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Selection and Deployment of a Standard COTS Monte Carlo Software Tool

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BAE Systems, USCS:

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Agenda

- Introduction and Background.
- Sample uses of Monte Carlo capability.
- Need for Monte Carlo capability.
- Need for standardization of tool.
- Formation of Tool Selection and Standardization Team.
- Tool Selection Project Organization.
- Tool Use Study to Compare Features.
- Deployment of Software
- Conclusion.

Introduction

- BAE Systems: US Combat Systems
- BAE Systems Land & Armaments, U.S. Combat Systems is a world-leading developer and producer of a full spectrum of gun systems, weapon launching systems and containers, as well as armored combat systems, such as the Bradley Combat System and next-generation systems for manned and unmanned ground vehicles.
- The division has several facilities located around the U.S. The relevant facilities to this presentation are: Santa Clara, CA; York, PA; Sterling Heights, MI; Orlando, FL;
- In October 2008 USCS (legacy Ground Systems) received CMMI level 5 Certification.
- **Bradley Fighting Vehicle**

Background

- Early in 2008 the division's Performance Excellence and Systems Engineering organizations began serious investigation into the use of Monte Carlo COTS tools with an eye towards improving the robustness of our resource and time estimates with respect to our development projects.
- In 2008 CMMI certification as a high maturity organization was made significantly more rigorous.
- Part of this rigor was the expectation that such an organization could develop and utilize quantitative models that could explicitly include expected variation in operational measures.
- The CMMI high maturity expectation increased the focus and the scope for the use of such a tool within the Division.

Background

- Initial Concerns with Monte Carlo tools.
  - How useful?
  - How much training required to use the tool?
  - How much computer network infrastructure required to use the tool?
  - What is the likelihood of potential proliferation of different software tools performing the Monte Carlo function in the division?
  - How costly are the software licenses?

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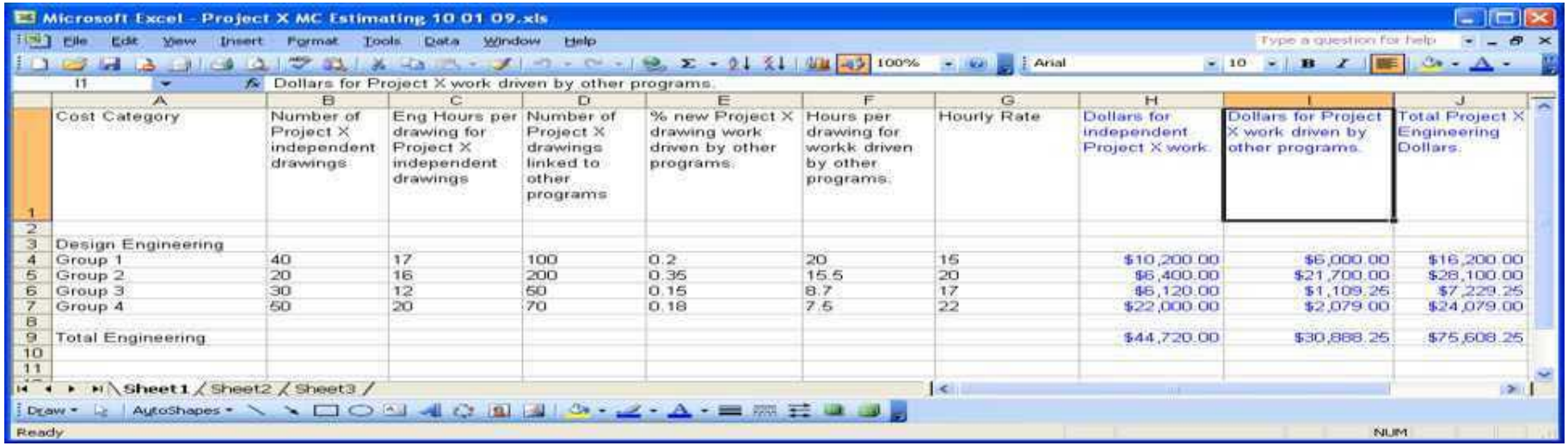
Sample use of Monte Carlo wrt Project Management

- **How useful?**
- **Current State**

- **Currently "most people" involved with project management estimate resource requirements using Excel spread sheets.**

- **They use single point estimates for key parameters.**

- **This technique can very easily result in the use of "all success" assumptions and resultant in all success estimates.**



	A	B	C	D	E	F	G	H	I	J
1	Cost Category	Number of Project X independent drawings	Eng Hours per drawing for Project X independent drawings	Number of Project X drawings linked to other programs	% new Project X drawing work driven by other programs.	Hours per drawing for workk driven by other programs.	Hourly Rate	Dollars for independent Project X work.	Dollars for Project X work driven by other programs.	Total Project X Engineering Dollars.
2										
3	Design Engineering									
4	Group 1	40	17	100	0.2	20	15	$10,200.00	$6,000.00	$16,200.00
5	Group 2	20	16	200	0.35	15.5	20	$6,400.00	$21,700.00	$28,100.00
6	Group 3	30	12	50	0.15	8.7	17	$6,120.00	$1,109.25	$7,229.25
7	Group 4	50	20	70	0.18	7.5	22	$22,000.00	$2,079.00	$24,079.00
8										
9	Total Engineering							$44,720.00	$30,888.25	$75,608.25
10										
11										

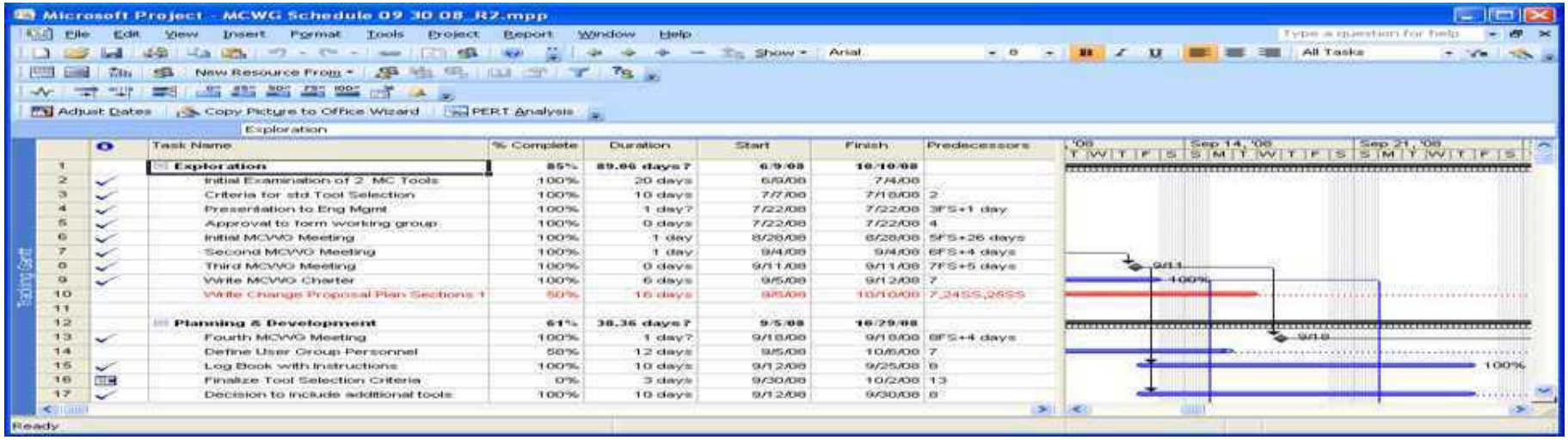
Sample use of Monte Carlo wrt Project Management

How useful?

Currently “most people” involved with project management estimate schedule task and milestone dates using MS Project.

They use single point estimates for key parameters, especially duration.

This technique can very easily result in the use of “all success” assumptions and result in all success schedules.



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Sample use of Monte Carlo for Project Management

- What if, instead of using single point estimators we could use a distribution that would represent the potential variation around our best estimate for a parameter?

- And instead of obtaining a single point forecast we could obtain a distribution of resulting of forecasts that the potential variation in the estimating parameters would generate?

- We could select the estimate that would place us at the desired level of risk/robustness.

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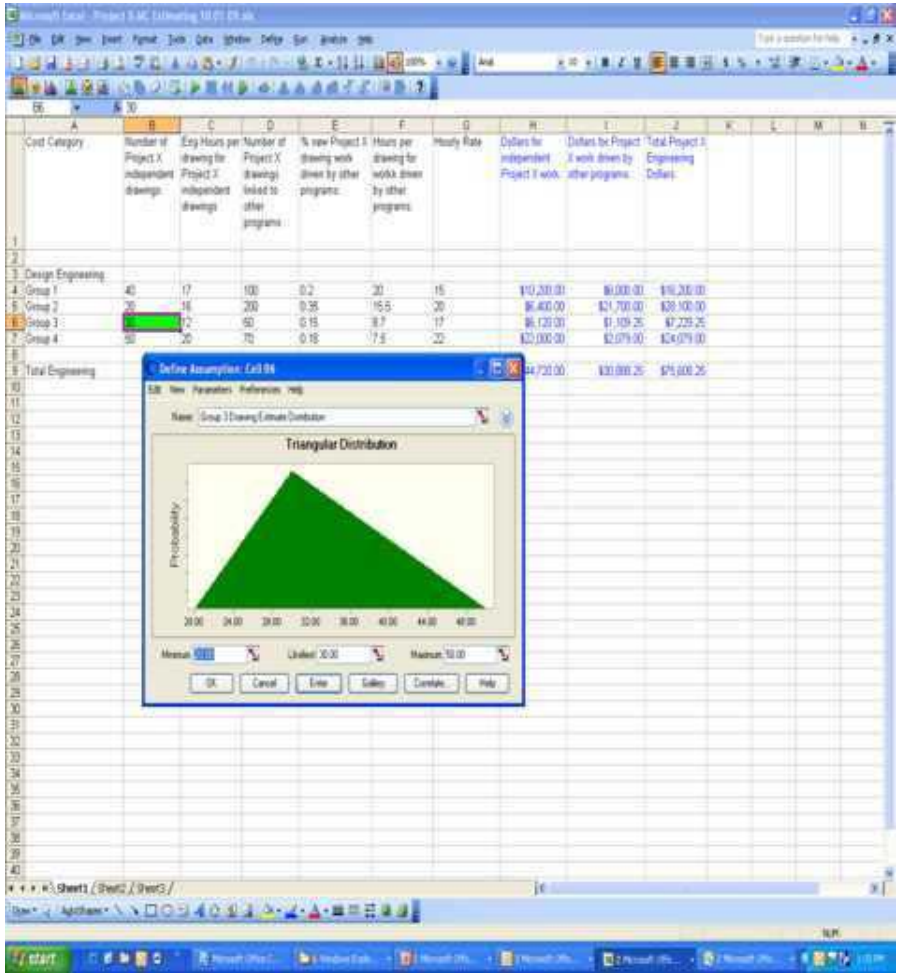
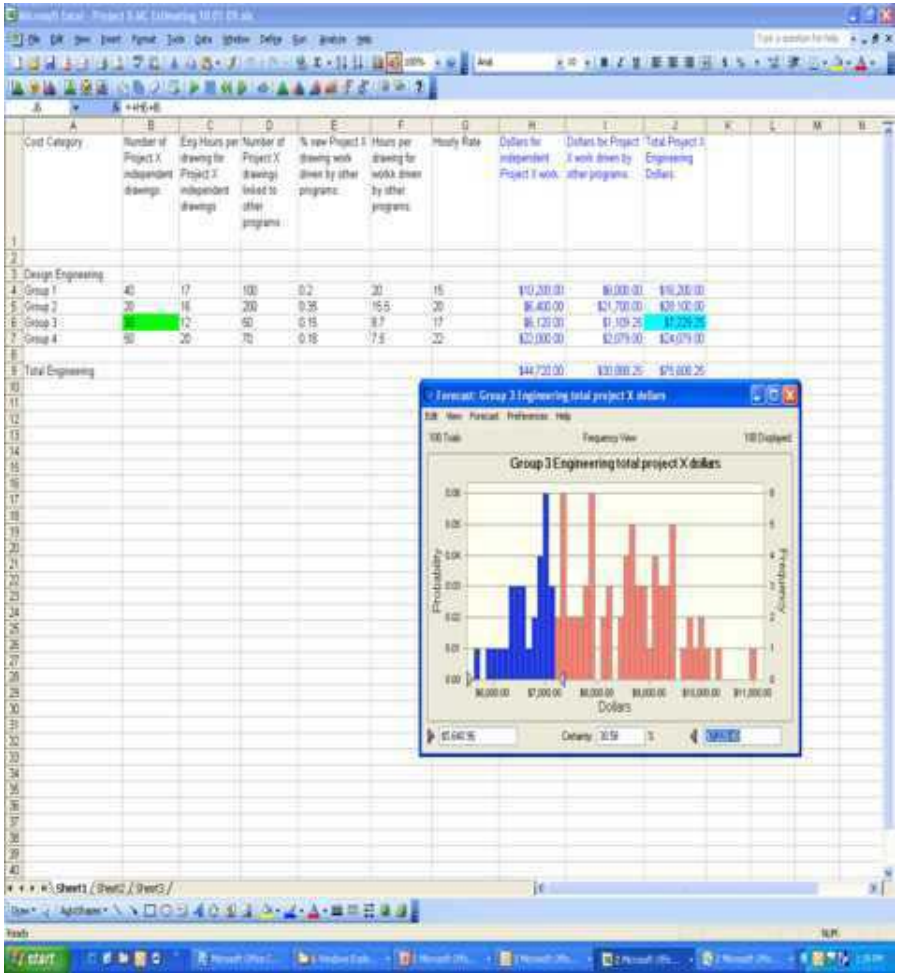
Sample use of Monte Carlo for Project Management





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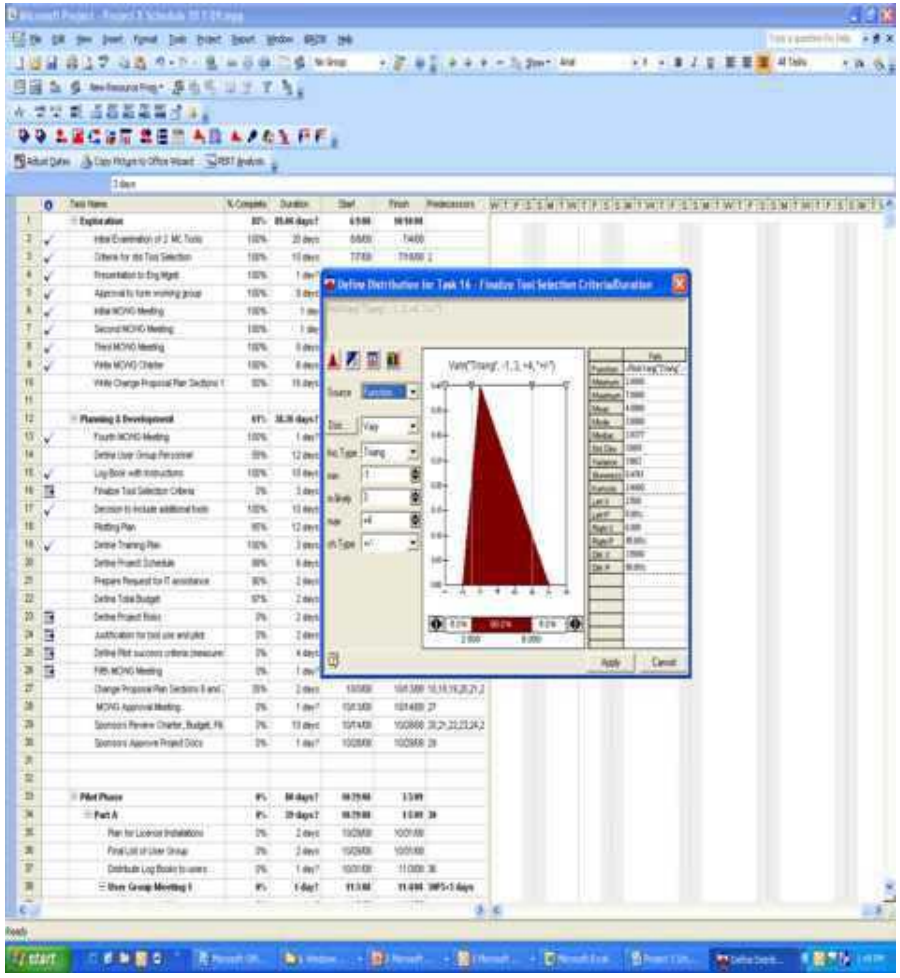
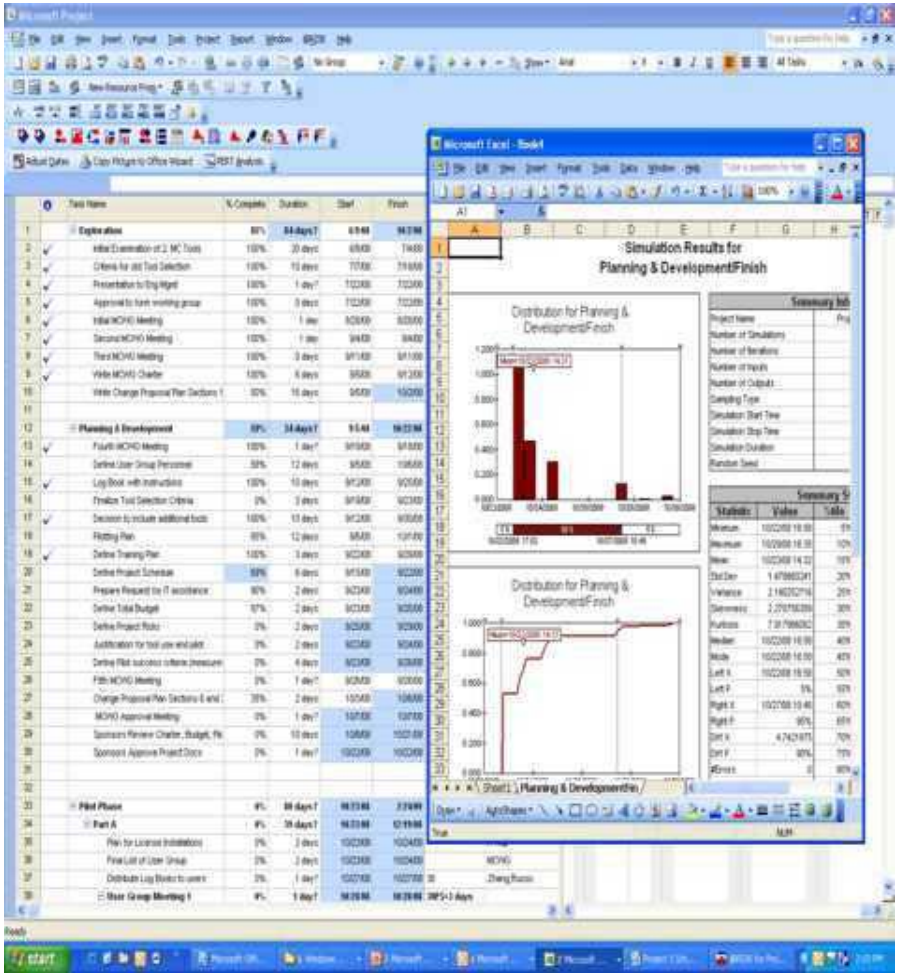
Sample use of Monte Carlo for Project Management





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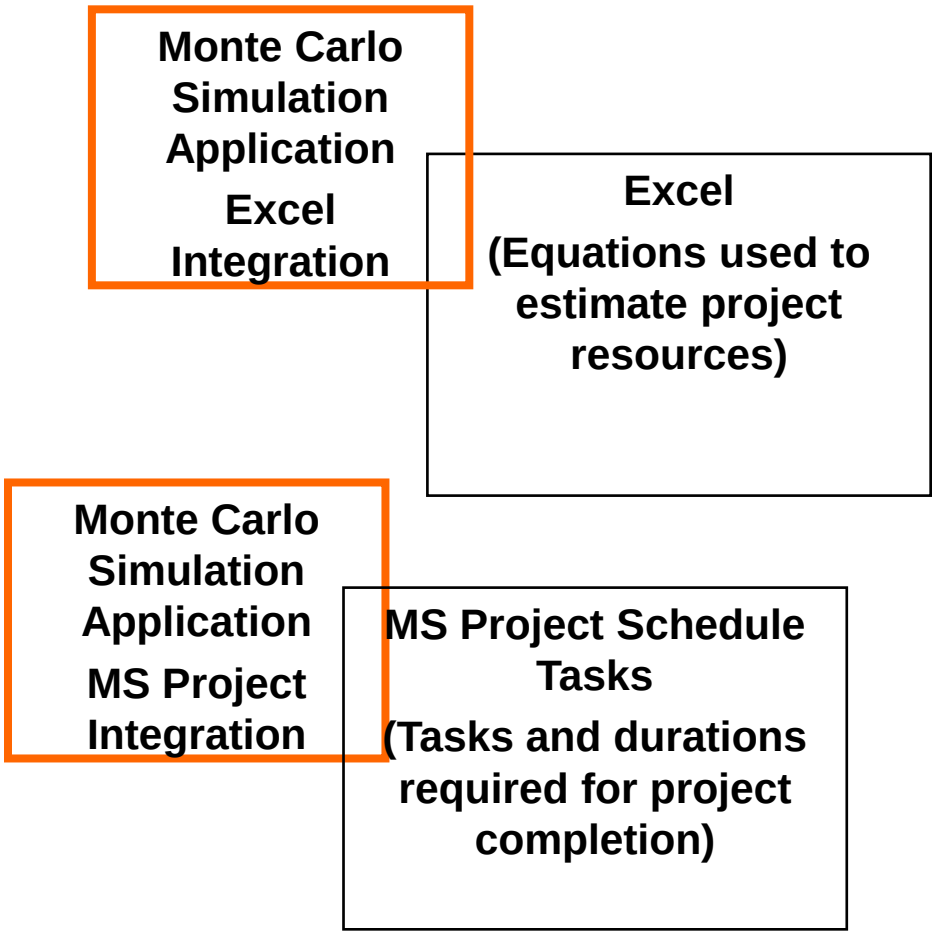
The Generic Tool



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Need for Monte Carlo Capability?

- Improve Robustness of Resource Estimates, and Milestone Estimates.
  - Improve communication with Customers.
  - Increase Probability of Accepted Proposals.
  - Improve potential profitability of accepted projects.
  - Improve our ability to manage projects after we receive the contract (quantification of risk and opportunity).
  - Improved insight into impact of variability on our defined processes.

- Enhance our credibility as a high Maturity Organization with respect to CMMI level 5 certification.

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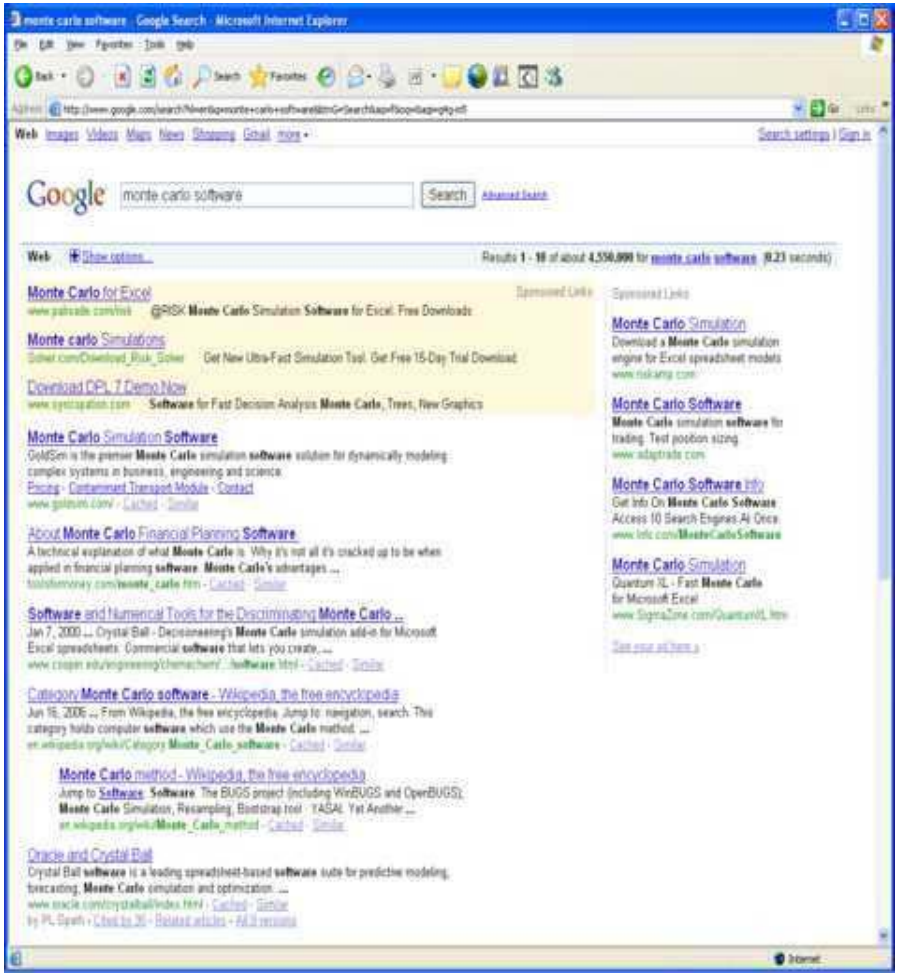
Need to Standardize on a Tool?

- Once determined that a Monte Carlo tool for project management is needed, series of questions arise.
- Should we standardize on a tool, or let people pick their own?
- There are a variety of software applications available.
- From free share ware, to special purpose analytical software.
- Prepared 1 Excel based estimation model using 2 different tools.
- Realized that ability to reuse models and analyses between facilities depended upon use of a single standard tool.



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How much training required?

- In preparing our process model using trial software, we found a quantitative management subject matter expert could be up to speed in 4 to 8 hours using free training available at the software vendor's web site.

- This convinced us that training for the packages we initially looked at would be a tractable issue and something we could use to evaluate between competing software packages.

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Trade Study of Tools

- If a standard tool for the division is to be selected need to develop.
  - Criteria for Selection.
  - Weighting of Criteria.
  - Scoring of Candidates by Criteria.

- If Criteria are to be listed.
  - Who/what group lists the criteria?
  - How is the group selected?

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Trade Study of Tools

- Group to do initial trade study.
  - Quantitative Project Management subject matter experts (SMEs).
    - Systems Engineering
      - 2 People
    - Performance Excellence (Project Management Office).
      - 2 People

- First Cut Criteria
  - Monte Carlo Simulation
  - Excel Integration
  - MS Project Integration
  - Intuitive GUI
  - Learning Curve
  - Application is stable
  - Free training
  - Cost of single license
  - Cost of Annual support
  - Cost of Network license
  - Tech Support
  - Vendor Stability

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Trade Study Outcome

- 2 software packages emerged as clear leaders.
- Very close numerical result between the two (<10% difference).

- Presented results to management.
- Alternative 1.
  - Standardize on package that scored the highest on this “paper study”.
  - Aim usage at subject matter experts.

- Alternative 2.
  - Require a usage study to choose the standard package.
  - Increase the scope of desired user base to include engineers/project support people.
  - Form a working group from larger base of stakeholders:
  - Review criteria and modify.
  - Design the usage study.

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Formation of Working Group

- Formed a Workers Group (8 people, part time) to define a pilot, or trial and complete the selection of a standard tool.
- To form the workers group, recruited 4 new people to original team of SMEs.
  - Information Technology Representatives: 2 people.
  - Engineering Planning: 1 person.
  - Engineering tool infrastructure: 1 person.
- The Workers Group:
  - Organized this work as a project.
  - Recruited and organized a larger Users Group (12 people) to participate in the pilot and provide feedback.
  - Ran the pilot trial.
  - Selected the standard tool.
  - Implemented the standard tool.

Monte Carlo (MC) tool selection and Standardization Project

- Project Goal: Improve Estimating Capability/Accuracy for Project Bids, Project Management, Technical Performance Measures Management.

- Project Purpose: Select a Commercially Available Monte Carlo computer program that integrates with Excel and MS Project to be the standard MC tool for the division (engineering, perf excellence).
  - Study and quantify the improvements by use of such a tool.
  - If justified, prepare for implementation and support of the standard MC tool for the division.

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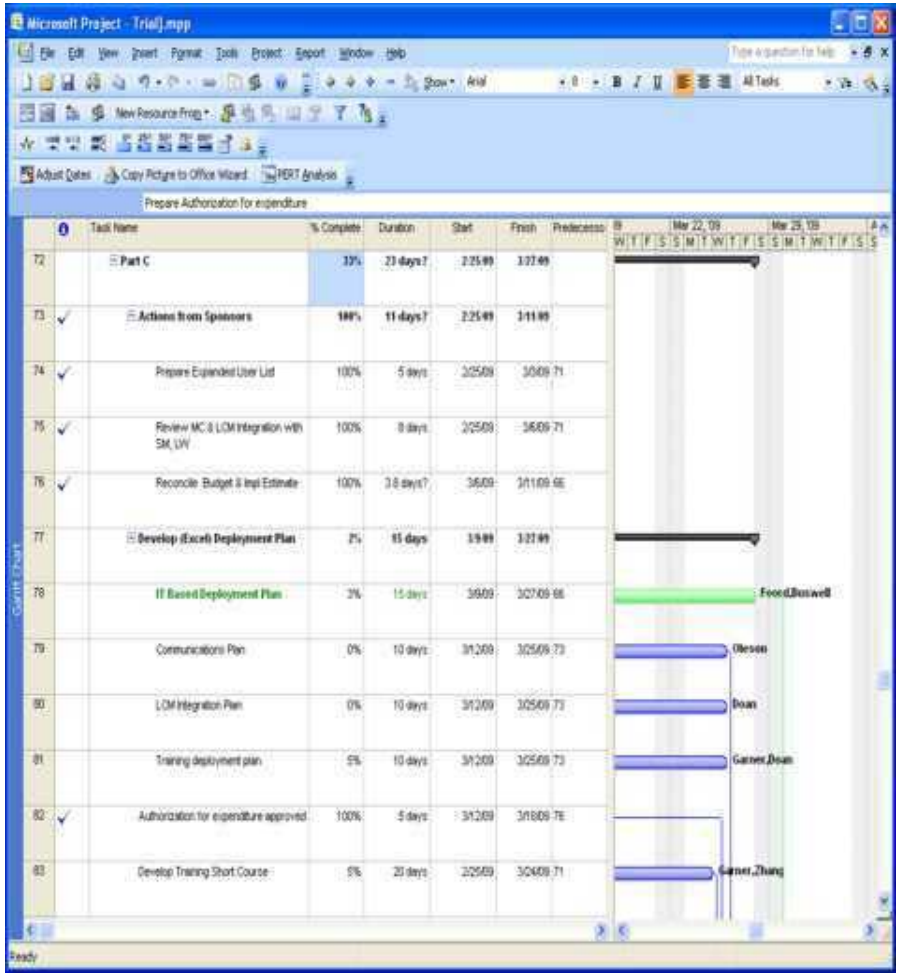
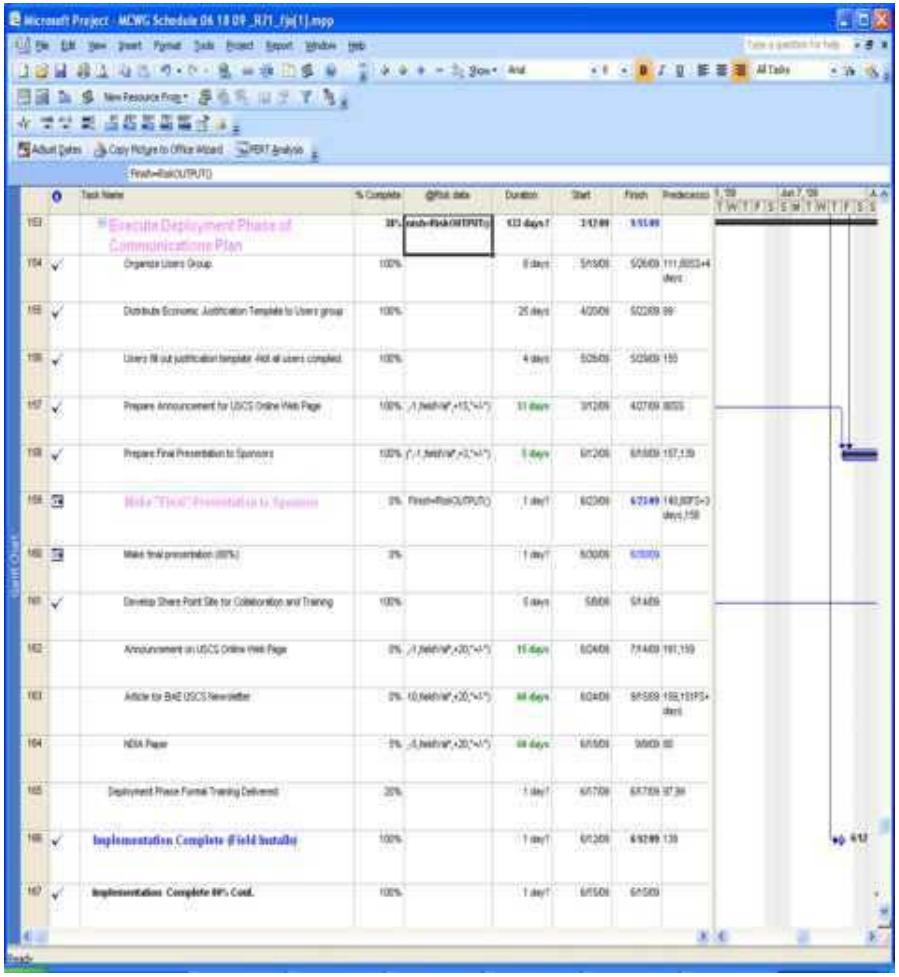
This Project was managed using the competing Monte Carlo software packages





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Documents Delivered at Initial Project Milestone

- Group Charter
- Change Proposal Plan
- Schedule
- Risk Register
- User Group Log Book

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Evaluation Criteria-Update

1. It is a Monte Carlo Simulation Integration.
2. Allows Integration with Excel.
3. Allows Integration with MS Project.
4. Intuitive Graphical User Interface.
5. “Short” Learning Curve (goal=4 hours).
6. Application run time stability.
7. Free Training Available
8. Cost of single user license.
9. Cost of annual support for single license.
10. Availability of network license.
11. Initial cost of network license.
12. Annual cost of support for network license.
13. Network license allows usage data collection.
14. Helpful and available tech support.
15. Vendor stability.

User Centric Criteria

IT Centric Criteria

Prior to implementation of the Usage Study a final paper analysis of criteria with the expanded worker's group.

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To take into account the continuing uncertainties in our ranking of criteria, the criteria matrix was recorded in Excel/ MC Tool and set up as a Monte Carlo simulation. Green cells indicate a value was put in as a distribution and not as a single point estimate. Blue cells indicate that the resultant value was collected across 1,000 simulations. The "Comparison" cell records the "winner" of each simulated ranking.

Numbers shown are samples only, not actual data.

Index Number	Criteria	Vendor A	Vendor B	Max=5, Min=-0	Max=1. Min=0	Max=1, Min=0		
				Weight	Vendor A	Vendor B	Vendor A	Vendor B
1	Monte Carlo Simulation	xxx	xxx	5	1	1	5	5
2	Excel Integration	xxx	xxx	5	1	1	5	5
3	MS Project Integration	xxx	xxx	4	0.5	1	2	4
4	Intuitive GUI	xxx	xxx	5	1	0.8	5	4
5	Learning Curve (Hours)	xxx	xxx	5	1	0.7	5	3.5
6	App Stable	xxx	xxx	4	1	0.9	4	3.6
7	Free Training	xxx	xxx	4	1	0.7	4	2.8
8	Cost of Single License	xxx	xxx	3	0.8	0.6	2.4	1.8
9	Cost of Annual Support	xxx	xxx	3	0.8	0.8	2.4	2.4
10	Network Licence Available	xxx	xxx	3	0.7	1	2.1	3
11	Cost of 1 NL	xxx	xxx	3	0	0	0	0
12	Cost of annual support for NL	xxx	xxx	3	0	0	0	0
13	Network License Use Data Available	xxx	xxx	3	0	0	0	0
14	Tech Support	xxx	xxx	4	1	0.9	4	3.6
15	Vendor Stability	xxx	xxx	2	1	0.9	2	1.8
	Total						42.9	40.5
	Comparison			**Comparison**	**AB**	-2.4		

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User Study to Compare Applications.

- Recruit User Group.
  - Representation by facility.
  - Representation by type of use.
  - Representation by type of project.
- Gain Cooperation of Vendors (licenses, training)
- Design and Distribute Log Book.
- Train User Group.
- Tutor and meet with user group members, collect information.

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Study Method (1)

- Study to confirm usefulness of Monte Carlo use in project estimation, risk analysis and scheduling tasks.
- Study to compare ease of use and performance of:
  - Vendor A and Vendor B applications
- Study Period from 11/13/08 through 01/09/09.
- Both vendors provided software licensing for study team for 100 days.
- Both vendors provided 1 WebEx based training session.

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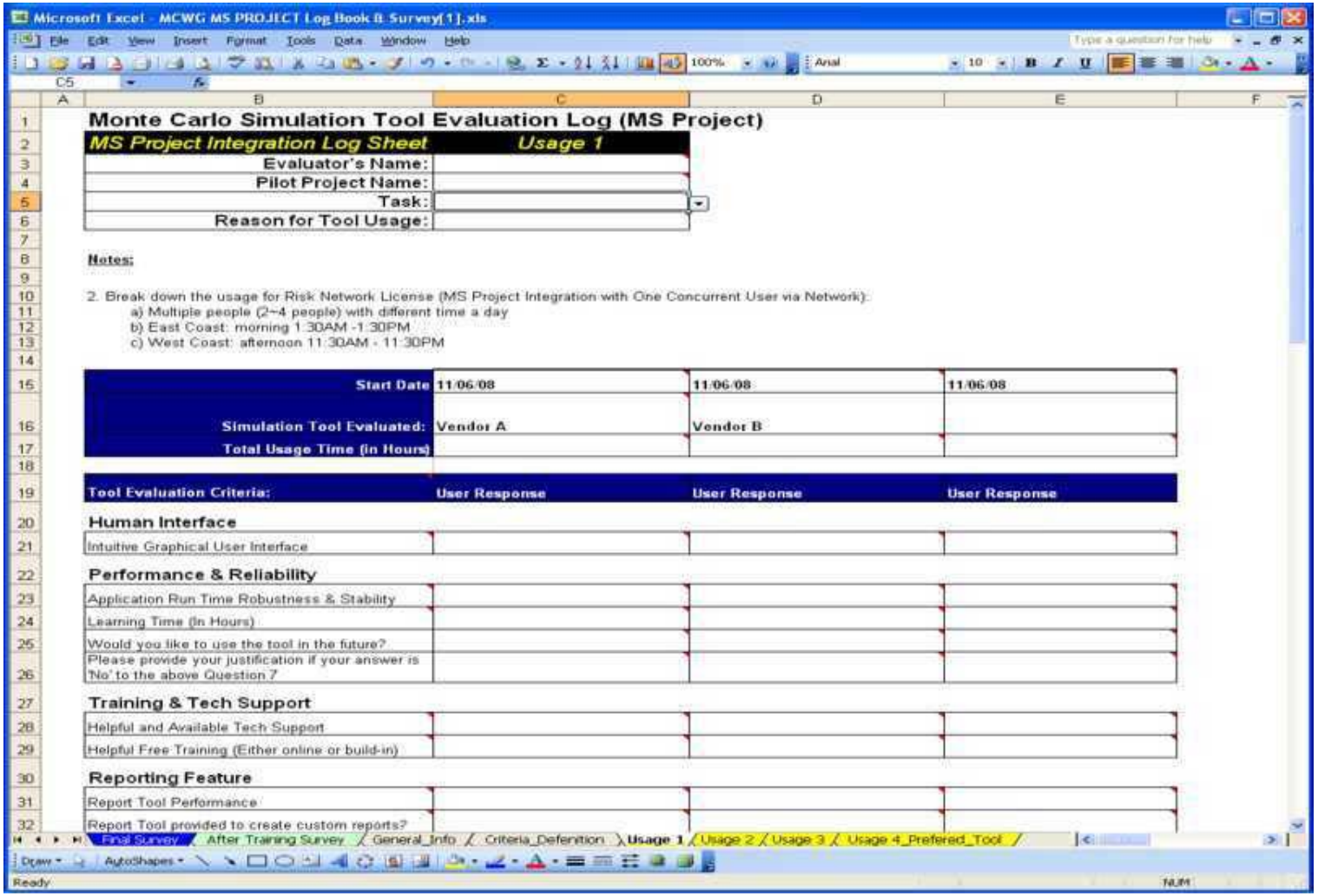
Log Book Usage Detail



Microsoft Excel - MCWG MS PROJECT Log Book & Survey[1].xls

Monte Carlo Simulation Tool Evaluation Log (MS Project)

MS Project Integration Log Sheet	*Usage 1*
Evaluator's Name:	
Pilot Project Name:	
Task:	
Reason for Tool Usage:	

Notes:

2. Break down the usage for Risk Network License (MS Project Integration with One Concurrent User via Network):
   a) Multiple people (2~4 people) with different time a day
   b) East Coast: morning 1:30AM -1:30PM
   c) West Coast: afternoon 11:30AM - 11:30PM

Start Date	11/06/08	11/06/08	11/06/08
Simulation Tool Evaluated:	Vendor A	Vendor B	
Total Usage Time (in Hours)			

Tool Evaluation Criteria:	User Response	User Response	User Response
Human Interface			
Intuitive Graphical User Interface			
Performance & Reliability			
Application Run Time Robustness & Stability			
Learning Time (In Hours)			
Would you like to use the tool in the future?			
Please provide your justification if your answer is 'No' to the above Question 7			
Training & Tech Support			
Helpful and Available Tech Support			
Helpful Free Training (Either online or build-in)			
Reporting Feature			
Report Tool Performance			
Report Tool provided to create custom reports?			

Final Survey | After Training Survey | General_Info | Criteria_Defenition | Usage 1 | Usage 2 | Usage 3 | Usage 4_Prefered_Tool

Ready

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Study Method (2)

- Total Study Group 20 people (8 core team, 12 user group).
- In their study log book provided by the core team, the participating user provided weighted rankings of the vendors applications based upon user centric criteria.
- The participating user also provided comments.

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Study Method (3)

- Study Group Included 2 representatives from BAE IT.
- The IT reps obtained technical and cost information from the 2 vendors about their applications.
- The IT reps also worked with others in the IT community to compare the characteristics of the vendor applications against BAE IT operating characteristics.
- The IT Reps prepared an analysis for the core team which ranked the 2 vendor applications by IT centric criteria and cost.

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Study Method (4)

- The User and IT Rankings were then integrated by the project leader.
- These rankings were discussed by the core team and approved.
- To the rankings were then factored comments from the users and other non quantitative factors to develop the final recommendations and path forward.

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Study Findings Comparison of Applications(1)

- We found that the subject matter experts planned to use both the MS Excel and MS Project Monte Carlo capabilities in their work.
- We found that members of the larger user group either had an interest in the MS Excel MC capability, or the MS Project MC Capability but not both.
- A majority of our large user group were only interested in the MS Excel application.
- The data showed that the users of the Excel MC application scored Vendor A the highest.
- The data showed that the users of the MS Project MC application scored Vendor B the highest.

Study Findings (2)

- The vendor with the strongest MS Project application (Vendor B) was adamant that their applications for Project and Excel were independent pieces of software and were priced accordingly.
- Our BAE Systems IT representatives determined that both applications were compatible with our division's IT infrastructure.
- IT felt they could make cost and operating accommodations with either vendor. Therefore IT would support the selection based on the user group scores.
- The Core team recommended that Vendor A be selected for MS Excel Monte Carlo application, and Vendor B be selected for only the MS Project Monte Carlo application.

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Project Path Forward (1)

- Our Management accepted the core team's recommendations that Vendor A would supply the standard Monte Carlo tool for MS Excel applications, and Vendor B would supply the standard Monte Carlo tool for MS Project applications.
  - Initial License Recipients.
    - Only those in the user group who had shown they would use the application would receive an initial license.
  - Additional Authorized Users.
    - New requests for access to the MC application would be accompanied by explanation of intended use, and potential savings.
      - However there was no mandatory savings threshold.

Project Path Forward (2)

- Training
  - A divisional training course would be provided for each application.
  - Providing this in house training course was to mitigate the registered risk of “garbage in-garbage out”. (Prevent abuse of an easy to use tool).

- Economic Justification
  - All users would be asked to track their use of the tool, estimate savings, or cost avoidance.
  - Designated members of the MC core team would periodically follow up with license holders to obtain savings estimates.

- Proposed Life Cycle Cost Management best practice:
  - Provide Confidence Level for Early Phase Reviews.

Tool Deployment (1)

- Reached detailed agreement on how many authorized users for each Monte Carlo application for major projects, sites, and departments.

- Developed a detailed deployment plan and schedule.
  - The hard work of the IT organization was especially important during this phase.

- Prepared justification documentation and obtained Authorization for Expenditure.
  - Required referencing the study results and support from all study participants, particularly the IT group.

Deployment (2)

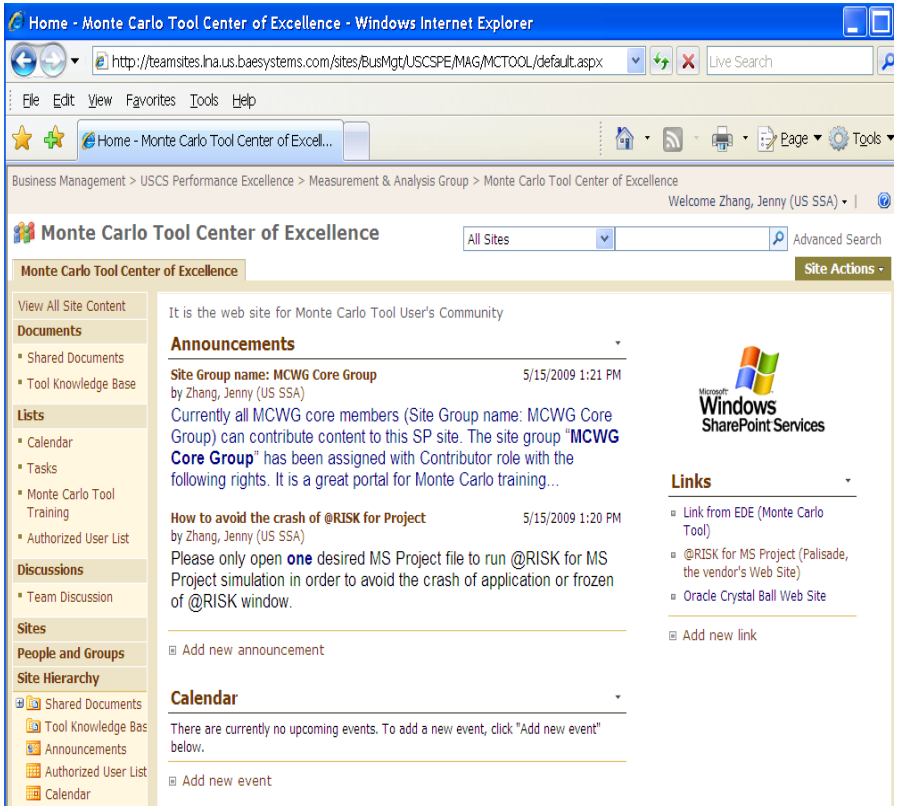
- The Core Team:
  - Tracked preparation of purchase orders against the project deployment schedule.
  - Receipt of the licenses against the project schedule.
  - Developed 3 divisional on line Monte Carlo training courses for new users.
  - Contacted initial authorized users and kept them informed of the scheduled “Go Live” date.

- The IT reps on the core team:
  - Obtained final technical approval from IT organization.
  - Trained their field reps in the new applications.
  - Developed a detailed paperwork methodology for users to request license installation.

Deployment (3)

- The Core team drove to a defined "Go live" date.
  - The team had been quoting an 80% probability "Go Live" date.
  - We actually began installations on users' machines a few days early.

- After the "Go live" date the original group of 4 subject matter experts became the "Application Trustees" for this application.
  - A Monte Carlo User Web Site was established.
  - Tasks embodied in the project's communications plan were implemented.



Summary of Results (1)

- On line training classes have been established in the division.
- The MC software has been installed and is in use.
- An MC User group and web site have been established.
- There are Monte Carlo software users at all division sites.
- Process models have been written and shared across sites.
- Subject matter experts use the application consistently.
- The authorized users have expanded beyond the original individuals involved in the study user group.

Summary of Results (2)

- The tool has been used on a major project to supply information requested by the customer.
- The tool has been used on a LEAN project to predict expected cost avoidance, given a proposed process change.
- Use of Monte Carlo has been very beneficial in managing stakeholder expectations of schedule and cost.
- The application trustees have not encountered any problems with complaints about the wrong tool being selected.
- The IT organization have not encountered any problems with requests to purchase other MC tools.

Conclusion

- This project of selection, standardization and implementation of a Monte Carlo software application has been counted as a success.
  - The expectation is that data for quantitative justification of the tool will come mainly by records kept by the subject matter experts.
  - The more general and infrequent users will see the Monte Carlo application as an additional tool to improve the likelihood of business winning and customer satisfaction.