GALORATH

Project Mangement Decisions Based on SW Measurement

Modeling Beyond the Estimate

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SEER

The Issue!

- Depending on which data you reference, there is a 50 to 80% probability that a software project will fail
  - Project will require significantly more time than planned
  - Cost significantly more than budgeted or
  - Deliver significantly less functionality than originally expected
- The larger the project – the longer the planned duration, the greater the likelihood that it will fail
- Software projects require management during execution, not just at planning
  - Managing resources
  - Managing requirements growth
  - Managing processes and training

Project Management

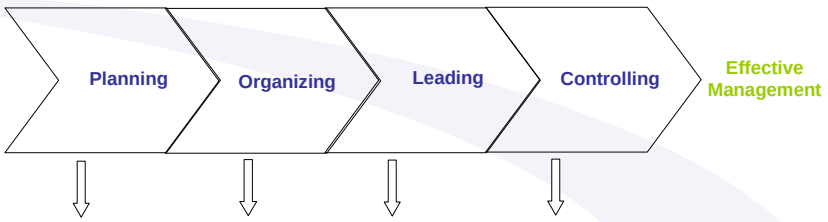
Project management: A discipline that employs skills and knowledge to achieve project goals through various project activities. It involves planning, organizing, leading, and controlling *costs, time, risks, project scope, and quality*

Supporting Project Management –

Planning and Estimation Model

* STC Crosstalk Jan 2003

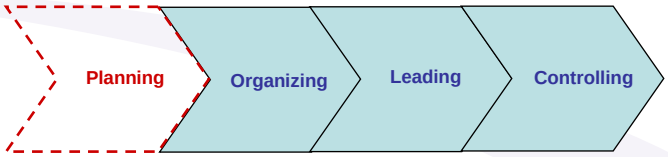
Effective Project Management



- Planning the project and establishing its life cycle
- Organizing resources such as personnel, equipment, materials, facilities, and finances
- Assigning the right people to the right tasks
- Motivating people
- Setting the project's course and goals
- Evaluating project progress
- Applying changes to keep project on track

Projects rarely succeed by themselves. They must be planned well and *executed well*.

Cost Estimation Team Supports the Entire Program Management Life Cycle

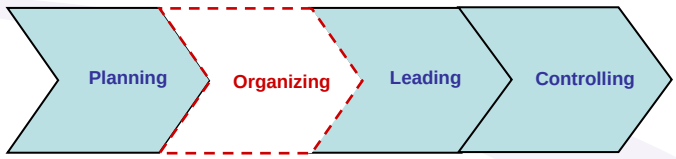


• Planning the project and establishing its life cycle

- The cornerstone of successfully establishing and completing any project or program is a rational cost and schedule estimate*
- Estimates based on parametric models provide both rational cost and schedule estimates and effective tools for ongoing project management
- Estimates are the basis for trade-off studies and management decisions regarding realistic project lifecycle planning

*STC Jan 2003

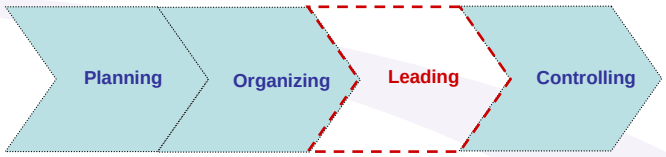
Cost Estimation Team Supports Organizing



• Organizing resources such as personnel, equipment, materials, facilities, and finances

- Models provide "objective" evaluation of alternatives for example:
  - Architecture and design alternatives
  - Staffing – level and experience
  - Processes for productivity

Cost Estimation Team Supports Leading

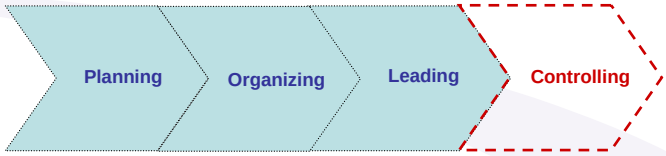


Models provide "objective" evaluation of decision alternatives, for example

- Effort/schedule as result of personnel assigned
- Evaluate accomplishments against goal
- Compare actuals to model projections
- Model projections provide assessment of alternatives during reassignment

- Assigning the right people to the right tasks
- Setting the project's course and goals
- Reassign resources to optimize project performance

Cost Estimation Team Supports Controlling



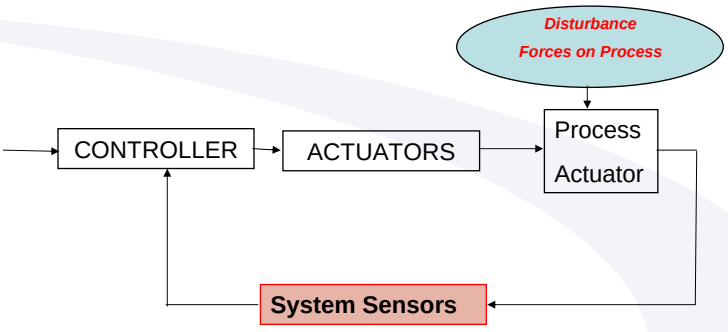
- Earned Value Management, detailed project plans, resource management
- Objective inputs from models provide evaluation of project metrics
- Models support objectively predicting problems
- Models provide objective assessment of alternatives
- Models provide objective assessment of risk mitigation strategies

- Evaluating project progress
- Applying changes to keep project on track

Control Theory

- Control Systems are what make machines, in broadest sense work
- Most often based on the principle of feedback
  - A desired objective is defined for the system
  - Resources are applied, raw material is processed
  - Sensors are used to collect metrics
  - Metrics are analyzed to determine if the system is meeting its objectives
  - Math models of the “real world” system are typically used to choose corrective actions from a set of possible actions
  - Corrections are made to the input in order to improve the performance of the system

Sample Control System



Control Theory
Software Project Management

- Software Project Management provides control in order to satisfy project objectives
- Establish objectives
- Apply resources
- Obtain metrics
- Analyze results
- Identify alternative actions to correct problems identified
- Implement corrective action

Control Theory – Project Management

- Feedback control systems typically implement a model
  - Best possible math representation of the real world
  - Provides the basis to evaluate alternative control actions available
  - Typically control inputs are the result of analysis supported by a math model representing the “real world”
- Software Project Management control system can be implemented in the same fashion
  - The parametric models used to establish plan (effort, staffing, schedules) can provide basis for Project Management “feedback” control
  - Maintaining the models “after the estimate” allow the models to continually improve the fidelity of the information provided
  - Enhancing the models to provide project management data such as EVM, staff planning, schedule, risk improves the management support.

Metrics For SW Project Management

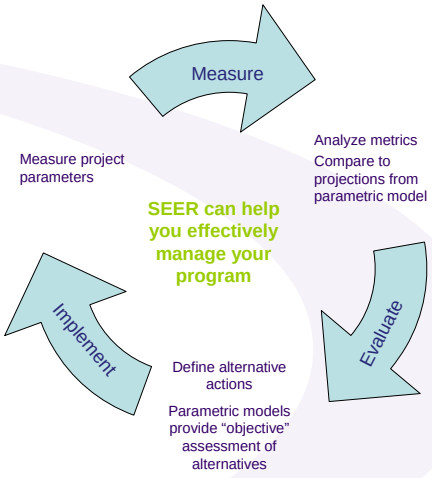
- Measurement should not be implemented as a *check-the-box* process that is rolled out to satisfy a scheduled review or process improvement assessment – Metrics should be collected to support "feedback control" for project management
- ***Feedback control requires continual collection of metrics reflecting performance of "the system"***
- Measurement must provide real information to support critical project and organizational business and technical decisions, and the measurement results must be effectively communicated and used across the entire corporate entity
- As in physical process control—project management can benefit from a model of the process to support analysis of alternative actions

Models applied to SW Projects

- **Glass Cockpit upgrade project**
  - Initially budgeted from an optimistic estimate
  - Requirements changes for screen content from customer
  - Software EVM for CPI and SPI both significantly below "1"
  - Problem: Reduce costs and improve schedule if possible
  - Alternatives were modeled:
    - Additional training in tools yields improved productivity
    - Modeling same scenario with improved performance indicated a reduction of 22 days over 18 months – reduced 22 days from project burn rate of $100K per day
- **Requested to reduce schedule 21 days on critical component of air craft upgrade**
  - Customer indicated agreement to adding people
  - Modeled with overly optimistic projections of increasing staff of 22 to 33.
  - Result increase time by over 3 weeks and increase cost bt 54%

Parametric Modeling: Beyond Estimation

- Implement actuals to improve model fidelity is part of maintaining the model
- High fidelity models provide a basis for realistic assessment of actuals against plans for large complex projects
- Model provides "objective" projections to compare project metrics



Project Control
(Typical)

- Introduce measurement and metrics process
- Next introduce tools that schedule tasks and allocate resources as some function of inter-task dependencies, resource availability, and priority
- Re-baseline
  - Identify all remaining tasks
  - Typically slide the schedule of the entire redefined project to begin on the current date
- Problem: Does not consider what may have caused the project to be in trouble in the first place, ie size is much larger than expected and/or actual performance is not matching actual performance
- Potential solution: Include established estimation methodology and algorithms as part of the prediction and re-baselining activities

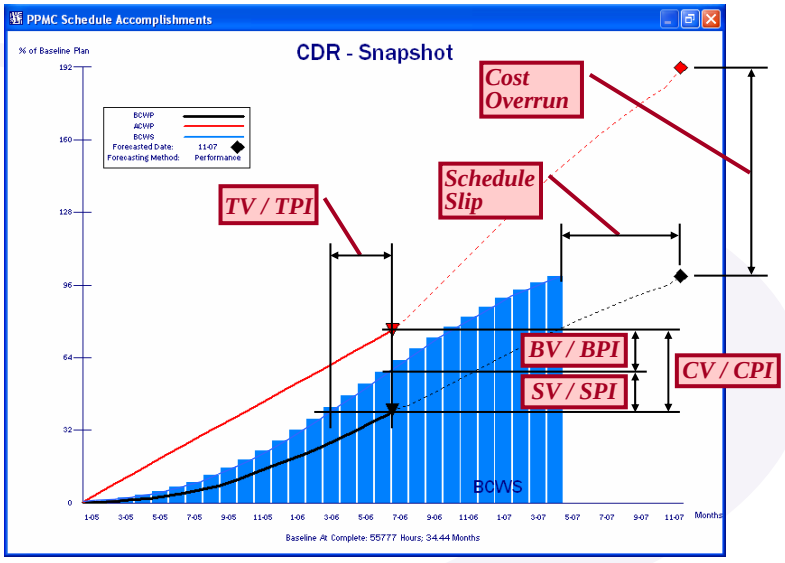
Parametric Project Monitoring and Control

- Extend the scope of software development project estimation to include projects underway where some project actuals (metrics) already exist
- Performance based Modeling supports analysis of project metrics
- Performance-based forecasting and re-baselining -- *At the heart of PPMC is the desire to forecast the final project outcome*
- Forecasting the final outcome
  - Start a new estimate with current baseline as starting point
  - Update size estimates – critical to evaluate reuse effeciency
  - Update technology assumptions
  - Update schedule assumptions (review start dates to ensure the model is aligned with actual accomplishments.
  - Update staffing assumptions – staffing constraints
  - Re-baseline project – May require reduction in functional capability, delay in delivery of some functions

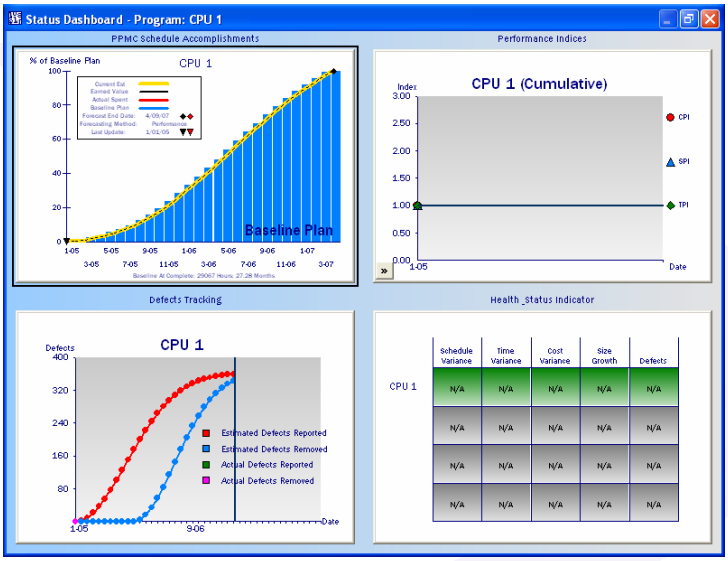
Parametric Project Monitoring & Control

- Software cost/effort estimation tools can be used to support project monitoring and control
- PPMC is an extension to SEER-SEM
- Tool provides
  - Establishing a baseline
  - Input snapshots (actual performance data – EVM data)
  - Series of charts and reports reflecting accomplishment against plan
  - Projections of EAC (baseline – re-baseline from actual performance
  - Stop light chart to provide quick look information

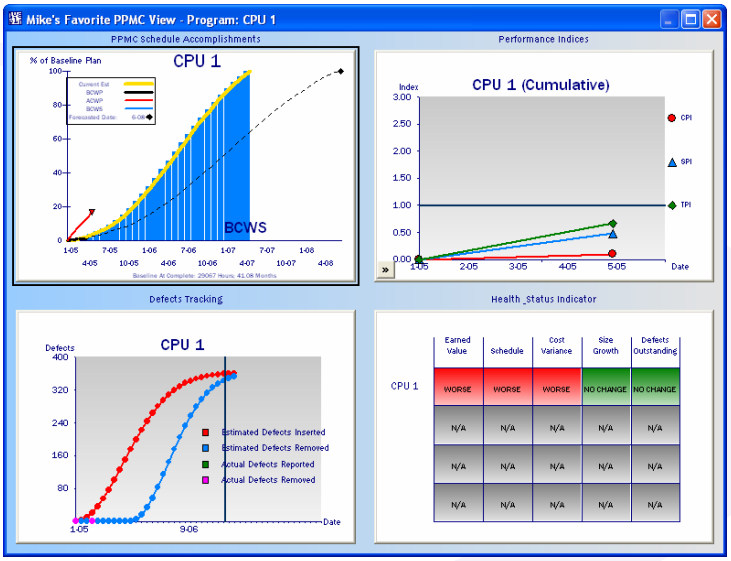
Schedule Accomplishments Chart



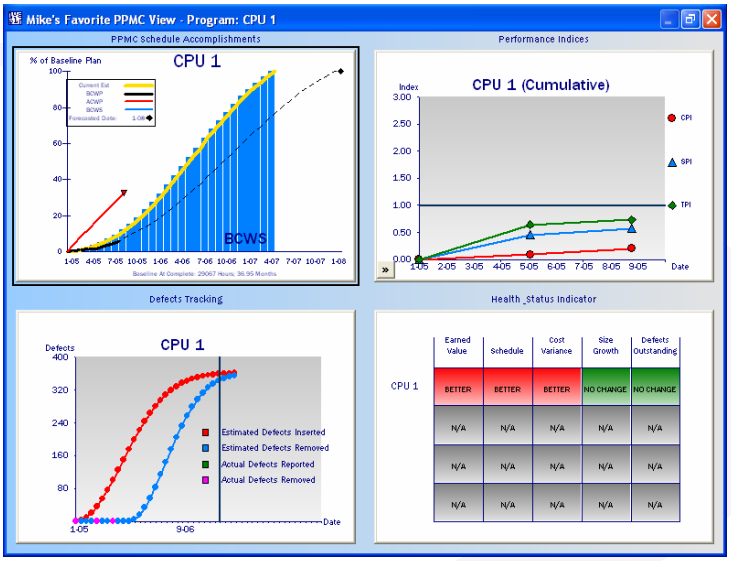
Example Project: Metrics Charts at Project Start (Initial Plan)



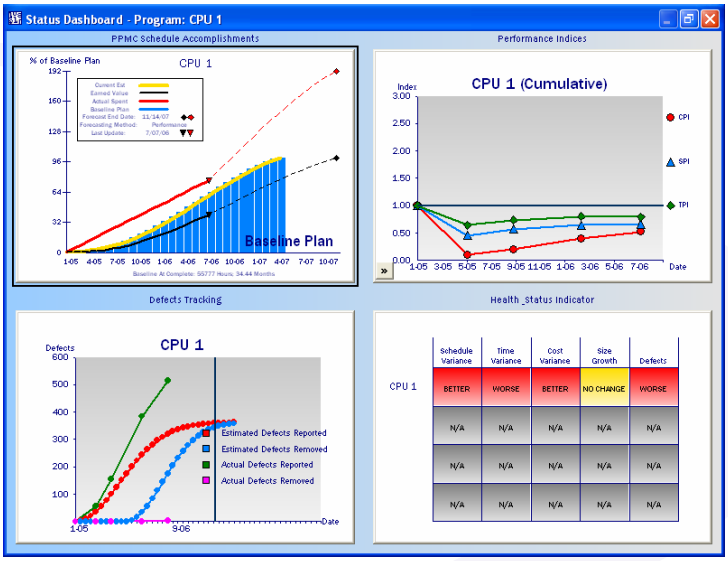
Example Project: Metrics Charts at System Design Review



Example Project: Metrics Charts at Software Requirements Review



Example Project: Metrics Charts at Critical Design Review



Project Management: Parametric Models *Beyond the Estimates*

SYSTEM EVALUATION OF RESULTS -- Actuals compared to Model projections.

	Accomp.	Schedule Status	Staffing Status	Error Detection Rate	ESLOC
Computing Sys					
COE (Common Operating Environment)					
Training Ser.					
Decision Support					
Mission Eval					
Network Mgt					
Sensor Mgt					

Project Metrics – Model Projections

Comparison range settings

*	Accomp.	Schedule	Staffing	Error Rate	ESLOC
Computing Sys	20%	10%	5	10%	20%
	10%	5%	3	5%	10%
COE	20%	10%	5	10%	15%
	10%	5%	3	5%	10%
Training Ser.	20%	10%	5	10%	10%
	10%	5%	3	5%	5%
Decision Support	20%	10%	5	10%	10%
	10%	5%	3	5%	5%
Mission Eval	20%	10%	5	10%	10%
	10%	5%	3	5%	5%
Network Mgt	20%	10%	5	10%	10%
	10%	5%	3	5%	5%
Sensor Mgt	20%	10%	10	10%	10%
	10%	5%	5	5%	5%

Project Metrics – Model Projections "raw data"

PARAMETER VALUES FROM THE MODEL AND METRICS DATA									
Accomp.		Schedule		Staffing		Error Rate		ESLOC	
Model Data	**metrics data**	**Model Data**	**metrics data**	**Model Data**	**metrics data**	**Model Data**	**metrics data**	**Model Data**	**metrics data**
27.5%	30.0%	40.0%	45.0%	16.0	15.0	68	65	4400.0	4100.0
61.7%	52.6%	61.7%	60.0%	40.0	38.0	120	80	26730.0	25200.0
35.0%	35.0%	35.0%	40.0%	40.0	39.0	75	73	26830.0	26100.0
40.0%	34.0%	40.0%	40.0%	42.0	40.0	90	88	26930.0	25900.0
50.0%	59.0%	50.0%	51.0%	47.0	43.0	65	63	27030.0	26570.0
55.0%	50.0%	55.0%	52.0%	43.0	41.0	110	108	27130.0	27000.0
50.0%	58.0%	60.0%	57.0%	51.0	42.0	50	47	27230.0	23500.0

Project Management – Model Projections

- **High fidelity models provide effective measures to evaluate project metrics**
- **Maintaining high fidelity models provides a realistic estimate of cost and cost-to-complete for the program on a continuous basis**
- **Maintaining an ongoing analysis of the contractor metrics reports as compared to the parametric model's projection of the metric.**
  - Metrics analysis can be provided as "stop-light" type charts for easy management review, quickly indicating areas of performance that require review.

Summary and Conclusions

- **Effort/Scheduling Models have been shown to provide objective information as a basis for project management decisions**
  - Analysis of alternative actions to impact effort and/or schedule
  - Analysis of project performance against an expected nominal project team
  - Development of ETC based on project performance to date
- **Project Management for large projects (especially multi-year projects with significant software and hardware subsystems) should utilize cost/effort estimating models in the suite of project management tools.**
- **Cost/effort estimating models such as SEER-SEM with it PPMC provide a powerful aid to Project Management, yielding "objective information" for systems trade-offs and project management decisions throughout the development, integration, and test of a program's life cycle.**

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Thank you

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