Management of Large-Scale, Software-Intensive System Development

Is Maturity Level 3 enough?

Kevin Richins

USAF Software Technology Support Center
Hill AFB, Utah

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Why should it matter?

State of Software Development

- Corporate America spends more than $275 billion each year on approximately 200,000 application software projects.
  - ✓ 31.1% of projects will be canceled before they ever get completed.
  - ✓ 52.7% of projects will cost 189% of their original estimates
  - ✓ 16.2% for software projects that are completed on-time and on-budget.
  - ✓ **9%** of [large company] projects come in on-time and on-budget.
  - ✓ Projects completed by the largest American companies have only approximately 42% of the originally-proposed features and functions
- "… most will fail for lack of **skilled** project management"
- ' I'm sick and tired of getting 60% functionality, on time, at twice the original cost ! ' Lt.Col. USAF

Standish Group Statistics - 1994

CBA-IPI Method Description

- "When the team has achieved full coverage of the CMM ... the rating process may begin by rating each goal for each KPA within the assessment scope … If the team decides that there are no significant weaknesses that have an impact on a goal, it is rated satisfied."
- "For a KPA to be rated satisfied, all goals for the KPA must be rated satisfied."
- "For a particular maturity level rating to be achieved, all KPA's within and below a given maturity level must be satisfied."
- **An organization must satisfy all the *GOALS* of Maturity Levels 2 & 3 to be considered a CMM Level 3 organization**

SW-CMM: What does it say?

- Software Project Planning KPA
  - ✓ Goal 1: Software estimates are documented for use in planning and tracking the software project.
  - ✓ Goal 2: Software project activities and commitments are planned and documented.
- Software Project Tracking and Oversight KPA
  - ✓ Goal 1: Actual results and performances are tracked against the software plans.
  - ✓ Goal 2: Corrective actions are taken and managed to closure when actual results and performance deviate significantly from the software plans.
  - ✓ Goal 3: Changes to software commitments are agreed to by the affected groups and individuals.

Does CMMI Solve the challenge?

- A NEW MEASUREMENT PROCESS AREA
  - ✓ Measurement & Analysis Process Area (PA)
- "MONITORING" IS MORE PRO-ACTIVE THAN "TRACKING"
  - ✓ Project Monitoring & Control PA

SCAMPI Method Description

- "Goal ratings are a function of the extent to which the corresponding **practices** are present in the planned and implemented processes of the organization."
- "In the SCAMPI method, a fundamental premise is that satisfaction of goals can be determined only upon detailed investigation of the extent to which each corresponding **practice** is implemented"
- **Practice Implementation Indicators**

Measurement & Analysis PA

- **Specific Goal 1:** Measurement objectives and practices are aligned with **identified information needs** and objectives
  - ✓ Specific Practice -1 Establish Measurement Objectives
  - ✓ Specific Practice -2 Specify Measures
  - ✓ Specific Practice -3 Specify Data Collection and Storage Procedures
  - ✓ Specific Practice -4 Specify Analysis Procedures
- Specific Goal 2: **Measurement results** that address identified information needs and objectives **are provided**
  - ✓ Specific Practice -1 Collect Measurement Data
  - ✓ Specific Practice -2 Analyze Measurement Data
  - ✓ Specific Practice -3 **Store** Data and Results
  - ✓ Specific Practice -4 **Communicate** Results

Project Planning PA

- Specific Goal 1: Estimates of project planning parameters are established and maintained
  - ✓ Specific Practice -2 Establish and document estimates of the attributes of the work products and tasks
    - Sub-Practice - 2 Use appropriate methods to determine the attributes of the work products and tasks that will be used to estimate the resource requirements
      - ❖ NOTE: Methods for determining **size** and complexity should be based on validated models or historical data
  - ✓ Specific Practice - 4 Estimate the project effort and cost for the attributes of the work products and tasks **based on estimation rationale**
    - Sub-Practice - 3 Estimate the effort and cost using models and/**or** historical data

Project Planning PA

- Specific Goal 2: A project plan is established and maintained as the basis for managing the project
  - ✓ Specific Practice - 1 **Establish and maintain the project's budget and schedule**
  - ✓ Specific Practice - 3 Plan for the management of project **data**
  - ✓ Specific Practice - 7 Establish and maintain the overall project plan content

- Generic Practice 2.8 Monitor and control the project planning process against the plan and take appropriate corrective action
  - ✓ Examples of measures used in monitoring and controlling the **activities of the Project Planning process** area include the following
    - Number of revisions to the plan
    - Cost, schedule, and effort variance per revision

Project Monitoring & Control PA

- Specific Goal 1 Actual performance and progress of the project is monitored against the project plan
  - ✓ Specific Practice -1 Monitor the actual values of the project planning parameters against the project plan
    - Sub-Practice - 1 Monitor progress against the schedule.
    - Sub-Practice - 2 Monitor the project's cost and expended effort.
    - Sub-Practice - 3 Monitor the attributes of the work products and tasks
    - Sub-Practice - 4 Monitor resources provided and used
    - Sub-Practice - 5 Monitor the knowledge and skills of project personnel
  - ✓ NOTE: … monitoring … typically includes the following:
    - **Periodically measuring** the actual ...
    - **Comparing** actual ...
    - **Identifying significant deviations** from ...

Project Monitoring & Control PA

- Specific Goal 2 Corrective actions are managed to closure when the project's performance or results deviate **significantly** from the plan
  - ✓ Specific Practice - 1 Collect and analyze the issues and determine the corrective actions necessary to address the issues
    - Sub-Practice - 1 Gather issues for analysis
      - Examples of issues to be gathered include:
        - Issues discovered through performing verification and validation activities
        - **Significant deviations in the project planning parameters from the estimates in the project plan**
        - Commitments (either internal or external) that have not been satisfied
        - Significant changes in risk status
        - Data access, collection, privacy, or security issues
        - Stakeholder representation or involvement issues

Some ACAT 1A Demographics

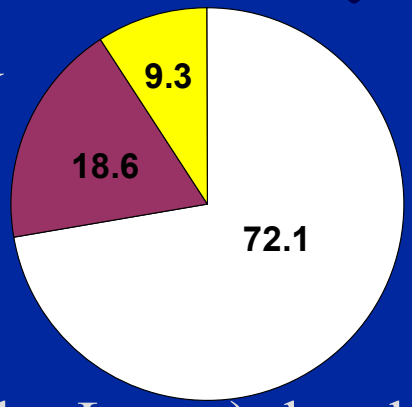
- Minimum Budget: $365,000,000
- Typical Budget: ~ $500,000,000 - $ 3,000,000,000 +
- Software Budget: ~ $200,000,000 - $ 1,000,000,000 +
- Incremental Development (Multiple releases)
- ~ 5,000,000 - 20,000,000 SLOC
- ~ 250 - 1250 Configuration Items
- ~ 25,000 - 125,000 Modules

What's the Problem ?

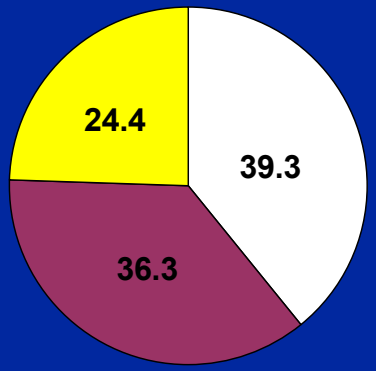
- Why do we have an 18 month schedule slips 6 months before delivery ?
- How did we ever get to the point of overrunning our budgets by 189% ?
- Why do 80% + of our software projects either exceed budget, schedule, or BOTH ?
- You can't manage that which you do not measure
- "Thou shalt not fool thyself"

Have we made progress ?

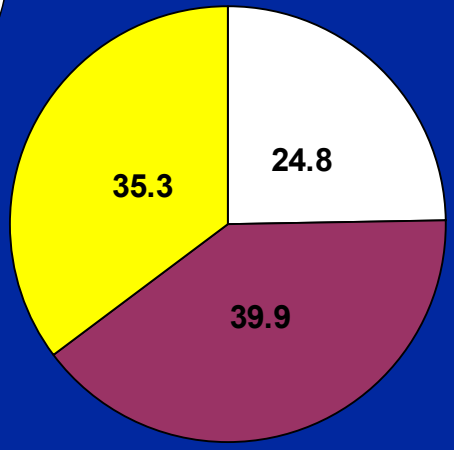
- 1993 : First Maturity Profile developed
  - ✓ CMM Level 1: 72.1 %,
  - ✓ CMM Level 2: 18.6 %
  - ✓ CMM Level 3+: 9.3 %



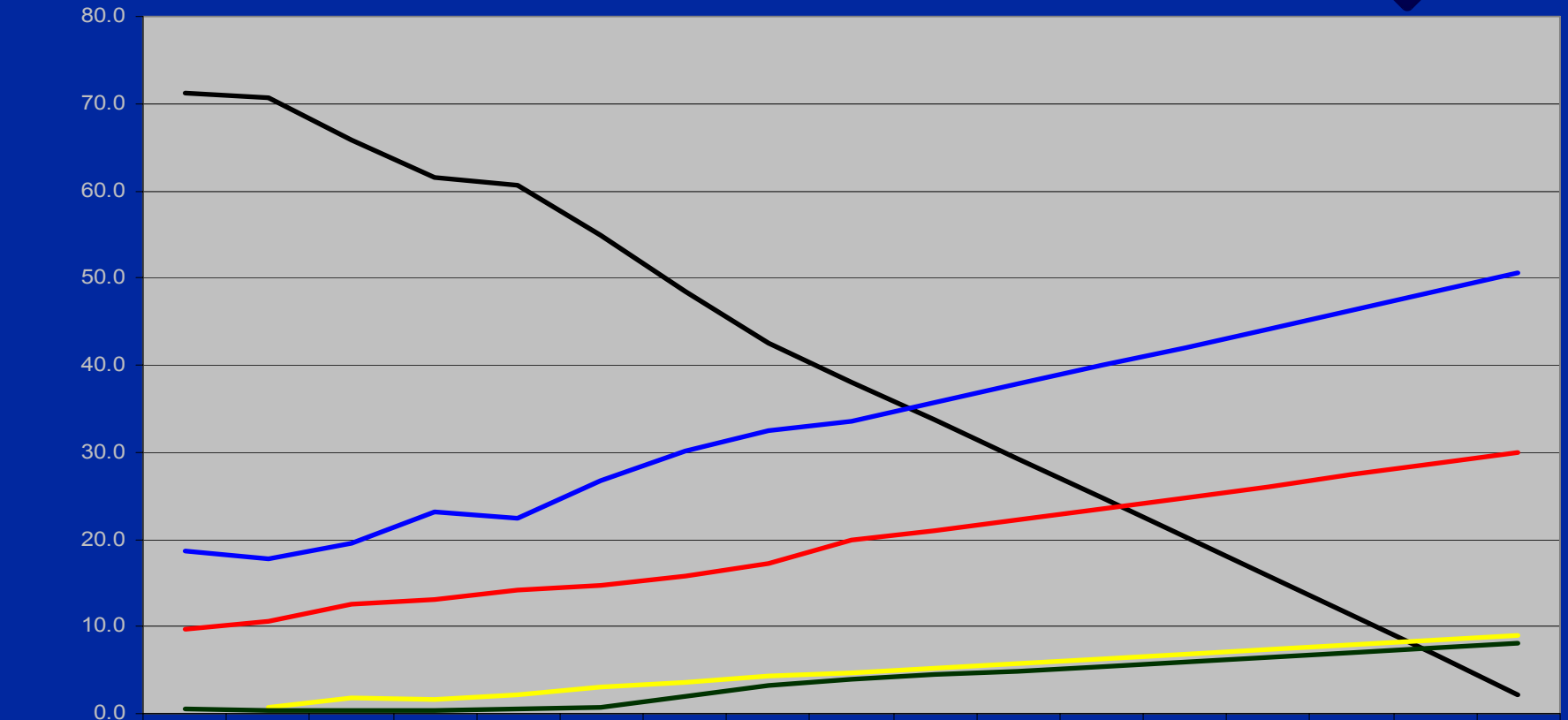
- 1999 : SW-CMM Level 3 Policy (Gansler Letter) developed
  - ✓ CMM Level 1: 39.3 %,
  - ✓ CMM Level 2: 36.3 % **(75.6 %)**
  - ✓ CMM Level 3+: 24.4 %



- 2001
  - ✓ CMM Level 1: 24.8 %,
  - ✓ CMM Level 2: 39.9 % **(64.7 %)**
  - ✓ CMM Level 3+: 35.3 %



We're progressing TOO SLOW !



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Level 1	71.2	70.6	65.8	61.6	60.7	54.8	48.5	42.6	38.0	33.7	29.3	24.8	20.3	15.8	11.3	6.8	2.2
Level 2	18.6	17.8	19.6	23.2	22.5	26.7	30.2	32.5	33.5	35.6	37.8	39.9	42.1	44.2	46.3	48.5	50.6
Level 3	9.6	10.5	12.5	13.1	14.2	14.7	15.7	17.3	19.9	21.1	22.3	23.5	24.8	26.1	27.4	28.7	30.0
Level 4		0.8	1.8	1.7	2.1	3.1	3.6	4.3	4.6	5.1	5.7	6.2	6.8	7.3	7.8	8.4	8.9
Level 5	0.6	0.3	0.3	0.4	0.5	0.7	2.0	3.3	4.0	4.4	4.9	5.4	6.0	6.5	7.1	7.6	8.2

What am I really proposing ?

- **QUANTITATIVE PROJECT MANAGEMENT**
- Capability Maturity Model Integrated (CMMI)
  - ✓ Staged Representation Maturity Level 4
  - ✓ Continuous Representation w/ QPM / OPP as required PA's
- My DoD policy proposal
  - ✓ Require PM's to perform a thorough program risk analysis
  - ✓ Select PA's based upon risk results
  - ✓ Make QPM / OPP required PA's

Quantitative Project Management

- Specific Goal 1: The project is quantitatively managed using quality and process-performance objectives
  - ✓ Specific Practice 1: Establish and maintain the project's quality and process-performance objectives
  - ✓ Specific Practice 2: Select the sub-processes ... **based on historical stability and capability data**
  - ✓ Specific Practice 3: Select the sub-processes ... that will be statistically managed
  - ✓ Specific Practice 4: Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate
  - ✓ Specific Practice 5: The performance of selected sub-processes ... is statistically managed

Quantitative Project Management

- Specific Goal 2: The performance of selected sub-processes within the project's defined process is statistically managed
  - ✓ Specific Practice 1: Select the measures and analytic techniques to be used in statistically managing the selected sub-processes
  - ✓ Specific Practice 2: Establish and maintain an **understanding of the variation** of the selected sub-processes using the selected measures and analytic techniques
  - ✓ Specific Practice 3: Monitor the performance of the selected sub-processes to determine their capability to satisfy their quality and process-performance objectives, and identify corrective action as necessary
  - ✓ Specific Practice 4: Record statistical and quality management data in the organization's measurement repository

Organizational Process Performance

- Specific Goal 1: Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained
  - ✓ Specific Practice 1: Select the processes or process elements in the organization's set of standard processes that are to be included in the organization's process performance analyses
  - ✓ Specific Practice 2: Establish and maintain definitions of the measures that are to be included in the organization's process performance analyses
  - ✓ Specific Practice 3: Establish and maintain quantitative objectives for quality and process performance for the organization
  - ✓ Specific Practice 4: Establish and maintain the organization's process performance baselines
  - ✓ Specific Practice 5: Establish and maintain the process performance models for the organization's set of standard processes

Conclusion ?

- If we are ever really going to get this software gorilla off our backs, we need to get serious about management (measurement and control)

- If the Department of Defense really wants **quality, high-performance software delivered on-time and within budget**, it needs to require software producers to live in the world of objective, quantitative management.

- It won't be easy but … somebody has to step up and

LEAD !

BACKUP SLIDES

SW-CMM: What does it say?

- Key Process Area: Requirements Management
  - ✓ Goal 1: System requirements allocated to software are controlled to establish a baseline for software engineering and management use.
  - ✓ Goal 2: Software plans, products, and activities are kept consistent with the system requirements allocated to software.
  - ✓ Measurement 1: Measurements are made and used to determine the **status of the activities** for managing the allocated requirements.

SW-CMM: What does it say?

- Key Process Area: Software Project Tracking and Oversight
  - ✓ Goal 1: Actual results and performances are tracked against the software plans.
  - ✓ Goal 2: Corrective actions are taken and managed to closure when actual results and performance deviate significantly from the software plans.
  - ✓ Goal 3: Changes to software commitments are agreed to by the affected groups and individuals.

  - ✓ Measurement 1: Measurements are made and used to determine the **status of the software tracking and oversight activities**.

SW-CMM: What does it say?

- Key Process Area: Software Project Planning
  - ✓ Goal 1: Software estimates are documented for use in planning and tracking the software project.
  - ✓ Goal 2: Software project activities and commitments are planned and documented.
  - ✓ Goal 3: Affected groups and individuals agree to their commitments related to the software project.

  - ✓ Measurement 1: Measurements are made and used to determine the **status of the software planning activities**.