Achieving Common Metrics for Multiple Disciplines in a CMMI Environment

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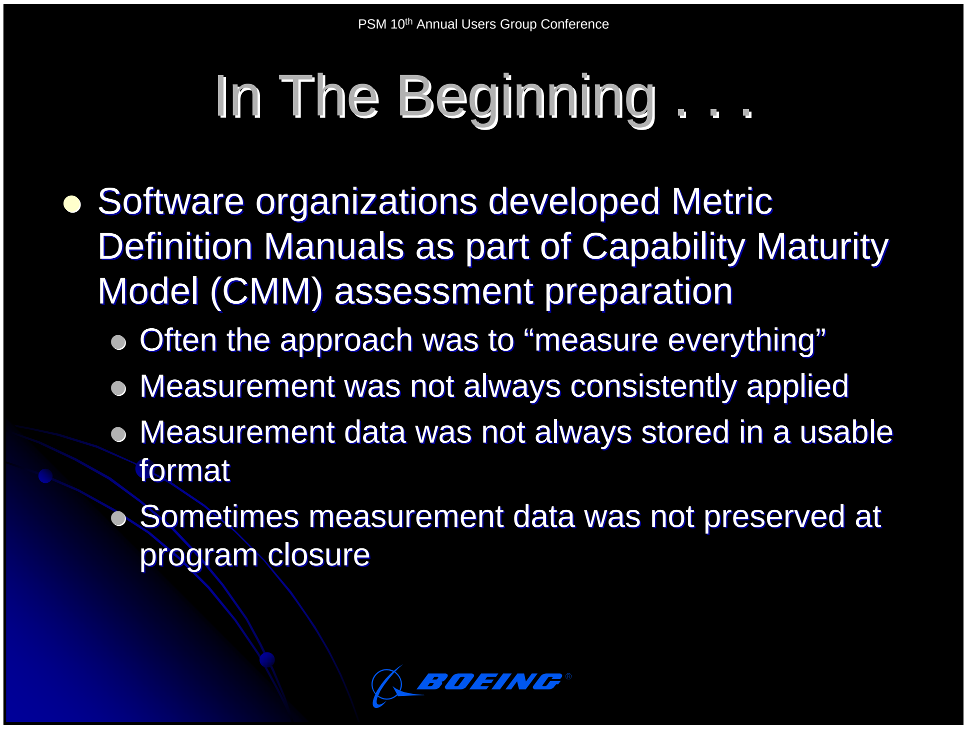
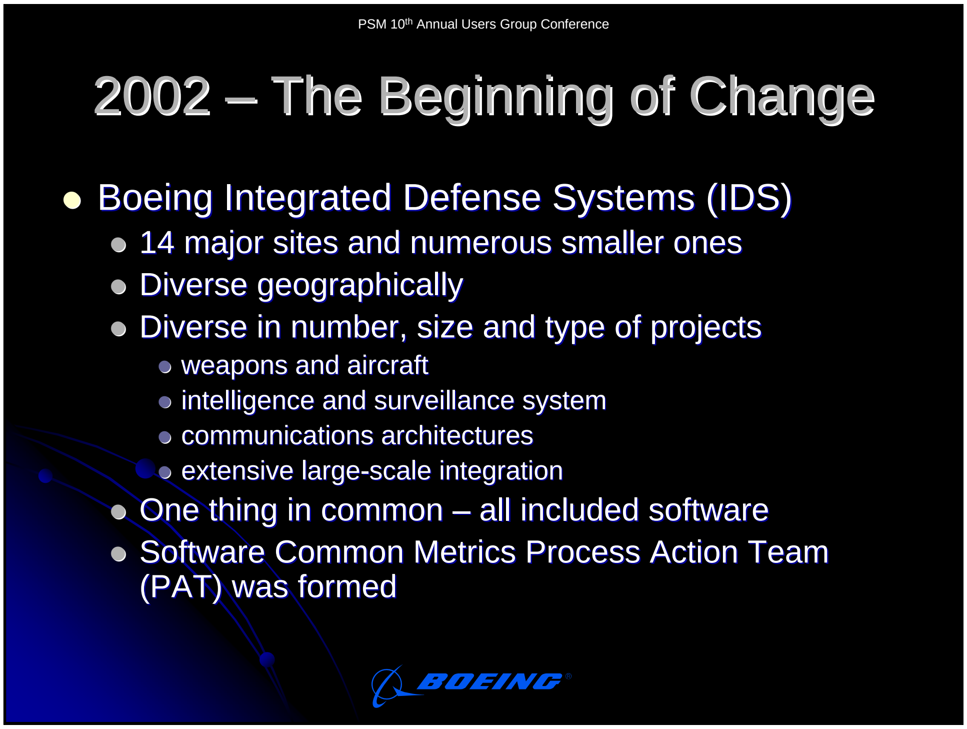
The Boeing Company



In The Beginning . . .

- Software organizations developed Metric Definition Manuals as part of Capability Maturity Model (CMM) assessment preparation
  - Often the approach was to “measure everything”
  - Measurement was not always consistently applied
  - Measurement data was not always stored in a usable format
  - Sometimes measurement data was not preserved at program closure



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2002 – The Beginning of Change

- Boeing Integrated Defense Systems (IDS)
  - 14 major sites and numerous smaller ones
  - Diverse geographically
  - Diverse in number, size and type of projects
    - weapons and aircraft
    - intelligence and surveillance system
    - communications architectures
    - extensive large-scale integration
  - One thing in common – all included software
  - Software Common Metrics Process Action Team (PAT) was formed

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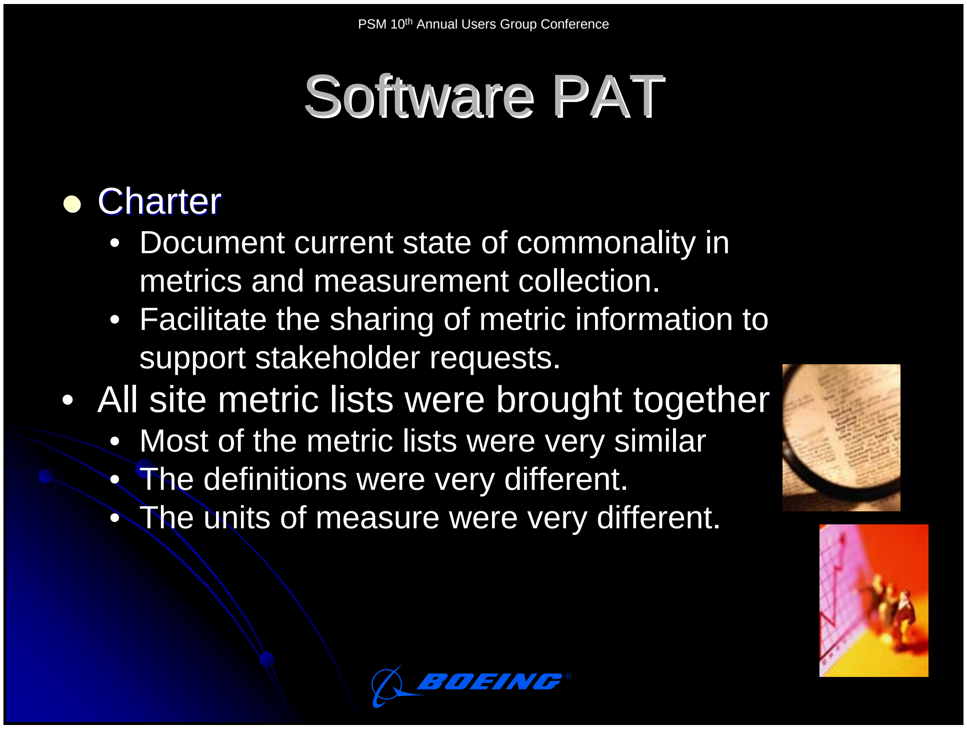

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Software PAT

- Charter
  - Document current state of commonality in metrics and measurement collection.
  - Facilitate the sharing of metric information to support stakeholder requests.
- All site metric lists were brought together
  - Most of the metric lists were very similar
  - The definitions were very different.
  - The units of measure were very different.

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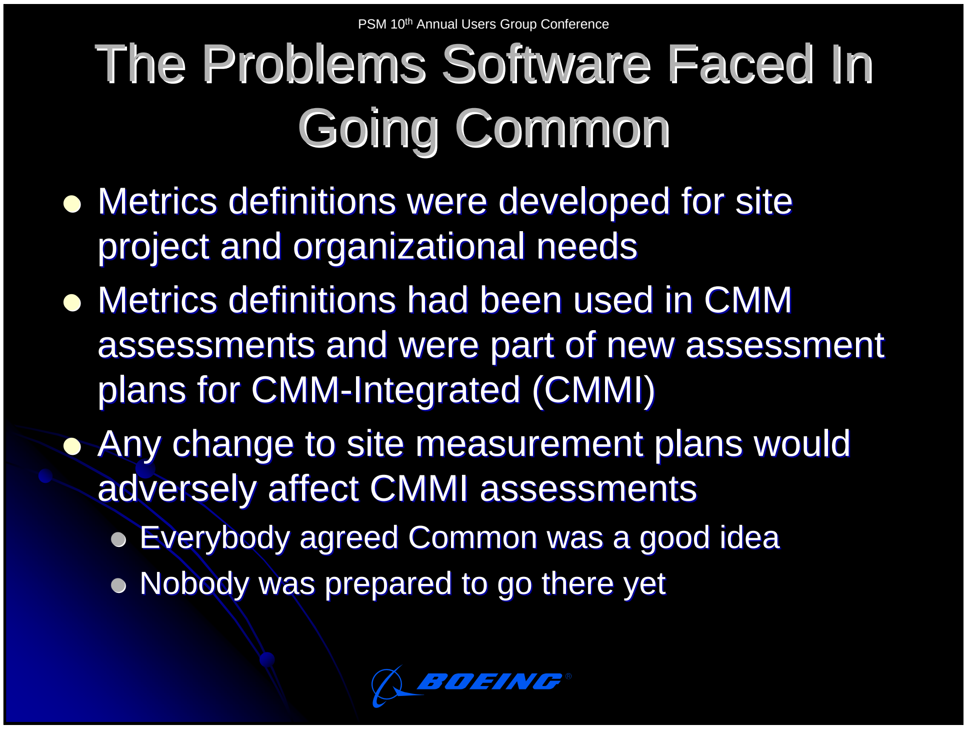
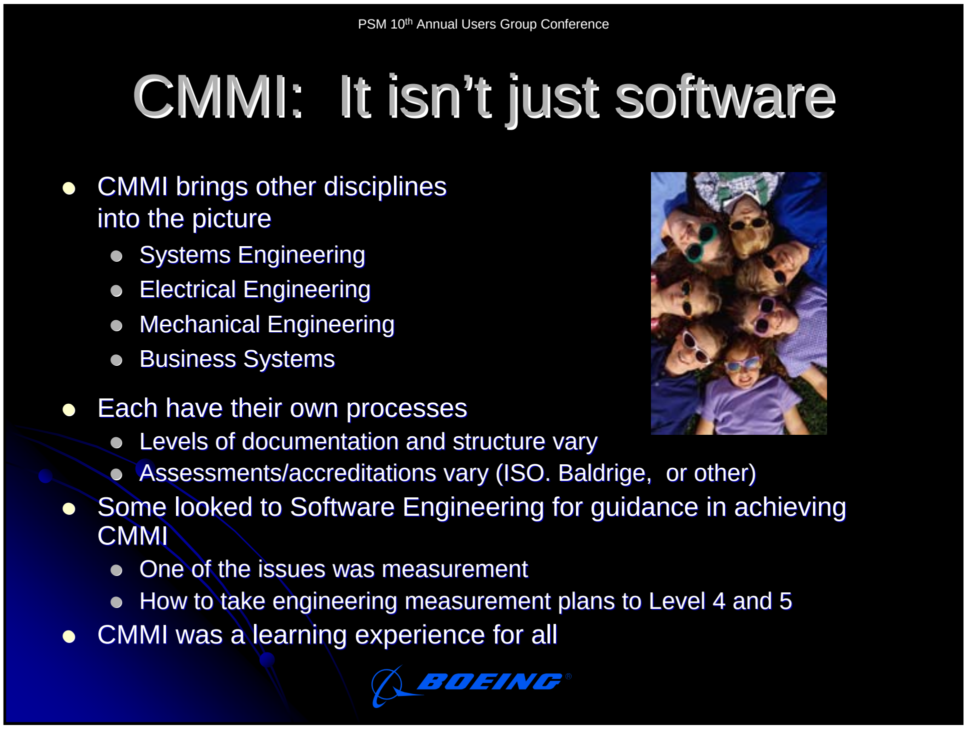


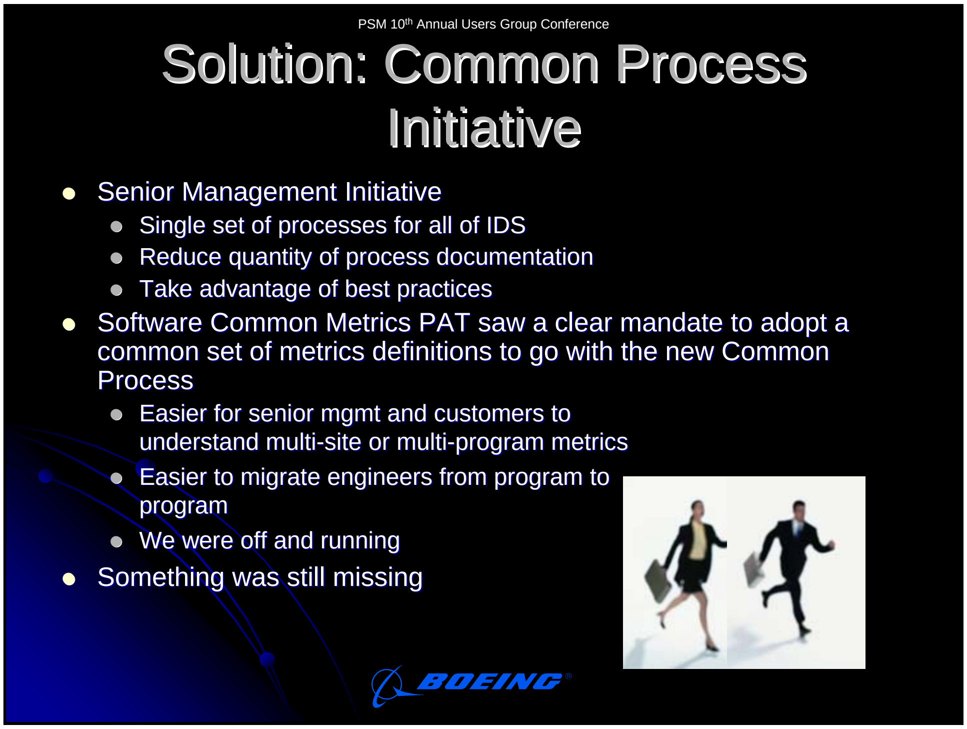
The Problems Software Faced In Going Common

- Metrics definitions were developed for site project and organizational needs
- Metrics definitions had been used in CMM assessments and were part of new assessment plans for CMM-Integrated (CMMI)
- Any change to site measurement plans would adversely affect CMMI assessments
  - Everybody agreed Common was a good idea
  - Nobody was prepared to go there yet



CMMI: It isn't just software

- CMMI brings other disciplines into the picture
  - Systems Engineering
  - Electrical Engineering
  - Mechanical Engineering
  - Business Systems
- Each have their own processes
  - Levels of documentation and structure vary
  - Assessments/accreditations vary (ISO. Baldrige, or other)
- Some looked to Software Engineering for guidance in achieving CMMI
  - One of the issues was measurement
  - How to take engineering measurement plans to Level 4 and 5
- CMMI was a learning experience for all



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Solution: Common Process Initiative

- Senior Management Initiative
  - Single set of processes for all of IDS
  - Reduce quantity of process documentation
  - Take advantage of best practices
- Software Common Metrics PAT saw a clear mandate to adopt a common set of metrics definitions to go with the new Common Process
  - Easier for senior mgmt and customers to understand multi-site or multi-program metrics
  - Easier to migrate engineers from program to program
  - We were off and running
- Something was still missing

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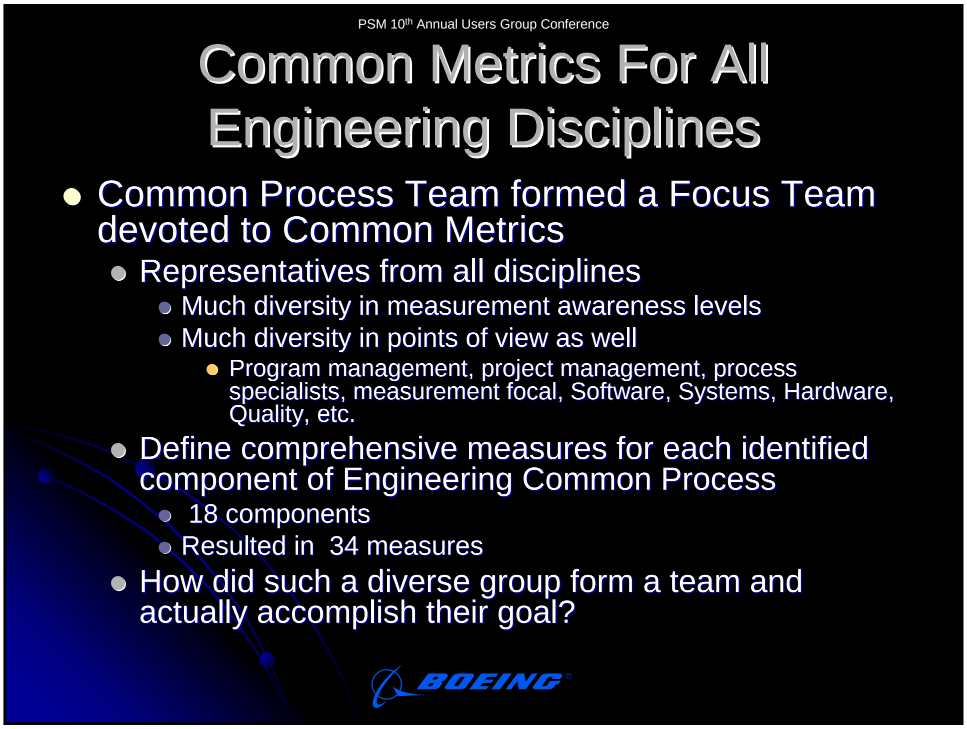

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Common Metrics For All Engineering Disciplines

- Common Process Team formed a Focus Team devoted to Common Metrics
  - Representatives from all disciplines
    - Much diversity in measurement awareness levels
    - Much diversity in points of view as well
      - Program management, project management, process specialists, measurement focal, Software, Systems, Hardware, Quality, etc.
  - Define comprehensive measures for each identified component of Engineering Common Process
    - 18 components
    - Resulted in 34 measures
  - How did such a diverse group form a team and actually accomplish their goal?

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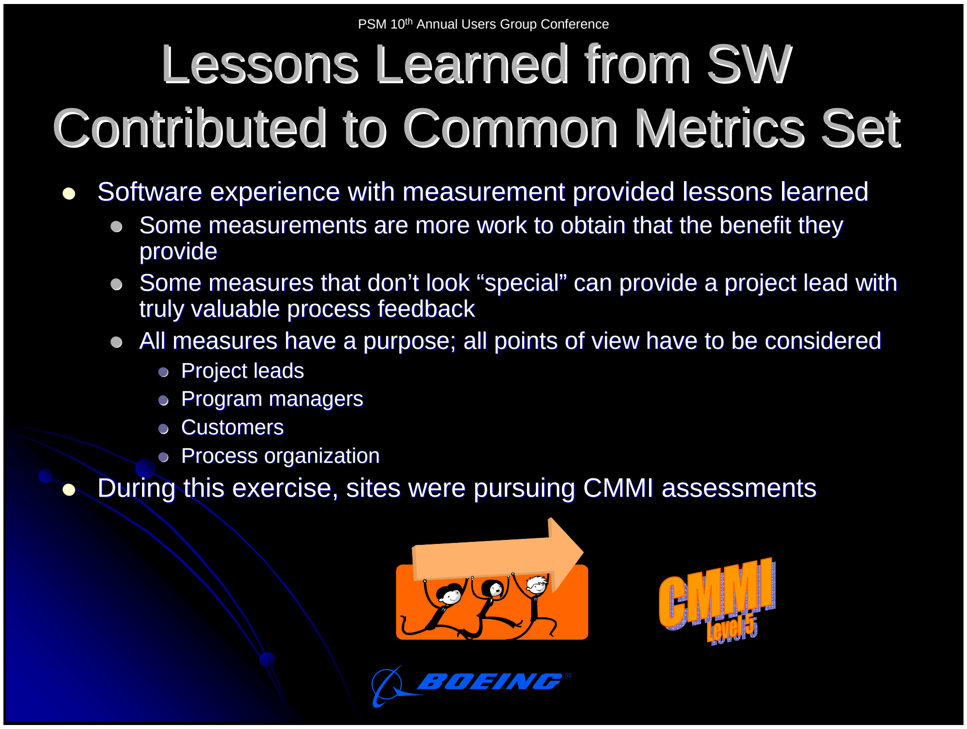

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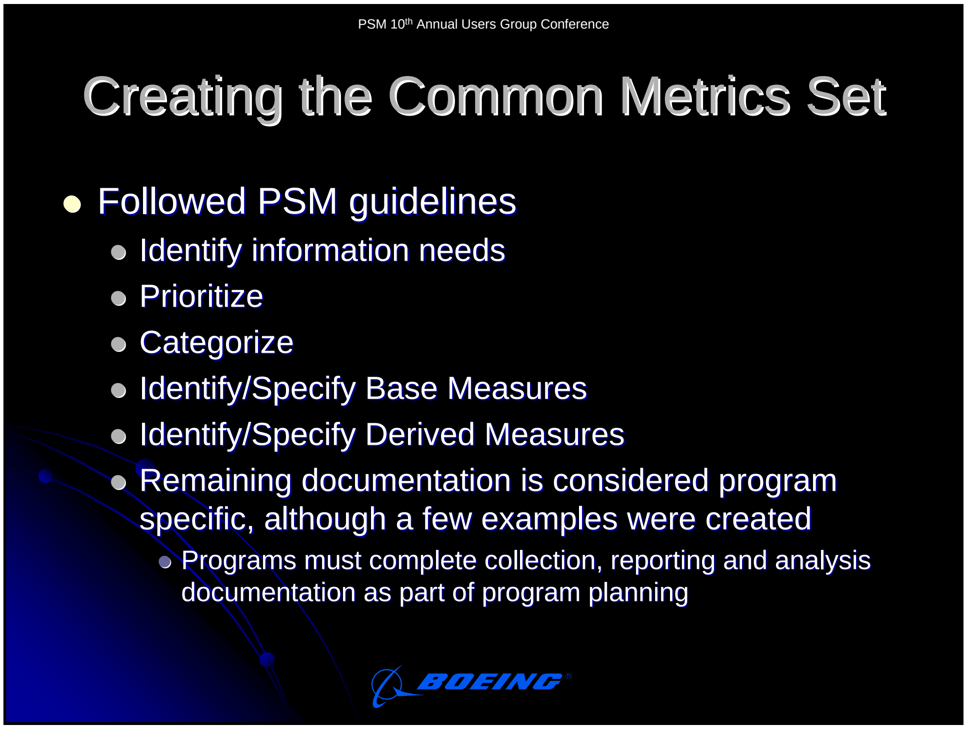
Lessons Learned from SW Contributed to Common Metrics Set

- Software experience with measurement provided lessons learned
  - Some measurements are more work to obtain that the benefit they provide
  - Some measures that don’t look “special” can provide a project lead with truly valuable process feedback
  - All measures have a purpose; all points of view have to be considered
    - Project leads
    - Program managers
    - Customers
    - Process organization
- During this exercise, sites were pursuing CMMI assessments

CMMI
Level 5



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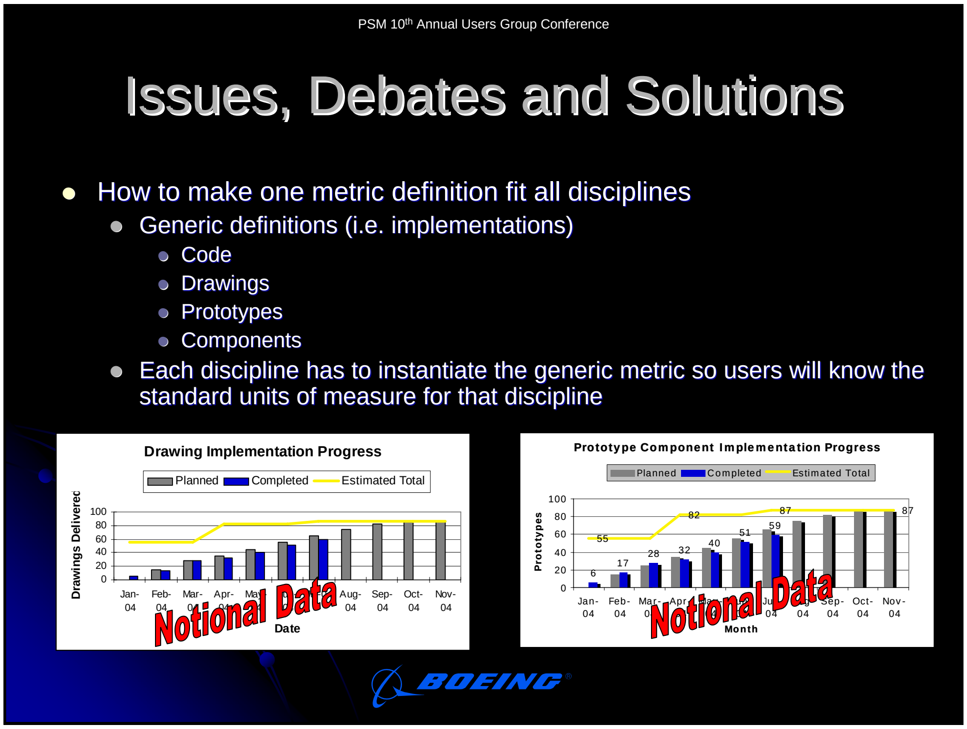
Creating the Common Metrics Set

- Followed PSM guidelines
  - Identify information needs
  - Prioritize
  - Categorize
  - Identify/Specify Base Measures
  - Identify/Specify Derived Measures
  - Remaining documentation is considered program specific, although a few examples were created
    - Programs must complete collection, reporting and analysis documentation as part of program planning



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Issues, Debates and Solutions

- How to make one metric definition fit all disciplines
  - Generic definitions (i.e. implementations)
    - Code
    - Drawings
    - Prototypes
    - Components
  - Each discipline has to instantiate the generic metric so users will know the standard units of measure for that discipline

Drawing Implementation Progress
Planned
Completed
Estimated Total
Drawings Deliverec
100
80
60
40
20
0
Jan-04
Feb-04
Mar-04
Apr-04
May
Aug-04
Sep-04
Oct-04
Nov-04
Date
Notional Data
Prototype Component Implementation Progress
Planned
Completed
Estimated Total
Prototypes
100
80
60
40
20
0
55
82
87
87
6
17
28
32
40
51
59
Jan-04
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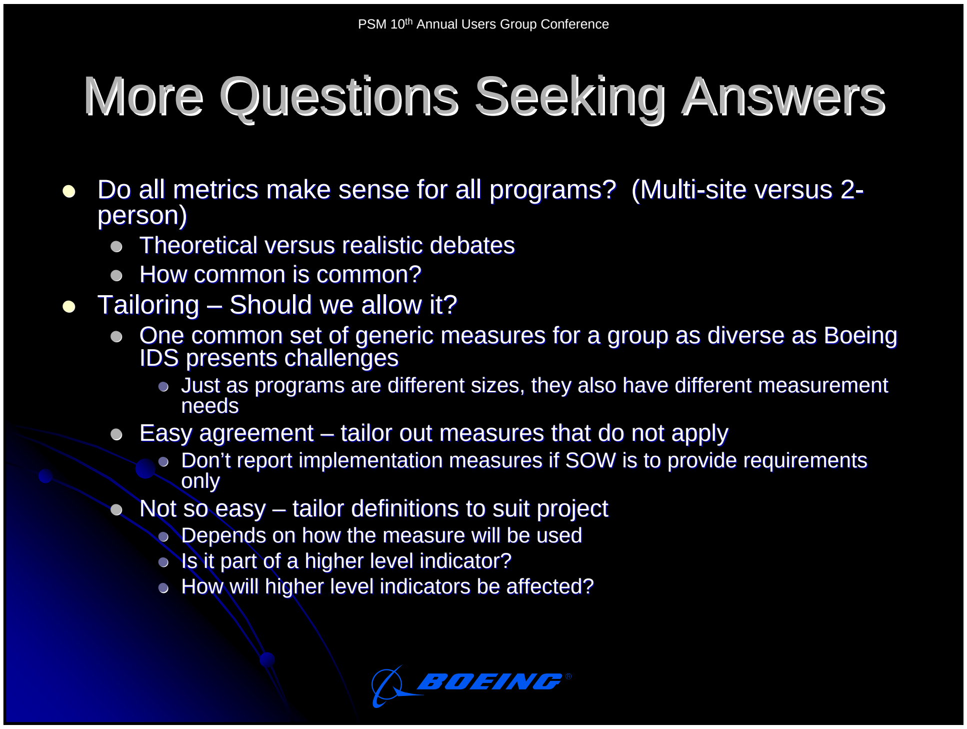

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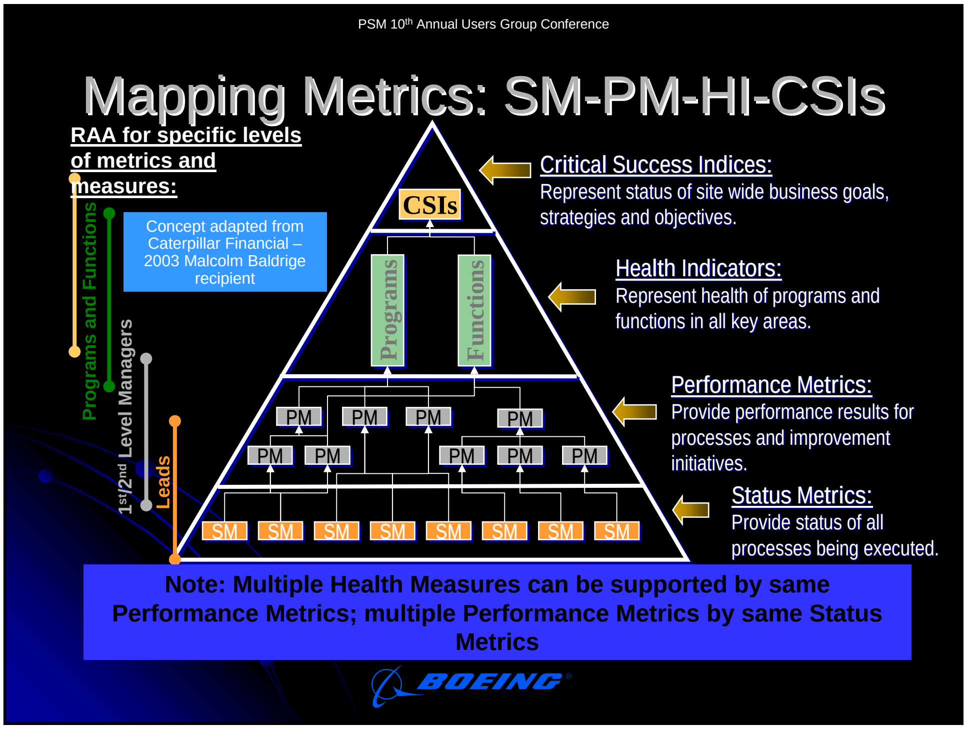
More Questions Seeking Answers

- Do all metrics make sense for all programs? (Multi-site versus 2-person)
  - Theoretical versus realistic debates
  - How common is common?
- Tailoring – Should we allow it?
  - One common set of generic measures for a group as diverse as Boeing IDS presents challenges
    - Just as programs are different sizes, they also have different measurement needs
  - Easy agreement – tailor out measures that do not apply
    - Don’t report implementation measures if SOW is to provide requirements only
  - Not so easy – tailor definitions to suit project
    - Depends on how the measure will be used
    - Is it part of a higher level indicator?
    - How will higher level indicators be affected?



Mapping Metrics: SM-PM-HI-CSIs

RAA for specific levels of metrics and measures:

Concept adapted from Caterpillar Financial – 2003 Malcolm Baldrige recipient

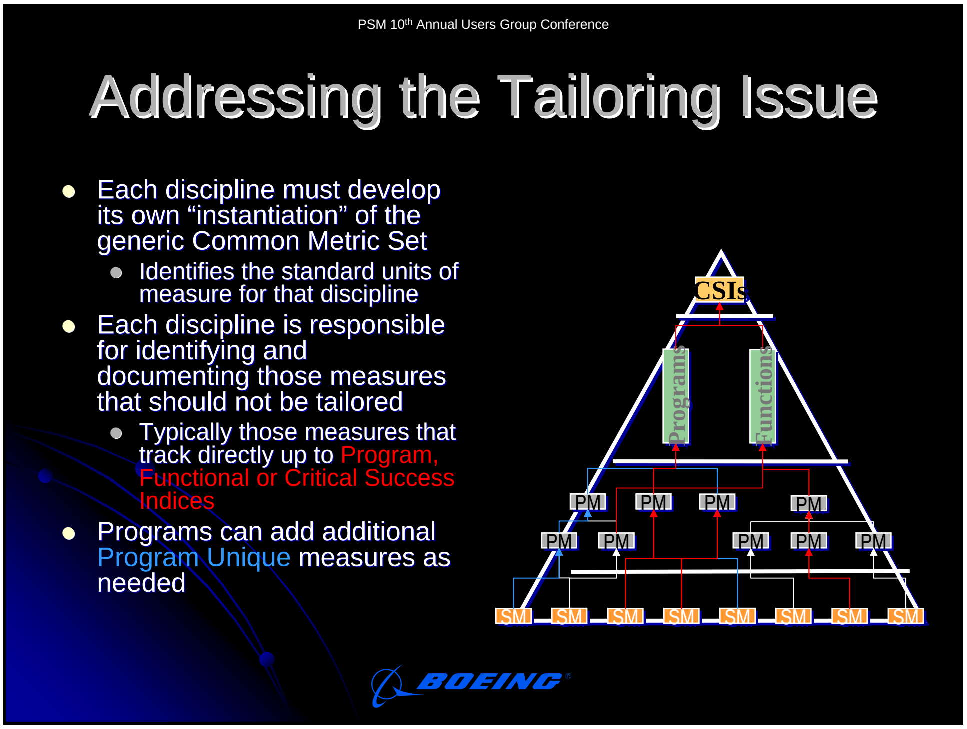
Critical Success Indices: Represent status of site wide business goals, strategies and objectives.

Health Indicators: Represent health of programs and functions in all key areas.

Performance Metrics: Provide performance results for processes and improvement initiatives.

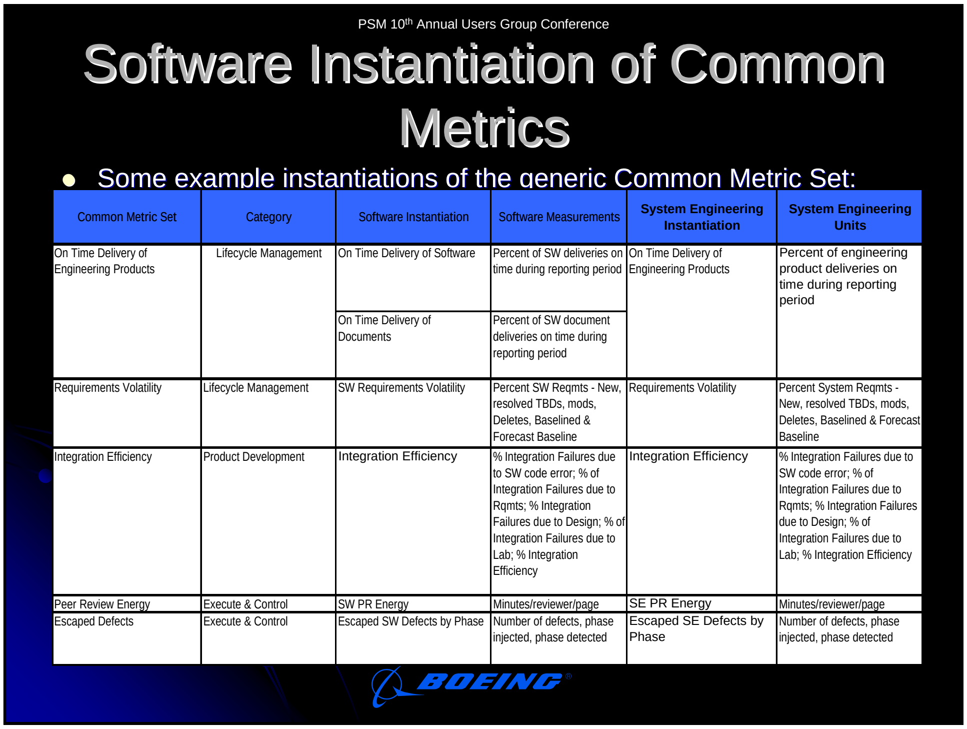
Status Metrics: Provide status of all processes being executed.

Note: Multiple Health Measures can be supported by same Performance Metrics; multiple Performance Metrics by same Status Metrics



Addressing the Tailoring Issue

- Each discipline must develop its own “instantiation” of the generic Common Metric Set
  - Identifies the standard units of measure for that discipline
- Each discipline is responsible for identifying and documenting those measures that should not be tailored
  - Typically those measures that track directly up to Program, Functional or Critical Success Indices
- Programs can add additional Program Unique measures as needed



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Software Instantiation of Common Metrics

- Some example instantiations of the generic Common Metric Set:

Common Metric Set	Category	Software Instantiation	Software Measurements	System Engineering Instantiation	System Engineering Units
On Time Delivery of Engineering Products	Lifecycle Management	On Time Delivery of Software	Percent of SW deliveries on time during reporting period	On Time Delivery of Engineering Products	Percent of engineering product deliveries on time during reporting period
		On Time Delivery of Documents	Percent of SW document deliveries on time during reporting period		
Requirements Volatility	Lifecycle Management	SW Requirements Volatility	Percent SW Reqmts - New, resolved TBDs, mods, Deletes, Baselined & Forecast Baseline	Requirements Volatility	Percent System Reqmts - New, resolved TBDs, mods, Deletes, Baselined & Forecast Baseline
Integration Efficiency	Product Development	Integration Efficiency	% Integration Failures due to SW code error; % of Integration Failures due to Rqmts; % Integration Failures due to Design; % of Integration Failures due to Lab; % Integration Efficiency	Integration Efficiency	% Integration Failures due to SW code error; % of Integration Failures due to Rqmts; % Integration Failures due to Design; % of Integration Failures due to Lab; % Integration Efficiency
Peer Review Energy	Execute & Control	SW PR Energy	Minutes/reviewer/page	SE PR Energy	Minutes/reviewer/page
Escaped Defects	Execute & Control	Escaped SW Defects by Phase	Number of defects, phase injected, phase detected	Escaped SE Defects by Phase	Number of defects, phase injected, phase detected

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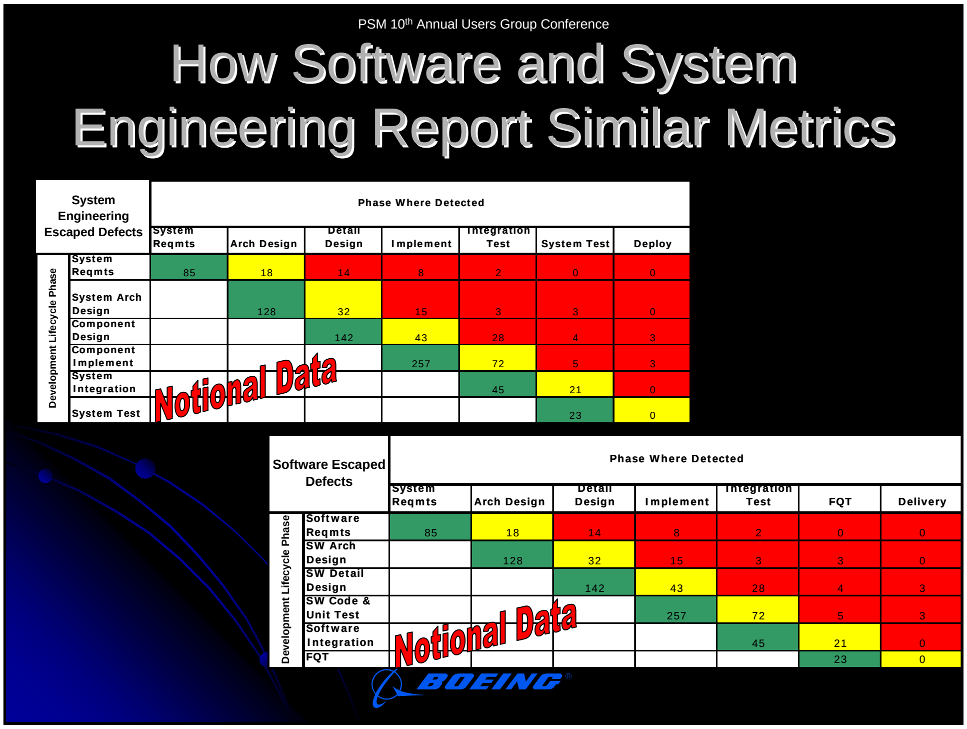

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How Software and System Engineering Report Similar Metrics

System Engineering Escaped Defects		Phase Where Detected						
		System Reqmts	Arch Design	Detail Design	Implement	Integration Test	System Test	Deploy
Development Lifecycle Phase	System Reqmts	85	18	14	8	2	0	0
	System Arch Design		128	32	15	3	3	0
	Component Design			142	43	28	4	3
	Component Implement				257	72	5	3
	System Integration					45	21	0
	System Test						23	0

Notional Data

Software Escaped Defects		Phase Where Detected						
		System Reqmts	Arch Design	Detail Design	Implement	Integration Test	FQT	Delivery
Development Lifecycle Phase	Software Reqmts	85	18	14	8	2	0	0
	SW Arch Design		128	32	15	3	3	0
	SW Detail Design			142	43	28	4	3
	SW Code & Unit Test				257	72	5	3
	Software Integration					45	21	0
	FQT						23	0

Notional Data

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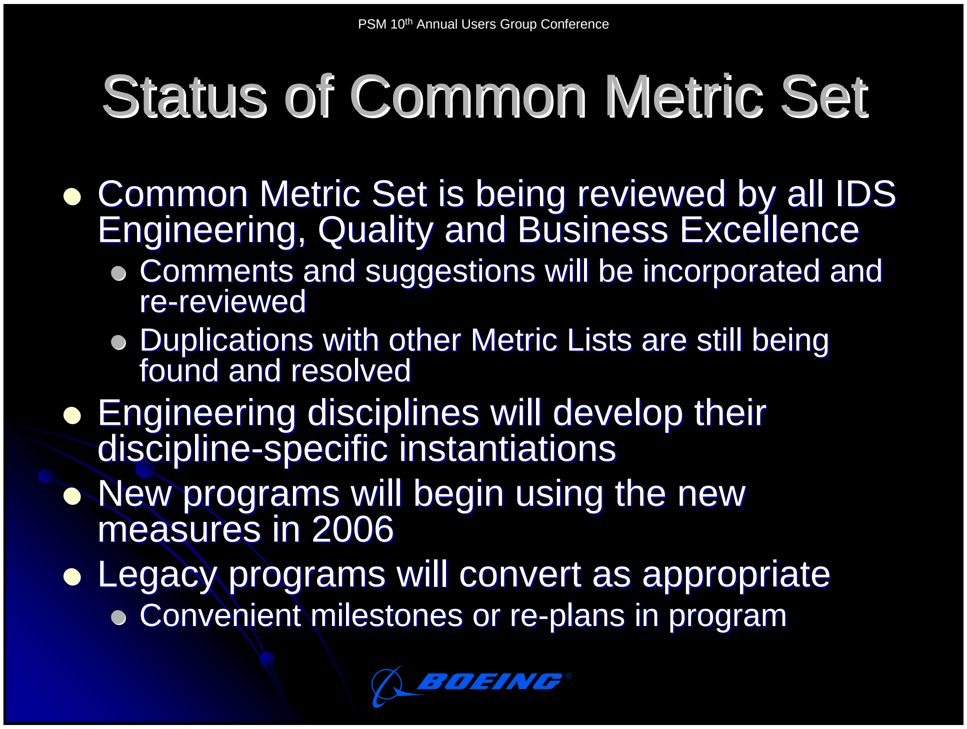
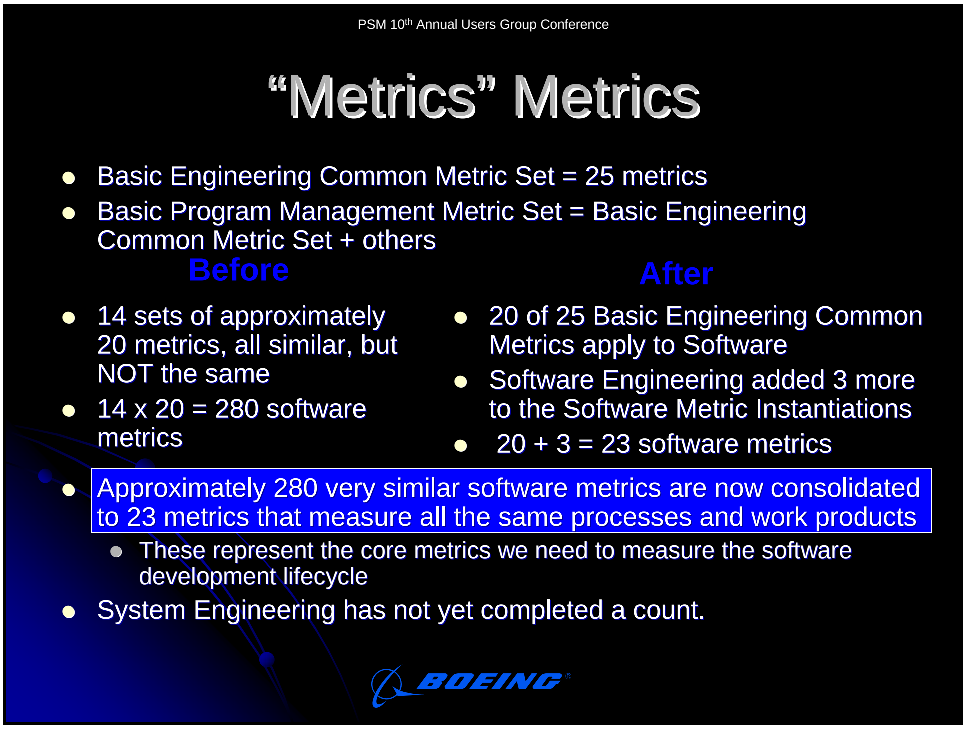


Status of Common Metric Set

- Common Metric Set is being reviewed by all IDS Engineering, Quality and Business Excellence
  - Comments and suggestions will be incorporated and re-reviewed
  - Duplications with other Metric Lists are still being found and resolved
- Engineering disciplines will develop their discipline-specific instantiations
- New programs will begin using the new measures in 2006
- Legacy programs will convert as appropriate
  - Convenient milestones or re-plans in program



"Metrics" Metrics

- Basic Engineering Common Metric Set = 25 metrics
- Basic Program Management Metric Set = Basic Engineering Common Metric Set + others

Before

- 14 sets of approximately 20 metrics, all similar, but NOT the same
- 14 x 20 = 280 software metrics

After

- 20 of 25 Basic Engineering Common Metrics apply to Software
- Software Engineering added 3 more to the Software Metric Instantiations
- 20 + 3 = 23 software metrics

- Approximately 280 very similar software metrics are now consolidated to 23 metrics that measure all the same processes and work products
  - These represent the core metrics we need to measure the software development lifecycle
- System Engineering has not yet completed a count.