Honourcode, Inc.

Systems Engineering Return on Investment

SE-ROI Research Results Nov11

Eric Honour
+1 (850) 479-1985
ehonour@hcode.com

Funding provided by
- ***Honourcode, Inc.***
- ***DASI (Univ of South Australia)***

University of South Australia | Defence and Systems Institute

Agenda

- **SE-ROI Project**
  - **Motivation: How much is enough?**
  - **Goals and methodology**
- **SE-ROI Results**
  - **Demographics**
  - **Primary correlations: success* vs. SE**
  - **Eight SE Activities**
    - **Success vs. SE activities**
    - **Front-end vs. Back-end**
  - **Right-Sizing SE**

**Cost compliance, schedule compliance, stakeholder acceptance, technical quality*

Bottom Line

- **Better programs expend**
  - **more SE effort overall**
  - **more mission definition, more tech leadership**
- **<u>All</u> SE activities correlate well with**
  - **Stakeholder acceptance**
  - **Cost/schedule control**
- **<u>No</u> SE activities correlate with**
  - **System technical quality**

SE today leads to better programs – but does not lead to better systems.

- **Results can be used to right-size SE**

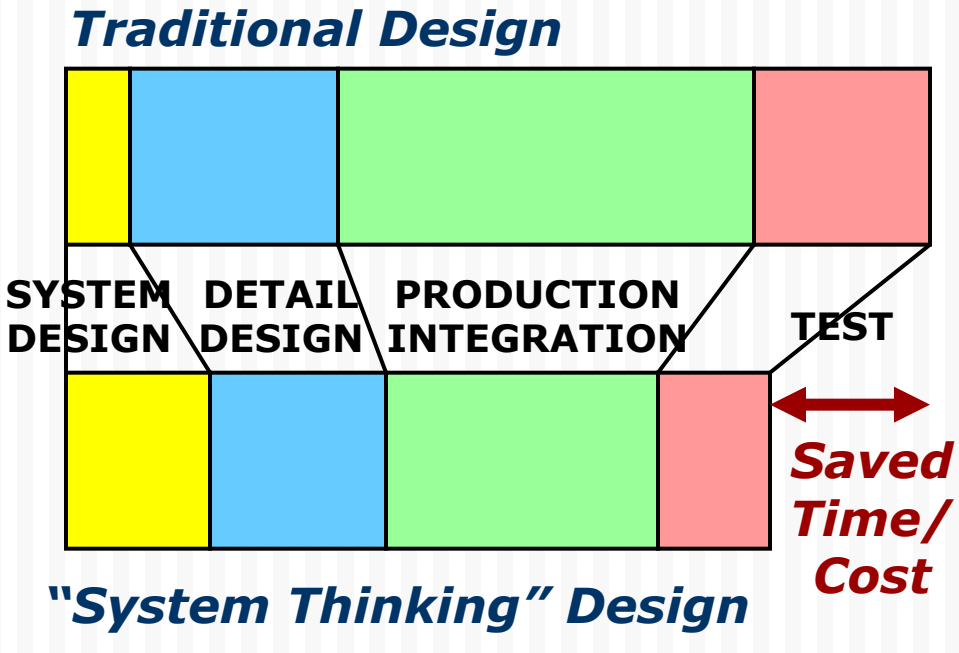
SE-ROI Project

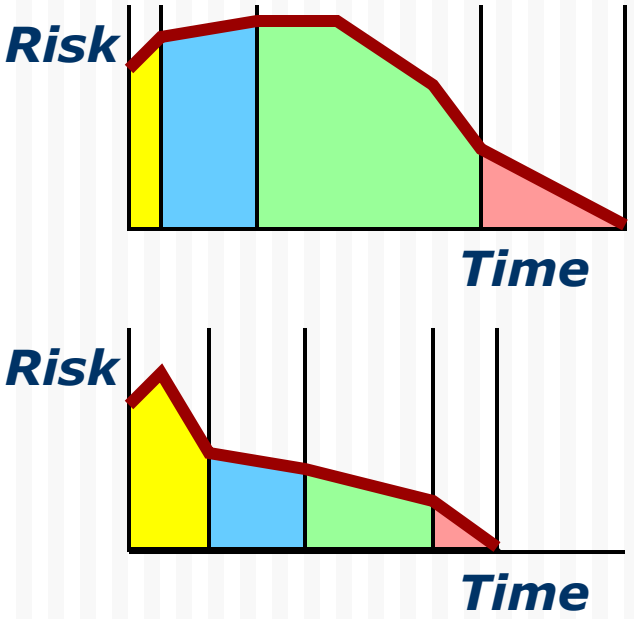
Methodology

Industry support

Heuristic Claim of SE

- **Better systems engineering leads to**
  - **Better system quality/value**
  - **Lower cost**
  - **Shorter schedule**





Not Known: How Much Is Enough?

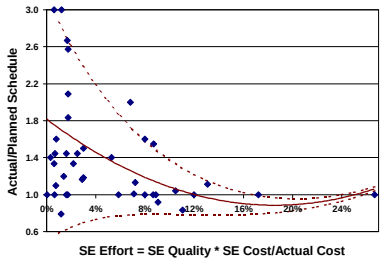
SE-ROI Project

Interviews

- **Just-completed programs**
- **Key PM/SE/Admin**
- **Translate program data into project structure**

- ***Program characterization***
- ***Program success data***
- ***SE data (hours, quality, methods)***

Statistical correlation



Desired Results

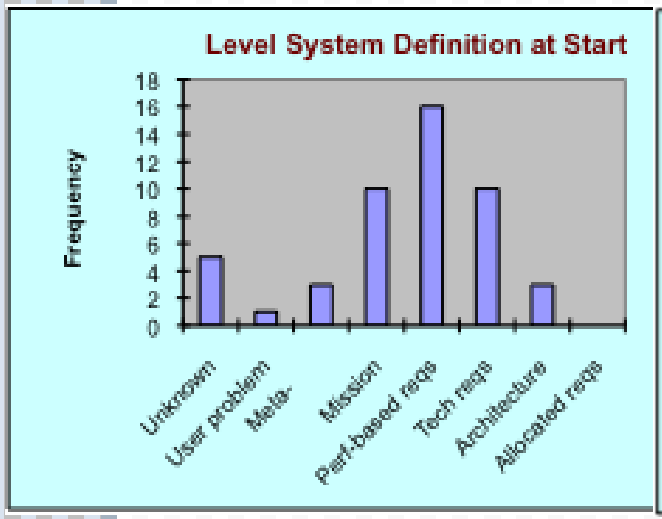
1. **Statistical correlation of SE practices with project success**
2. **Leading indicators**
3. **Identification of good SE practices**

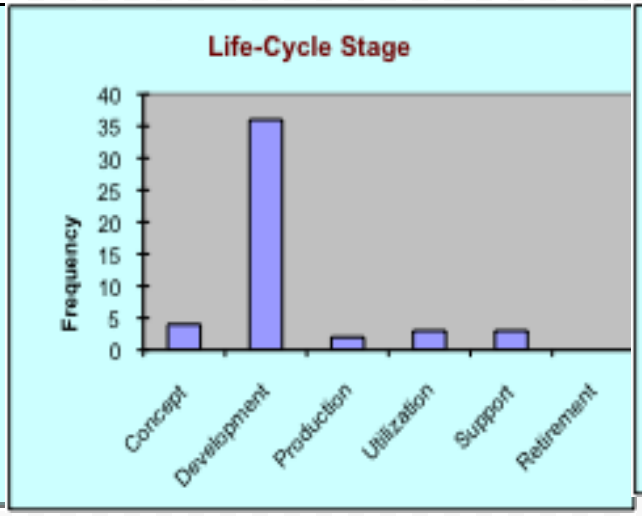
SE-ROI Results: Demographics

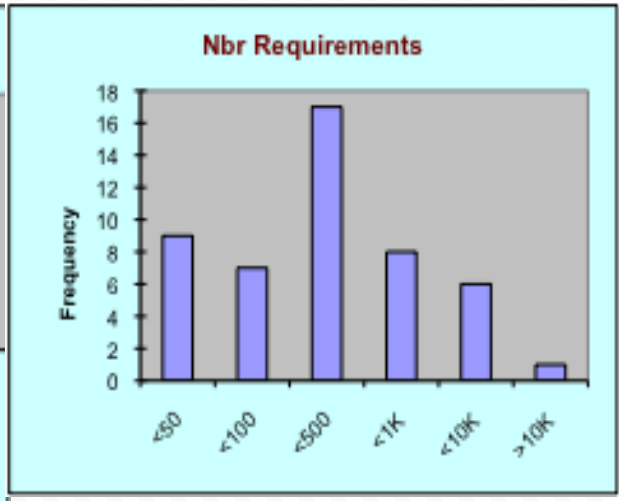
Basic Demographics

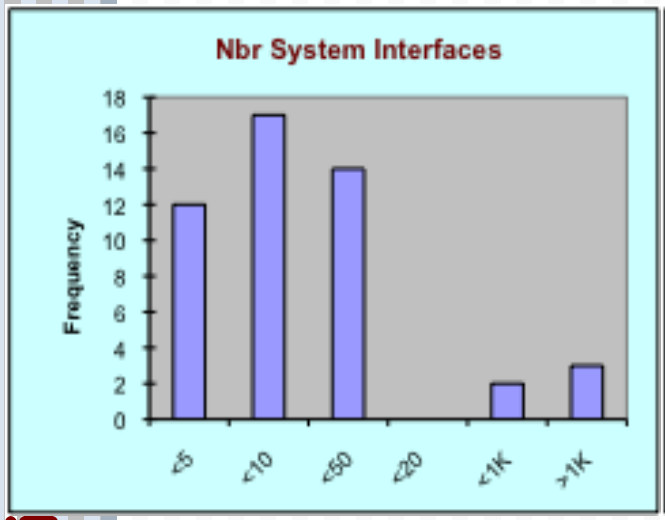
Characteristic	ValueSE Data Set	SE-ROI Data Set
Number of organizations	Unknown	16
Number of data points	44	48
Funding method	Unknown	39 contracted, 9 amortized
Program total cost	$1.1M - $5.6B Median $42.5M	$600K - $1.8B Median $14.4M
Cost compliance	(0.8):1 – (3.0):1 Median (1.2):1	(0.6):1 – (10):1 Median (1.0):1
Development schedule	2.8 mo. – 144 mo. Median 43 mo.	2 mo. – 120 mo. Median 35 mo.
Schedule compliance	(0.8):1 – (4.0):1 Median (1.2):1	(0.3):1 – (2.5):1 Median (1.1):1
Percent of program used in systems engineering effort, by cost	0.1% - 27% Median 5.8%	0.1% - 80% Median 17.4%
Subjective assessment of systems engineering quality (1 poor to 10 world class)	Values of 1 to 10 Median 5	Values of 1 to 10 Median 7

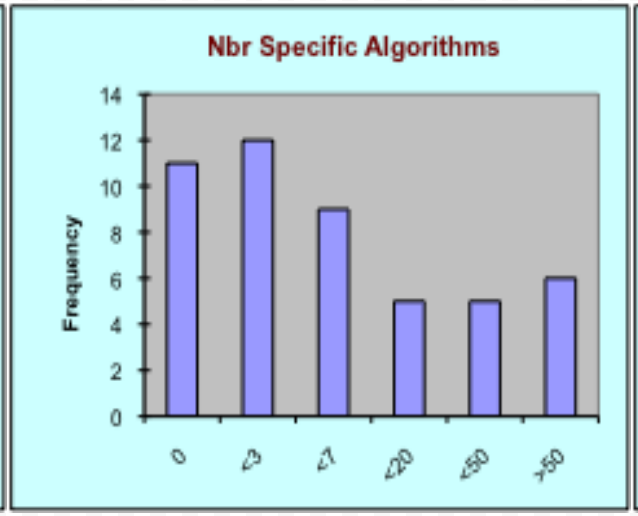
Program "Size"

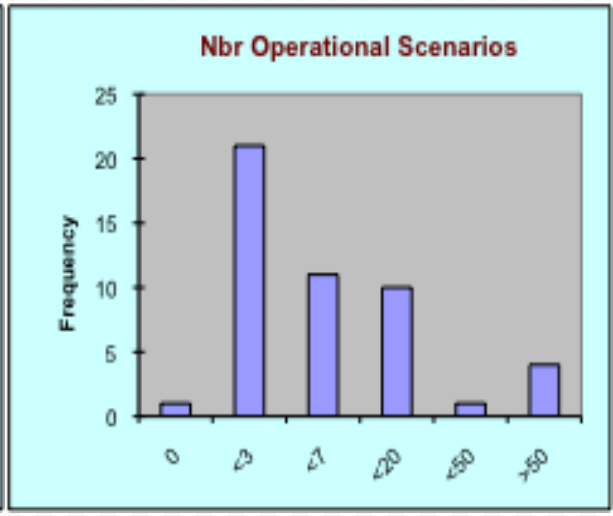




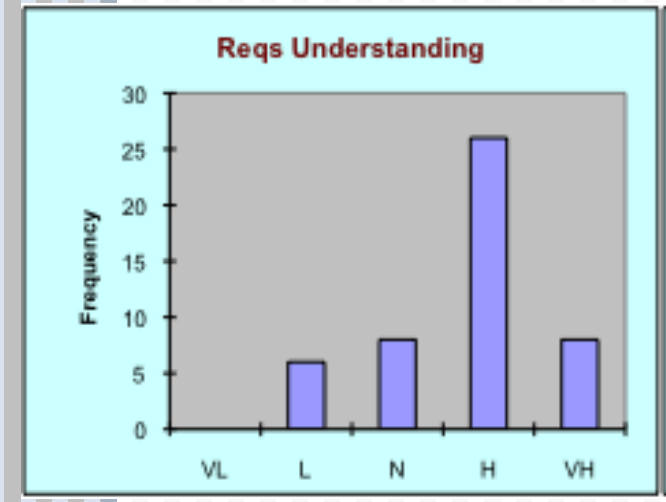


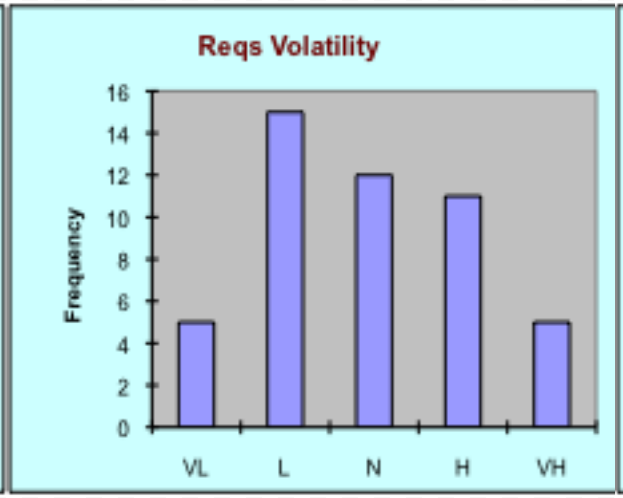


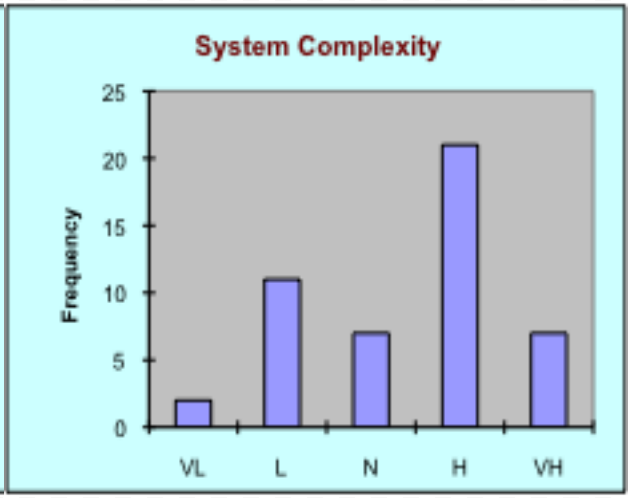


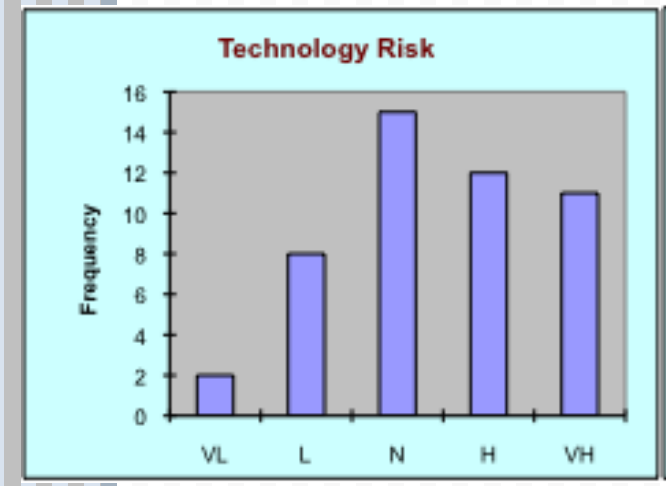


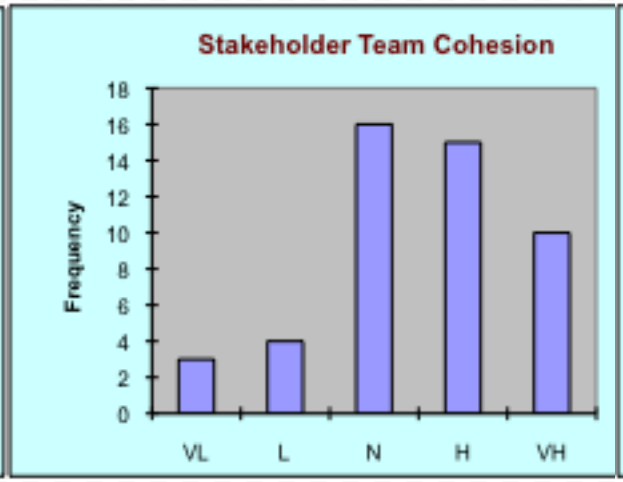
Program/Team Parameters

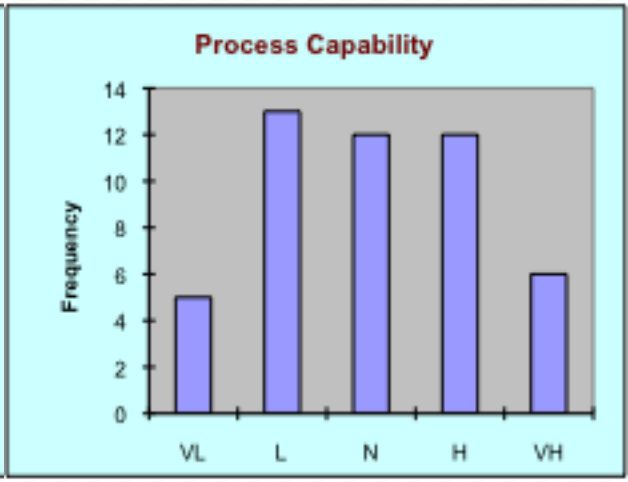










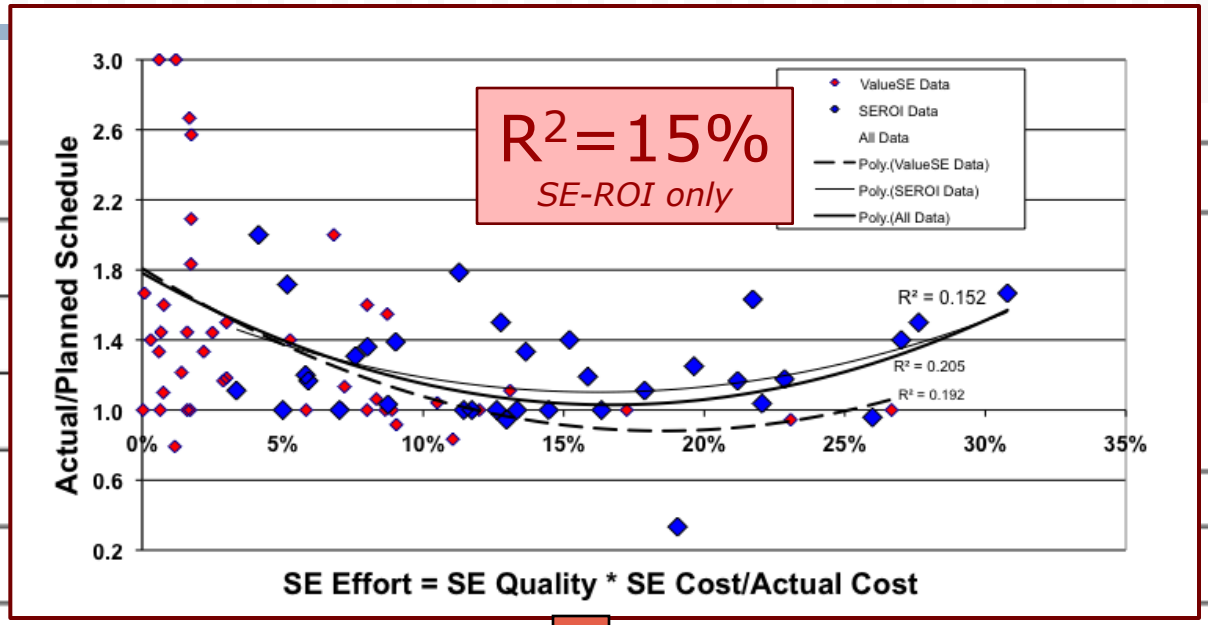


SE-ROI Results: Primary Relationships

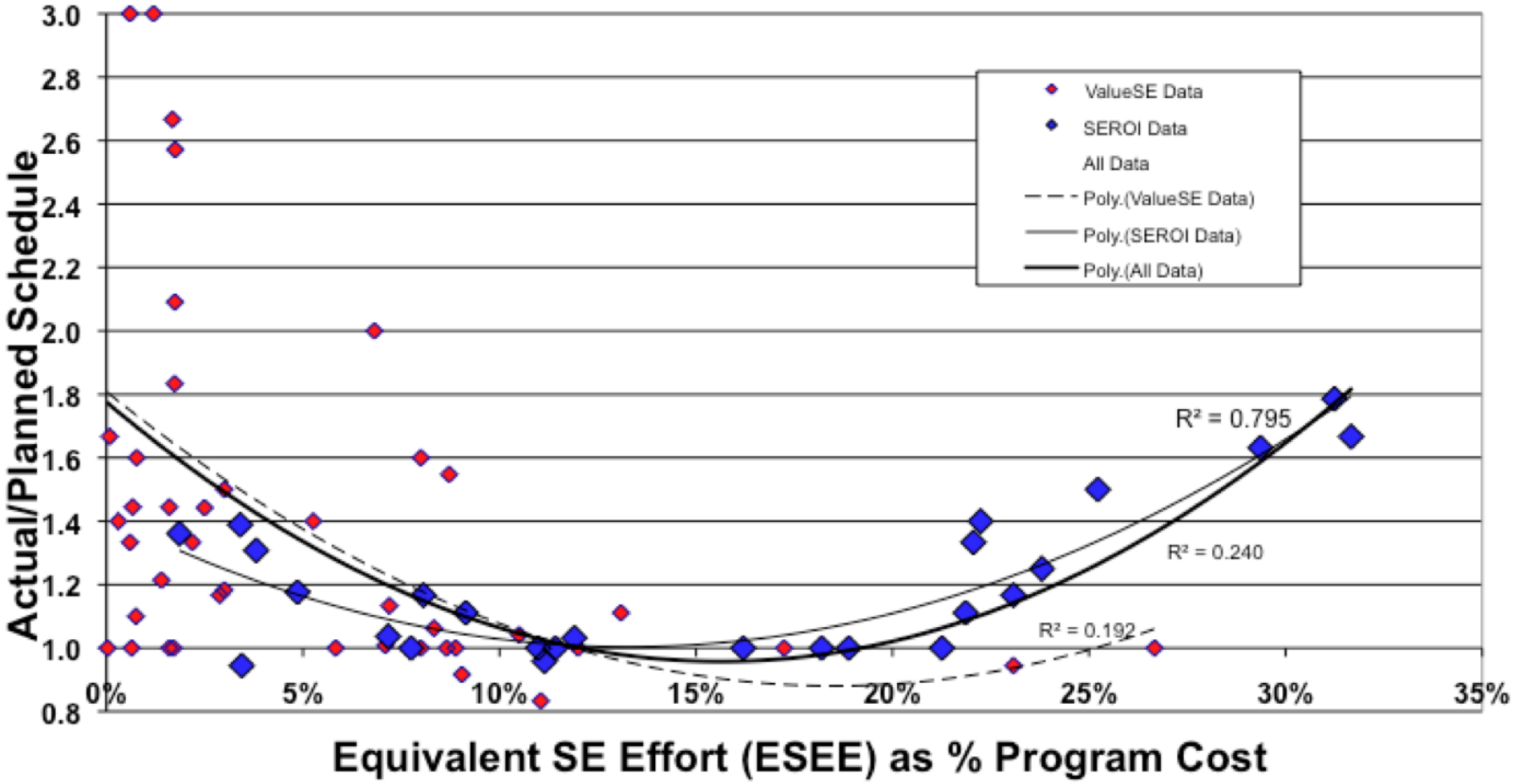
SE effort correlates with 3 of 4 success measures

Optimum SE effort ~16% of total development cost

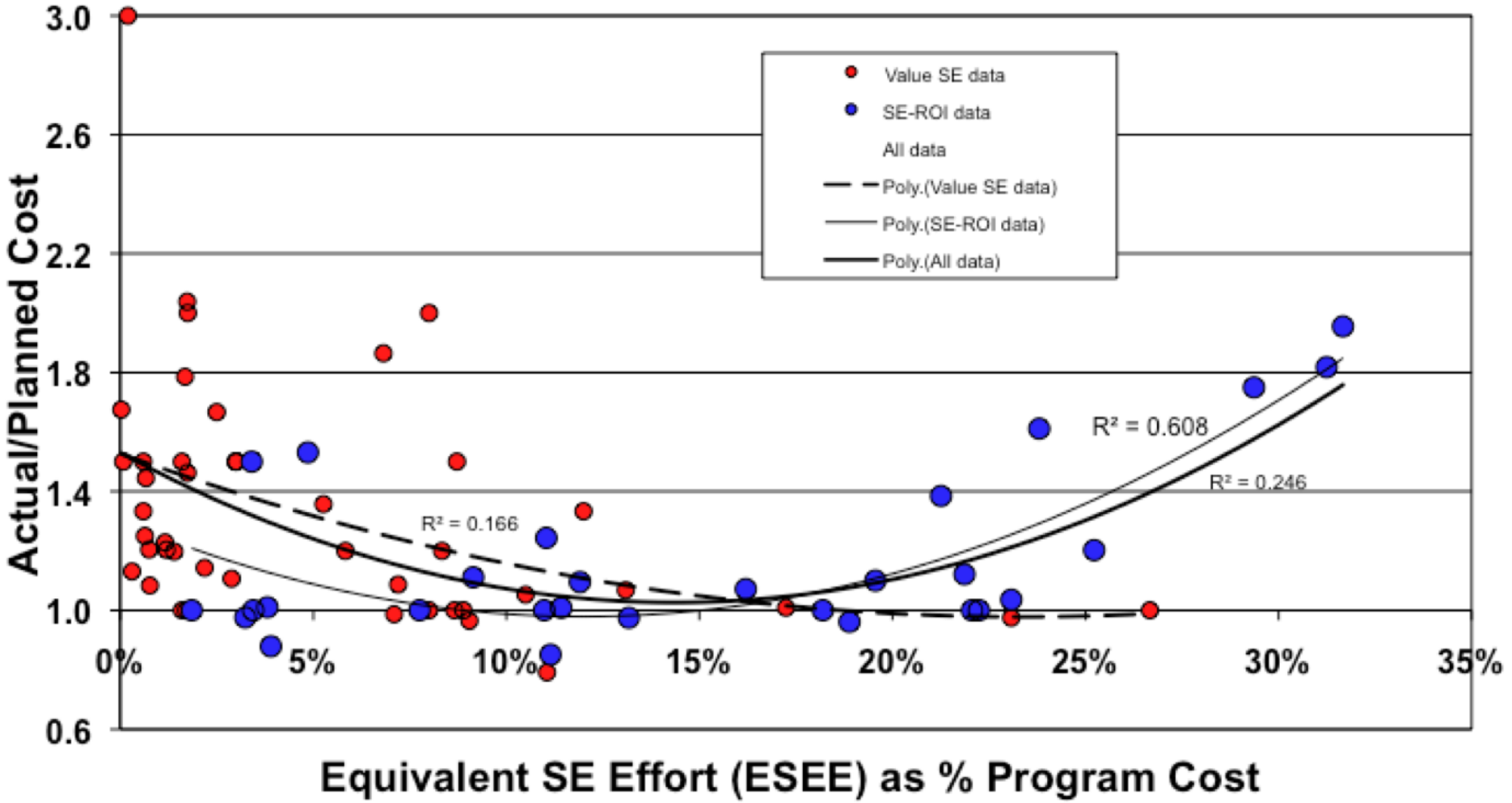
Effect of Characterization Parameters



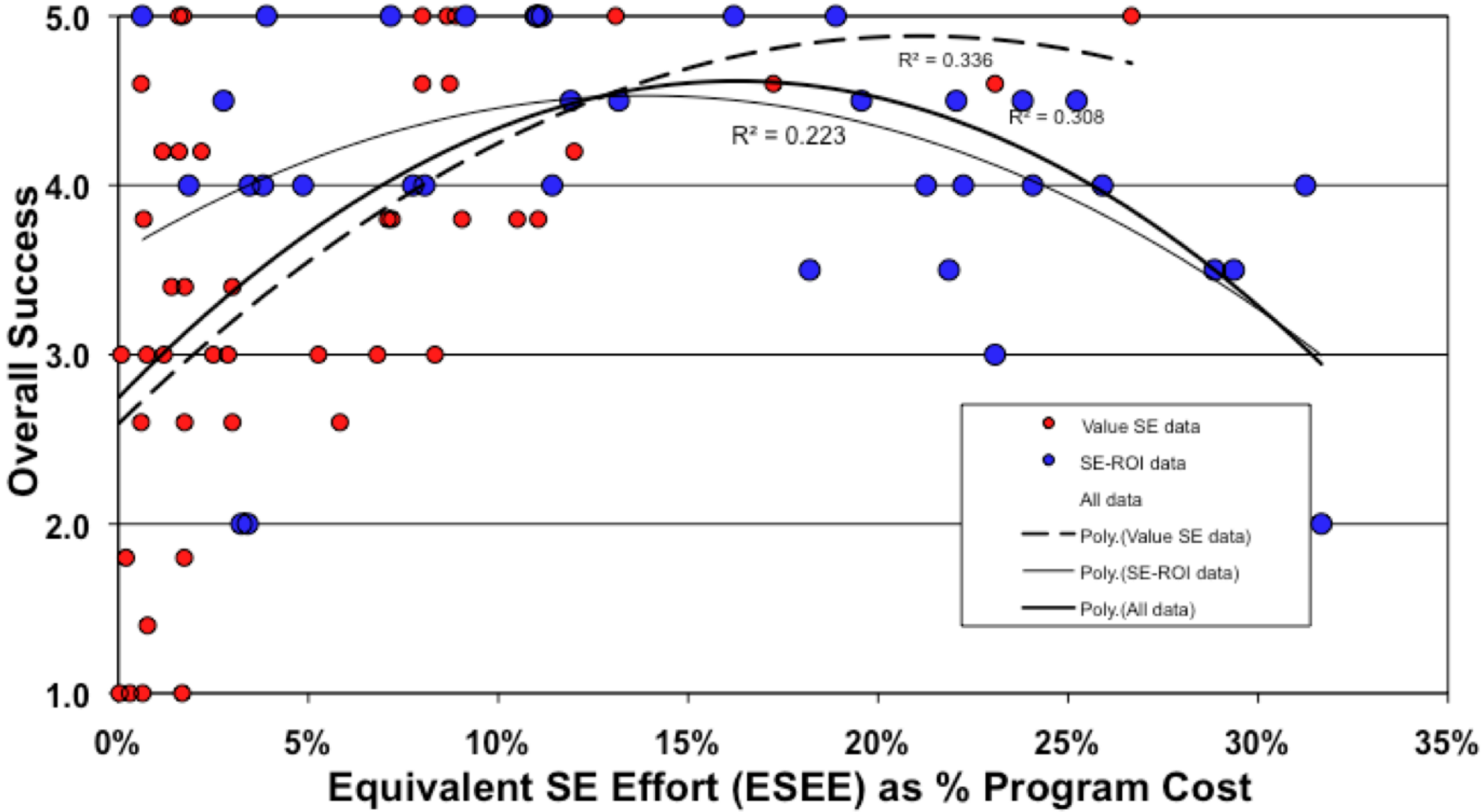
Schedule vs. SE Effort



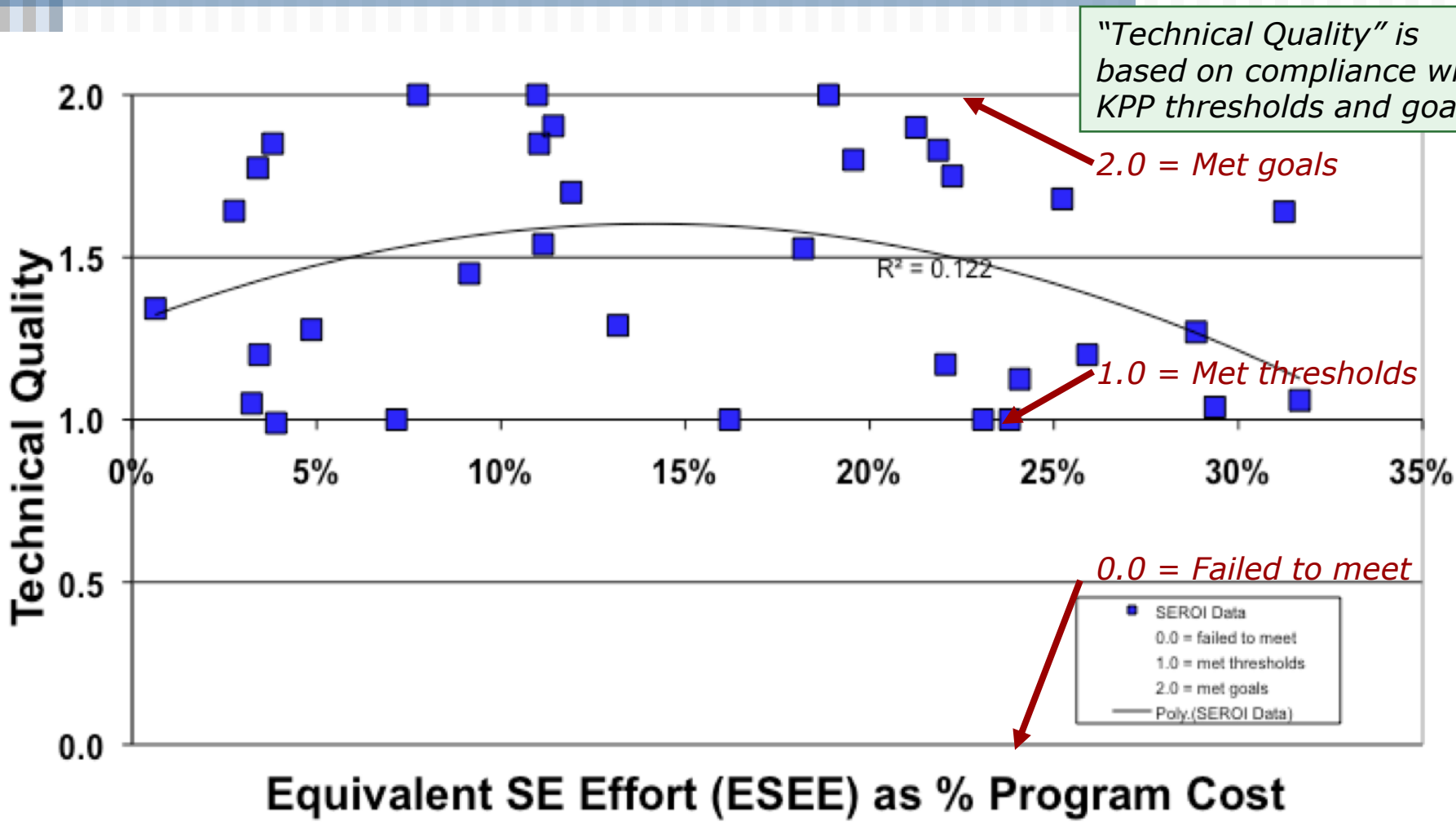
Cost vs. SE Effort



Overall Success vs. SE Effort



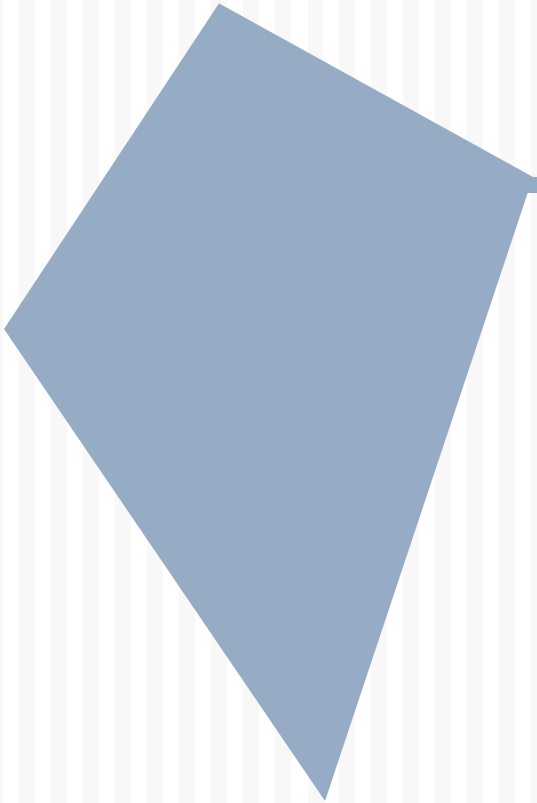
Technical Quality vs. SE Effort



Return on Investment

Current SE Effort (% of Program Cost)	Average Cost Overrun	ROI for Additional SE Effort (Cost Reduction Per $$ Added)
0%	53%	6.0
5%	24%	3.6
7.2% (median of all programs)	15%	2.5
10%	7%	1.1
15%	3%	-0.7
20%	10%	-3.8

SE-ROI Results: Eight SE Activities



All SE activities correlate w/ cost, schedule, acceptance

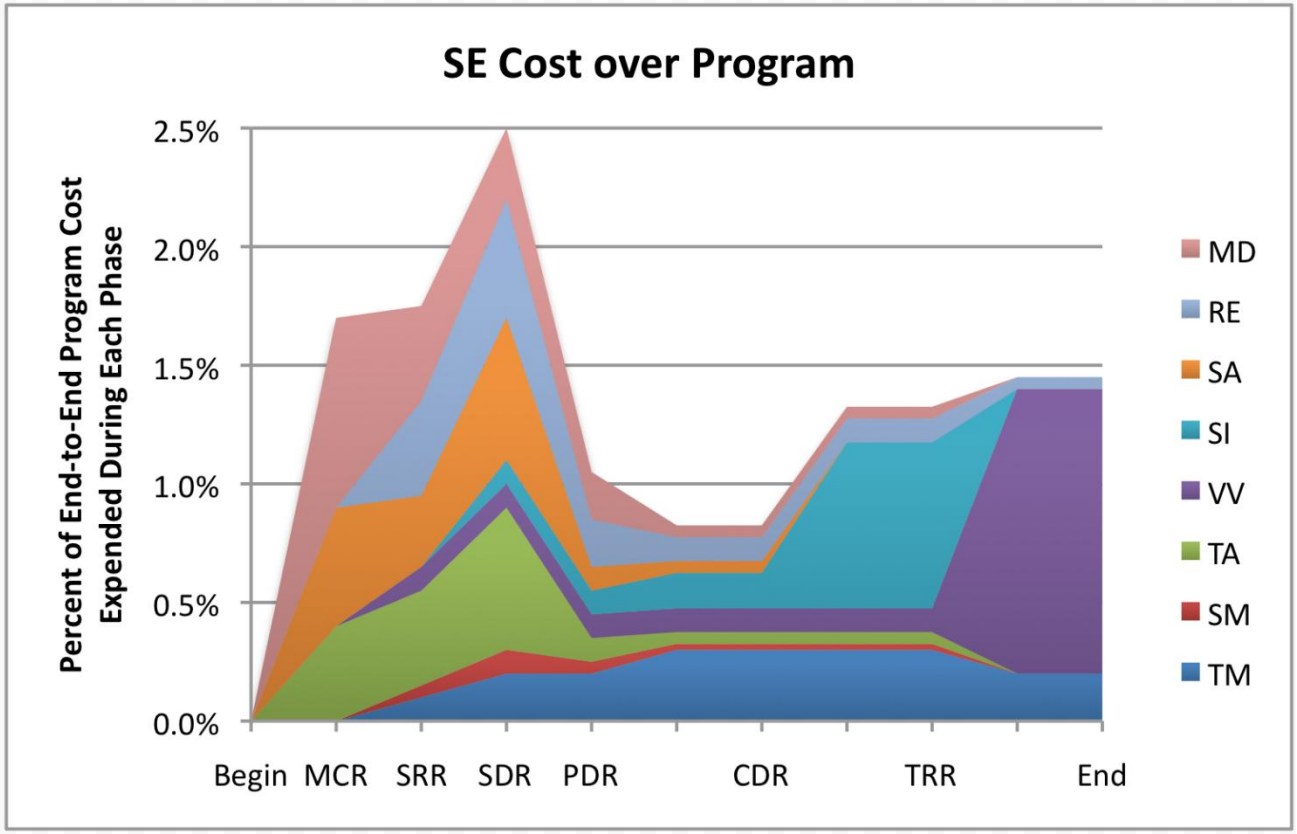
None correlate w/ quality

Successful programs use front-end; poor programs use back-end

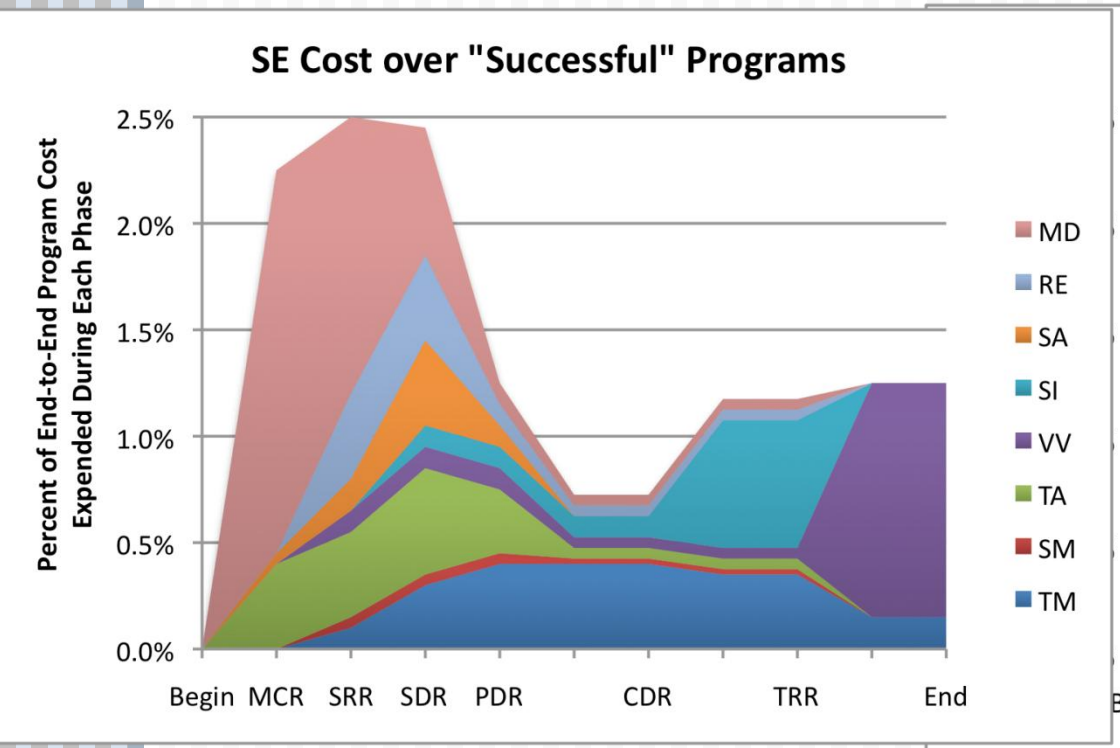
Breakout by SE Activities

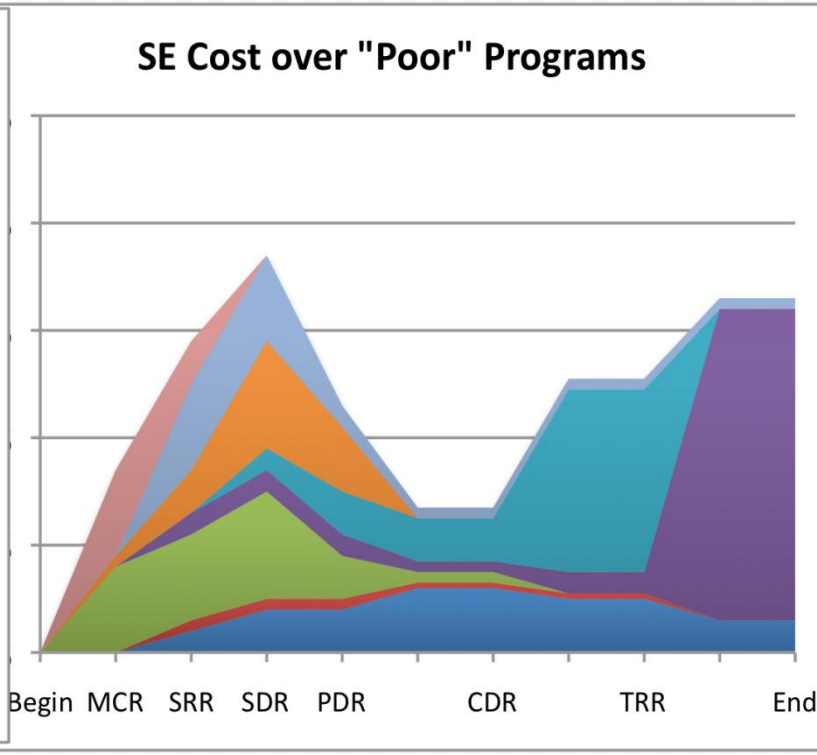
MD Mission/Purpose Definition
RE Requirements Engineering
SA System Architecting
SI System Integration
VV Verification & Validation

TA Technical Analysis
SM Scope Management
TM Technical Leadership/Management



Breakout by Success



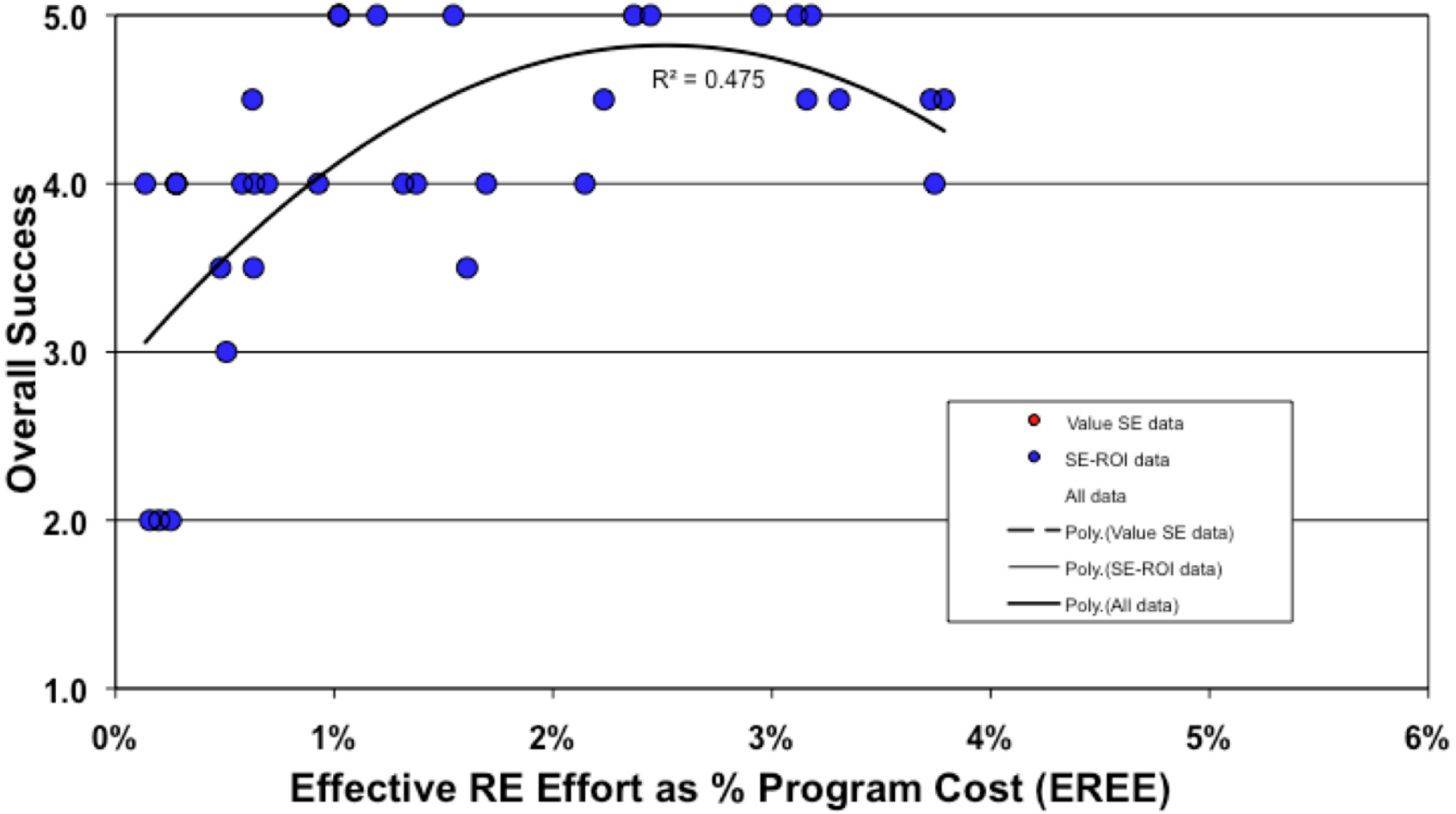


Successful *(~on cost)*
- More mission/purpose defn
- More tech leadership/mgmt
- More Systems Engineering

Poor *(overran cost)*
- More system integration
- More verif & valid
- Less Systems Engineering

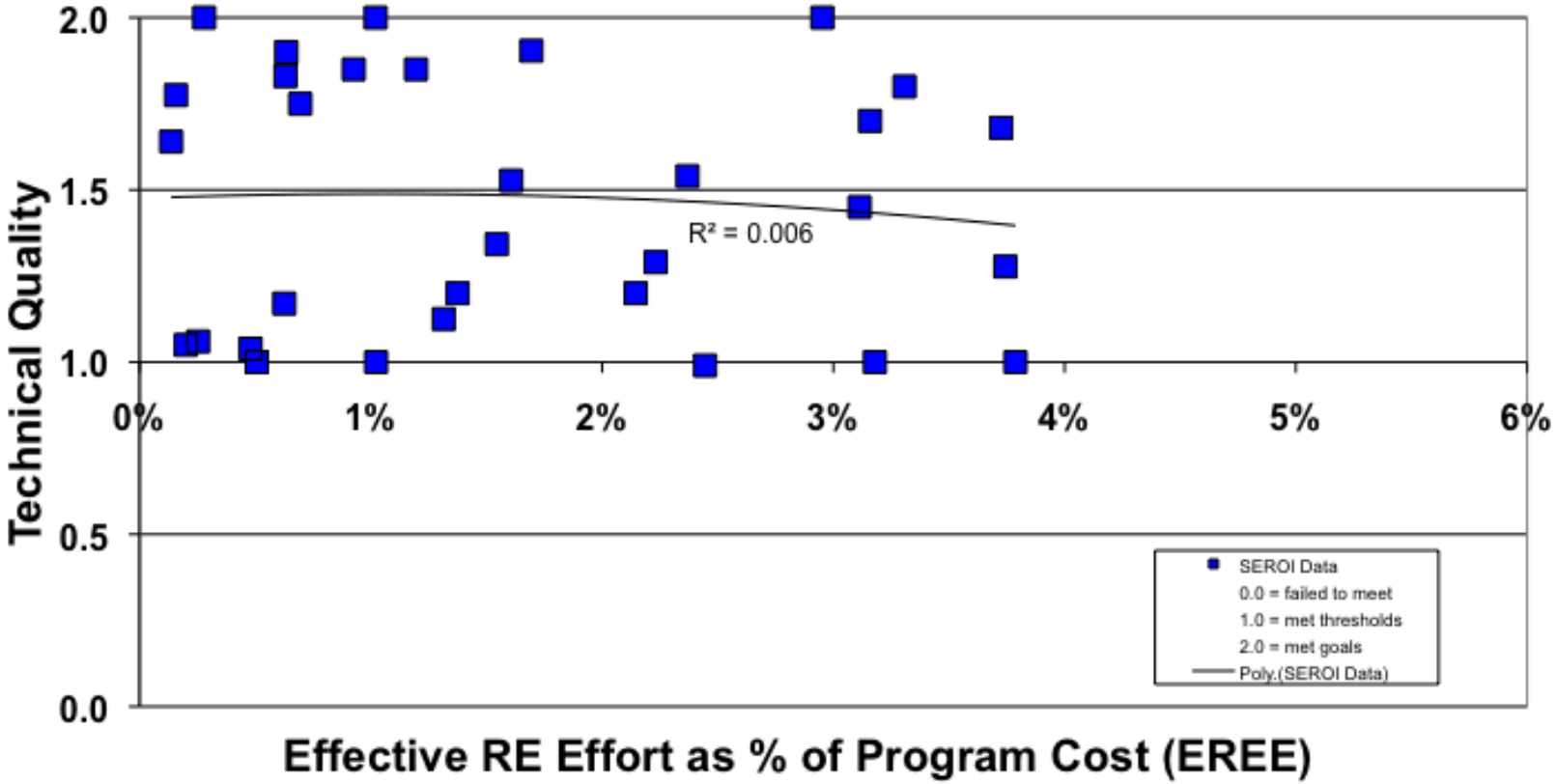
Typical Data:

Overall Success vs. Reqs Engr



Typical Data:

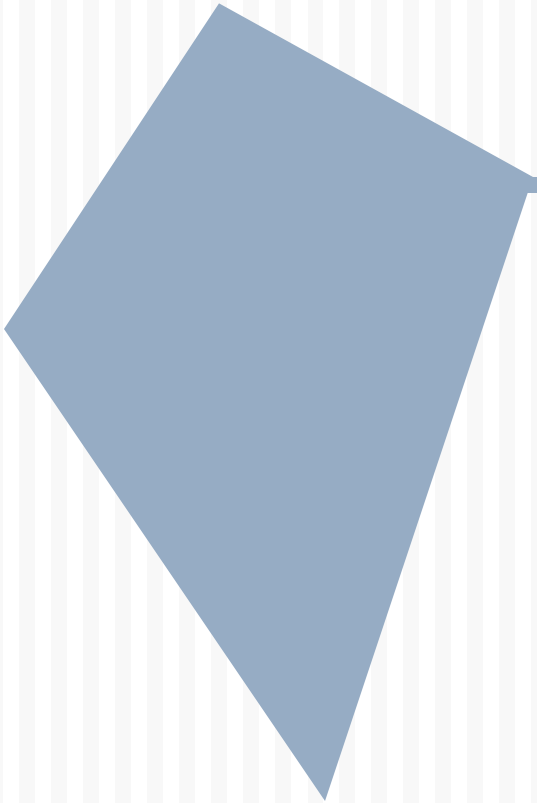
Tech Quality vs. Reqs Engr



Effect of SE Activities

Activity	Code	Quantifiable Correlation Exists With			
		Cost Compliance	**Schedule Compliance**	**Overall Success**	**Technical Quality**
Total Systems Engineering Effort	SE	Yes	Yes	Yes	Perhaps
Mission/Purpose Definition Effort	MD	Yes	Yes	No	No
Requirements Engineering Effort	RE	Yes	Yes	Yes	No
System Architecting Effort	SA	Yes	Yes	Yes	No
System Integration Effort	SI	Yes	Yes	Yes	No
Verification & Validation Effort	VV	Yes	Yes	No	No
Technical Analysis Effort	TA	Yes	Yes	Perhaps	No
Scope Management Effort	SM	Yes	No	Yes	No
Technical Management/ Leadership Effort	TM	Yes	Yes	Yes	No

SE-ROI Results: Right-Sizing SE



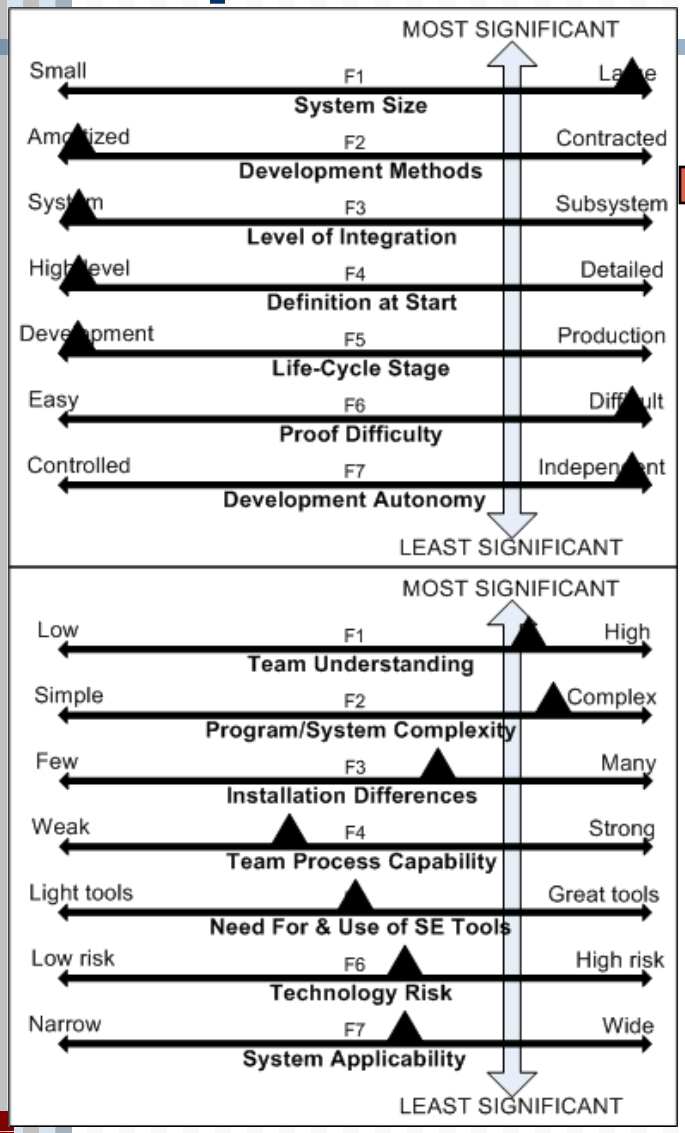
Results are further optimized using characterization parameters

Parametric sizing of SE to optimize success

Optimum Levels, Median Program

Activity	Code XX	Optimum (% total cost)	Median of data
Total Systems Engineering Effort	SE	16.4%	8.5%
Mission/Purpose Definition Effort	MD	1.3%	1.6%
Requirements Engineering Effort	RE	2.0%	0.8%
System Architecting Effort	SA	4.0%	1.4%
System Integration Effort	SI	3.0%	1.5%
Verification & Validation Effort	VV	2.5%	2.0%
Technical Analysis Effort	TA	1.9%	1.3%
Scope Management Effort	SM	1.4%	0.3%
Technical Management/ Leadership Effort	TM	4.0%	1.9%

Optimum "President George"



	Median Optimum	Adjustment	Program Optimum
MD	1.3%	0.82	1.1%
RE	2.0%	0.58	1.1%
SA	4.0%	0.26	1.0%
SI	3.0%	0.74	2.3%
VV	2.5%	0.68	1.9%
TA	1.9%	0.61	1.1%
SM	1.4%	0.27	0.4%
TM	4.0%	0.66	2.7%
SE	**16.4%**	**0.76**	**12.5%**

Summary

Quantified, Proven Results

- **Better programs expend**
  - **more SE effort overall**
  - **more mission definition, more tech leadership**
- **All SE activities correlate well with**
  - **Stakeholder acceptance**
  - **Cost/schedule control**
- **No SE activities correlate with**
  - **System technical quality**

SE today leads to better programs – but does not lead to better systems.

- **Results can be used to right-size SE**

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Questions?

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