Presentation

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P R E S E N T A T I O N

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Thursday, March 9, 2000
10:30AM

MEASUREMENT MATURITY AT CMM LEVEL 3

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Measurement Maturity at CMM Level 3

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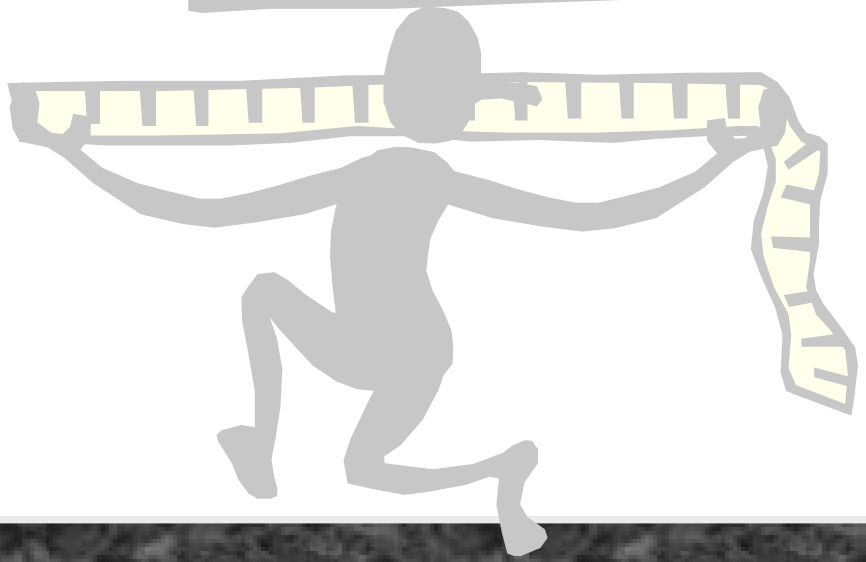


Objectives

Discuss CMM Level 2 and 3

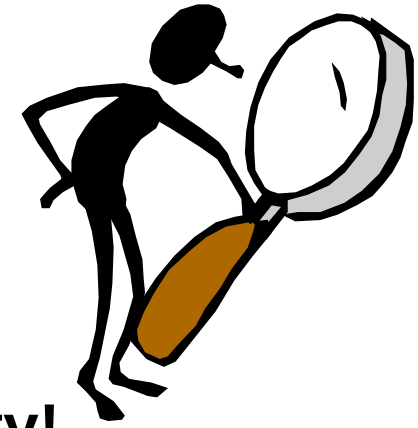
- **Measurement requirements are embedded throughout model**
- **Intent is that measurements are taken and used**

Describe characteristics of a mature measurement program at Level 3

Discuss measurement requirements from an assessor's perspective

Provide examples and good and bad practices/programs

CMM and Measurement



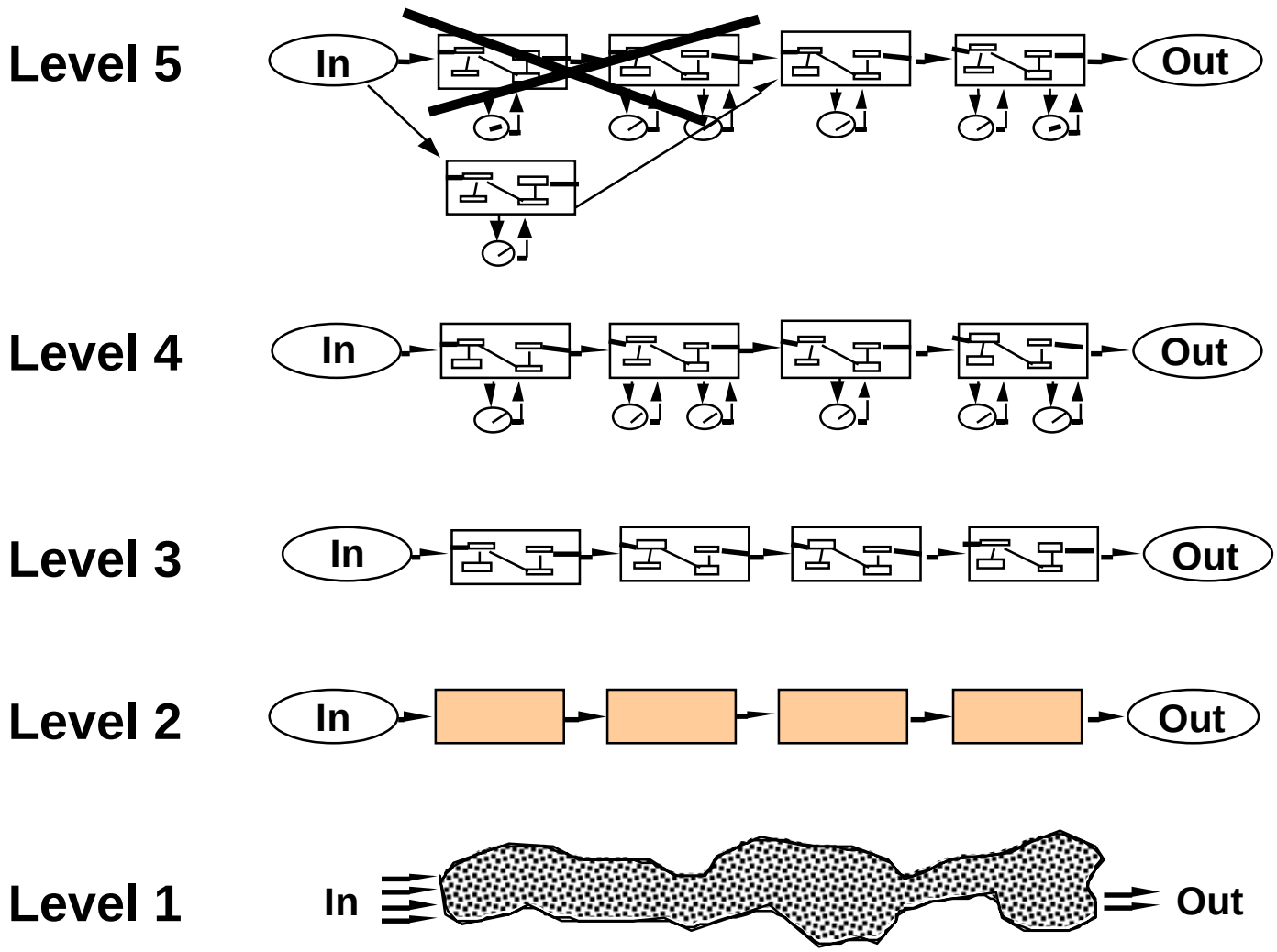
Measurement provides visibility into the process

Measurement is not a “Level 4 only” activity!

Measurement is scattered throughout CMM Level 2 and Level 3

To be ready for CMM Level 4, must have solid measurement at Level 3

Measurement Visibility



Source: Perdue in (Paulk et al., 1995)

Measurement Requirements...

Project Management Measures

- Planning and Tracking (SPP, SPTO, ISM)
  - Work Product/Software Size (SLOC, FP, Pages, Reqs)
  - Work Effort, Cost, Schedule
  - Critical Computer Resources
- Organizational Database (OPF/OPD, ISM)
  - Historical Data (Size, Productivity, Effort Distribution)

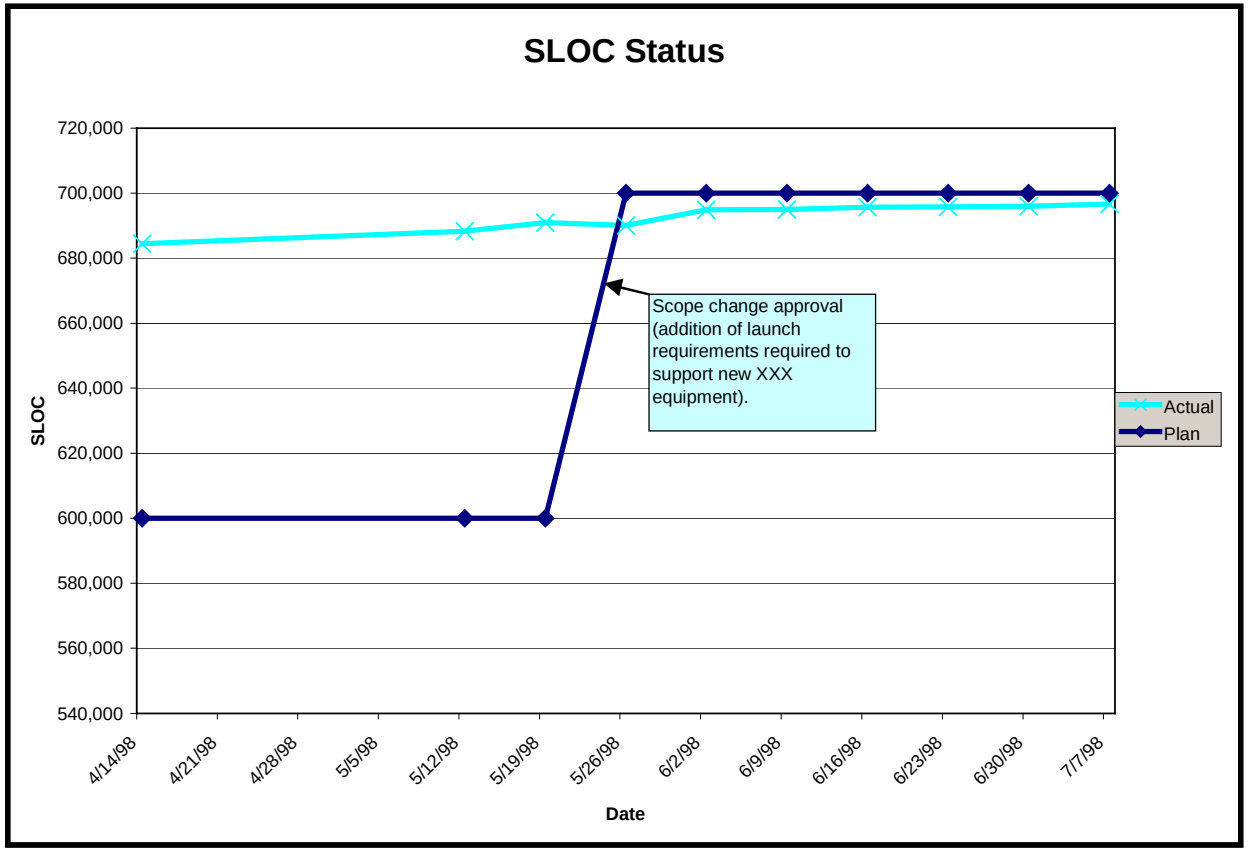
Product Management Measures

- Peer Review Defect Data (PR, SPE)
- Test Defect Data (SPE)

Process Management Measures

- Process Status (ME1s - All KPAs)
- Peer Review Process Data (PR)
- SPI Progress (OPF/OPD)
- Training Quality (TR)

Project Management Measures



Project Management Maturity

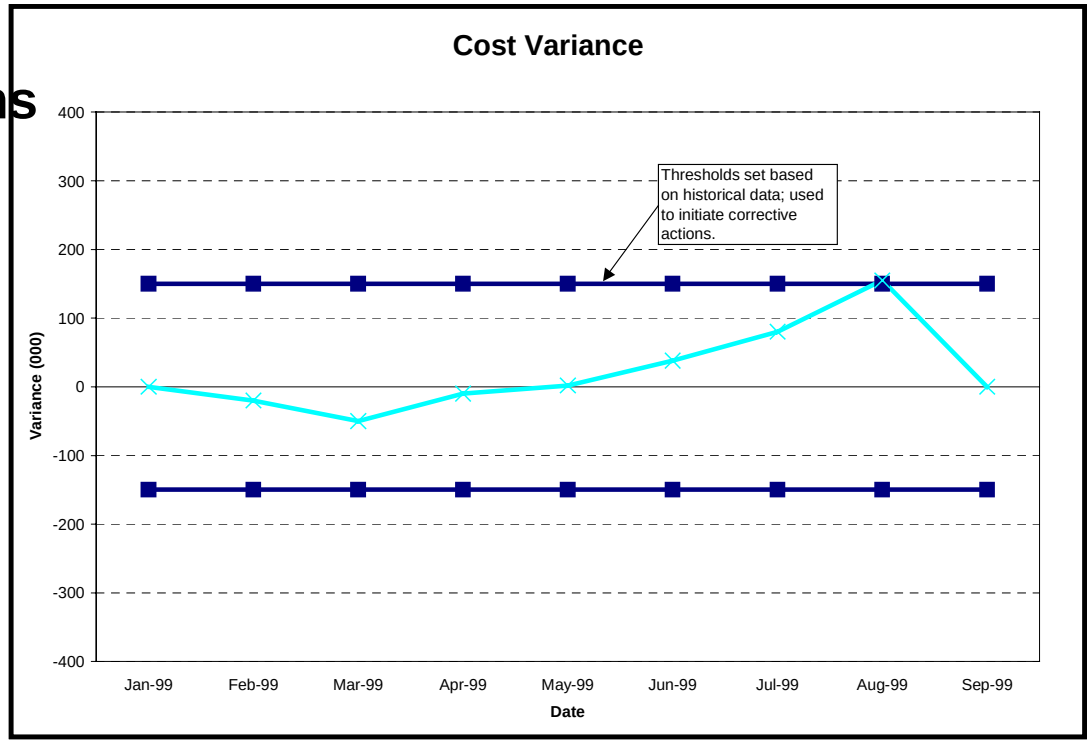
Expectation of increased maturity from L2 to 3

Level 2 - Plans vs. Actuals

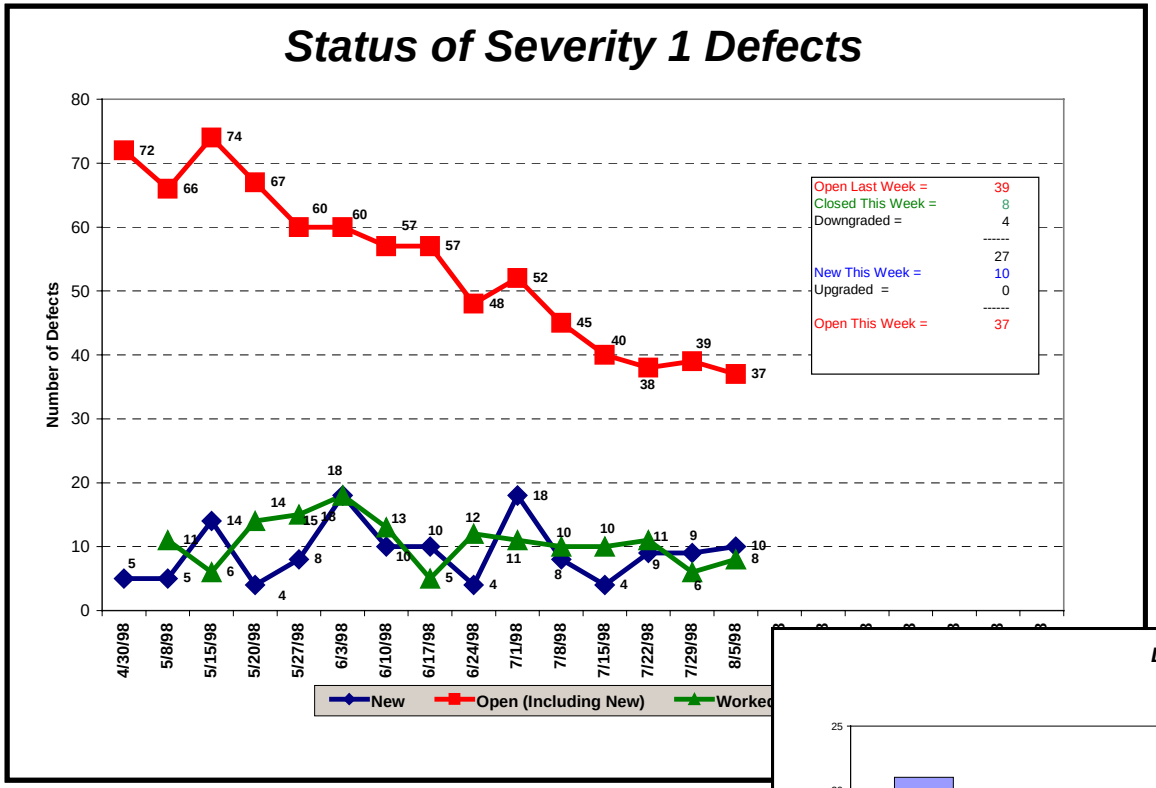
- Plans may be best guess, some historical data

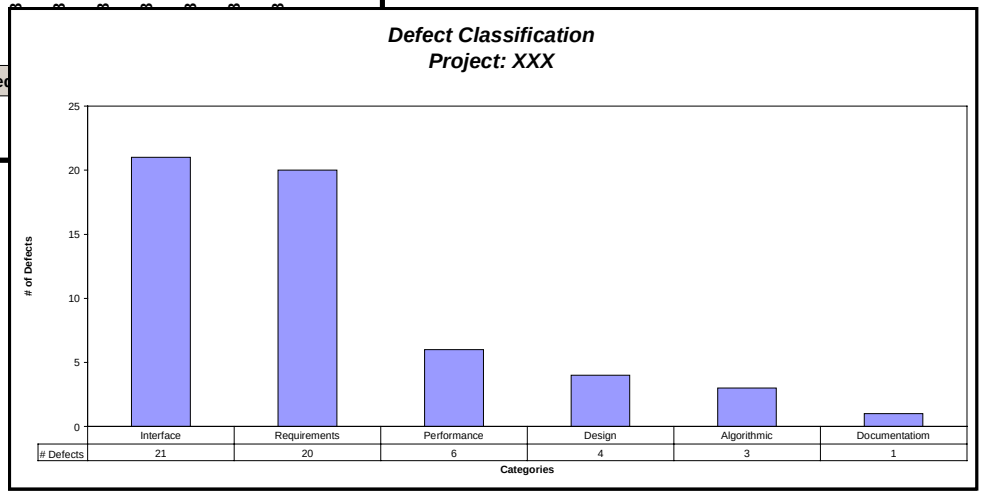
Level 3 - In-process correction

- Thresholds
- Expectation of norms

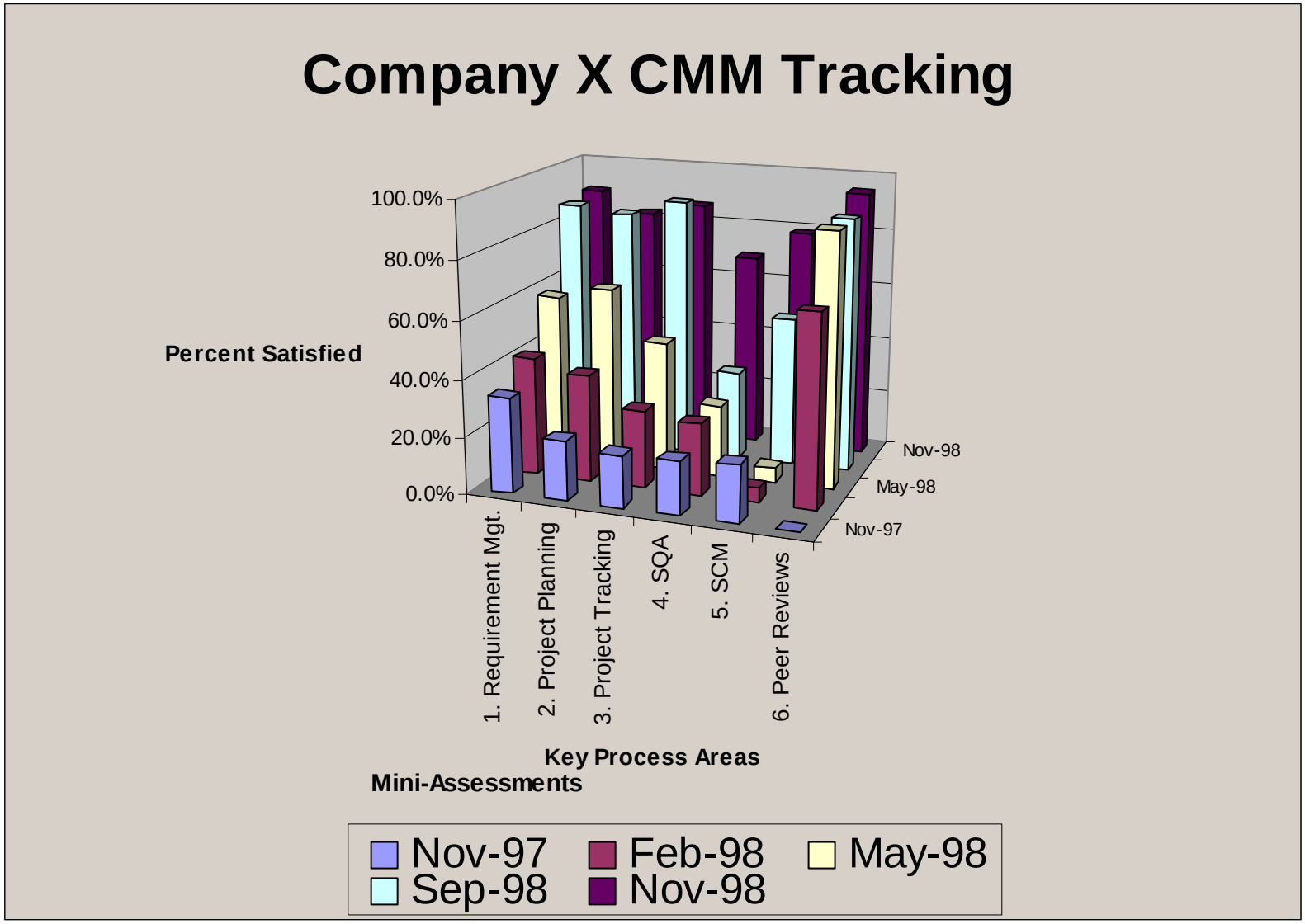


Product Management Measures

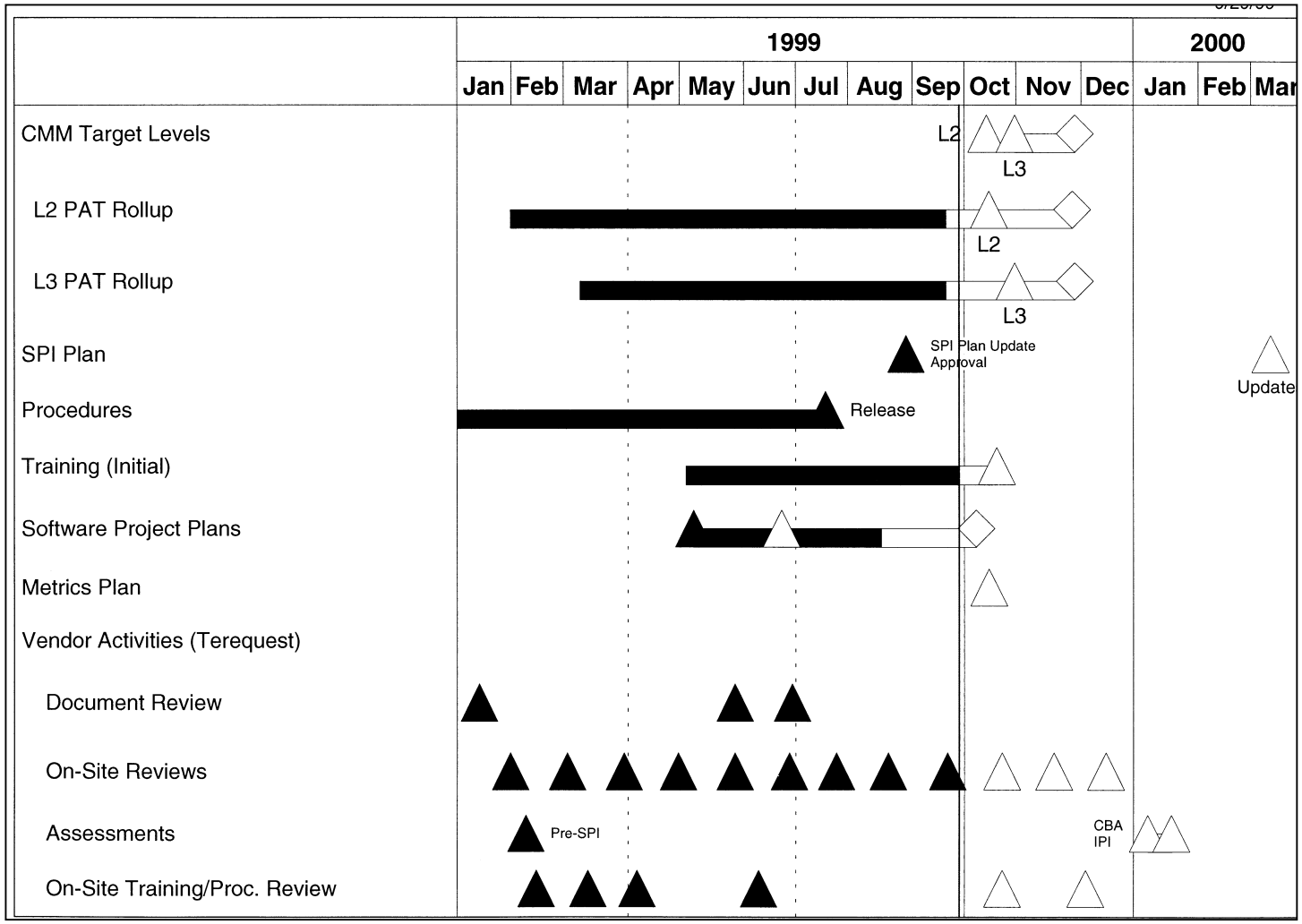


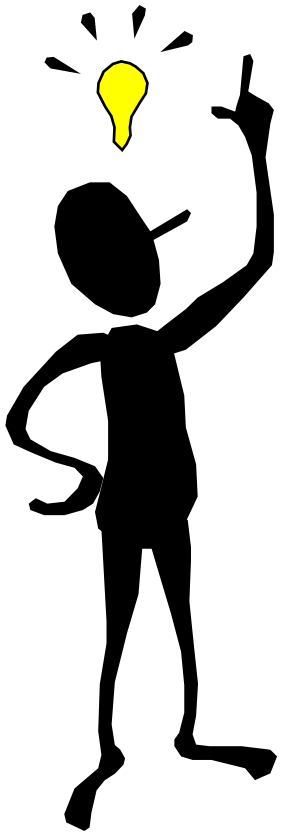


Process Management Measures



Process Management Measures



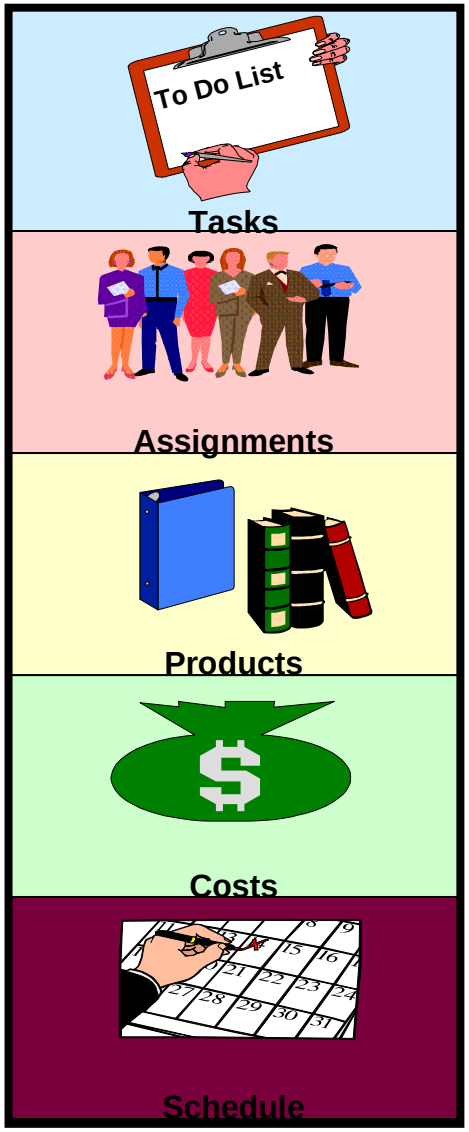


Good Examples
Lessons Learned

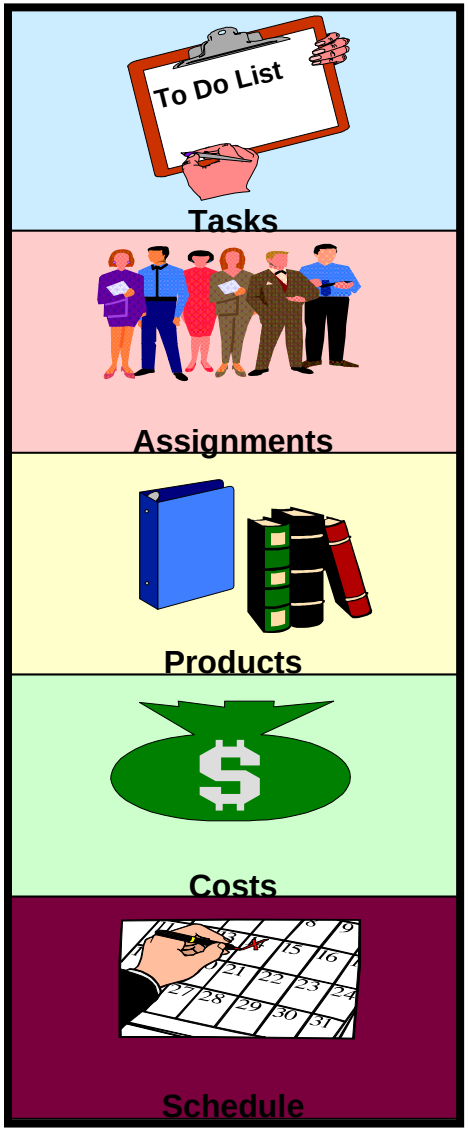
Problems with ME practices

Each CMM key process can be described in terms of:

- **Tasks or Activities**
- **Assignments or Resources**
- **Work Products/Deliverables**
- **Costs/Dollars**
- **Schedule/Dates/Milestones**



Problems with ME practices



Purpose: To provide insight into the STATUS of the Key Process Areas.

Activity Status

Tasks:
- Actual progress vs. plan
- How soon will we be done?
- Are we behind schedule?

Resources:
- Costs incurred vs. plan
- Effort Consumed vs. plan
- Are we over budget?

Product Status

- Deliverables produced vs. plan
- Deliverables complete?
- Behind schedule?

Problems with ME practices

Common misinterpretations:

- SPP and PTO -- Insight into the effort and resources required to do proper project management (planning and tracking)
- PR - not defects found, but number of reviews performed and review time spent vs. time allocated for reviews

Collected AND USED:

- Collect data
- Analyze data
- Interpret results
- Report results
- Take action

Level 2 & 3 ME doesn't prepare you for Level 4!!

- examples shown are not always what will be placed under SPC

Problems with Standard Sets

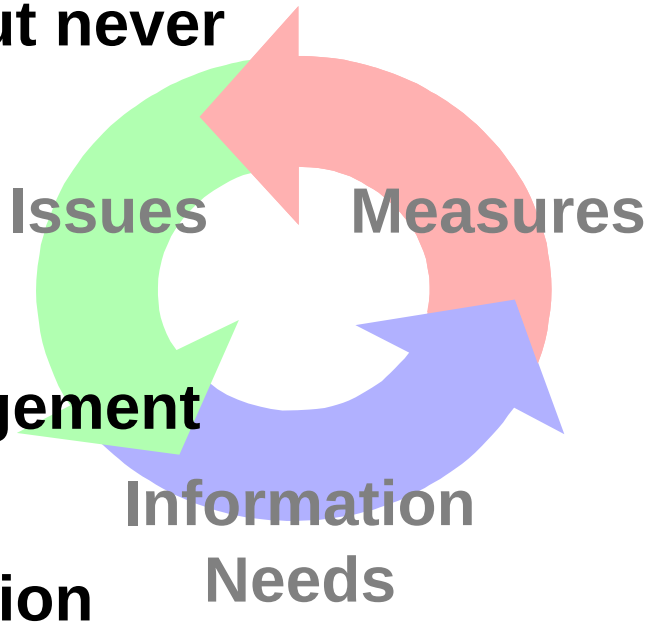
Metrics Group dreams them up - if it can be measured...

Asked for (projects must submit) but never used

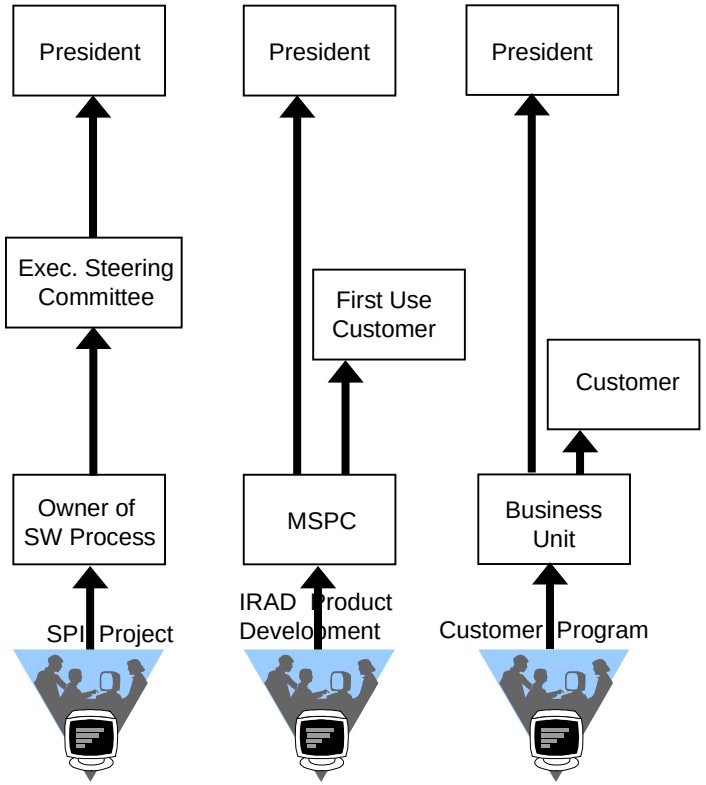
Data not used is rarely accurate

Projects don't incorporate use of measurement into their daily management process

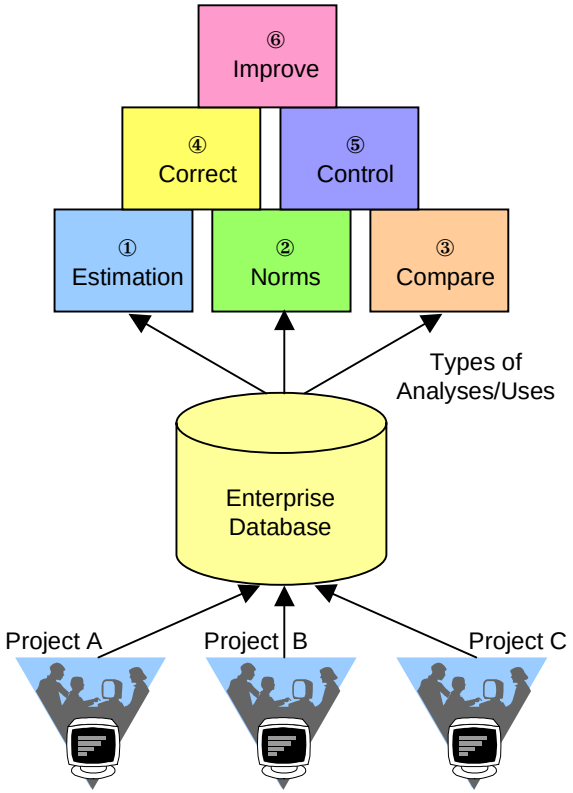
Clearly identify issues and information needs of both project management and process management before identifying "required" measures



Project vs. Process Needs



Project Oversight: Only projects report status up the chain - they own the status.



Process Insight: Analysis of the process increases with Maturity - organizational metrics used and SEPG or metrics group responsible.

Peer Review Data

Product Type	# Peer Reviews	# Defects Found		Average Size (Pages or KLOC)	Total Size	Average Number of Reviewers per Review	Review Times		Productivity		
		Major	Total				Avg Prep Time per Reviewer	Avg Mtg Time per Reviewer	Major Defects Found / Hour (Total Rvw Time)	Total Defects Found / Hour (Total Rvw Time)	Major Defects Found / Size
RAD	1	0	28	13.00	13	6.0	0.67	0.67	0.00	3.11	0.00
SRS	7	0	73	6.86	48	4.4	0.68	0.87	0.00	1.48	0.00
PS	8	3	76	3.50	28	4.5	0.33	0.67	0.08	1.96	0.11
DA	13	2	188	13.23	172	4.5	0.57	1.20	0.02	1.91	0.01
PS & DA	1	0	11	12.00	12	5.0	0.23	1.00	0.00	1.65	0.00
FRS	1	0	15	6.00	6	6.0	0.62	0.75	0.00	1.76	0.00
SDD	6	0	215	23.50	141	5.3	1.00	2.47	0.00	1.72	0.00
Code	16	11	393	1.45	23.2	3.7	0.95	1.48	0.07	2.46	0.47
Proc	6	24	129	14.67	88	4.5	0.39	1.24	0.50	2.71	0.27
SCM	0	0	0	0	0	0.0	0.00	0.00	0.00	0.00	0.00
Totals	**59**	**40**	**1128**			**4.4**	**0.54**	**1.03**	**0.07**	**1.88**	
							Hours per defect:		**14.9**	**0.5**	

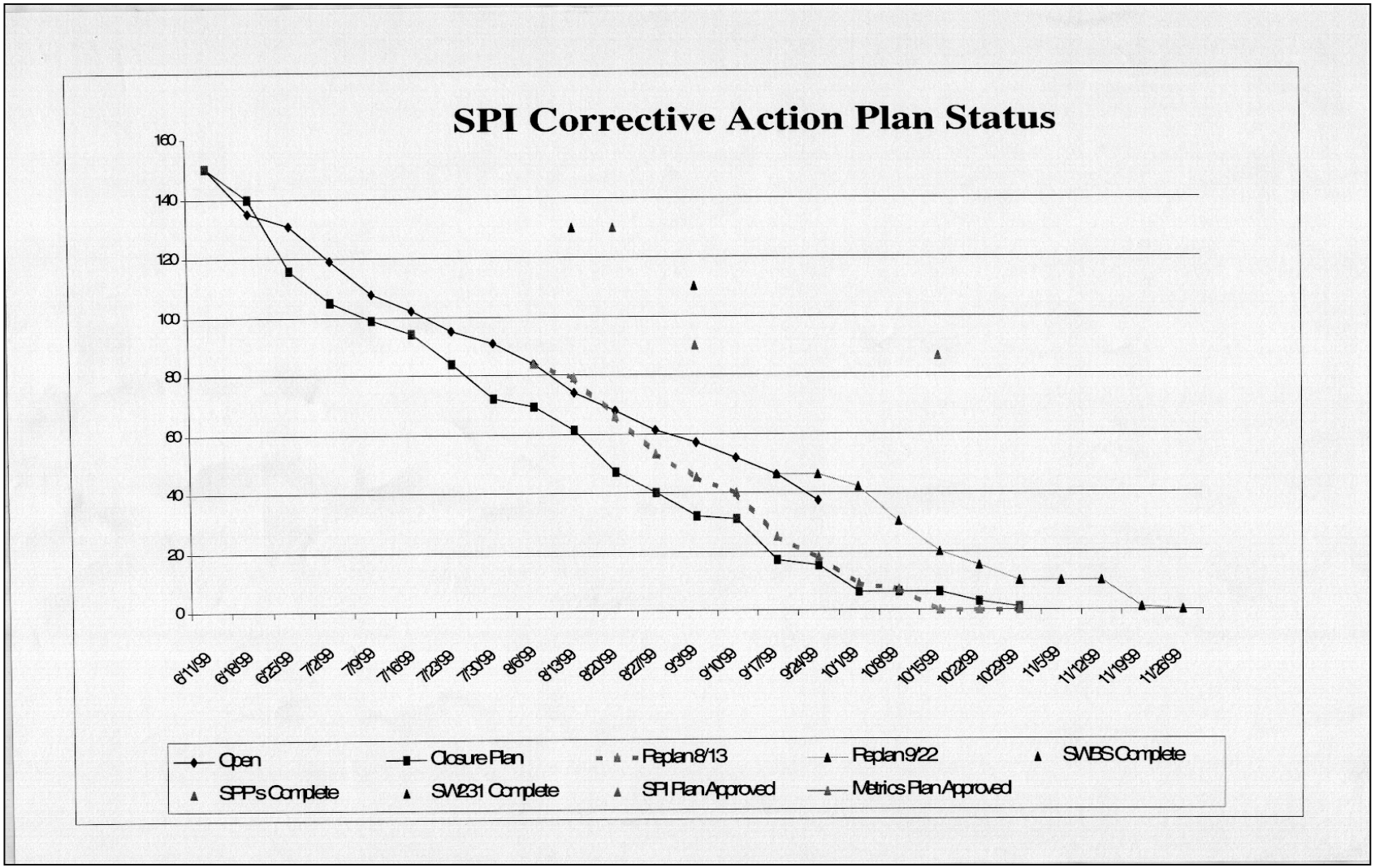
Analysis of Initial Data

- **The peer review data required for meaningful analysis was not entered for 40 of the 99 peer reviews (40%) reported**
- **Few "major" defects are being detected for the time spent**
- **The average number of LOC reviewed per session is very high, making it difficult to detect major defects**
- Currently spending about twice as much time in the Peer Review Meetings versus preparing for the review.
- **Need to spend more time preparing for the review and finding major defects.**
- Rework time does not appear to be captured.
- Analyze test results (in Tracker) to determine how many defects should have detected in earlier Peer Reviews
- Use this information to (a) keep defect from occurring in the first place, and (b) improving the Peer Review process (or execution).

Results due to Corrective Actions

Document Inspections				
Date	Work Product	Total Defects	Major Defects	% Major
6/4/99	PS	13	12	92%
5/21/99	SPP	12	5	42%
5/16/99	DA	20	16	80%
5/7/99	PS	11	8	73%
5/5/99	RAD	28	24	86%
4/27/99	DA	8	3	38%
4/19/99	SDD	71	40	56%
4/16/99	SDD	7	2	29%
3/17/99	DA	10	7	70%
	Total	180	117	65%
Code Inspections				
Date	Work Product	Total Defects	Major Defects	% Major
5/19/99	Code	17	3	18%
4/2/99	Code	13	5	38%
4/6/99	Code	16	8	50%
4/9/99	Code	11	8	73%
4/16/99	Code	13	3	23%
	Total	70	27	39%

Good SPI Tracking



Training Status

Group XYZ - Training Attendance

	SW201	SW210	SW220	SW230	SW231	SW234	SW240	SW251	SW261
Required	159	69	157	154	56	77	75	147	156
Waivers	1	0	0	0	0	0	0	4	1
1st Class	101	39	103	113	28	**20-Oct**	27	99	98
2nd Class	23	14	21	28	15	**27-Oct**	19	13	37
3 rd Class	21	n/a	22	n/a	**1-Oct**		14	20	10
No Shows	**13**	**16**	**11**	**13**	**10**		**15**	**19**	**10**
% Complete	**92%**	**77%**	**93%**	**92%**	**77%**	**0%**	**80%**	**93%**	**94%**

	SW301	SW302	SW310	SW330	SW340	SW350	SW351	SW360
Required	161	50	76	162	148	155	162	143
Waivers	0	0	0	0	0	0	0	0
1st Class	115	38	46	120	107	113	**6-Oct**	107
2nd Class	23	**Oct**	18	18	27	25	**13-Oct**	26
No Shows	**23**	**12**	**12**	**24**	**14**	**17**		**10**
% Complete	**86%**	**76%**	**84%**	**85%**	**91%**	**89%**	**0%**	**93%**

Note: SW260, SCM Group was a 4 person class taught in 4 classes (100% attendance).
SW232, SQA Cost Estimation was a 5 person class (100% attendance)
SW233, SCM Cost Estimation is a 4 person class to be taught 8 October.

NOTE: Quality Measures also required (evaluations, post-training effectiveness)

A Measurement Infrastructure

Systems

People

Process/Procedures

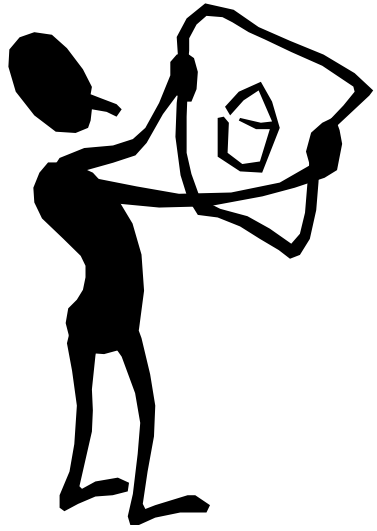
Selection of Measurement (s/b issue/goal driven)

Collection

Analysis and Interpretation

Actions

Measurement Specs (use PSM)



Measurement Specifications

Metric Category: **Earned Value**

The Earned Value Metric Category provides effective cost and schedule status information at any point in each task within a project's Work Breakdown Structure (WBS). Earned Value is valuable in pinpointing a cost or schedule concern, in projecting cost or schedule completion status, and in assessing the possible changes in scope. "Earned Value" is an objective task completion measurement represented by the BCW indicator and is used for most of the Earned Value calculations. The Earned Value method used to calcu BCWP is the 0-50-100 or LOE.

Data Items Collected:

- **Actual Cost of Work Performed (ACWP)** - the accumulated actual effort incurred for performing a ta
- **Monthly ACWP** – the amount of work completed in the month
- **Budgeted Cost of Work Scheduled (BCWS)** - the planned accumulated effort scheduled for a task current reporting period
- **Budgeted Cost of Work Performed (BCWP)-** task completion progress represented as a portion, up 100%, of the task's budget
- **Monthly BCWP –** the BCWP for each completed work month
- **Budget at Completion (BAC)** - the total budget for a given task

Attributes:

- **Task ID** (13-15-digit) – the 3-digit extension specifies the task within the charge number WBS.
- **Project** - the name of the project; ACSIS
- **Baseline (Program)** - program version name (e.g., AEGIS Baseline 6 Phase 3; F100)

Aggregate Structures:

- **Project**
- **WBS Level** - by WBS hierarchy using [WBS]number and level
  - Level 1 - Project - rollup of hours and dollars for project include general tasks
  - Level 2 - Element - rollup of functions
  - Level 3 - Function - rollup of phase

Collected For Each:

- 15-digit charge number/task ID except those indicators prefixed with a $, which are at the 12-digit cha number level
- General Task (as defined in ACSIS WI 3.1.4) are collected at the Project level
- Effort Distribution collected for each % phase effort and % of Implementation (TBD T4-3.18)

Derived Metrics:	**Calculat**
• **Cost Variance (CV)** – difference in the budgeted cost of completed tasks and the actual cost	BCWP – ACW
• **CV %** - the magnitude of the cost variance as a percentage of BCWP	CV / BCWP
• **Monthly CV** – for each completed work month, the difference between each months BCWP and ACWP	Monthly BCWP Monthly ACWP
• **Monthly CV %** - the magnitude of the cost variance as a percentage of the BAC	Monthly CV/BA
• **Schedule Variance (SV)** – difference between the budgeted cost of completed tasks and the scheduled cost	BCWP – BCW
• **SV % -** the magnitude of the schedule variance as a percentage of BCWS	SV / BCWS
• **Cost Performance Index (CPI)** – relationship between the actual costs vs. the budgeted costs for tasks that have been completed	BCWP / ACWP
• **Schedule Performance Index (SPI)** – relationship between the tasks that have completed vs. the tasks scheduled to be completed	BCWP / BCWS
• **Estimate at Completion (EAC)** – computation of the projected final cost assuming the CPI remains constant	BAC / CPI
• **Variance at Completion (VAR) -** projected final cost variance	BAC – EAC
• **% Complete** - percent completed of effort	BCWP / BAC
• **% Spent** (% of MD budget expended) - percent of total task budget expended	ACWP / BAC
• **$BCWS** - equivalent BCWS in dollars at the 12-digit charge number level only	(BCWS/BAC) * [Cost]Budget
• **% Implementation Effort –** a tasks ACWP as a percentage of the ACWP for the Implementation tasks (13 digit) (TBD T4-3.18)	ACWP [Task] / ?ACWP of Imp. Tasks
• **% Phase Effort (Total) –** Percentage of total project ACWP verses the sum of the ACWPs across the components for each phase (component identified by 14th and 15th digits of charge number; phase identified by 13th digit of charge number) (TBD T4-3.18)	ACWP [task]/ ?Projects ACWP
• **$BCWP** - equivalent BCWP in dollars at the 12-digit charge number level only	% Complete*[Cost]Budget
• **$ACWP** - equivalent ACWP in dollars at the 12-digit charge number level	[Cost]Spent to Date
• **$CPI** - 12-digit charge number CPI based upon dollars	$BCWP / $ACWP
• **$CV** - 12-digit charge number CV based upon dollars	$BCWP - $ACWP
• **$CV %** - 12-digit charge number CV% based upon dollars	$CV / $BCWP

Reporting Frequency: Monthly - as of the end of each accounting month

Criteria for Counting Actuals:

- ACWP - actual labor hours expended
- BCWP should use these guidelines:
  - Each task not a level-of-effort task and greater than four weeks in duration should be subdivided into sub-tasks for establishing the task's BCWS and BCWP. At each reporting period, each BCWP should be calculated as follows:
    - 0-50-100 method: If task has started, 50% of BAC; if task has completed - 100% of BAC
    - Some tasks are LOW method
- Each WBS lowest-level task BCWP = sum of sub-task BCWPs if available
- For designated Level-of-Effort tasks: BCWP = BCWS
- $ACWP = [Cost]Spent to Date and must originate from the GES Cost Management System (CMS)
- [Cost]Budget must originate from the GES Cost Management System (CMS)

SMD Collection Mechanism:

- Content and Format: (TBD T4-3.15)

Reporting Mechanism:

- Center Manager Program Review
- ACSIS Metrics Analysis and Utilization Information (MAUI) Report (Monthly CV % section and Earned Value section)

Source of Data:

- ACWP: Cost Management System (CMS) via ACSIS earned value database
- All other inputs: Project's Earned Value database

Estimation Methodology:

Planning data is determined following ACSIS WI 3.1.4, Software Project Schedule, Staffing and Cost

Control Limits and Thresholds: SPI/CPI: target value = 1 with +/- .15, Monthly CV % see P-PPB in Appendix B

Metric Analysis:

BCWS, BCWP and ACWP Analysis: In hours at the top WBS Level (Project Level)
$BCWS, $BCWP and $ACWP Analysis: In dollars at the top WBS Level (Project Level)
SPI/CPI Analysis:
SPI = 1: on schedule
SPI < .85: behind schedule *
SPI > 1.15: ahead schedule *
CPI = 1: within budget
CPI < .85: over budget *
CPI > 1.15: under budget *
* Required additional analysis explanation documented in Analysis Report. If applicable, will provide more detail at lower level.

Source: Lockheed Martin NE&SS-Moorestown - ACSIS Project's Quantitative Management Plan

Maturity Differentiators

- Minimum Required Set
- Collected at right level (process element) and right time
- Right division between project and organizational collection & use
- Collected and used
- Well-defined life cycle (process) that drives WBS
- Use of historical data
- Validation of data (no dirty data)
- Automation
- Integration of tools/systems
- PTO vs. ISM KPAs

Measurement and CMM Level 4

Process and Product Measures must link to Business Goals

- Measurement becomes even more “issue/goal” driven
- Goals --> Processes to Control --> Measures
- Need ways to status the goals (prediction) as well as know whether goals have been met
- Focus is on project-level use of measurement data

Advanced Measurement Techniques assumed

- SPC
- Estimation/Prediction Models/Methods

Data Accuracy becomes crucial

- Major vs. Minor defects
- Sizing variances
- Accurate/complete data recording

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Beth Layman has more than 20 years' experience in software and systems development, as an individual contributor, manager, trainer, and consultant. Her background includes 17 years in software quality and process improvement. A published author and speaker, Ms. Layman is an authority on software measurement and quality management.

Beth's software consulting experience encompasses commercial, government, aerospace, and product software organizations. Prior to joining TeraQuest, Beth worked as a senior consultant at Lockheed Martin where she provided software measurement and process improvement consulting support to commercial, government, and Lockheed organizations. She also ran her own consulting company, worked as research director and senior consultant for the Quality Assurance Institute, and held a variety of software quality management and technical positions in IS and product software organizations.

Beth is a principal author of *Practical Software Measurement: A Foundation for Objective Project Management* and is associate editor for the American Society for Quality's *Software Quality Professional* journal.

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Kevin Schaan is a software process improvement director at TeraQuest Metrics, Inc. He has 20 years of professional experience in the software engineering field, including six years as a manager of software systems development projects. His core competencies include software process improvement, application management, planning, design, development, and implementation. As an authorized Software Engineering Institute (SEI) assessment leader for CBA IPI and software process assessments, he has performed over 30 SEI assessments, including post-assessment software process improvement recommendations. Kevin has helped establish software engineering process groups (SEPGs) in small and large organizations, and has provided improvement assistance to those teams as they established their process improvement programs.