

# Benchmarking System Development in the Defense Industry

NDIA Systems Engineering Conference  
October 2013

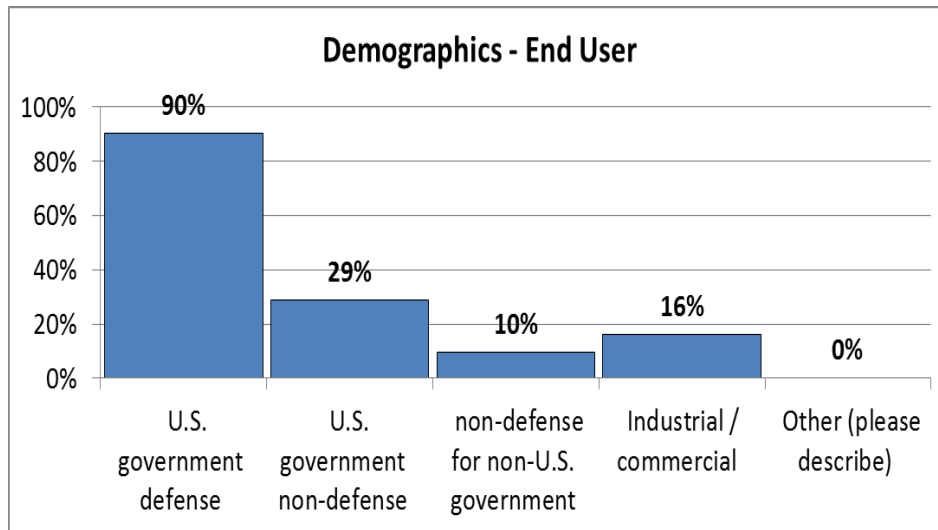
**Joseph Elm**  
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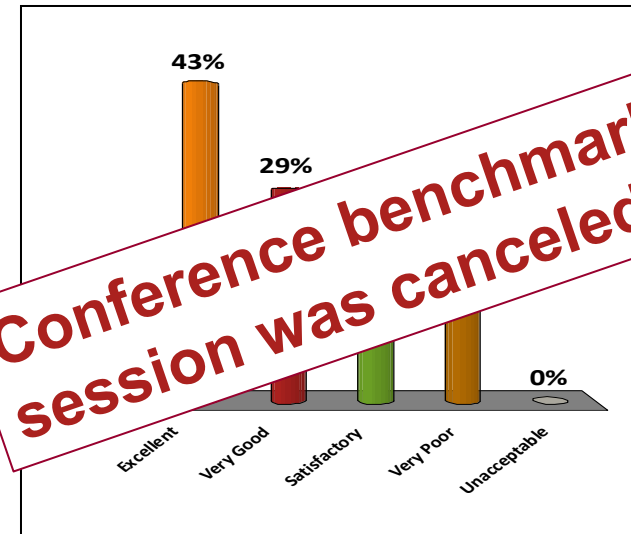
**Geoff Draper**  
Harris Corporation  
Govt Communications Systems

# Analysis Results

- Distribution of responses to survey questions
- SEI online survey results (pre-conference)



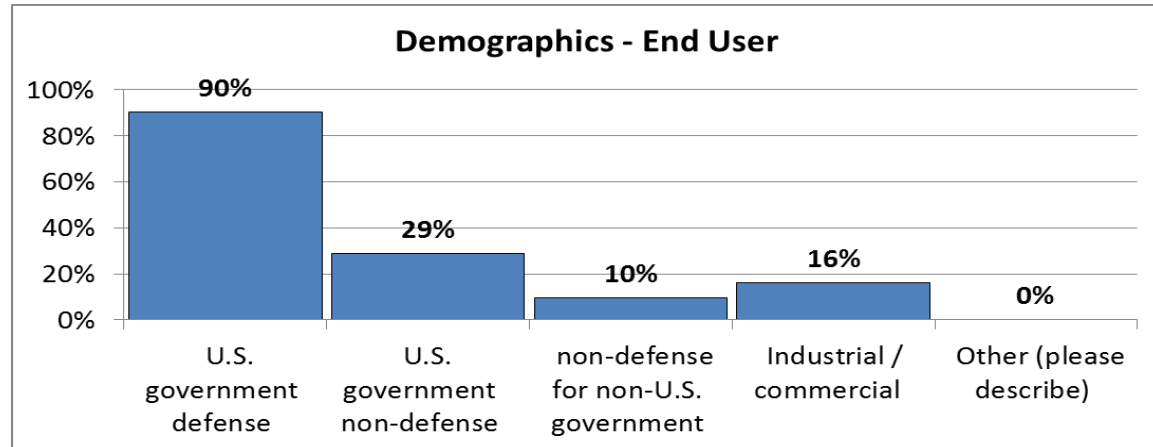
- Interactive results from NDIA SE Conference audience



## 2. Demographics – End User

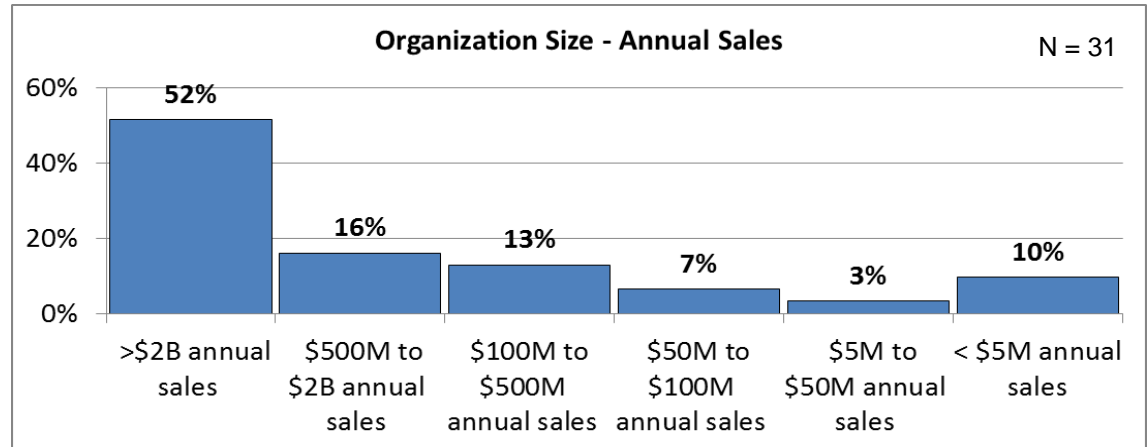
Which of the following best describes the ultimate end user of programs or products developed and delivered by your organization?

1. U.S. government defense
2. U.S. government non-defense
3. non-defense for non-U.S. government
4. Industrial / commercial
5. Other (please describe)



# 3. Demographics – Org Size (Sales)

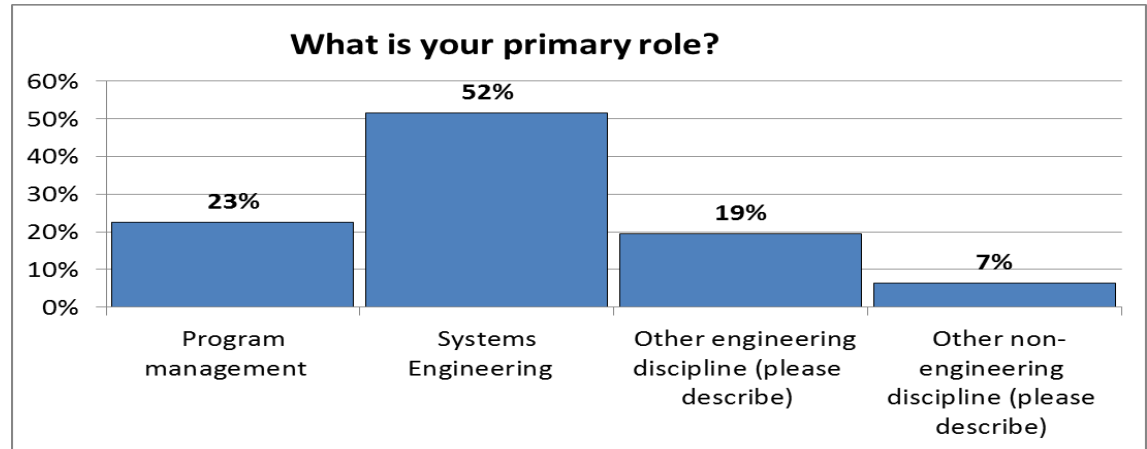
**Based on annual sales, what is the size of your company?**



1. >\$2B
2. \$500M - \$2B
3. \$100M- \$500M
4. \$50M - \$100M
5. \$5M - \$50M
6. < \$5M

# 4. Demographics – Primary Role

What is your primary role in the organization?

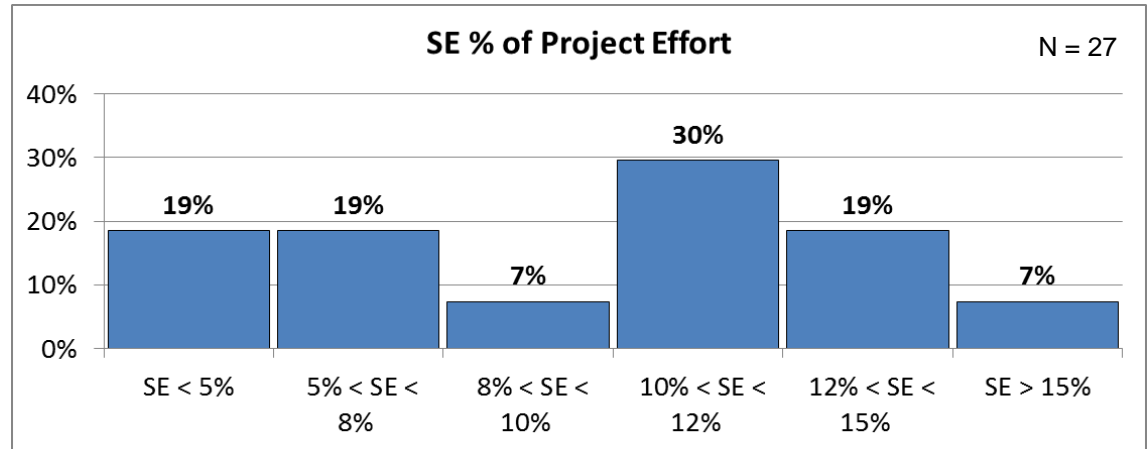


1. PM
2. SE
3. Other Eng discipline
4. Other non-Eng

# 5. SE % of Project Estimates

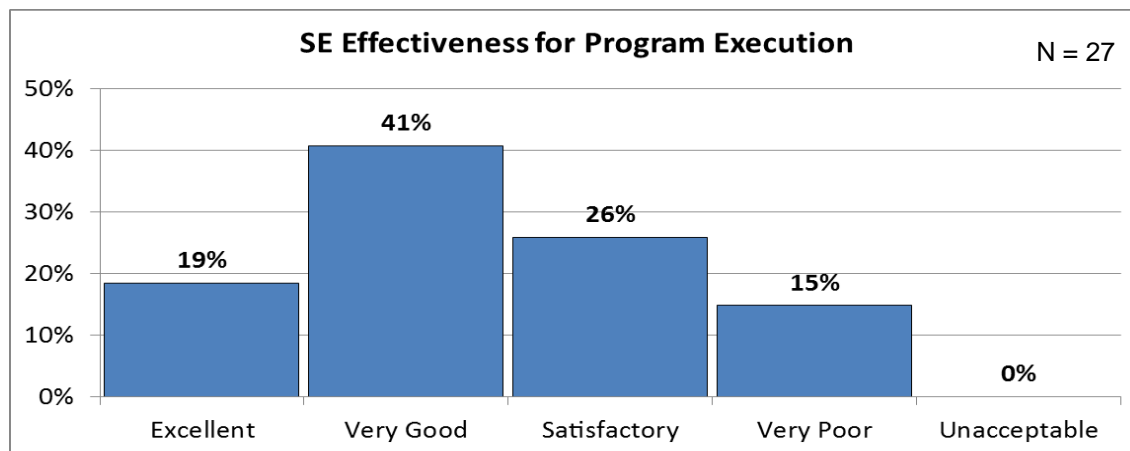
Approximately what % does systems engineering typically comprise for development project estimates (non-recurring engrg)?

1. SE < 5%
2. 5% < SE < 8%
3. 8% < SE < 10%
4. 10% < SE < 12%
5. 12% < SE < 15%
6. SE > 15%



# 6. Systems Engineering Effectiveness

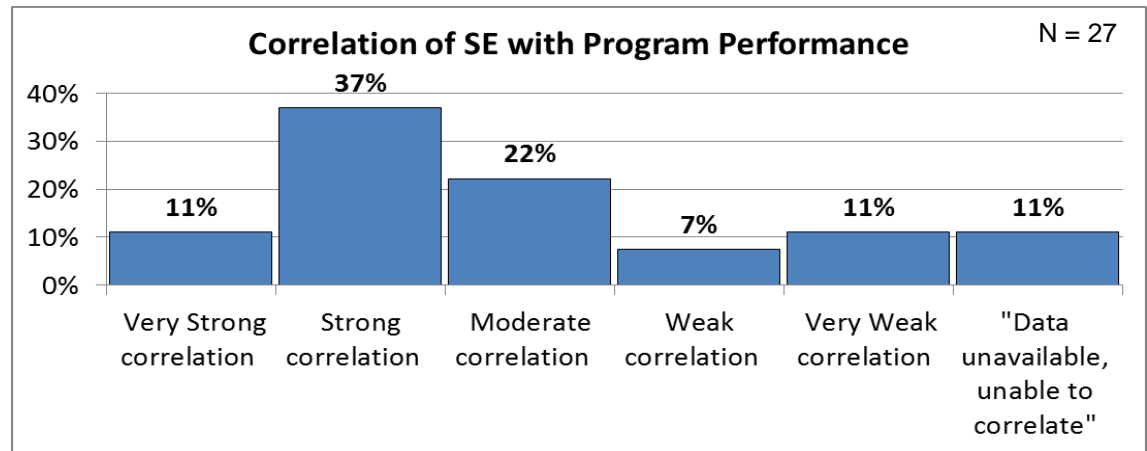
**How effective is that systems engineering in supporting successful program execution?**



1. Excellent
2. Very Good
3. Satisfactory
4. Very Poor
5. Unacceptable

# 7. Correlation of SE with Performance

**To what extent is your organization able to correlate systems engineering capability (high vs. low SE capability) with program performance (high vs. low performance)?**

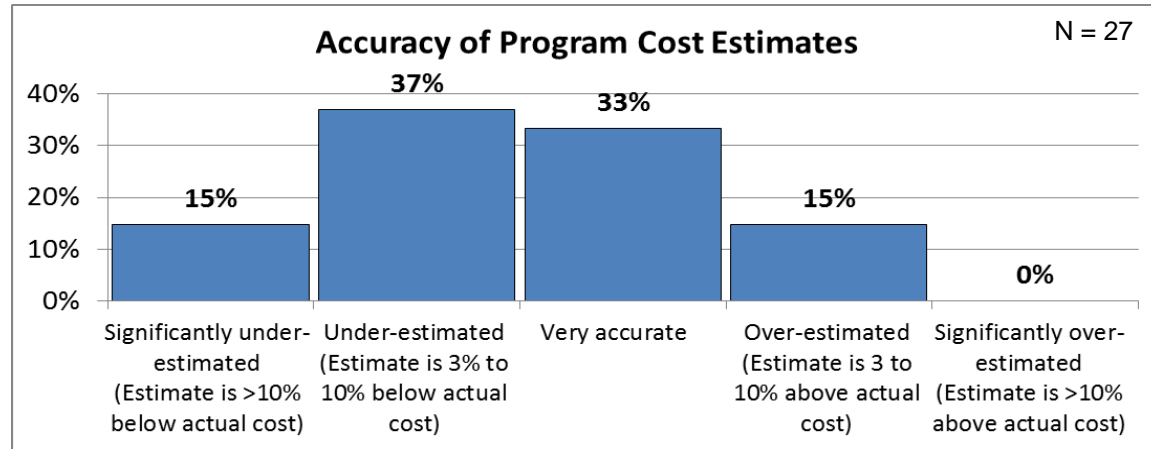


1. Very Strong correlation
2. Strong correlation
3. Moderate correlation
4. Weak correlation
5. Very Weak correlation
6. Data not available



# 8. Accuracy of Cost Estimates

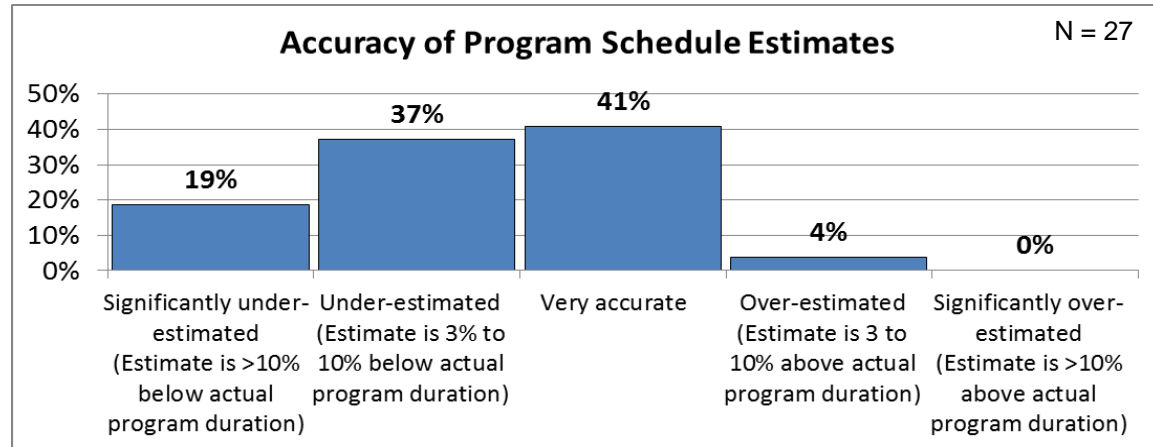
**On average, where would the programs in your organization's portfolio fall regarding the accuracy of program cost estimates against actual program performance?**



1. Significantly under-estimated (-10%)
2. Under-estimated (-3% to -10%)
3. Very accurate
4. Over-estimated (+3% to +10%)
5. Significantly over-estimated (>+10%)

# 9. Accuracy of Schedule Estimates

**On average, where would the programs in your organization's portfolio fall regarding the accuracy of program schedule estimates against actual program performance?**



1. Significantly under-estimated (-10%)
2. Under-estimated (-3% to -10%)
3. Very accurate
4. Over-estimated (+3% to +10%)
5. Significantly over-estimated (>+10%)

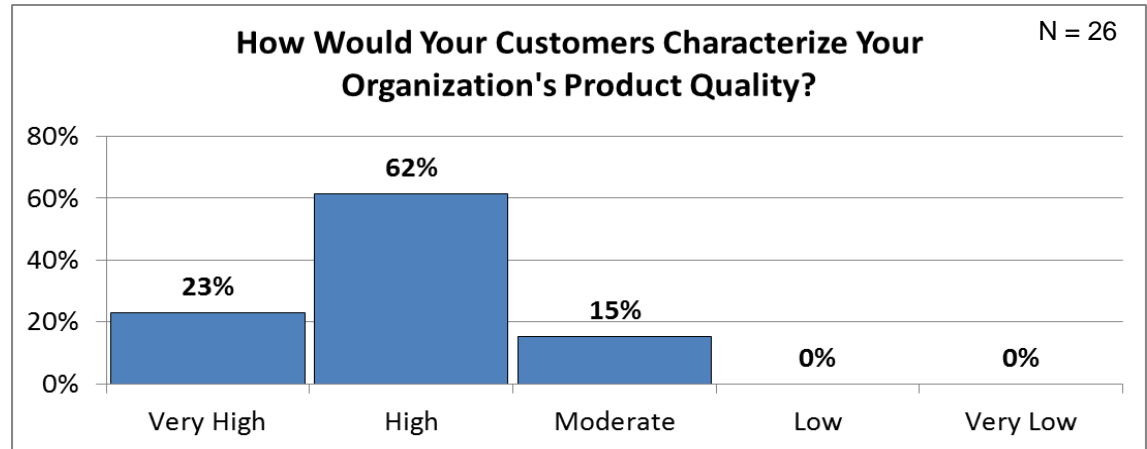
# Comments – SE and PM within your organization?

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- Good SEs are difficult to find and hire
- Engineering discipline “silos” vs. integrated (IPPD)
- HSI: shortage of funding and interest. Apply HSI early, integrated with program team.
- SE % varies by application domain and business unit.
- Most schedule overruns are directly related to funding delays.
- “Systems engineering” is not clearly defined in this survey – should be expressed in terms of products.
- Government strengthening of SE is correcting historical problems where SE was put in unofficial lead integrator role but viewed by developers as a competitor.

# 10. Product Quality

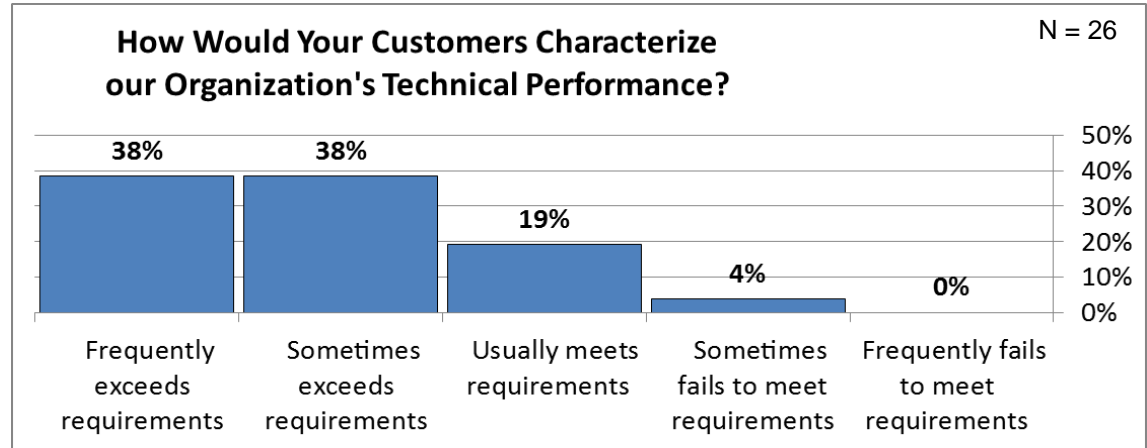
How would your customers generally characterize your organization's product quality?



1. Very high
2. High
3. Moderate
4. Low
5. Very Low

# 11. Technical Performance

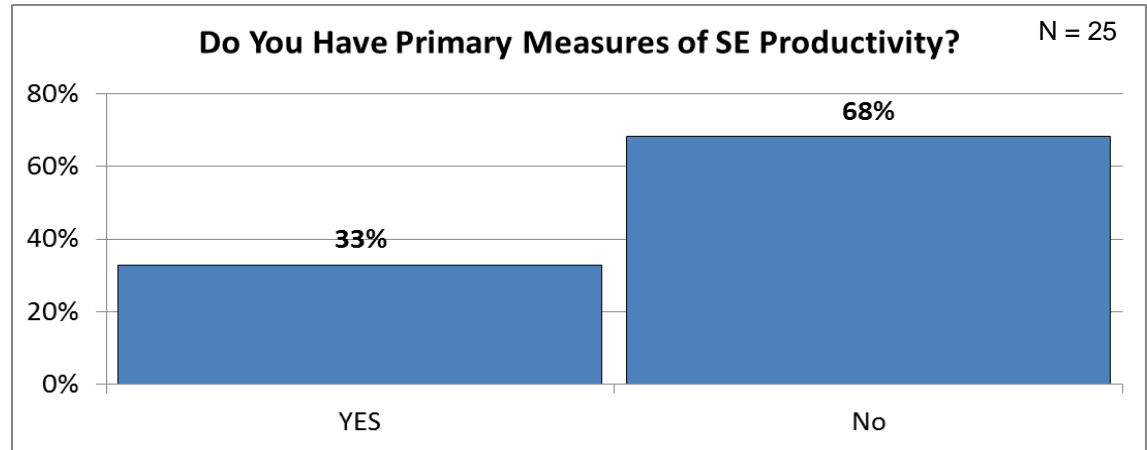
How would your customers generally characterize your organization's technical performance?



1. Frequently exceeds reqts
2. Sometimes exceeds reqts
3. Usually meets reqts
4. Sometimes fails to meet reqts
5. Frequently fails to meet reqts

# 12. SE Productivity Measures

Do you have primary measures you collect and use to monitor SE productivity (e.g., requirements/hr)?



1. Yes
2. No

# Comments (22) – SE Productivity Measures

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## Requirements

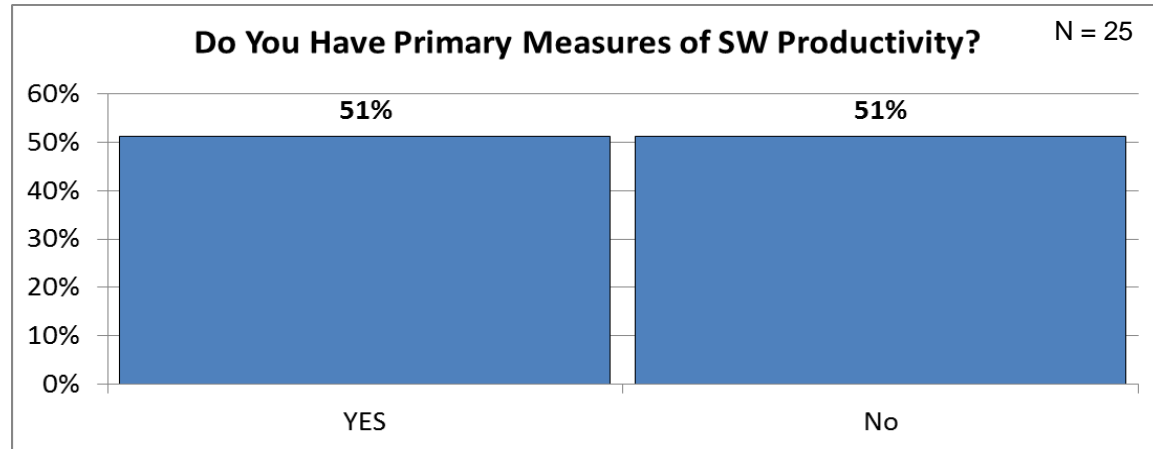
- Requirements Volatility (scope creep)
- Requirements per person-month
- \$ per Reqt
- Effort for unplanned reqts changes
- Reqts quality
- Requirements trends and other leading indicators (INCOSE Guide)
- Discrepancy Reports / Reqt
- Defects / Reqt

## Other:

- EVMS / monthly reports
- Schedule
- Cost
- Risk
- Design points per person-month
- Interface trends
- % SE product reuse
- # workarounds per build

# 13. SW Productivity Measures

Do you have primary measures you collect and use to monitor SW productivity (e.g., LOC/hr, function pts)?



1. Yes
2. No



# Comments (17) – SW Productivity Measures

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## LOC

- LOC, LOC/hr (8)
- ESLOC / reqt
- ESLOC per person-month
- Defects / ESLOC

## Function points:

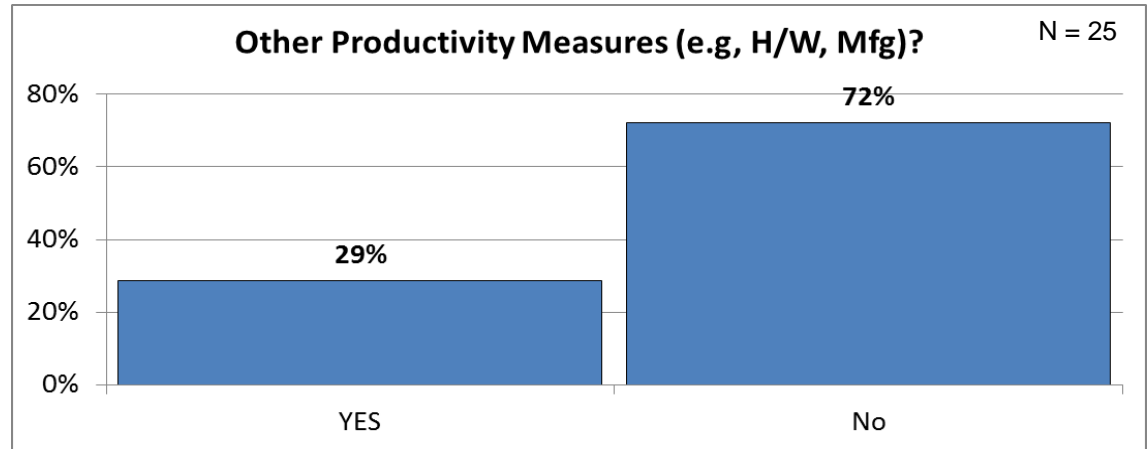
- Function pts, function pts / hr

## Other

- EVMS
- Monthly reports
- % reuse

# 14. Other Productivity Measures

**Do you have other primary measures (e.g., hardware, manufacturing) you collect and use to monitor productivity?**



1. Yes
2. No

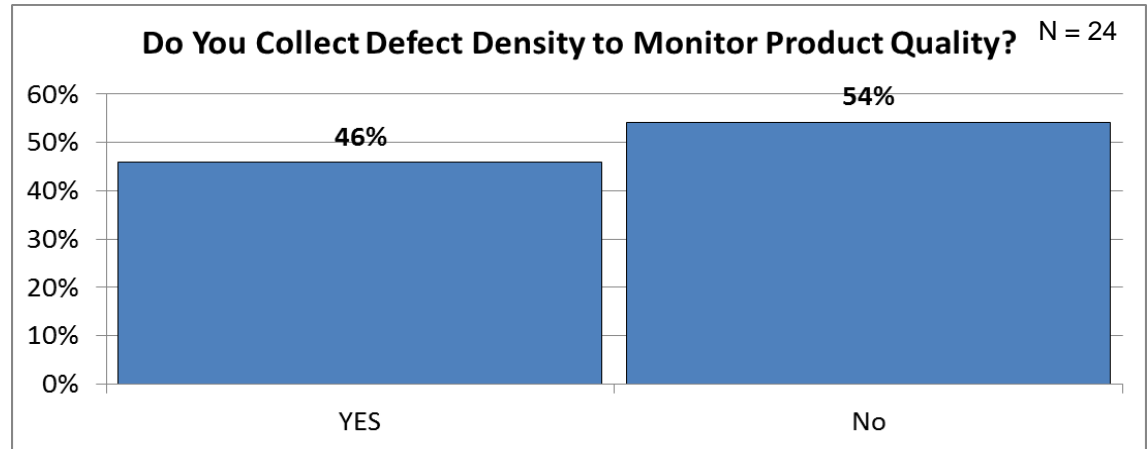
# Comments (13) – Other Productivity Measures (HW, Mfg)

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- Results-based
- # of defects
- Drawings / hr
- Electronics reqts volatility (2)
- \$ / person-hour
- Yield
- Gates / hr
- Electronics integration returns
- Mechanical assembly design hours
- HW drawing effort by drawing type
- Unplanned drawing & analysis growth
- Hours per test point

# 15. Defect Density Measures

**Do you collect and use Defect density (e.g., defects per unit size/qty) to monitor product quality?**



1. Yes
2. No

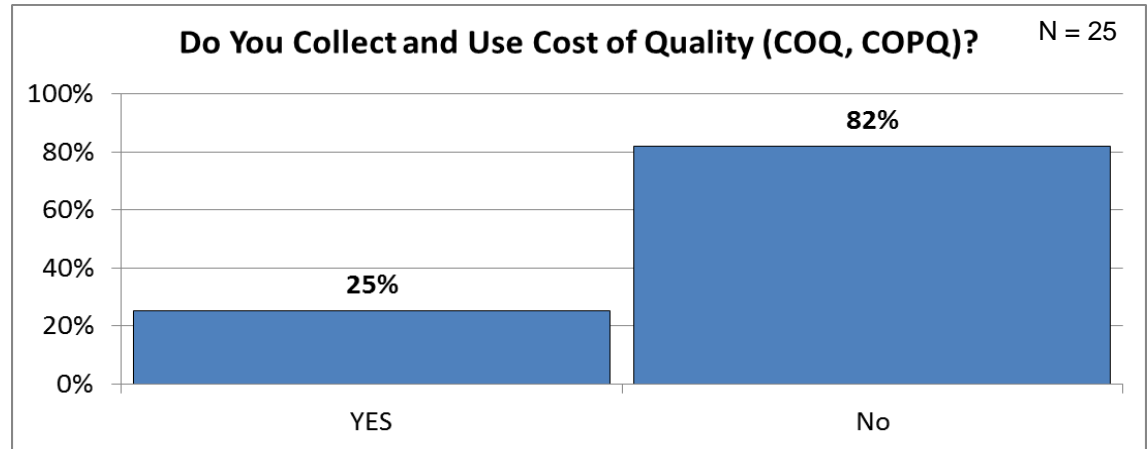
# Comments (19) – Defect Density Measures

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- Defects / KLOC (5)
- Defects / unit qty (3)
- Defects / hr
- Defects / function
- Total defect reports
- % Change in Defects
- Defects per test procedures
- Defect categorization
- Defects per drawing by drawing type
- Failure analysis
- Sampling against specifications (2)
- Inspection
- Built-In Test

# 16. Cost of Quality

**Do you collect and use Cost of Quality (COQ, COPQ) to monitor product quality?**



1. Yes
2. No

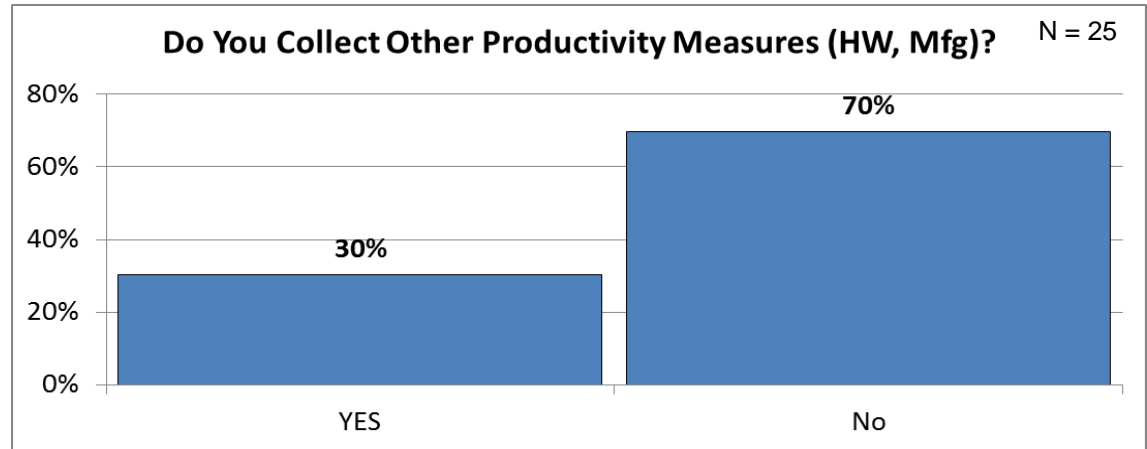
# Comments (19) – Cost of Quality Measures

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- Rework and repair cost
- Rework and repair % defects
- Cost of Quality (COQ)
- Cost of detection
- Cost of correction
- Cost of prevention
- Lost schedule time
- Engineering changes

# 17. HW / Mfg Quality Measures

**Do you collect and use other measures (e.g., hardware, manufacturing) to monitor product quality?**



1. Yes
2. No

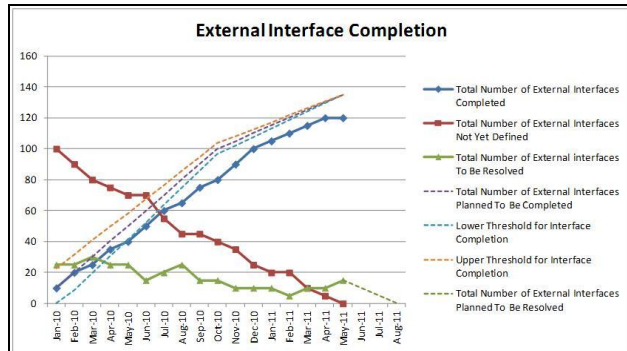
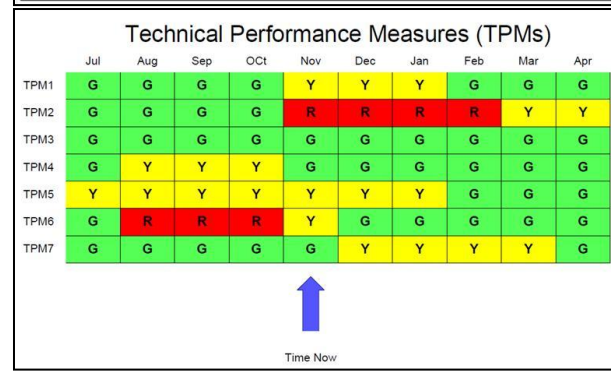
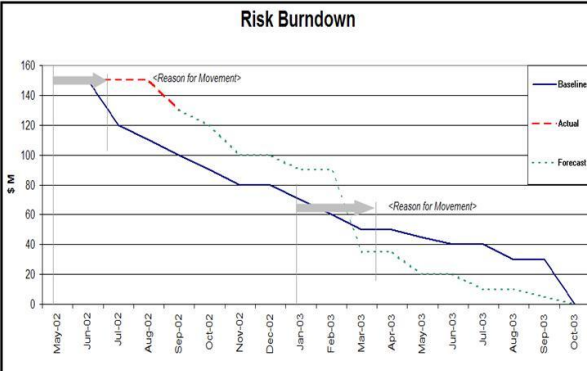
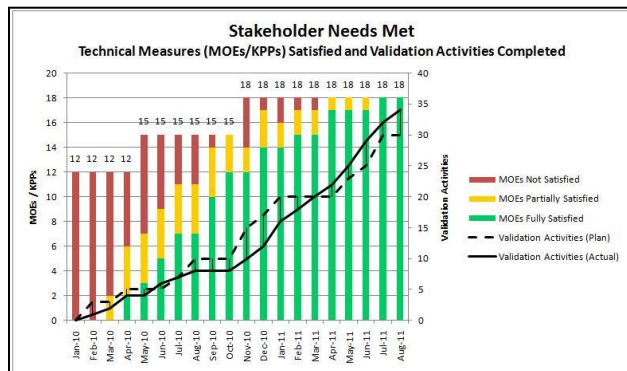
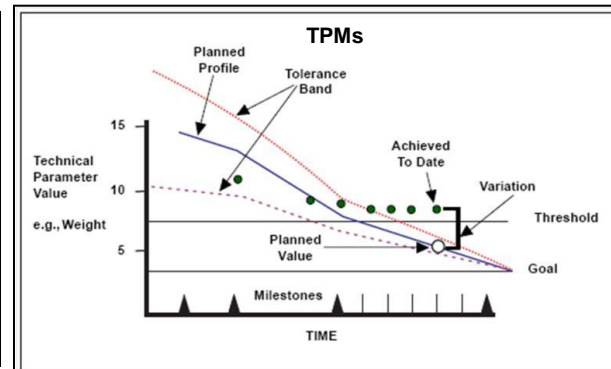
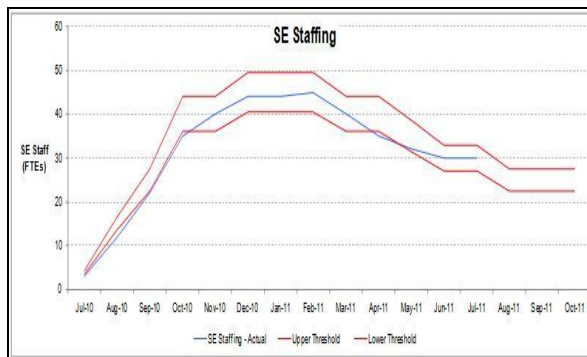
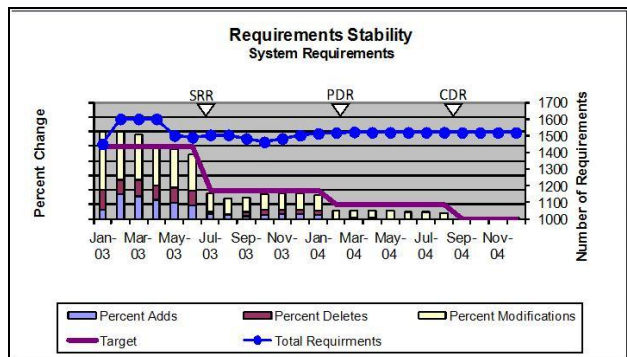


# Comments (12) – Other productivity measures (HW, Mfg)

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- Rework and repair costs
- Rework
- Non-conformances
- Scrap
- ECOs, engineering changes
- TPMs
- Cost
- Schedule
- Government acceptance rate

# NDIA System Development Performance Measurement



### TRL / MRL

System Milestone / Technical Review	TRL (Plan)	TRL (Actual)	MRL (Plan)	MRL (Actual)	Comments / Risk Action Plan
ITR	TRL 2	TRL 3	MRL 2	MRL 3	Analysis model based on ABC study
ASR	TRL 3	TRL 3	MRL 3	MRL 3	Lab validation of ASIC mfg concept
MS A	TRL 4	TRL 3	MRL 4	MRL 3	Study funding delayed 30 d. TRA completed.
SRR	TRL 5	TRL 4	MRL 5	MRL 3	Mechanical packaging ICD validation issues. Supplier facility contention elevated.
SFR	TRL 6	TRL 5	MRL 6	MRL 5	Prototyped XYZ subsystem w/ test bed I/F. Investigating low yield on lot 6 water fab.
PDR / MS B	TRL 6	TRL 6	MRL 6	MRL 6	Dwgs on plan. Tin whisker fab issue ok. Producibility plan approved.
CDR	TRL 7		MRL 7		Evaluating alternative pW feeds (risk #23).
TRR	TRL 7		MRL 8		
SVR (FCA PRR)	TRL 7		MRL 8		
MS C	TRL 8		MRL 9		
FDP Decision Review	TRL 9		MRL 10		

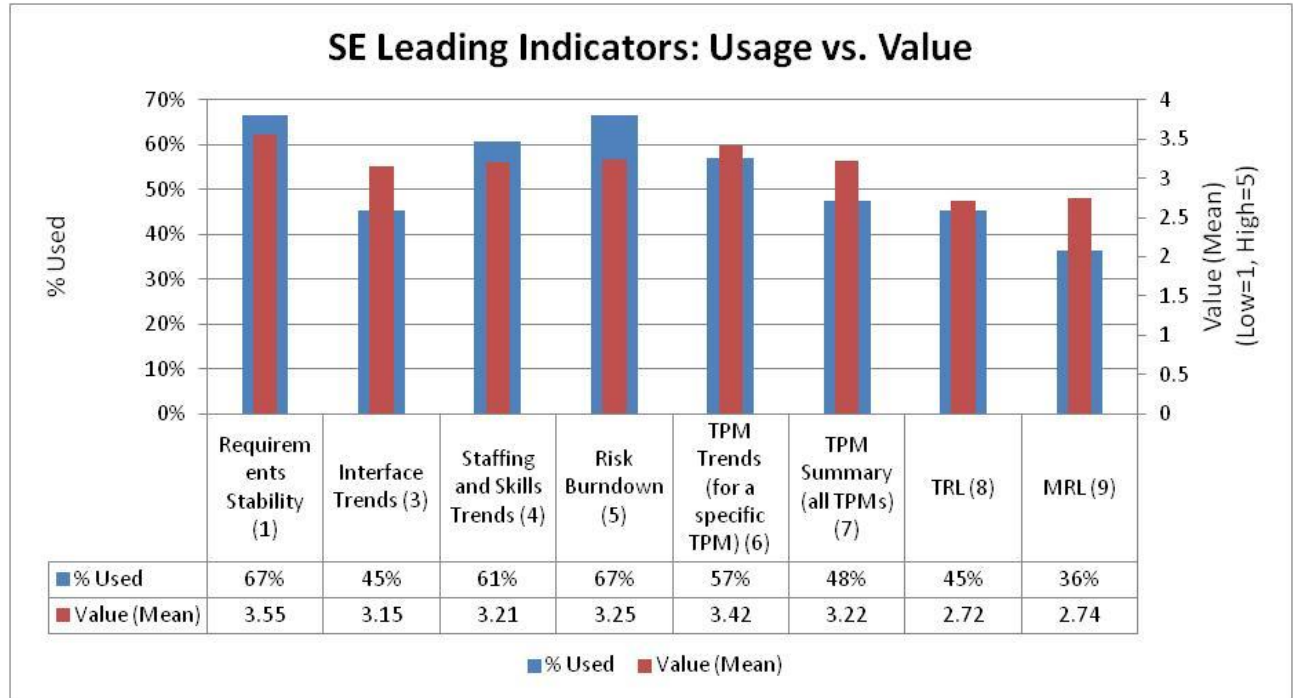
Reference: NDIA System Development Performance Measurement Report, December 2011.

[http://www.ndia.org/Divisions/Divisions/System Engineering/Documents/Studies/NDIA%20System%20Development%20Performance%20Measurement%20Report.pdf](http://www.ndia.org/Divisions/Divisions/System%20Engineering/Documents/Studies/NDIA%20System%20Development%20Performance%20Measurement%20Report.pdf)

# 18. Measures of Effectiveness

To what extent are these or similar measures used effectively in your organization?

- Are they used?
- Are they perceived as valuable?



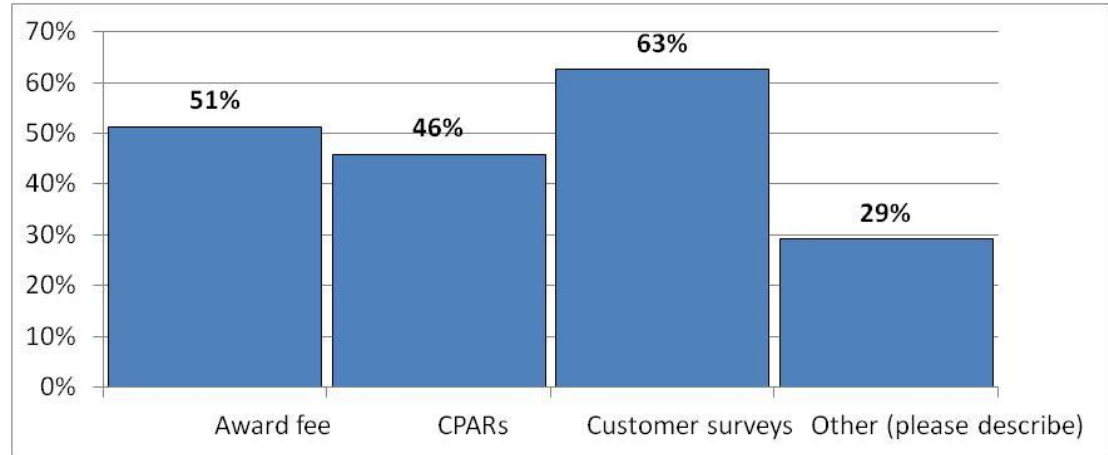
	Very Low (1)	Low (2)	Moderate (3)	High (4)	Very High (5)	Response	Mean
Requirements Stability (1)	3	0	6	8	5	22	3.55
Interface Trends (3)	5	0	6	5	4	20	3.15
Staffing and Skills Trends (4)	2	3	4	9	1	19	3.21
Risk Burndown (5)	5	1	4	4	6	20	3.25
TPM Trends (for a specific TPM) (6)	3	2	3	6	5	19	3.42
TPM Summary (all TPMs) (7)	5	0	4	4	5	18	3.22
TRL (8)	4	3	6	4	1	18	2.72
MRL (9)	4	4	5	5	1	19	2.74

# Measures – Useful Leading Indicators

- Customer satisfaction and customer relationships (3), validation
- Requirements (5): quality, specifications, volatility (changes, quantity, impact)
- Budget
- Schedule (2)
- Productivity changes / volatility in core measures
- Staffing
- Design reviews
- EVMS (4): TCPI, (BCWS, BCWP, ACWP), CPI/SPI trends (“dance floor chart”)
- Test milestones
- Failure rate, repair rate
- Degree of IPPD staffing used with expert representatives
- Interfaces
- Defect density. Defect closure.
- Sampling and Spot-Checks

# 19. Measures of Customer Satisfaction

**What are the primary measures you use to monitor customer satisfaction? (please choose all that apply)**

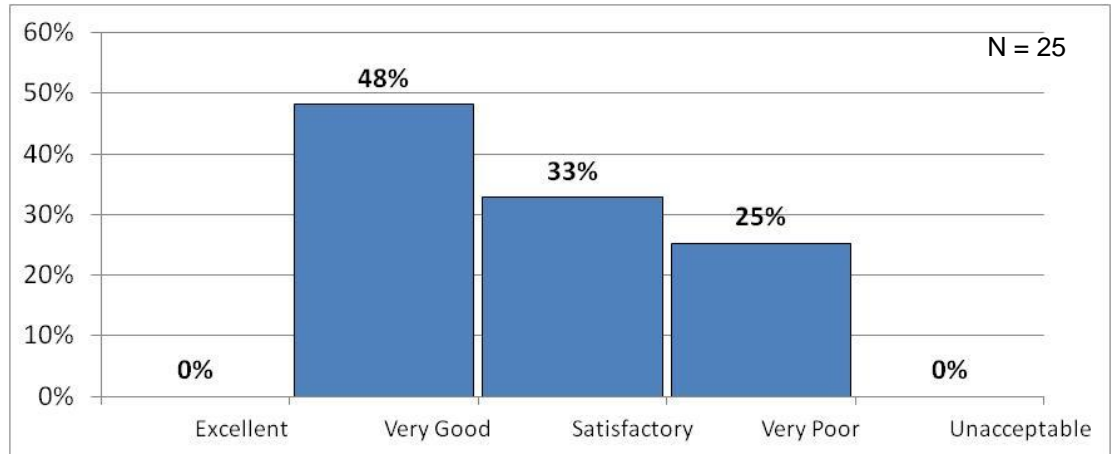


1. Award fee
2. CPARs
3. Customer surveys
4. Other

Other: Customer relationships. Direct feedback. Frequent customer mtgs. For agile, customer surveys are integral.

# 20. Measurement Insight

**How well do the metrics used in your organization provide insight into the performance of your programs and/or your organization?**



1. Excellent
2. Very Good
3. Satisfactory
4. Very Poor
5. Unacceptable

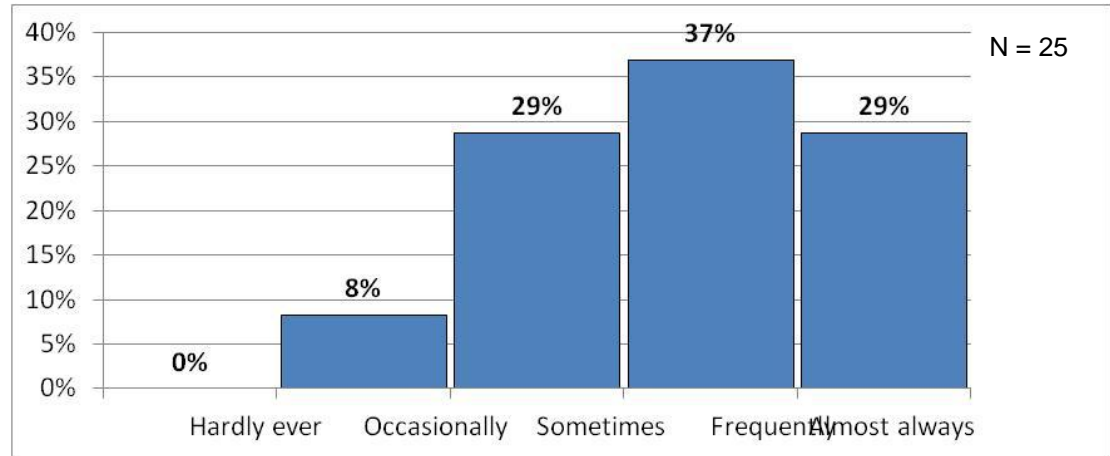
# 21. If you could fix one thing about the chosen metrics, what would it be?

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- Easier to collect and accumulate (2), automation (3)
- Standardized and visible
- Comparison of subjective metrics with hard metrics (objectively measurable, but seldom useful).
- Increase reporting frequency (EVMS bi-weekly)
- Greater emphasis on defect tracking/resolution
- Manage more by the numbers (quantitative management)
- Identify the right metrics that are good predictors of where corrective action is needed.
- Greater consistency in definitions, collection, usage, data governance.
- Measurement of satisfying requirements.
- Continuous improvement to weak processes and training
- Cost per unit produced
- Strong TPM plan – government is only recently interested, authorized a focused effort
- Investment in training and tools to promote use of performance measures among company PMs and SEs
- Expand beyond solitary measures of cost – no quantitative measures other than bid competition

## 22. Risk Management Behavior and Action

**To what extent does risk management actually drive program management behavior and action in your organization? (i.e., are risks acted upon or just monitored)**

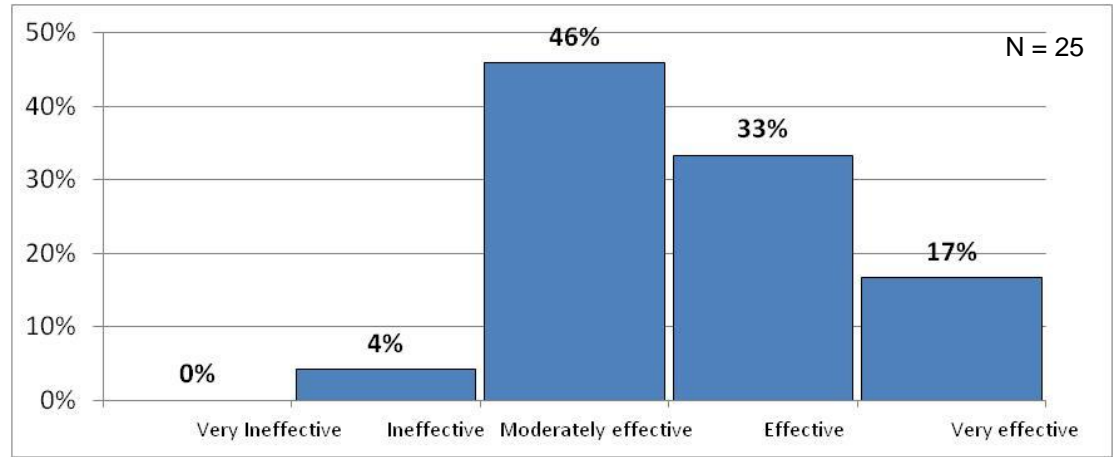


1. Hardly ever
2. Occasionally
3. Sometimes
4. Frequently
5. Almost always



# 23. Risk Management Effectiveness

How would you characterize the effectiveness of your risk management processes in actually improving program performance?



1. Very ineffective
2. Ineffective
3. Moderately effective
4. Effective
5. Very effective

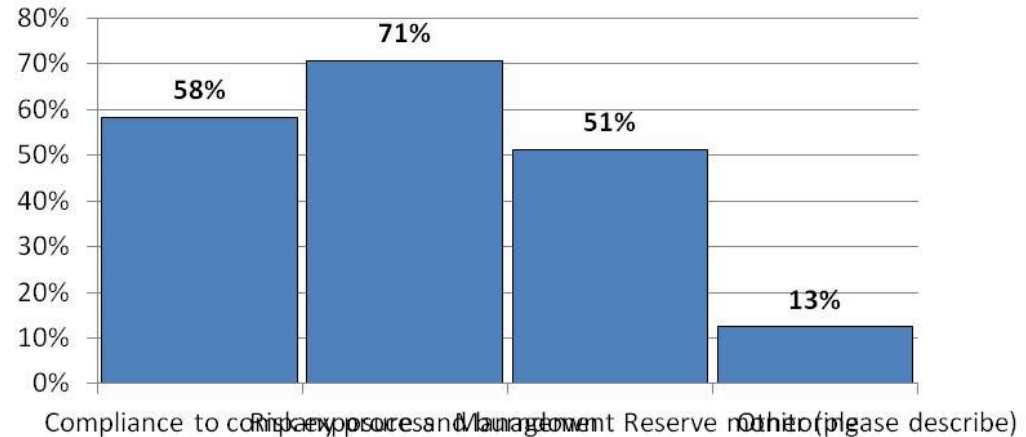
## 23. Measuring Risk Management Effectiveness

**How do you measure the effectiveness of your risk management process? (please choose all that apply)**

1. Compliance to company process
2. Risk exposure and burndown
3. Management reserve monitoring
4. Other (please describe)

Other:

Direct customer feedback during execution.  
Meeting schedule with specs and budget.  
Only effective measure is interest level of org heads using group results.



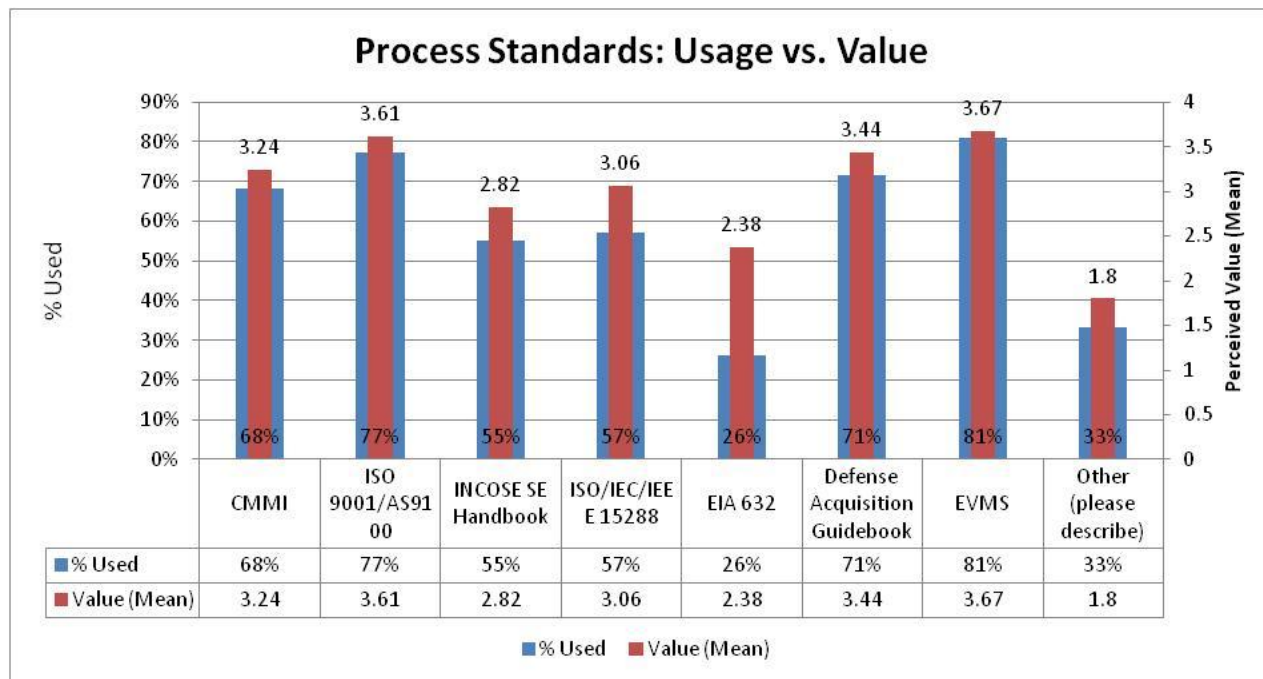
## Is there anything else you would like to share with us regarding risk management within your organization?

- Could probably be a stronger part of program execution, but does serve to maintain awareness of potential problems and minimizing impacts.
- Environmental risk impacts
- Direct experience in customer's environment is often critical to risk mitigation success. Cookie cutter approaches will fail too often.
- Independently facilitated risk assessments are valuable.
- Integrating opportunity management with risk management processes.
- Company needs to promote use of risk management throughout company PM's and SE's through training and tools
- Process compliance is used exclusively.

# 24. Industry Process Models/Standards

Which key industry process models or standards are adopted by your organization?

- Are they used?
- Are they perceived as valuable?

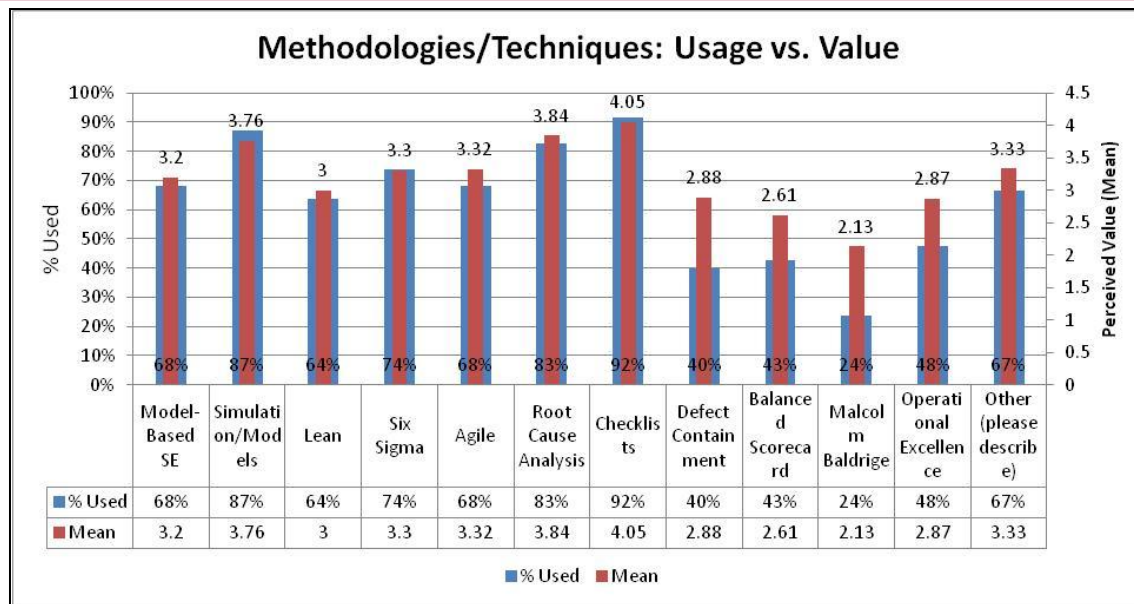


Standard	Very Low	Low	Moderate	High	Very High	Responses	Value (Mean)
CMMI	2	3	4	5	3	17	3.24
ISO 9001/AS9100	1	1	6	6	4	18	3.61
INCOSE SE Handbook	2	3	9	2	1	17	2.82
ISO/IEC/IEEE 15288	1	4	6	5	1	17	3.06
EIA 632	3	4	5	0	1	13	2.38
Defense Acquisition Guidebook	1	0	10	4	3	18	3.44
EVMS	1	3	3	5	6	18	3.67
Other (please describe)	3	0	2	0	0	5	1.8

# 24. Methodologies and Techniques

What methodologies, techniques, or practices does your organization use for program development or management?

- Are they used?
- Are they perceived as valuable?



Methodology / Technique	% Used	Responses	Value					Responses	Mean
			Very Low	Low	Moderate	High	Very High		
Model-Based SE	68%	22	2	3	6	7	2	20	3.2
Simulation/Models	87%	23	0	1	9	5	6	21	3.76
Lean	64%	22	3	2	8	4	2	19	3
Six Sigma	74%	23	2	2	5	10	1	20	3.3
Agile	68%	22	1	2	8	6	2	19	3.32
Root Cause Analysis	83%	23	0	2	3	10	4	19	3.84
Checklists	92%	24	0	0	3	15	4	22	4.05
Defect Containment	40%	20	3	4	3	4	2	16	2.88
Balanced Scorecard	43%	21	4	5	4	4	1	18	2.61
Malcolm Baldrige	24%	21	6	3	4	2	0	15	2.13
Operational Excellence	48%	21	4	1	4	5	1	15	2.87
Other (please describe)	67%	3	0	1	1	0	1	3	3.33

# Processes and Standards – Other Comments?

- Every engagement is heavily tailored to what the client is willing to do. Clients often lack clear views of what they need and how to produce it.
- Statistical cost models are used for cost estimates in several disciplines.
- In large organizations, it can be difficult to consistently communicate the value of processes and standards.
- We are inventing as we go. A very slow process.
- Our engineering processes are sloppy. Other parts of the org (non-engineering) have well defined processes and measure them well.
- We need management and review of processes, in addition to their identification and ownership by leadership.
- There are a lot of good standards available to become a better SE organization. It would be helpful to also have templates to serve as examples in better implementing these.
- Need to understand use of experts in each special function working in integrated "IPPD" environment versus : "silo" systems engineering manner.

## Thank you for participating!

- Results collected in this session will be posted with the conference proceedings
- Additional analysis of the results will be conducted after the conference (e.g., data slicing by demographics, correlations)
- Questions? Contact one of the benchmark data analysts below.

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