2013 NASA Cost Analysis Symposium

Maximizing the Utility of Your Tool Set for Project Support

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Agenda

- Key GRC Project Planning Tools
- Project Planning & Control Elements
- Proposal Support
- Formulation/Implementation Support
- Other PP&C Integration Support Activities

Key GRC Project Planning Tools

- GRC Cost Model – Used for task/resource estimating for NASA and Space Act proposals and projects (MS Excel)
- MS Project/Project Server – Project scheduling with resource loading
- Phasing Plan Database – MS Access database for creating and tracking progress for project phasing plans

Project Planning & Control (PP&C) Elements

- Note: This presentation only discusses the GRC Cost and Economic Analysis Office role in promoting the sharing of common project data amongst the PP&C disciplines
- Elements per the Agency Project Planning & Control (PP&C) Working Group

	Tool Set Role
– Cost Estimating/Cost Assessment	←
– Scheduling	←
– Resource Management	←
– Risk Management	←
– Management of Contracts	←
– Configuration and Data Management	
– Integration	←

Proposal Support

- The GRC Center Cost Model was initially created in the early 1990s to support GRC proposal cost estimating
- Cost model setup has been automated with inputs for start/end years and number of WBS elements
- WBS setup has been further automated with the ability to support a multi-level WBS
- Cost model input is per WBS by task and resource – Milestones provided to tie resource estimating to the schedule
- Cost tables have been created to meet Cost Proposal reporting requirements
  - FTE, WYE, Elements of cost by fiscal year and/or by reporting period
  - Cost by WBS by year or period
  - Labor hours and rates by organization
  - Center cost summaries for multi-Center estimates – Ability to include Center FTE/cost, WYE/cost, procurements, and travel
  - Formats to support the Guidebook for Proposers Responding to a NRA
  - Formats to support NSPIRES input (NASA proposal review & evaluation site)

Cost Model – Example WBS Inputs

Task-level WBS info

Resource codes

Estimated resources by month

Add Task Rows | Delete this WBS | Select CC Codes

PROGRAM	PROJECT	Proc. K$	Total K$	FTE	WYE	RESPONSIBLE ORG.	COGNIZANT ENGINEER	DATE
Crosscutting STD	Beamed Electric Propulsion Technology Demon	$115.4	$447.4	2.3	0.6	DES	Karen Jaeger	8-11-13

		MILESTONES			ATP 10/1			SRR 1/1			ISS MCR 5/1	PDR 5/15			ISS Safety Rev 8
WBS #	WBS TITLE				<----------Base---------->								<----------		
4.6	Structure Subsystem	C	U	PROD. HRS/	FY14										
TASK #	TASK DESCRIPTION	C	M	FTE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
.1	Requirements Development														
.1.1	Detailed review of project science requirements	DES	HR	1726	300										
.1.2	Create system level (SRD) engineering requirements	DES	HR	1726		100	100								
.1.3	Identify system level technical performance requirements	DES	HR	1726			120								
.1.4	Evaluate conceptual designs and identify tradeoffs between concepts	DRPC-VAN	HR	1800			80	80							
.1.5	Review structural interface for SpaceX dragon capsule	DES	HR	1726				120	120	120					
.1.6	Structural analysis to size the beaming module structure	DRPC-VAN	HR	1800				120	120	120					
.1.6	Structural analysis to size the beaming module structure	MAT	$K					24							
.1.7	Devolve SRD requirements to level 3 and level 4 engineering requirements	DES	HR	1726						150	150				
.2	Subsystem Design and Analysis														
.2.1	Oversee creation of detail design drawings	DES	HR	1726								40	40	80	80
.2.2	Structural analysis of ground support equipment (GSE)	DES	HR	1726							120	120	40		
.2.3	Analysis of launch/thermal loads including sub-systems	DES	HR	1726								120	120	40	

Cost and Economic Analysis Office

Cost Model - Identified Proposal Needs

- Basis of Estimate (BOE) documentation
  - Next release of the cost model will support the development of BOE documentation based on output from the cost model
  - Each WBS tab has unprotected text boxes to document the WBS Dictionary and Basis of Estimate information

WBS Dictionary:
This element includes the detailed analysis and design, development, fabrication/procurement, integration and test of the beaming module structure. It includes manufacturing engineering oversight, material and fastener procurement, flight hardware logistical planning, bonded storage and configuration control . Included are associated labor and expenses for disciplines such as machining, fabrication and production instrumentation detection devices.

Basis of Estimate:
Estimates are based on engineering build-up of resources based on effort that was required for previous space flight hardware, such as InSPACE I, InSPACE 2, MOBI, Ares 1-X, and the CoNNeCT SCAN Testbed.. Parts will be manufactured in-house. Material and fastener pricing is current. Labor for the production of this structure is considered similar to CoNNeCT. Specific adjustments to labor have been applied for this article. Additional assumptions include 1) Quasi-Static and random vibration loads will be provided from WBS 2.0, 2) Interface control and definition documentation will be available at or shortly after ATP decision point, 3) Detail drawings of JEM Attached Payloads Bus available within one month of ATP decision point, and 4) COTS hardware vendors will supply GRC detailed interface drawings at least two months prior to PDR.

Cost Model - Identified Proposal Needs

- Basis of Estimate (BOE) documentation
  - The BOE export macro creates a basis of estimate sheet like the one on the right for every WBS tab in the model
  - The export routine uses information available in the cost model such as WBS Dictionary, Basis of Estimate and detailed cost information to populate the BOE template
  - The export routine can also be used to update an existing BOE in order to maintain the information entered in fields the cost model doesn't populate

Beamed Electric Propulsion Technology Demonstration Basis of Estimate

WBS Number	4.6	Title	Structure Subsystem
Cognizant Engineer	Karen Jaeger		
Section/Division			
Responsible Organization	DES		

WBS Dictionary

Description of work to be performed, including objectives and approaches

This element includes the detailed analysis and design, development, fabrication/procurement, integration and test of the beaming module structure. It includes manufacturing engineering oversight, material and fastener procurement, flight hardware logistical planning, bonded storage and configuration control . Included are associated labor and expenses for disciplines such as machining, fabrication and production instrumentation detection devices.

Assumptions

List of assumptions including heritage and technology development progress

Basis of Estimate

Description of methods used to estimate resources and comparison with previous projects/systems

Estimates are based on engineering build-up of resources based on effort that was required for previous space flight hardware, such as InSPACE I, InSPACE 2, MOBI, Ares 1-X, and the CoNNeCT SCAN Testbed.. Parts will be manufactured in-house. Material and fastener pricing is current. Labor for the production of this structure is considered similar to CoNNeCT. Specific adjustments to labor have been applied for this article. Additional assumptions include 1) Quasi-Static and random vibration loads will be provided from WBS 2.0, 2) Interface control and definition documentation will be available at or shortly after ATP decision point, 3) Detail drawings of JEM Attached Payloads Bus available within one month of ATP decision point, and 4) COTS hardware vendors will supply GRC detailed interface drawings at least two months prior to PDR.

Cost Uncertainty Assessment

Identify a lower and upper bound for the estimated WBS cost based on the factors identified.

Potential Cost Reduction %/$	Cost Reduction Factors
Potential Cost Increase %/$	Cost Increase Factors

Hardware Estimated

Include test and spare units provided (# per type)

Description	Flight	Spare Qty	BB	STM	DTM	EM	Notes

Facility Requirement

Provide a description of all planned facilities

Date Required	Description	Location

Resource Estimate

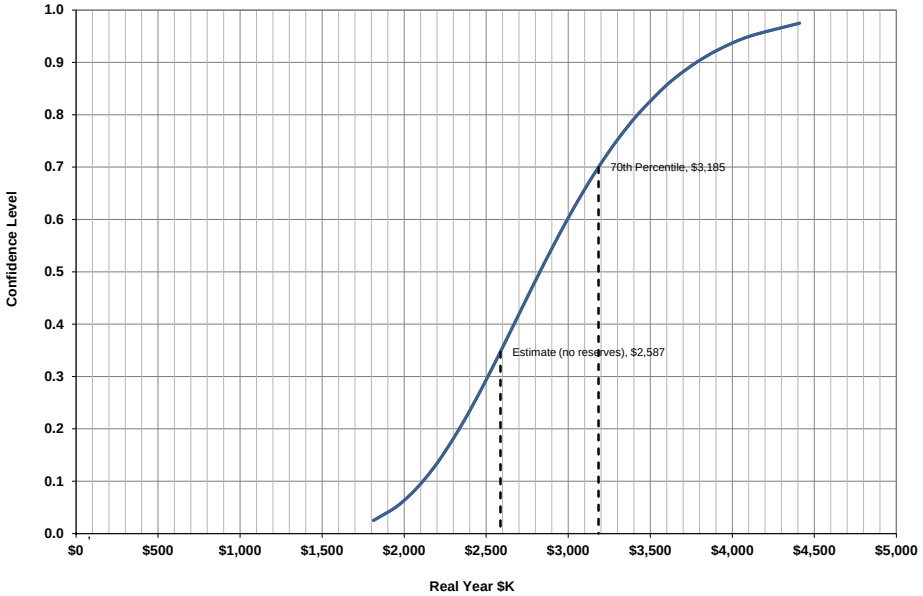
Summary resources for this WBS element and all sub-elements

Resource Title	FY14	FY15	FY16	FY17	FY18	Total
Civil Servant FTE	1.33	0.95	0.00	0.00	0.00	2.28
Local Contractor WYE	0.49	0.09	0.00	0.00	0.00	0.58
Civil Servant Labor Dollars (K$)	$191.1	$140.9	$0.0	$0.0	$0.0	$332.0
Local Contractor Labor Dollars (K$)	$77.1	$14.3	$0.0	$0.0	$0.0	$91.4
Travel (K$)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Procurements (K$)	$24.0	$0.0	$0.0	$0.0	$0.0	$24.0
WBS Total (K$)	$292.2	$155.2	$0.0	$0.0	$0.0	$447.4

Cost Model – Identified Proposal Needs

- Cost Risk Analysis
  - Model can provide a CDF based on a subjective assessment of cost risk by WBS (low, medium, high, extremely high)
  - Subjective risk levels have an associated CV as taken from the Air Force Cost Risk Uncertainty Handbook (e.g., “Medium” = 25% CV)
  - Analysis assumes each WBS estimate represents the mode of a lognormal distribution; mean values are calculated based on the mode and the implied CV, and the variances added using standard formula for variance of a sum with correlation (uniform correlation values assumed)

Real Year Dollars COST PER WBS ELEMENT	Totals (Without Reserves/Cost Sharing)	Assessed Risk
4.1 Project Management	$261,998	Low
4.2 Systems Engineering	$312,602	Medium
4.3 S&MA	$277,125	Low
4.4 Power Subsystem	$1,158,190	High
4.5 Thermal Subsystem	$129,648	Low
4.6 Structure Subsystem	$447,363	Medium
Total Cost of All WBS Elements	$2,586,924	



Formulation/Implementation Support

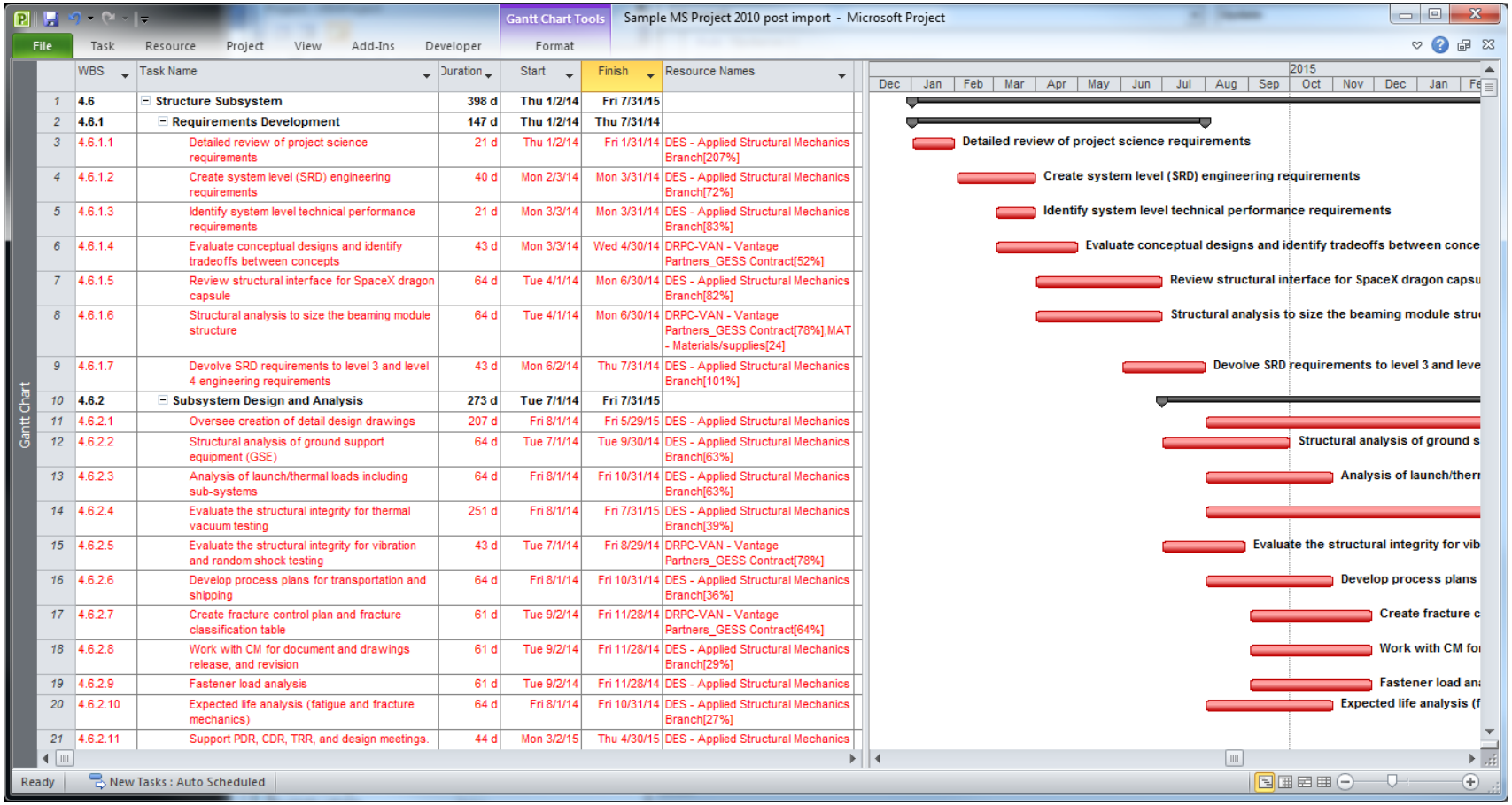
- GRC develops resource loaded schedules for space flight projects
  - Issue 1: Need the RLS resources to be consistent with the cost model
    - Solution: A rate table for every cost model update is provided to produce a MS Project template for project use
  - Issue 2: Developing an initial project RLS replicates the task and resource information in a proposal cost model
  - Issue 3: MS Project schedules need to provide cost and resource reporting during the project's life
  - Issue 4: Significant effort is required to develop a phasing plan based on the planned work/resources already identified in the cost model and/or MS Project schedule

Formulation/Implementation Support

- Issue 2: Developing an initial project RLS replicates the task and resource information in a proposal cost model
  - Solution: Develop macro to allow cost model proposal data to be captured in MS Project to create an initial resource loaded schedule (RLS) for the project
    - The process requires an MS Project template with resource names and rates that are consistent with the cost model
    - Each task line in the cost model translates to a task in the Project file. Exception: when multiple resources are required for the same task, lines with identical WBS number and name in consecutive input lines are combined to a single task in Project
    - Schedule dates are set by the first month and last month of resource inputs for the task(s)
    - The export process replicates in MS Project the work breakdown structure contained in the cost model

Cost Model to RLS

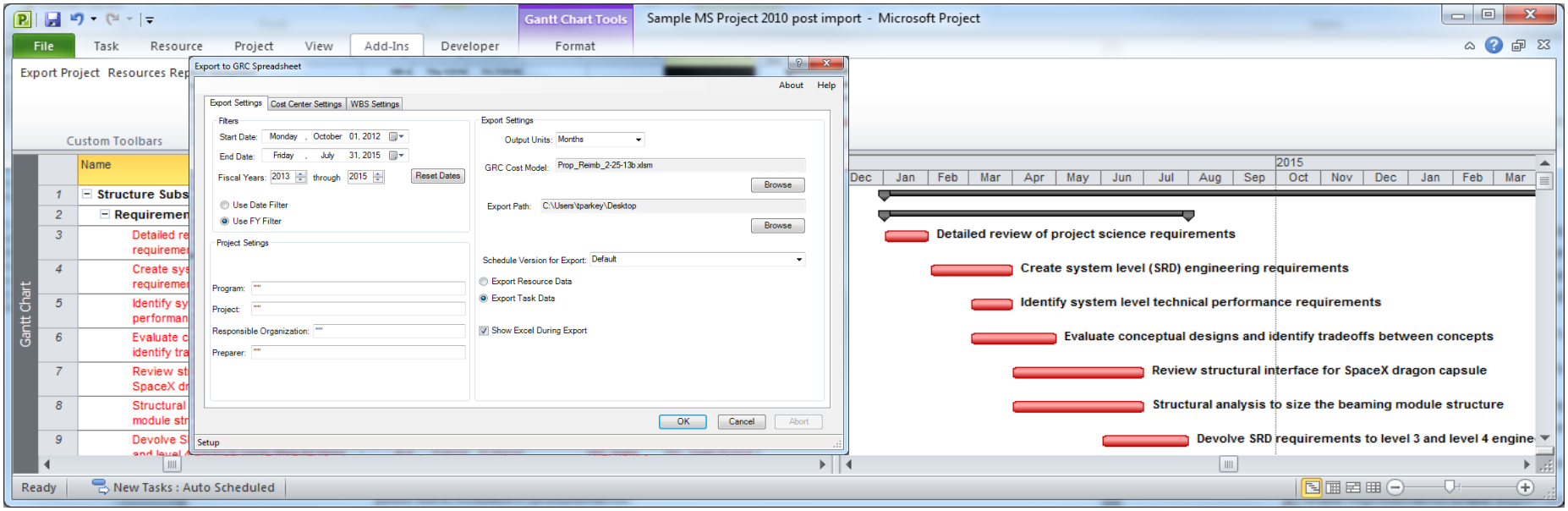
- After the export, a basic MS Project RLS can be created or appended to an existing schedule - Adding task relationship information and refining start and end dates will be necessary



	WBS	Task Name	Duration	Start	Finish	Resource Names
1	4.6	Structure Subsystem	398 d	Thu 1/2/14	Fri 7/31/15	
2	4.6.1	Requirements Development	147 d	Thu 1/2/14	Thu 7/31/14	
3	4.6.1.1	Detailed review of project science requirements	21 d	Thu 1/2/14	Fri 1/31/14	DES - Applied Structural Mechanics Branch[207%]
4	4.6.1.2	Create system level (SRD) engineering requirements	40 d	Mon 2/3/14	Mon 3/31/14	DES - Applied Structural Mechanics Branch[72%]
5	4.6.1.3	Identify system level technical performance requirements	21 d	Mon 3/3/14	Mon 3/31/14	DES - Applied Structural Mechanics Branch[83%]
6	4.6.1.4	Evaluate conceptual designs and identify tradeoffs between concepts	43 d	Mon 3/3/14	Wed 4/30/14	DRPC-VAN - Vantage Partners_GESS Contract[52%]
7	4.6.1.5	Review structural interface for SpaceX dragon capsule	64 d	Tue 4/1/14	Mon 6/30/14	DES - Applied Structural Mechanics Branch[82%]
8	4.6.1.6	Structural analysis to size the beaming module structure	64 d	Tue 4/1/14	Mon 6/30/14	DRPC-VAN - Vantage Partners_GESS Contract[78%],MAT - Materials/supplies[24]
9	4.6.1.7	Devolve SRD requirements to level 3 and level 4 engineering requirements	43 d	Mon 6/2/14	Thu 7/31/14	DES - Applied Structural Mechanics Branch[101%]
10	4.6.2	Subsystem Design and Analysis	273 d	Tue 7/1/14	Fri 7/31/15	
11	4.6.2.1	Oversee creation of detail design drawings	207 d	Fri 8/1/14	Fri 5/29/15	DES - Applied Structural Mechanics
12	4.6.2.2	Structural analysis of ground support equipment (GSE)	64 d	Tue 7/1/14	Tue 9/30/14	DES - Applied Structural Mechanics Branch[63%]
13	4.6.2.3	Analysis of launch/thermal loads including sub-systems	64 d	Fri 8/1/14	Fri 10/31/14	DES - Applied Structural Mechanics Branch[63%]
14	4.6.2.4	Evaluate the structural integrity for thermal vacuum testing	251 d	Fri 8/1/14	Fri 7/31/15	DES - Applied Structural Mechanics Branch[39%]
15	4.6.2.5	Evaluate the structural integrity for vibration and random shock testing	43 d	Tue 7/1/14	Fri 8/29/14	DRPC-VAN - Vantage Partners_GESS Contract[78%]
16	4.6.2.6	Develop process plans for transportation and shipping	64 d	Fri 8/1/14	Fri 10/31/14	DES - Applied Structural Mechanics Branch[36%]
17	4.6.2.7	Create fracture control plan and fracture classification table	61 d	Tue 9/2/14	Fri 11/28/14	DRPC-VAN - Vantage Partners_GESS Contract[64%]
18	4.6.2.8	Work with CM for document and drawings release, and revision	61 d	Tue 9/2/14	Fri 11/28/14	DES - Applied Structural Mechanics Branch[29%]
19	4.6.2.9	Fastener load analysis	61 d	Tue 9/2/14	Fri 11/28/14	DES - Applied Structural Mechanics
20	4.6.2.10	Expected life analysis (fatigue and fracture mechanics)	64 d	Fri 8/1/14	Fri 10/31/14	DES - Applied Structural Mechanics Branch[27%]
21	4.6.2.11	Support PDR, CDR, TRR, and design meetings.	44 d	Mon 3/2/15	Thu 4/30/15	DES - Applied Structural Mechanics

Formulation/Implementation Support

- Issue 3: MS Project schedules need to provide cost and resource reporting during the project's life
  - Solution: Develop a MS Project Add-in to export RLS task/resource information to the cost model
    - Add-in sets up and populates the GRC cost model based on the WBS and other settings in the Export Tool



Formulation/Implementation Support

- Issue 4: Significant effort is required to develop a phasing plan based on the planned work/resources already identified in the cost model and/or MS Project schedule
  - Solution: Port the available data from MS Project to the cost model or directly from the cost model to the Center Phasing Plan template
    - Maps the “Cost” data from the cost model to the applicable cost lines of the phasing plan including separate lines for each procurement

Update Procurements | Export to Phasing Plan Template | FY14 Phasing Plan

Project WBS: | Project Title: Beamed Electric Propulsion Technology Demonstration

			Full Cost ($K)			FY 2014												
		PY	NOA	EOY' 2013	Avail Fund	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Metric %	2014	Obligation																
		Cost																
	2013	Obligation																
		Cost																
	2012 & Prior	Obligation																
		Cost																
Incremental	2014	Obligation	-		-	-	-	-	-	-	-	-	-	-	-	-	-	
		Cost			-	-	-	-	24.9	8.3	25.3	51.5	20.5	32.9	32.9	42.1	53.7	
	2013	Obligation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Cost		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	2012 & Prior	Obligation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Cost		-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Total	Obligation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		Cost		-	-	-	-	-	24.9	8.3	25.3	51.5	20.5	32.9	32.9	42.1	53.7	
Cumulative	2014	Obligation				-	-	-	-	-	-	-	-	-	-	-	-	-
		Cost				-	-	-	24.9	33.2	58.5	110.0	130.5	163.4	196.4	238.5	292.2	(292.2)
	2013	Obligation				-	-	-	-	-	-	-	-	-	-	-	-	-
		Cost				-	-	-	-	-	-	-	-	-	-	-	-	-
	2012 & Prior	Obligation				-	-	-	-	-	-	-	-	-	-	-	-	-
		Cost				-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	Obligation				-	-	-	-	-	-	-	-	-	-	-	-	-
		Cost				-	-	-	24.9	33.2	58.5	110.0	130.5	163.4	196.4	238.5	292.2	(292.2)

Other PP&C Integration Support Activities

- Process for adding Cost and Schedule Uncertainty to MS Project
  - Discusses the additional columns to add to collect the cost and schedule uncertainty using the GRC RLS Template and any risk analysis tool (JACS, Polaris, @Risk)
  - Identifies and defines the type of information required
  - Provides basic instructions to schedulers to collect the information based on the use of triangular or lognormal distributions
  - Provides instruction on how to identify duration, time dependent cost, time independent cost and associated uncertainties
  - Provides guidance on the capture of discrete risks in the schedule

Other PP&C Integration Support Activities

- Develop/maintain the Access database that houses and reports on all GRC phasing plans
  - Generates the templates for each project at the level required
  - Collects completed phasing plans
  - Performs data entry error and missing data review
  - Generates various reports
    - Summary level (Mission, Theme, and Program)
    - Detailed data export
    - PMT flat file export

Tool Use by PP&C Element

- Cost Estimating/Cost Assessment
  - Cost Model: Estimates and reporting
  - MS Project: RLS estimates and labor assessments
- Scheduling
  - Cost Model: Export to create initial RLS
  - MS Project: Detailed project schedule download to the cost model for reporting by WBS
- Resource Management
  - Cost Model: Project estimates by element of costs, BOE, export to the phasing plan
  - MS Project: Tracking of work and resources, downloads to enable phasing plan development through the cost model
  - Phasing Plan Database: Development and reporting of phasing plans

Tool Use by PP&C Element (Cont.)

- Risk Management
  - Cost Model: Proposal cost risk analysis by WBS
  - MS Project: Process for adding cost and schedule uncertainty and risk
- Management of Contracts
  - Cost Model: Identification and reporting for planned procurements, export of procurements to RLS and phasing plan
  - MS Project: Identification and tracking of procurements
  - Phasing Plan Database: Identification and reporting of procurements in phasing plans
- Integration
  - See above

Summary

- GRC engineering cost estimating for new and existing projects is built around use of the GRC Cost Model and resource loaded schedules for space flight projects
- Capabilities to share information between these tools and with other Center tools have been developed to lessen the manual work required by the projects
- Not all projects take advantage of all the capabilities but usage is picking up
- GRC Cost Model tool training is offered at least four times per year at the Center – Often tailored to meet specific needs
- The GRC Cost Office continues to look for ways to assist our projects in meeting their evolving needs