Implementing a Systems Engineering Measurement Program at Raytheon (Falls Church)

Chris Miller (Software Productivity Consortium)

Roger Shepherd (Raytheon)

John Evers (Raytheon)

6th Annual Practical Software and Systems Measurement Users Group Conference

The Catalyst

"The team discussed the approach to developing the SE metrics, and discussed various factors associated with developing metrics. John reviewed the identified requirements on metrics (from the SSS), and it was agreed that a disciplined approach needs to be used. **Chris and John to get together and define a common approach to use.**

It was noted that addressing metrics takes time to do it well. This raised a concern for the Process Owners, in meeting their various commitments. Given expected transitions of personnel, it was decided that the team needs to revisit the SE PI Project Organization Chart, the Roles and Responsibilities, and the SEC membership next week."

- excerpt from *Minutes, 1/31/2001 SEC Stand-up Meeting*

Raytheon Measurement Needs

- Process Improvement goals drove measurement initiative
  - Improve how Systems Engineering is done (**better products with best practices**)
  - Increase win rates (**better proposals, better predictions**)
  - Increase productivity (**better execution, less rework**)
  - Institutionalize EIA/IS-731 "Level 3"
  - EIA/IS-731 "Level 3" (follow SW CMM Level 3 effort)
  - Integrating toward CMMI Level 3 (and beyond)
- Leverage existing measurement reports and methods
  - Earned value procedures and concepts
  - Functional managers as advocates & change agents
  - Institutional goals vs. project-specific measurement
 - SE and SW measurement approaches coordinated, but not unified

State of Measurement in January 2001

- Measurement History
  - Previous measurement efforts never employed
- Existing measurement procedures
  - Primarily CPI, SPI for Senior Engineering Management Reviews
- Site management wanted
  - Productivity measure
  - Better bids
- Multiple measurement users (matrix organization)
  - Varying information needs
  - Process and Tools Manager, Program Director, Program/Project Manager, Program Engineer, Cost Account Manager, Engineering Manager, Discipline Lead

Functional

PD   ED
      EM
PM   DSP
      DL
CAM   PT
   PE
BA   LSE

Program
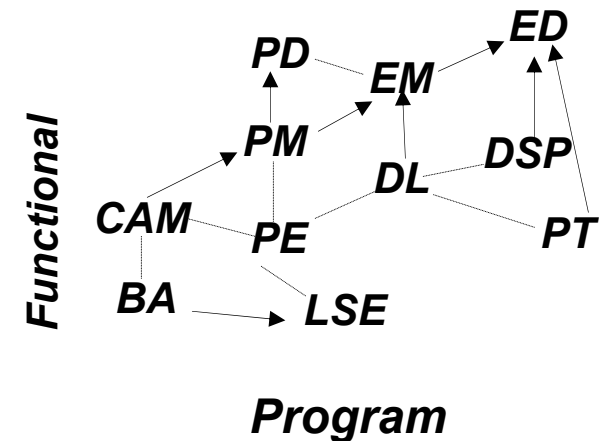
Measurement Approach

- Adoption of PSM and ISO 15939 Information Model
  - PSM training provided a common vocabulary
- Consortium lead PSM training
  - Overview training followed by Just-In-Time (JIT)
- Small group targeted to be measurement experts
  - Facilitate and mentor projects over time
- Share measurement technology between Systems Engineering and Software process initiatives
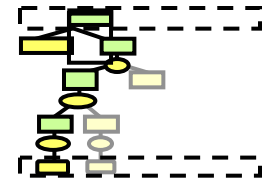
Measurement Planning Activities

- 3/27/2001 – PSM tutorial

- 4/02/2001 – First Measurement Offsite
  - Used PSM's Issue-Category-Question Table to identify specific issues for each of the information users
  - Identified 66 candidate measures

- 4/9/2001 – Prioritized Measures
  - Selected 16 candidate measures to define
  - Selected criteria:
    - Number of Information users
    - Implementation Scope (new, rework, reuse)
    - Effort to Implement
  - Added Award Fee & Win Rate

- Developed measurement definition template based on ISO 15939's Information Model

Candidate Measures
Milestone Dates
Gate Review Readiness
Effort (hours)
Staff Experience
Staff Turnover
Training (Skill mix)
Resource Availability
Requirements
Mission Scope
Requirements Defects
Defects
TPMs
Process Audit Findings
Productivity
Cycle Time
Baseline Changes
Award Fee
Win Rate

Defining the Measures

- Conducted measurement writing sessions between 4/9/2001 and 7/2/2001
  - EIA/IS 731 Evaluation during 3rd week of June
- 7/2/2001 – Measurement Offsite
  - Unified measurement definitions
  - Linked measures to affected engineering processes
- By 9/5/2001 MS Access database was created and contained measurement definitions, consisting of:
  - 33 Base Measures
  - 20 Derived Measures
  - 15 Indicators
  - 18 Data Sources (Entities)

Indicators

Derived Measures
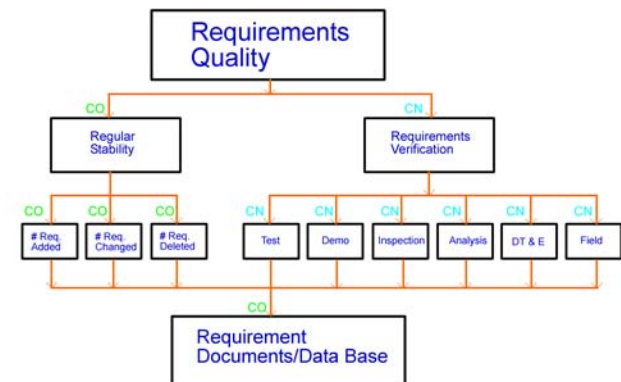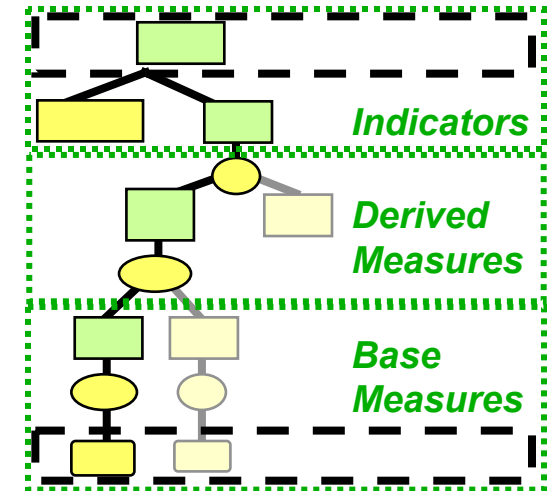
Base Measures

Rollout and Implementation

- No formal measurement training
  - SE measurement activity was communicated to project engineers
- Rollout
  - Began data collection with piloting on projects, then broader roll-out.
  - Used Incremental rollout for organizational reports
    - Updated charts periodically by phasing in measures over time
- Implementation
  - Emphasis on detail and collection of baseline data on work product performance, characterization, and estimation
  - Created duplicate collection paths to provide ease collection
  - De-emphasized changes to project reports as rolled up to senior management levels
- Validation
  - Defined scoring (compliance) mechanisms to promote the adoption of the practices that were to be measured

July 23,2002

Rollout and Implementation

- What worked well
  - Involvement of SE Discipline Leads (practitioner leads), addressing various users of information;
  - Involving functional leads and engineering managers in defining & prioritizing the measures
  - Pressed measurement issues gently, but consistently
  - Leveraging existing data (SEMR charts, existing cost collection systems, etc.)
- What didn't work well
  - Inconsistent WBS / cost collection structure across programs; driven by types of business
  - Made the measures **TOO** transparent to users
    - Many aren't aware of what's collected
  - Collection of HR data not progressing

The Bottom line

- Currently the MS Access database consists of:
  - 40 Base Measures, 27 Derived Measures, 14 Indicators
- Approximately 17 Full Time Equivalents (FTEs) over 15 months
  - Measurement team consisted of
    - 1 Measurement consult 20% for 6 months
    - 3 Measurement experts 30% for 15 months
    - 2 Measurement authors 10% for 2 months
    - 1 SE PI Lead 10% for 15 months
   - 5 Management 5% for 10 months

	10/2001	1/2002	4/2002	7/2002	Facility
Projects	3	12	18	40	200
Products	40	150	180	600	5000
Engineers	60	300	400	600	1200

6th Annual Practical Software and Systems Measurement Users Group Conference

Current Measurement Activities

- Closing the Bid Loop
  - Strong focus on collecting & analyzing data which feeds our bid model
  - Completing R6σ project, and pushing a broader activity and awareness of this issue (e.g., standard bid code project)
- Emphasizing Simplicity
- Up-Tempo Use for Projects
  - Some projects are adopting compatible measures to serve finer-grained project needs.
- Supporting TPM Emphasis
  - Providing measurement guidance to programs
  - Measurement development method to develop better measures
  - Captured approach details for development of standard workshop / guide for use by other programs
- Tools
  - MS Access & Excel - looking at more sophisticated tools for future

PSM as a Swiss Army Knife

- Incrementally applying PSM across Raytheon Falls Church site

- Terminology/glossary
    - Provided a common language
    - Helped align measurement efforts (SE & SW)

- Project level versus organization
    - Focused initially on organizational issues, then teamed with projects during pilot and rollout

- PSM was a stable technology that met many needs
    - We checked other measurement structures to verify we covered all the bases (the cube model; predictive / reactive; cost, quality, cost, performance; process, product, program)
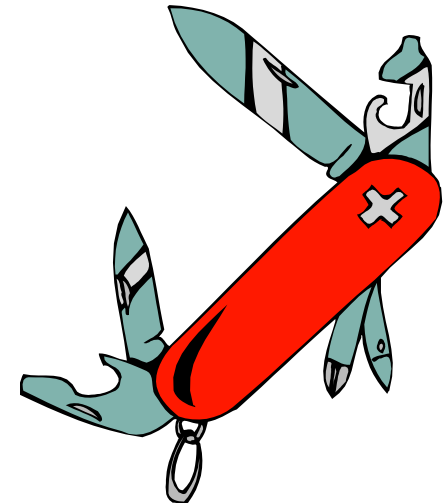
Lesson Learned

- Takes time to do it right
- Takes concentrated effort
- Use an agreed-on measurement process and measurement definition structure
  - PSM helped to validate our efforts
- Keep end users in mind
  - Satisfy information needs
- KISS

6th Annual Practical Software and Systems Measurement Users Group Conference

Next Steps

- Learning the Lessons

- Move towards CMMI - integrated set of organizational measures based on PSM structure

- Emphasize USE of the information (vs. data collection details) - keep it beneficial to end users

- Seeking to refine / simplify collection