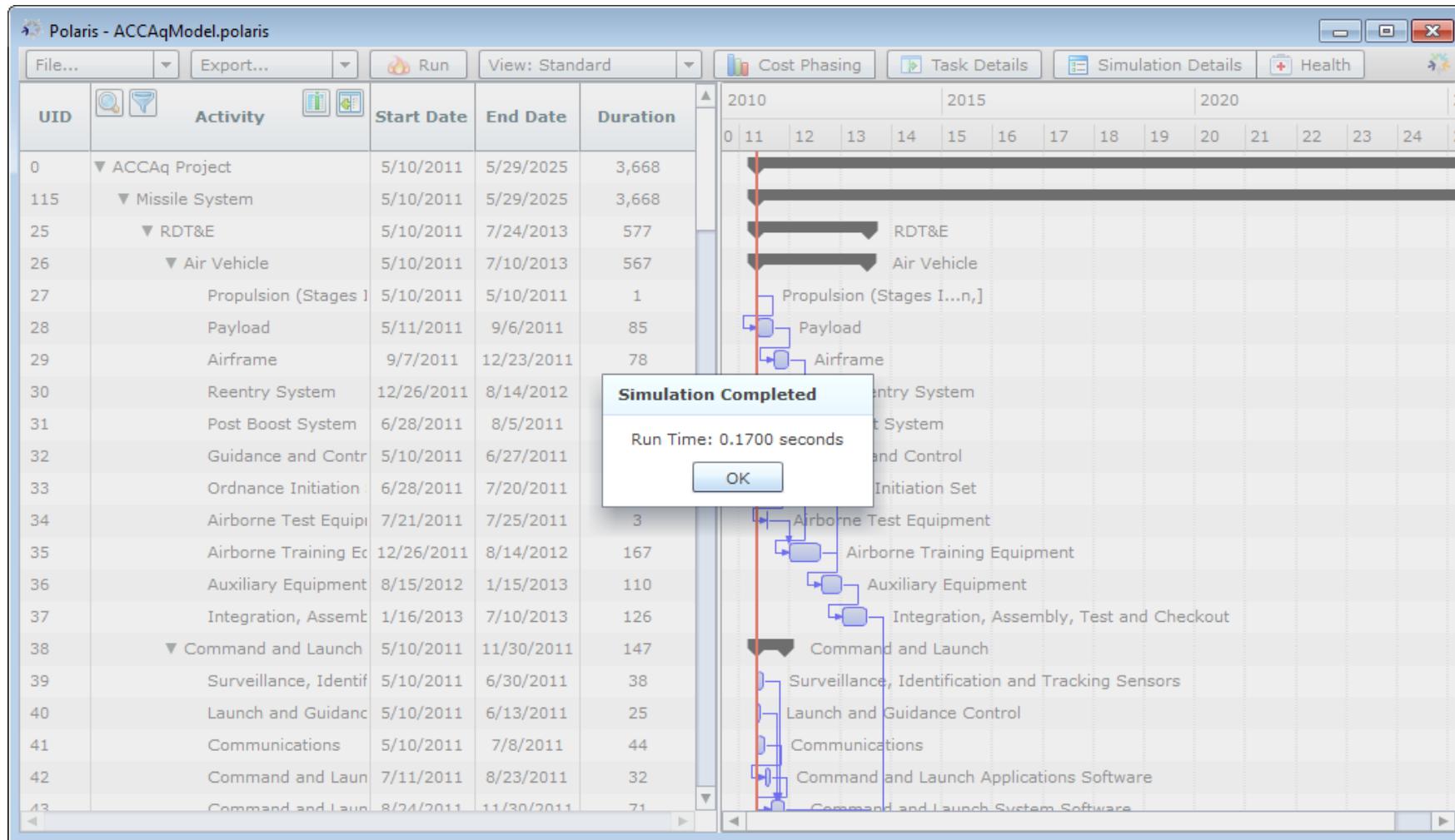
Resources Risks Templated Uncertainty Categories Correlation Options

Correlation Matrix Schedule 0.30 Entries Add Remove Categories Add Remove

Task	Task	Correlation
42 - Command and Launch Applications Software	43 - Command and Launch System Software	0.70
73 - Site Construction	74 - Site/Ship/Vehicle Conversion	0.50

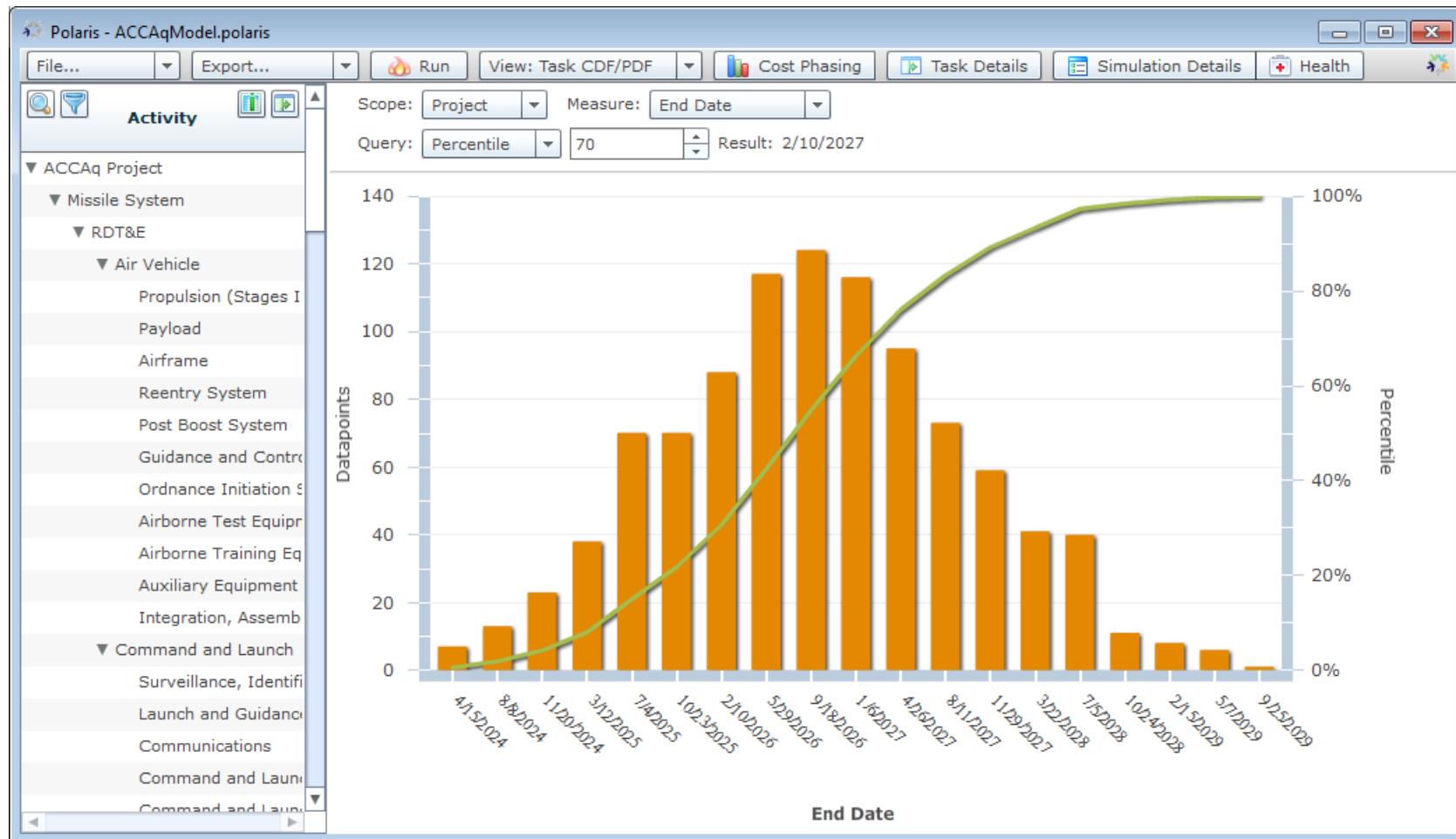
Simulation Run

- ▶ Unmatched simulation runtimes. 1000 trials in two-tenths of a second!



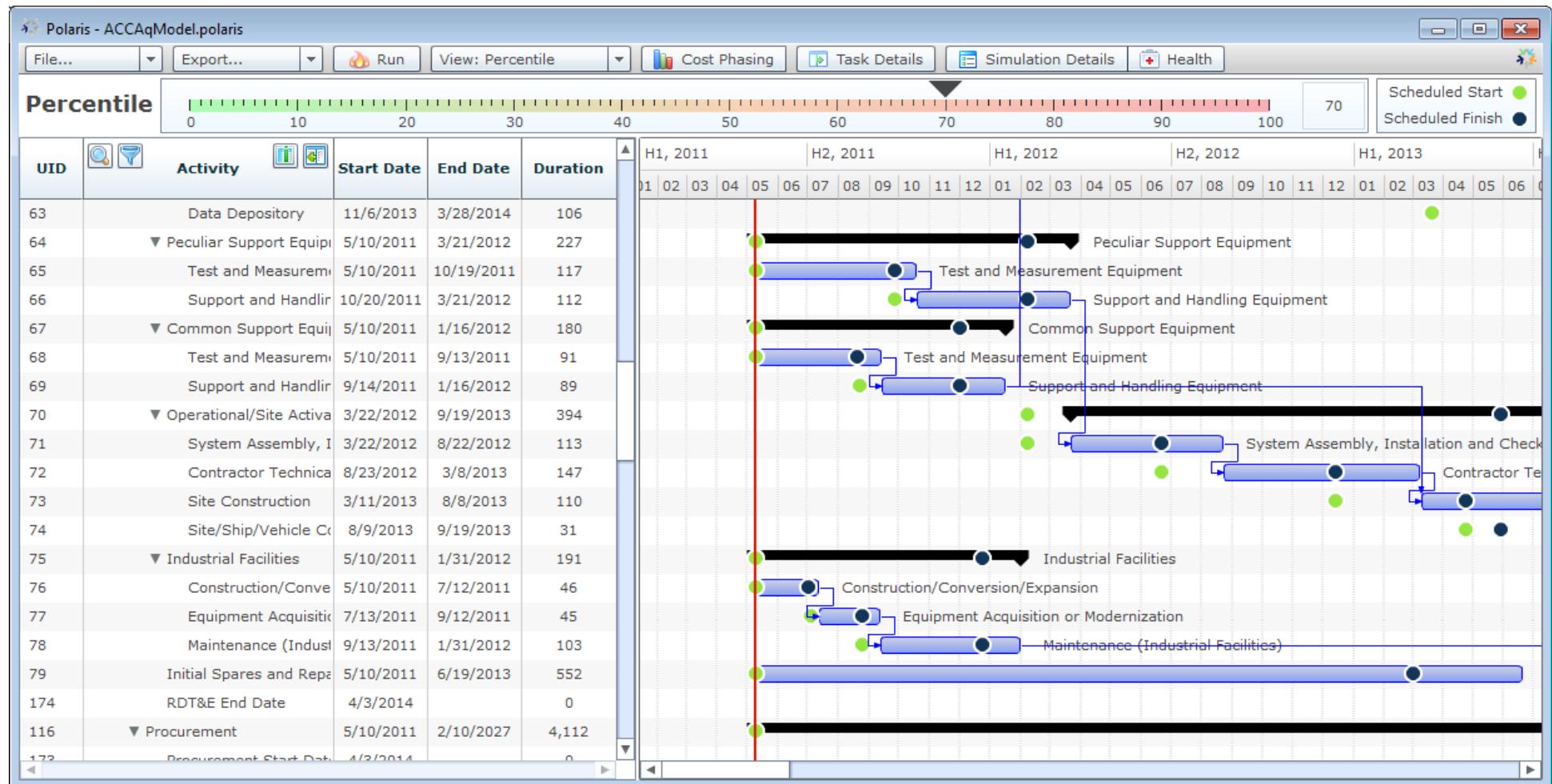
Cumulative Distribution/Probability Density Function

- ▶ Generate S-curves and histograms of schedule and cost measures as well as quickly query specific percentiles and values



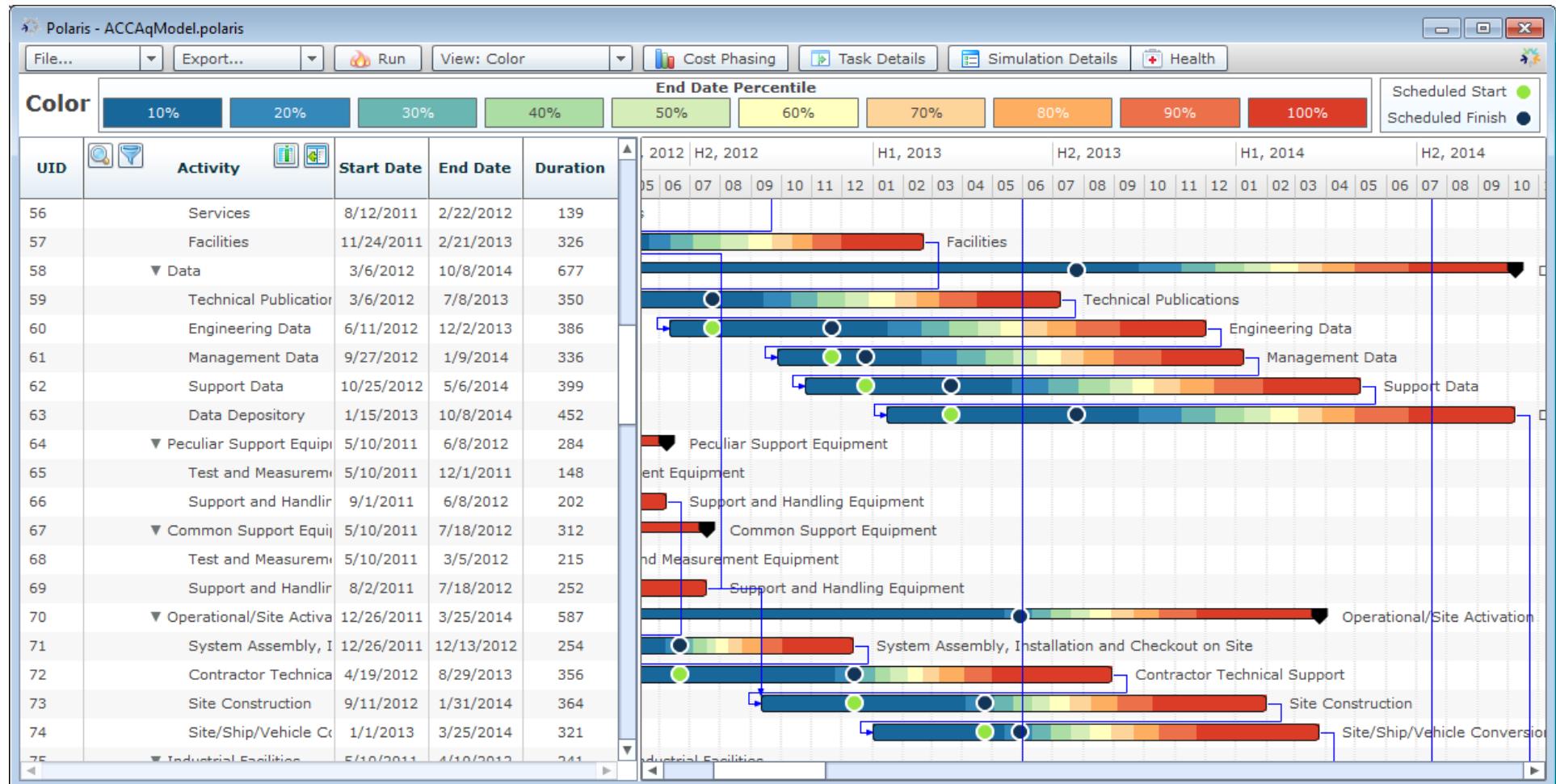
Percentile View

- Specify a schedule confidence level and view the schedule at the chosen level relative to baseline



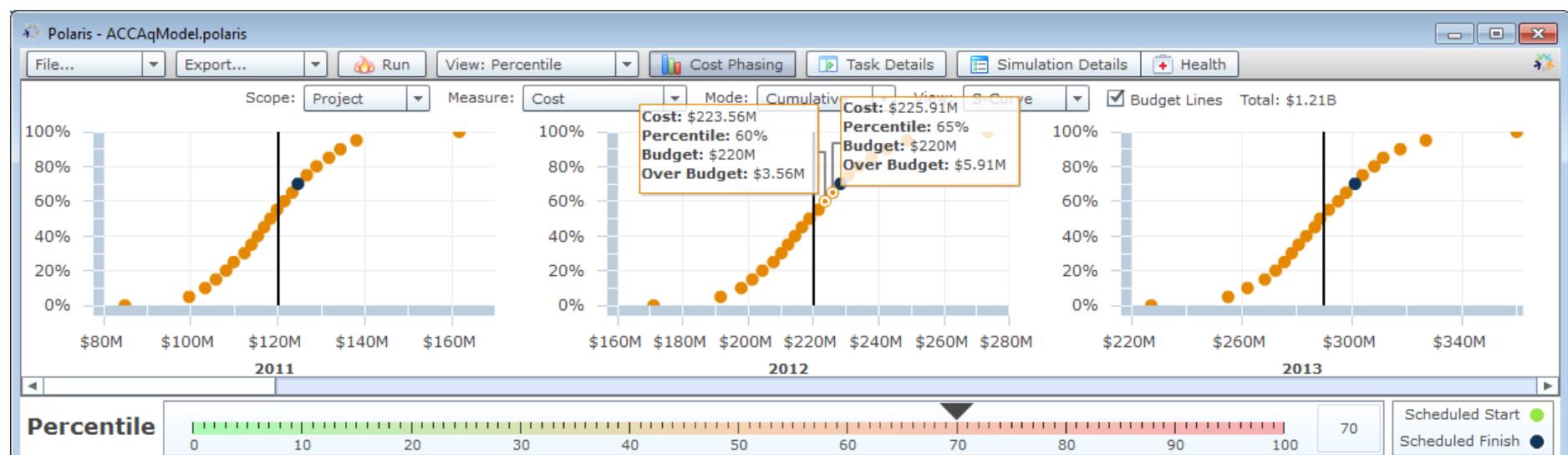
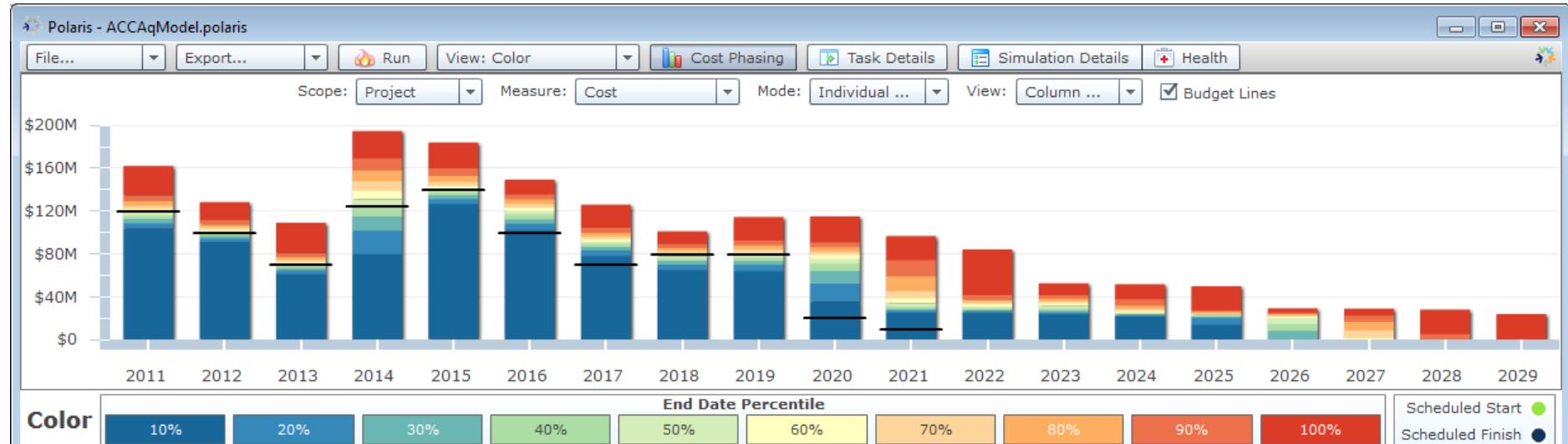
Color View

- Display all percentile values in one view revealing the range and likelihood of all possible outcomes



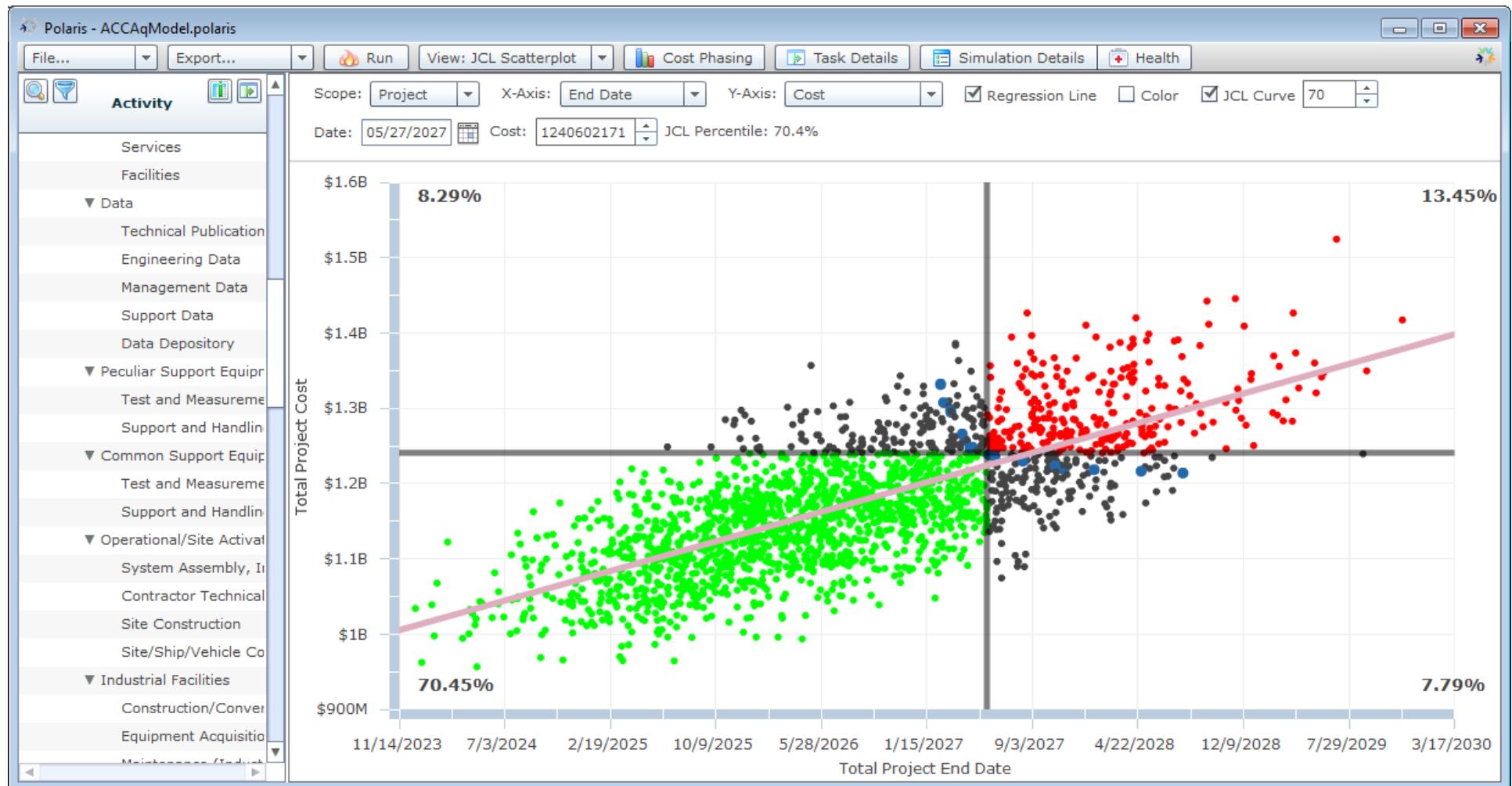
Cost Phasing

- Display cost by fiscal year, quarter, or month across the program lifecycle



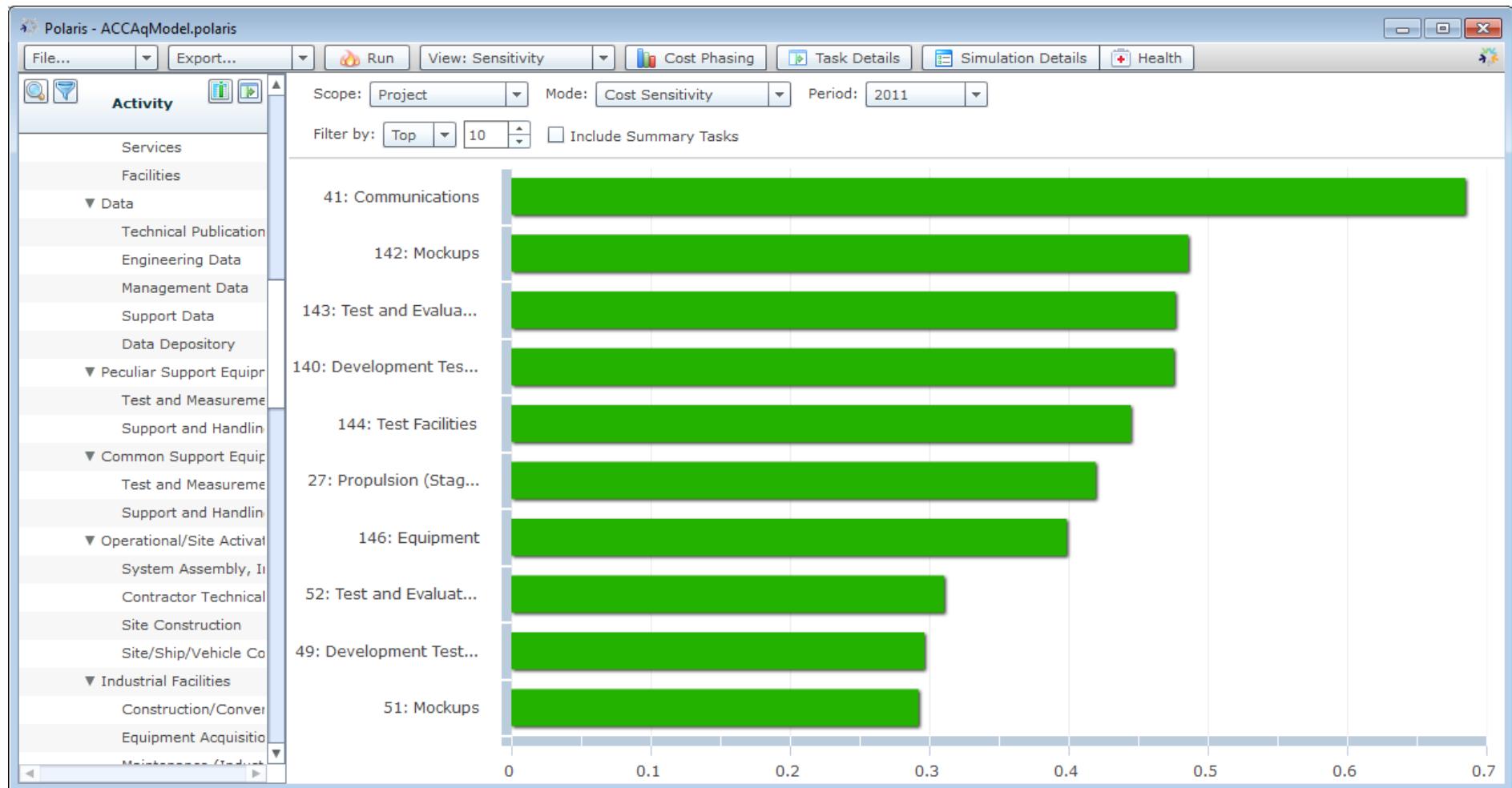
Cost and Schedule Scatterplot

- Plot all simulation cost and schedule outcomes, calculate the regression line, and show joint cost-schedule percentiles



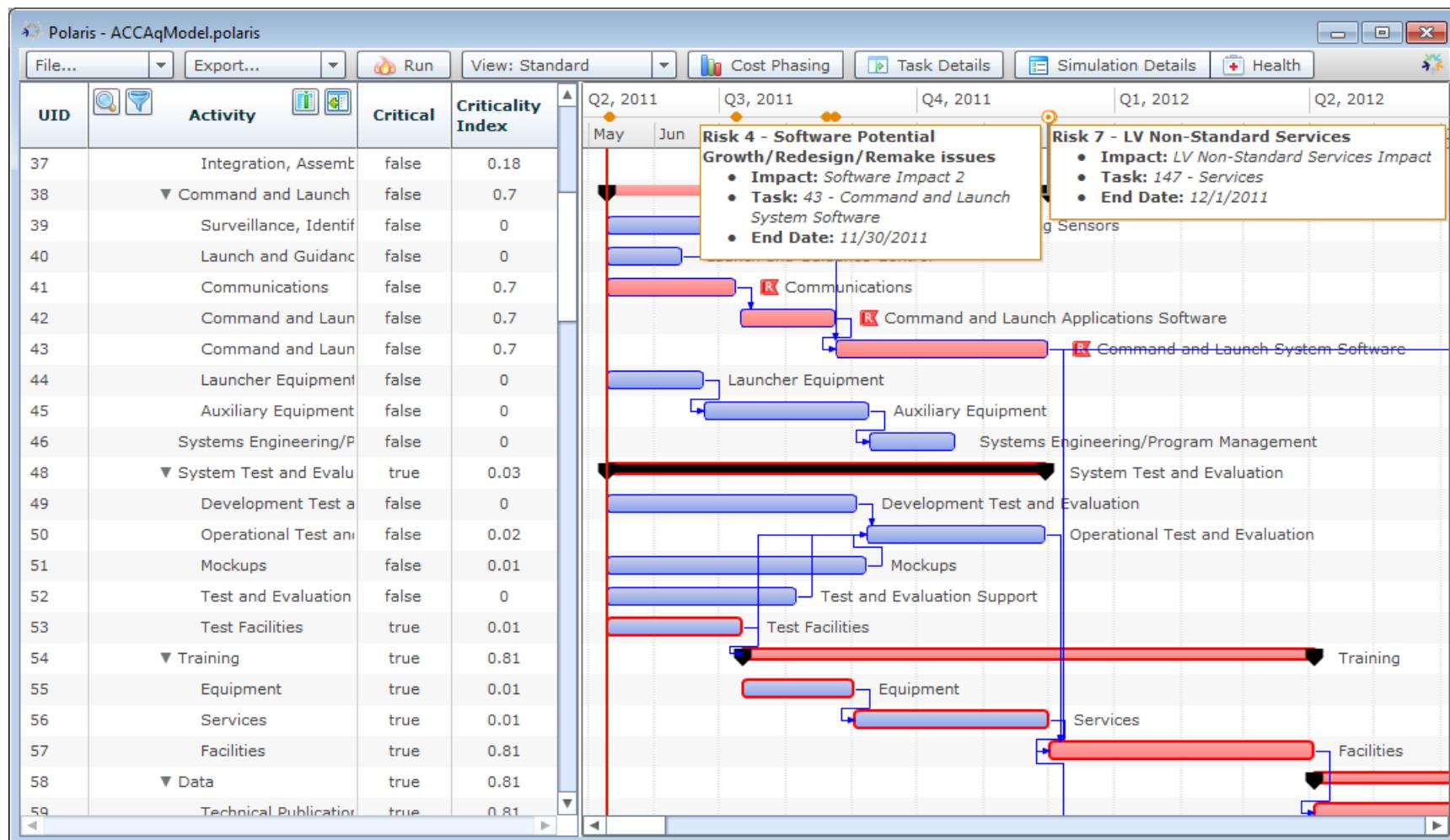
Sensitivity Analysis

- Display the full spectrum of standard schedule and cost sensitivity metrics as well as filter for specific portions of the schedule or time periods



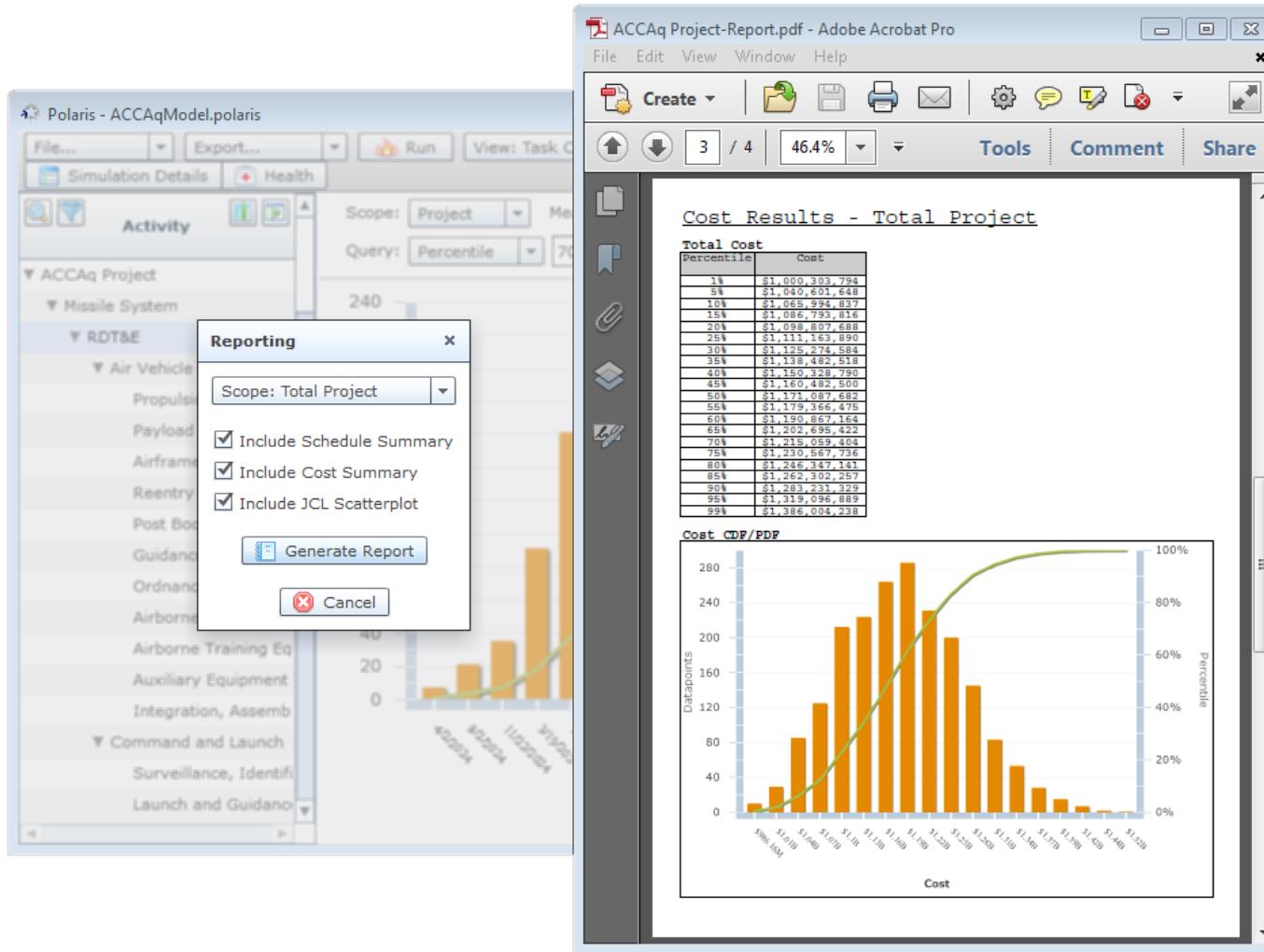
Gantt Based Criticality and Risk Tracking

- ▶ Show the probabilistic critical path in the Gantt view relative to baseline as well as indicate the occurrence of risks in the timeline



Export Data

- ▶ Export all charts as images which can be used in PowerPoint or Word, save all generated data to Excel, or create PDF reports



The screenshot displays two windows side-by-side. On the left is the Polaris software interface, showing a tree view of an 'ACCAq Project' under 'Missile System'. A 'Reporting' dialog box is open, set to 'Scope: Total Project', with three checkboxes checked: 'Include Schedule Summary', 'Include Cost Summary', and 'Include JCL Scatterplot'. Below the dialog is a bar chart with a trendline. On the right is an Adobe Acrobat Pro window titled 'ACCAq Project-Report.pdf'. It shows a 'Cost Results - Total Project' section with a table of 'Total Cost' data by percentile, followed by a 'Cost CDF/PDF' chart with orange bars representing data points and a green curve representing the cumulative distribution function.

Percentile	Cost
1%	\$1,000,303,794
5%	\$1,040,601,648
10%	\$1,065,994,837
15%	\$1,086,793,816
20%	\$1,098,807,688
25%	\$1,111,163,567
30%	\$1,123,758,584
35%	\$1,138,482,518
40%	\$1,150,228,790
45%	\$1,160,482,500
50%	\$1,171,087,682
55%	\$1,179,366,476
60%	\$1,190,857,164
65%	\$1,198,242,122
70%	\$1,215,059,404
75%	\$1,230,567,736
80%	\$1,246,347,141
85%	\$1,262,302,257
90%	\$1,283,231,329
95%	\$1,319,096,889
99%	\$1,386,004,238

Points of Contact

Eric Druker
Senior Associate

Booz | Allen | Hamilton

Booz Allen Hamilton Inc.
St. Louis, MO
Tel +1 (314) 368-5850
Druker_Eric@bah.com

Graham Gilmer
Senior Associate

Booz | Allen | Hamilton

Booz Allen Hamilton Inc.
Washington, DC
Tel +1 (202) 898-3385
Gilmer_Graham@bah.com

Tom Dauber
Principal

Booz | Allen | Hamilton

Booz Allen Hamilton Inc.
Herndon, VA
Tel +1 (703) 984-1800
Dauber_Tom@bah.com

Brandon Herzog
Associate

Booz | Allen | Hamilton

Booz Allen Hamilton Inc.
McLean, VA
Tel +1 (703) 377-6410
Herzog_Paul@bah.com