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Customer Success Is Our Mission

Integrated Engineering Metrics

NDIA – CMMI Technology Conference & User Group

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Our Organization
Raytheon Fullerton Operations (RFO)

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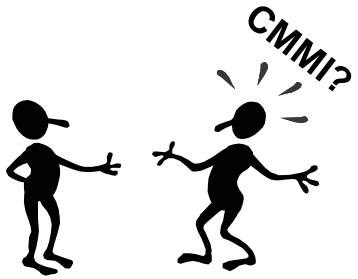
Network Centric Systems, Fullerton, CA

- Achieved CMMI SW Level 5 in December 2003
  - Achieved SW-CMM Level 5 twice before: 9/2002 and 10/1998
- Achieved CMMI SE Level 3 in December 2003
  - CMMI SE Level 2 in 10/2002

Background - 2002

- Fullerton had two separate process improvement goals
  - SW-CMM Level 5 (SCE)
  - SE-CMMI Level 2 (SCAMPI)
- Separate Software and Systems EPGs
  - SW EPG Team
    - **Been around since 1990s**
    - **Experienced personnel in model and appraisals**
    - **Achieved SW-CMM Level 5 rating more than once in 1998 and 2002**

  - SE EPG Team
    - **Not well defined until 2001**
    - **Personnel newly trained in the new CMMI model**
    - **Never been through an appraisal**



Background – Management Changes to 2003 Plans

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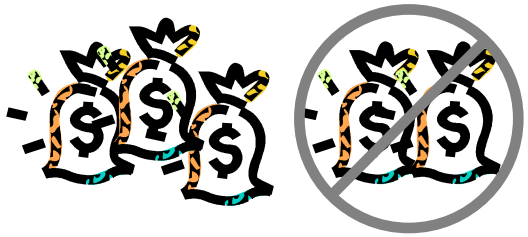
2002 2003 2004

Achievements:

- SW-CMM Level 5 in September 2002
- CMMI SE Level 2 in October 2002

SCAMPI CMMI Class B 3rd Qtr

~~SCAMPI Class A mid-2004 CMMI SE/SW Level 3~~



Faster & cheaper!

Management wants SW Level 5 & SE Level 3 in 2003

- Keep up with Competitors
- Budget reduced by 18%
- Higher SW maturity level
- Shorter schedule

From CMMI SE Level 2 to Level 3 in 12 months??

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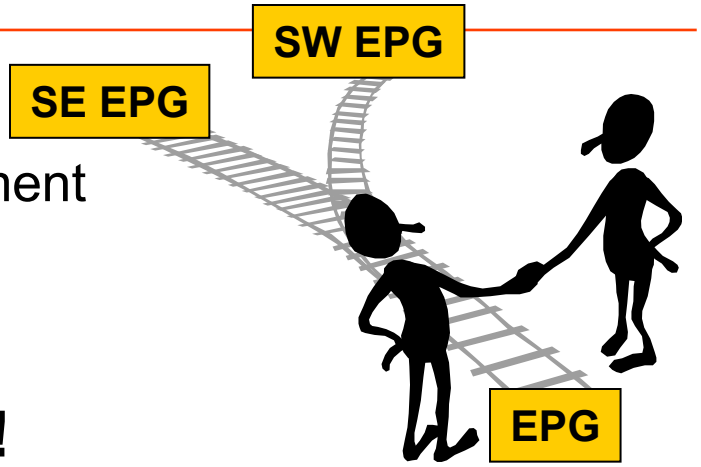
The Integrated Approach (CMMI)

- **Integrate the EPG Teams**
  - Team Building using R6σ Baseline Assessment
  - Use R6s methods to work big ticket items
  - Define common approaches



- **Key off of each others experiences !!**
  - SE folks mentored SW folks in difference between CMM and CMMI
  - SW folks mentored SE folks in what it takes to be a Level 5 organization
- **Integration stimulated lots of synergy, reuse and collaboration between the two engineering disciplines**
  - Made planning and resource allocation easier too

Extend the Integrated Approach to Metrics

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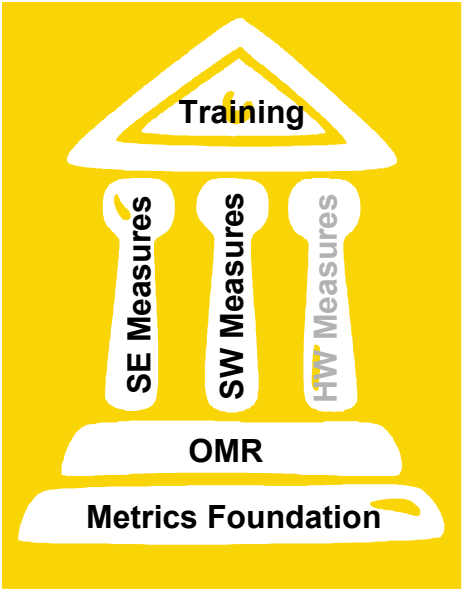
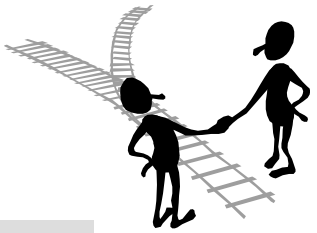
How do we improve the Raytheon Fullerton SE measurement program significantly, in such a short time?

- Leverage existing SE measures as building blocks
- Build on existing SW measurement program infrastructure
  - OMR
  - Existing Measurements
  - Training
- Leverage knowledge base from SW Metrics Program and Team
- Apply proven concepts used by SW to expand the SE measures
- Form an Integrated Engineering Metrics Team





M&A is the long pole for an appraisal

Understanding the Measurement Data Big Picture

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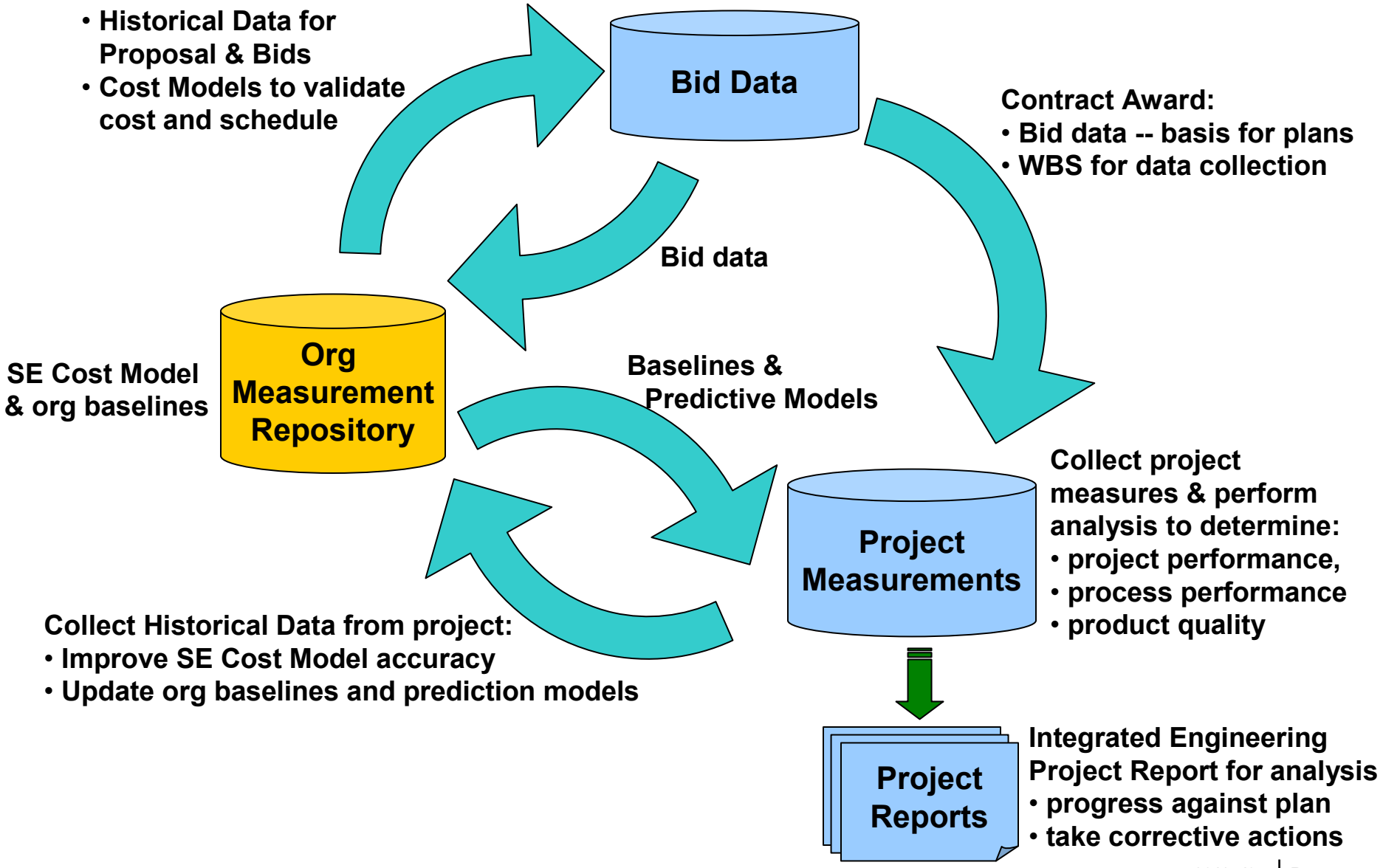

Measurements and Analysis Considerations (1)

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- Support management and program goals and objectives
- Support cost estimation for future bids and proposals
- Provide meaningful data to program management to manage and control program execution
- Know projects processes
  - Eliminate duplicate data entries
  - Support generation of project reports and deliverable documents
  - Support analysis
- Define data that can be collected from project processes – “KISS”
  - Support process and subprocess improvements
- Could easily train systems engineers to collect, (after all you gotta get them to collect the data)
- Apply synergy to project reporting
  - Use the same report for Engineering, Program, and Business Mgmt when possible
- Integrate Engineering Reporting Review
  - One engineering report, one engineering review

Measurements and Analysis Considerations (2)

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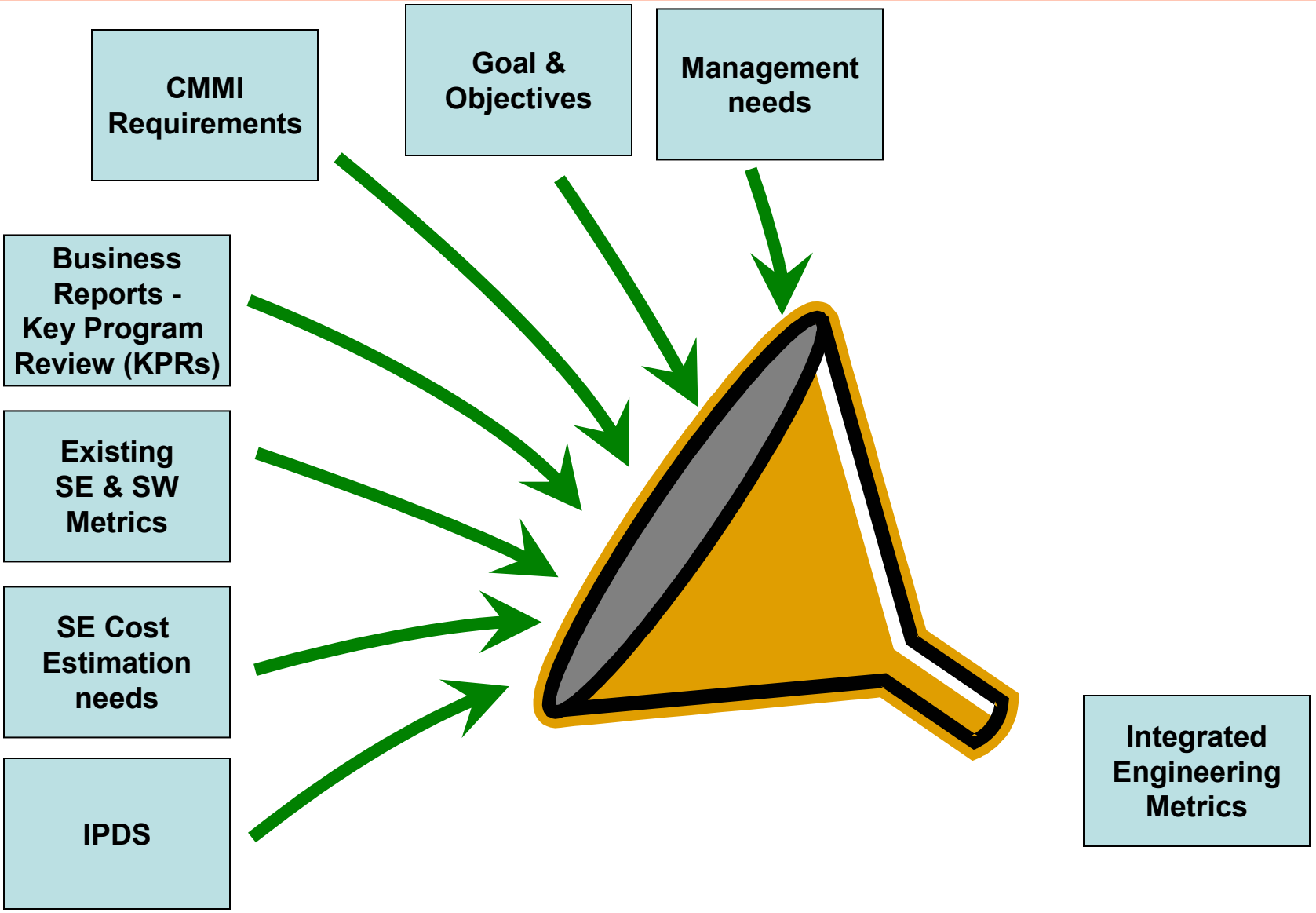

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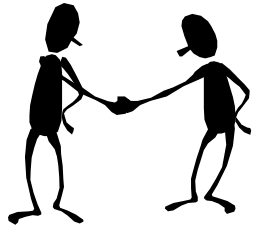
Implementation

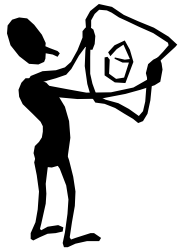
- Leverage from mature SW Metrics Program
- Follow their lead and modify their set of standard measures
- Develop analogous SE quantitative measures
- Develop Integrated Engineering Metrics:
  - Common Measures (e.g., CPI/SPI)
  - Common Look and Feel to the metrics
  - Extended SW measurements concepts to SE – examples:
    - Extend SW Trouble Report (STR) measures concept to Spec Change Request (SCR) measures and HW Problem Reports (HPRs)
    - Defect Containment
    - SW Cost Estimation Adders to SE Cost Estimation Adders
  - Discipline specific examples:
    - SW Productivity vs. SE Productivity
    - SW Size vs. Requirements Volatility (shalls)

More common metrics than expected

Get Project Buy-in

- Involve key project engineering managers in EPG R6σ Baseline Assessment
  - Develop solutions to integrated process approaches
  - Tailoring concepts
- Get key project engineering managers on the Engineering Configuration Control Boards (ECCB)
  - Review Common Engineering Process architecture and transition plan
  - Review measurement process changes
  - Get buy-in
- Involve project engineering managers from product areas
  - Review draft changes to measurement changes before submittal to ECCB
  - Get early feedback and early buy-in
- Develop enablers for measurement changes
  - Use similar format for SW and SE data (HW too)
    e.g., change request Open/Close trend reports, etc.
- Update training and roll out to projects
  - Phase 1 - roll out to pilot project first or key projects
  - Phase 2 - roll out to rest of projects
- Update formal training classes for normal process training





Example - The Genesis of Requirements Volatility Quantitative Measure

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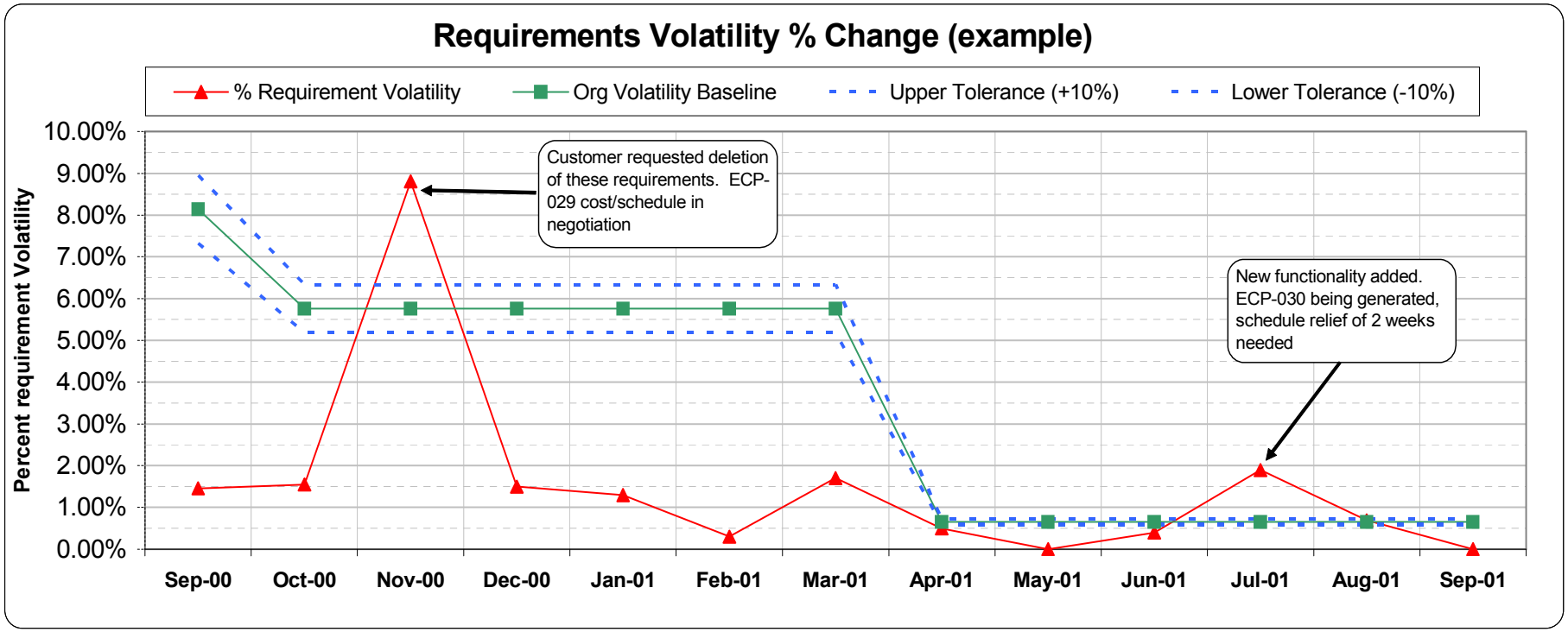
- Requirements Volatility – identifying the number of approved changes to the established requirements baseline
  - This includes the sum of new, deleted and modified requirements each month vs. the number of requirements in the baseline for that month on a given program

- Collect actual Volatility measurements:
  - Collect the data across past programs
  - Collect the data for each phase during the program's lifecycle

- Derive an organizational baseline and associated tolerance band associated with each phase of a program's lifecycle -- for program analysis

Sample Requirements Volatility Report



Totals	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01	May-01	Jun-01	Jul-01	Aug-01	Sep-01
Total # of Requirements	1100	1101	1004	1004	997	999	1006	1006	1006	1002	1011	1007	1007
# of Reqts Added	7	5	0	0	3	2	7	0	0	0	14	0	0
# of Reqts Modified	1	8	0	15	0	1	10	5	0	0	0	3	0
# of Reqts Deleted	8	4	97	0	10	0	0	0	0	4	5	4	0
Total # Reqts changed	16	17	97	15	13	3	17	5	0	4	19	7	0
% Requirement Volatility	1.45%	1.55%	8.81%	1.49%	1.29%	0.30%	1.70%	0.50%	0.00%	0.40%	1.90%	0.69%	0.00%
Org Volatility Baseline	8.14%	5.76%	5.76%	5.76%	5.76%	5.76%	5.76%	0.65%	0.65%	0.65%	0.65%	0.65%	0.65%
Upper Tolerance (+10%)	8.95%	6.34%	6.34%	6.34%	6.34%	6.34%	6.34%	0.72%	0.72%	0.72%	0.72%	0.72%	0.72%
Lower Tolerance (-10%)	7.33%	5.18%	5.18%	5.18%	5.18%	5.18%	5.18%	0.59%	0.59%	0.59%	0.59%	0.59%	0.59%
Program Lifecycle Phase		CDR						System Integration					

Common Data Collection Methods & Analysis

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- Common methods for SE and SW
  - One metrics team in the EPG responsible for collecting and analyzing all measurement data that comes from the projects
- Common database for defect containment data
  - All defect data in same database
  - Data is tagged (SE vs SW) for reporting separately or combined
  - Being expanded to include Hardware (HW) !
- One Org Metrics Team looking at data across projects and product lines
- Integrated project Team of Four or Metrics Team look at all the project data

Reporting of Measurement Analysis to Management

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- Previous to 2003, Fullerton programs performed separate reporting of software status and systems engineering status to higher level management:
  - Allot of duplication between the two reports
  - Same higher level managers attended both meetings
- One integrated (SE & SW) report:
  - SE and SW status presented together giving a more accurate overall picture to the health of the program
  - One less meeting that higher level managers need to attend, thus making a happier manager

SCAMPI Achievements
Rating Profile - Software

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PA	GP 2.1	GP 3.1	GP 2.2	GP 2.3	GP 2.4	GP 2.5	GP 2.6	GP 2.7	GP 2.8	GP 3.2	GP 2.9	GP 2.10							SP								
REQM													1.1	1.2	1.3	1.4	1.5										
PP													1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	
PMC													1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3					
SAM													1.1	1.2	1.3	2.1	2.2	2.3	2.4								
M&A													1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4							
PPQA													1.1	1.2	2.1	2.2											
CM													1.1	1.2	1.3	2.1	2.2	3.1	3.2								
RD													1.1	1.2	2.1	2.2	2.3	3.1	3.2	3.3	3.4	3.5					
TS													1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2						
PI													1.1	1.2	1.3	2.1	2.2	3.1	3.2	3.3	3.4						
VER													1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2							
VAL													1.1	1.2	1.3	2.1	2.2										
OPF													1.1	1.2	1.3	2.1	2.2	2.3	2.4								
OPD													1.1	1.2	1.3	1.4	1.5										
OT													1.1	1.2	1.3	1.4	2.1	2.2	2.3								
IPM													1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3							
RSKM													1.1	1.2	1.3	2.1	2.2	3.1	3.2								
DAR													1.1	1.2	1.3	1.4	1.5	1.6									
OPP													1.1	1.2	1.3	1.4	1.5										
QPM													1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4							
OID													1.1	1.2	1.3	1.4	2.1	2.2	2.3								
CAR													1.1	1.2	2.1	2.2	2.3										

SE/SW Rating Legend

NAME	COLOR
Fully Implemented	
Largely Implemented	
Partially Implemented	
Not Implemented	

SCAMPI Achievements
Rating Profile - Systems

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PA	GP 2.1	GP 3.1	GP 2.2	GP 2.3	GP 2.4	GP 2.5	GP 2.6	GP 2.7	GP 2.8	GP 3.2	GP 2.9	GP 2.10							SP								
REQM													1.1	1.2	1.3	1.4	1.5										
PP													1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	
PMC													1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3					
SAM													1.1	1.2	1.3	2.1	2.2	2.3	2.4								
M&A													1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4							
PPQA													1.1	1.2	2.1	2.2											
CM													1.1	1.2	1.3	2.1	2.2	3.1	3.2								
RD													1.1	1.2	2.1	2.2	2.3	3.1	3.2	3.3	3.4	3.5					
TS													1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2						
PI													1.1	1.2	1.3	2.1	2.2	3.1	3.2	3.3	3.4						
VER													1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2							
VAL													1.1	1.2	1.3	2.1	2.2										
OPF													1.1	1.2	1.3	2.1	2.2	2.3	2.4								
OPD													1.1	1.2	1.3	1.4	1.5										
OT													1.1	1.2	1.3	1.4	2.1	2.2	2.3								
IPM													1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3							
RSKM													1.1	1.2	1.3	2.1	2.2	3.1	3.2								
DAR													1.1	1.2	1.3	1.4	1.5	1.6									
OPP													1.1	1.2	1.3	1.4	1.5										
QPM													1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4							
OID													1.1	1.2	1.3	1.4	2.1	2.2	2.3								
CAR													1.1	1.2	2.1	2.2	2.3										

SE/SW Rating Legend

NAME	COLOR
Fully Implemented	
Largely Implemented	
Partially Implemented	
Not Implemented	

We exceeded our goal of CMMI SE level 3.
We were so very close to level 5!!!
Oh well, next time….

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Summary

- Define your initial set of measurements with the thought that they can be expanded as your processes mature
- Don’t wait till measurements are perfect before deployment
- Provide enough time to institutionalize your SE measurement processes and get your org baselines in place

M&A is the long pole of the appraisal – start early!!