Honourcode, Inc.

Sizing SE Activity Levels To Optimize ROI

INCOSE Symposium 2011

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

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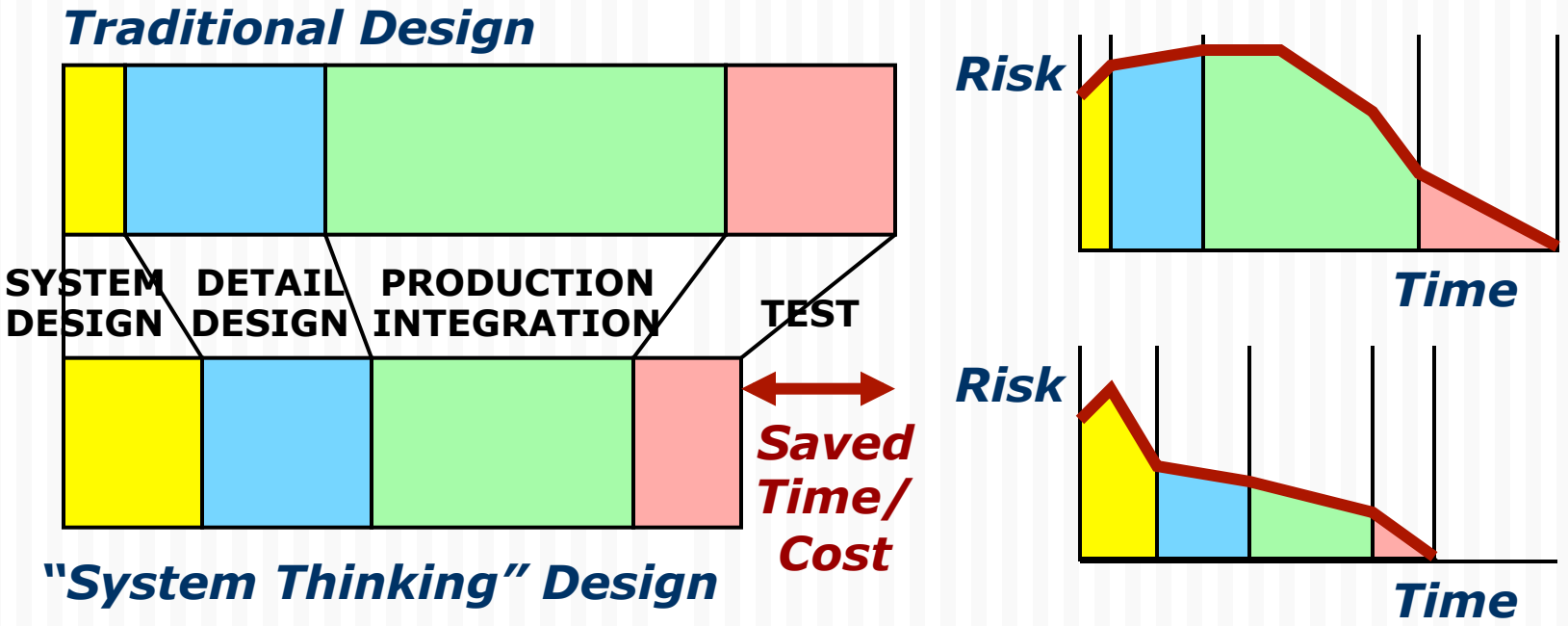
Agenda

- **SE-ROI Project**
  - **Motivation: How much is enough?**
  - **Primary results 2010**
- **Using Program Characterization Parameters**
  - **Improving the correlation by using program characterization**
- **SE Activity Levels**
  - **Eight SE activities with improved correlation**
  - **"Should-Be" levels based on program characterization**

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

Heuristic Claim of SE

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



Need to Know: How Much Is Enough?

Bottom Line

- **SE-ROI project has proven that**
  - **SE activities correlate well with cost control, schedule control, stakeholder acceptance**
- **Outside factors can be characterized to improve the correlation**
  - **Correlation factors increase from ~10% to as much as ~80%**
- **Results can be used to determine "should-be" levels of SE activities**

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SE-ROI Project

Methodology

Primary results

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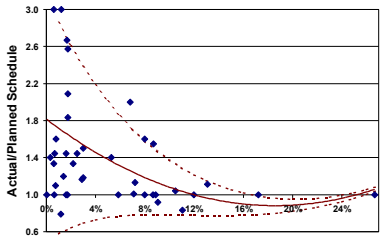
SE-ROI Project

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

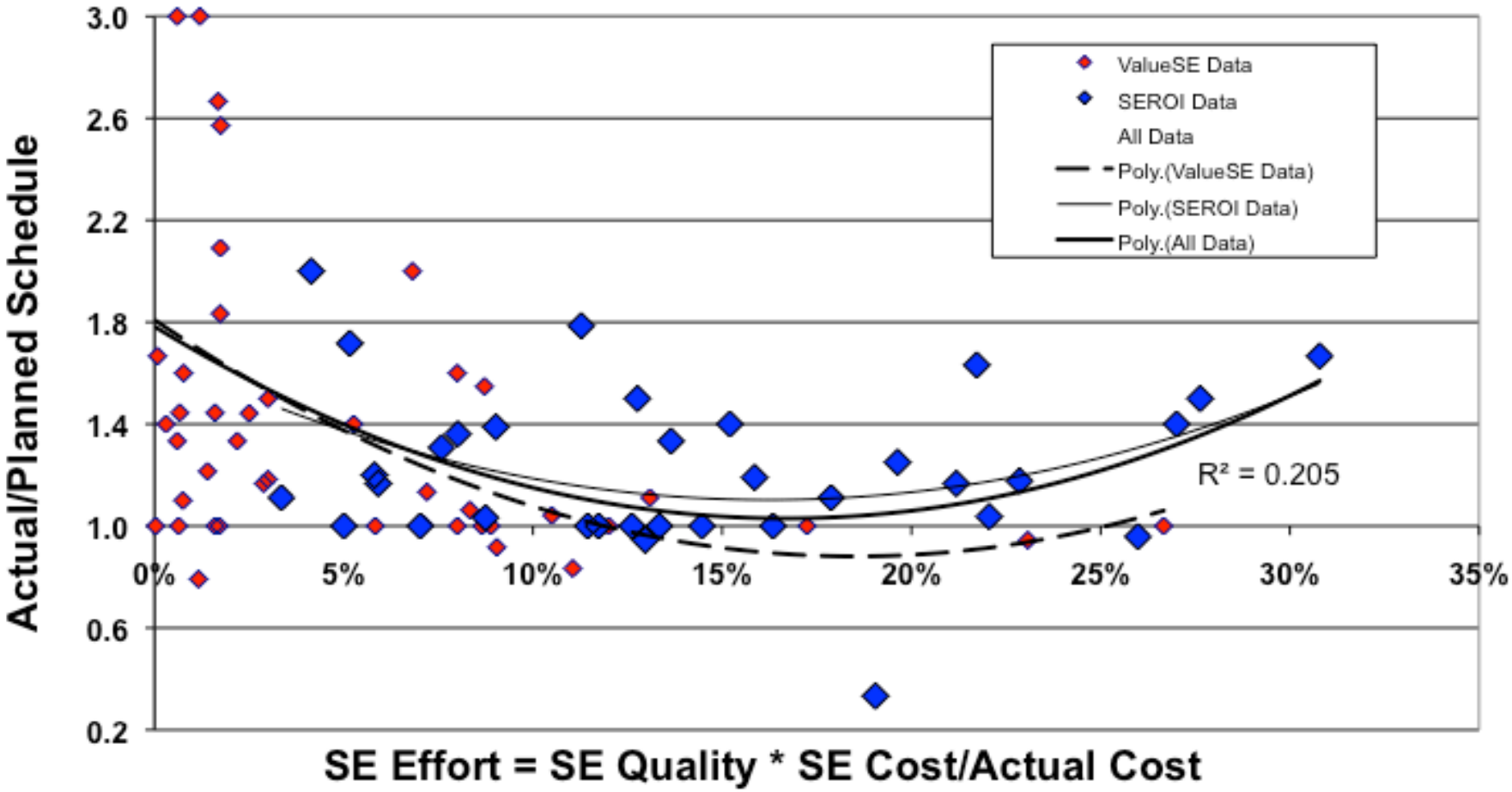
- *Program characterization*
- *Program success data*
- *SE data (hours, quality, methods)*

Statistical correlation

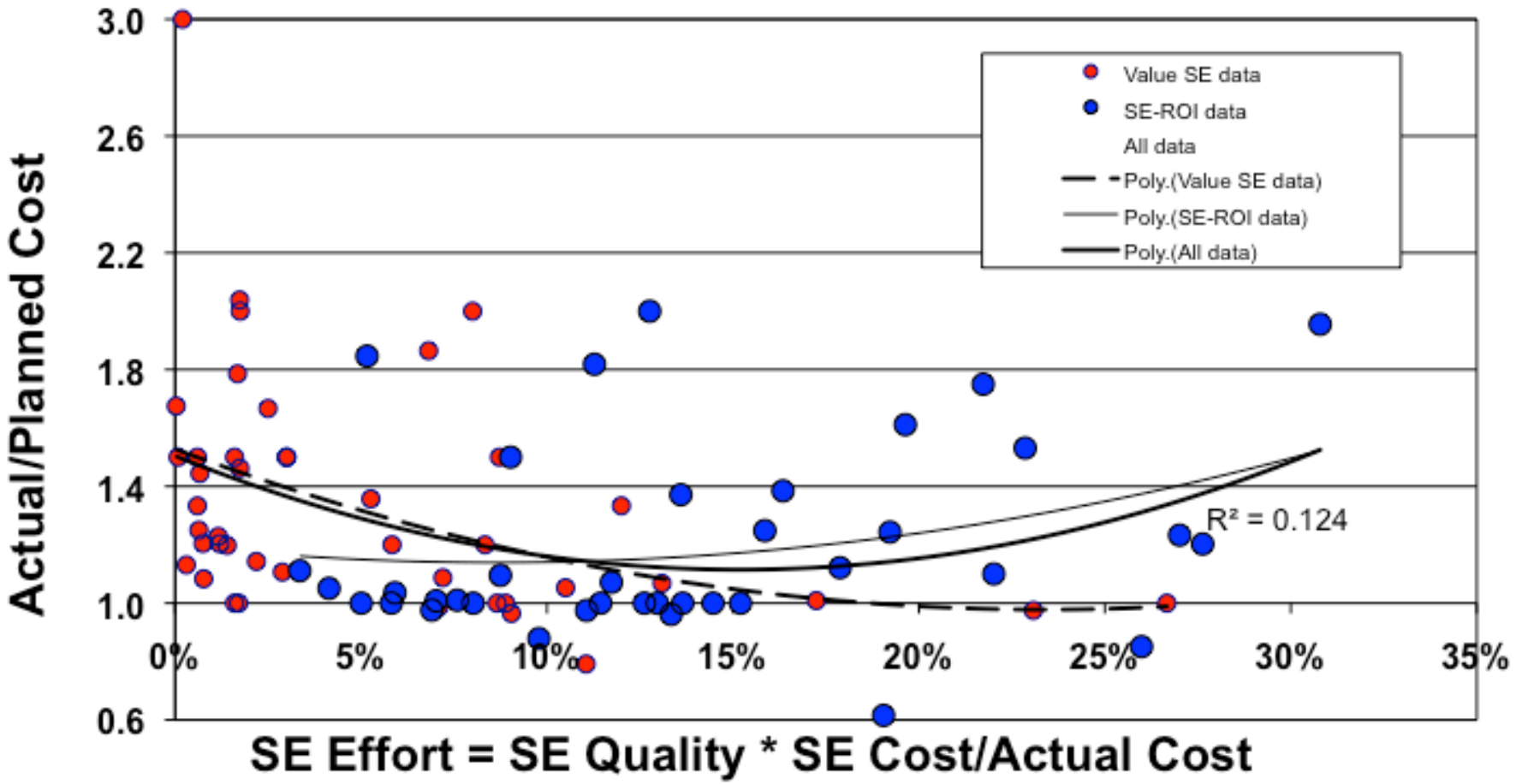


Desired Results
1. Statistical correlation of SE practices with project success
2. Leading indicators
3. Identification of good SE practices

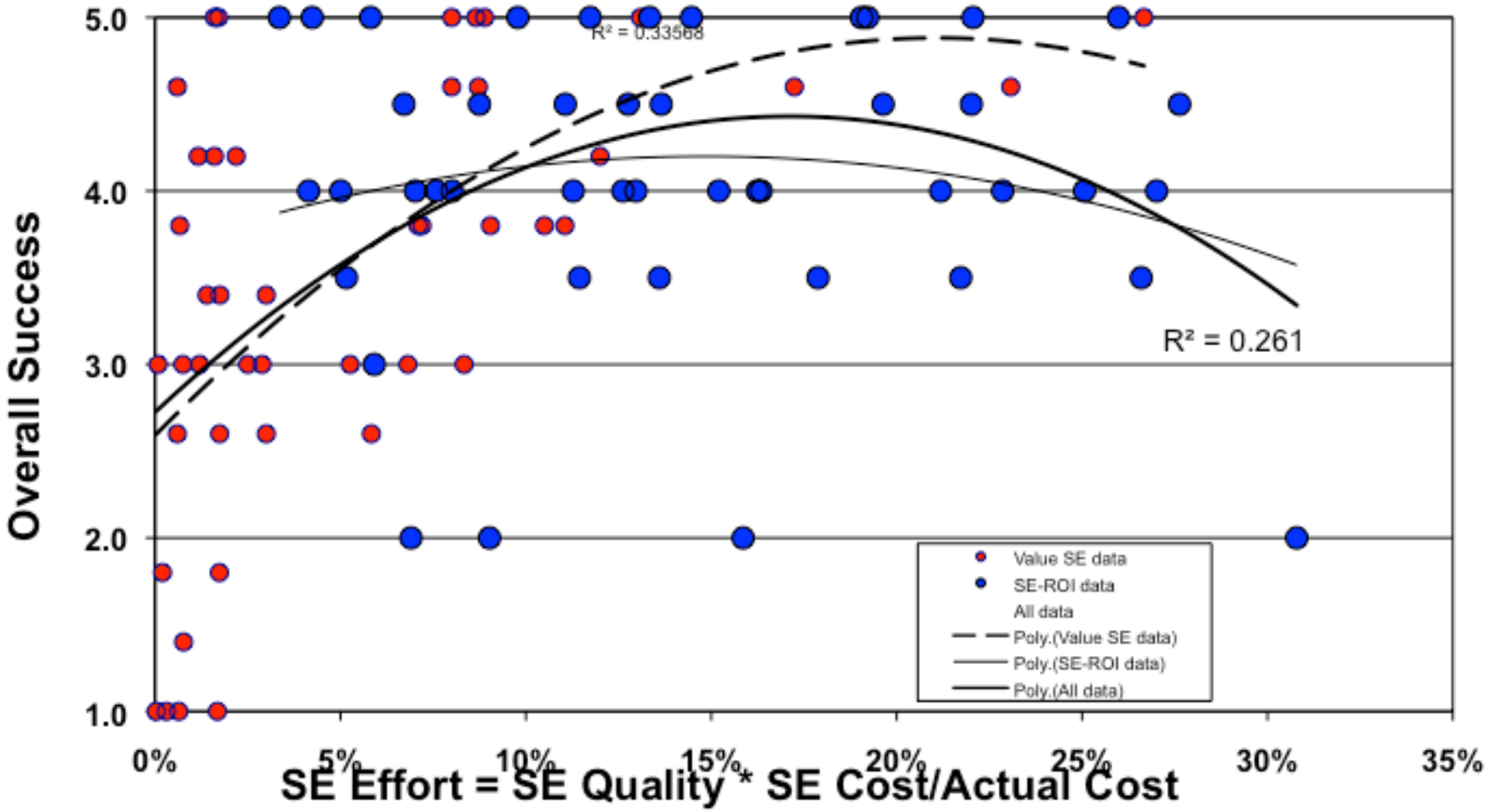
Schedule vs. SE Effort



Cost vs. SE Effort



Overall Success vs. SE Effort



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Using Program Characterization Parameters

- Defining parameters
- Method to use them
- Vast improvement in primary correlations

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More Data: "Size" Parameters

GRADED QUANTITIES – Enter three specific numeric values for each.

	EASY	NOMINAL	DIFFICULT
Number of system requirements			
Number of system interfaces (external)			
Number of algorithms			
Number of operational scenarios			

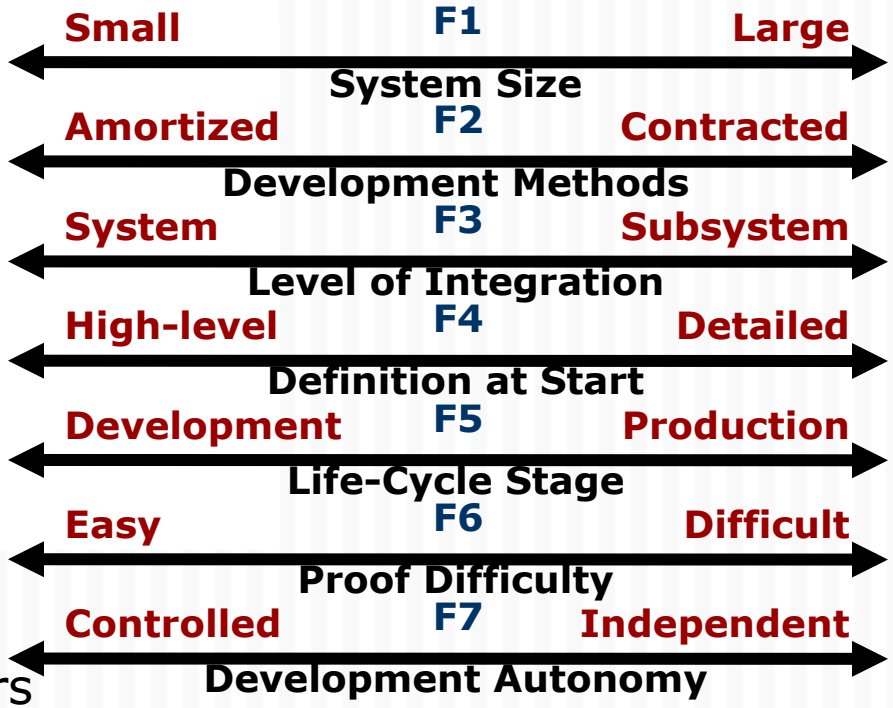
OTHER QUANTITIES – Enter a specific numeric value for each.

	NUMBER	
Number of unique components* in the system design		Number of developing organizations*
Number of unique components* designed as part of the programme		Number of customer agencies* active involved in the programme
Number of components* integrated per system (multiple instances count)		System production quantity under this programme
Number of documented trade studies* at the system level		Number of installation locations
Number of formal tests* at the system level		CMMI level of parent organization (pr developer only)
Number of formal test locations* at the system		

27 parameters

Principal Component Analysis

7 parameters



Honour (2010) "Effective Characterization Parameters for Measuring SE" CSER

More Data: Subjective Parameters

SUBJECTIVE PARAMETERS - Evaluate each parameter on the scale given

Mission/purpose understanding	VL ❑	L ❑	N ❑	H ❑	VH ❑
Requirements understanding	VL ❑	L ❑	N ❑	H ❑	VH ❑
Requirements volatility (changes to requirements)	VL ❑	L ❑	N ❑	H ❑	VH ❑
Requirements growth (additions to requirements)	VL ❑	L ❑	N ❑	H ❑	VH ❑
Architecture understanding	VL	L	N	H	VH
Overall system complexity					
Level of service requirements (environmental, safety, security, reliability, maintainability, etc.)					
Migration complexity					
Technology risk					
Documentation					
Number and diversity of installations/platforms					
Number of recursive levels in the design					
Stakeholder team cohesion					
Personnel/team capability					

18 parameters

Principal Component Analysis

7 parameters

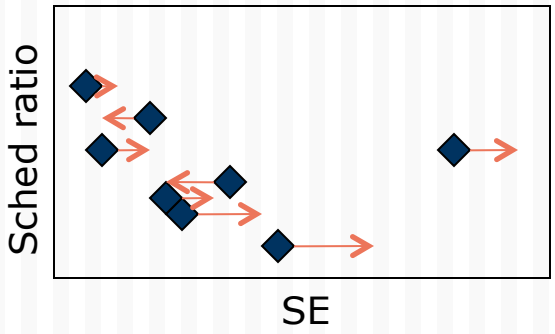
Honour (2010) "Effective Characterization Parameters for Measuring SE" CSER

Adjustment to SE Effort

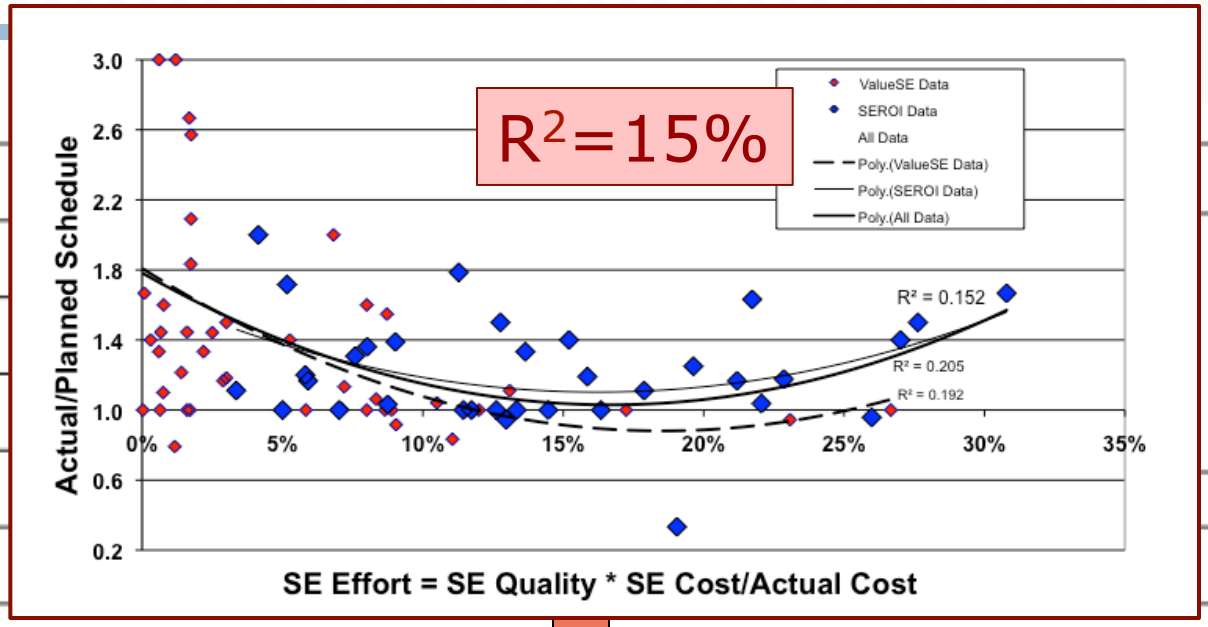
- **"Equivalent SE Effort" – adjust for 14 characterization parameters**
  - **Multiplicative factors as in COSYSMO**
  - **Select weights to optimize correlation**
  - **=0 for no effect; >0 to increase; <0 to decrease**

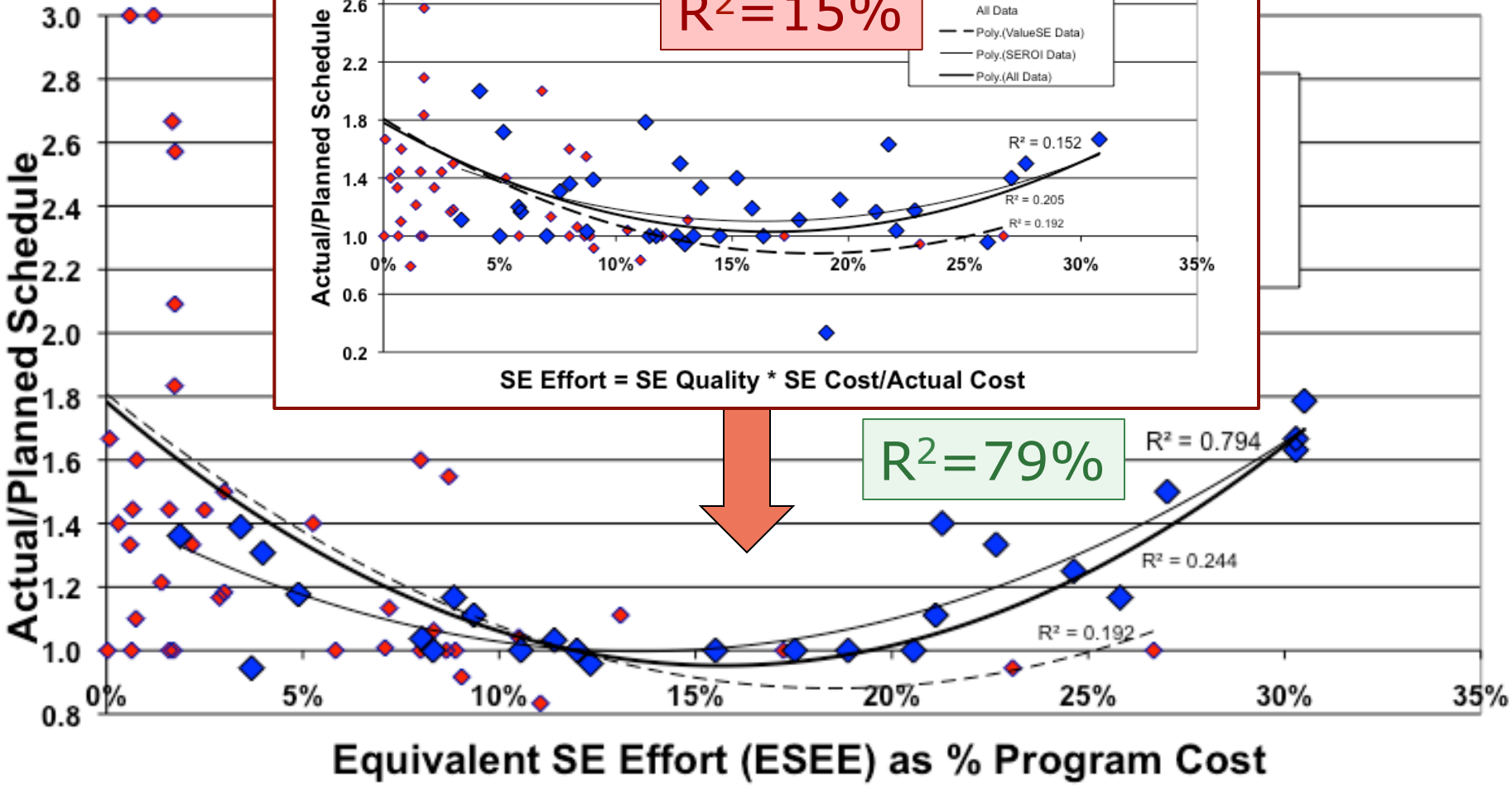
$$ESEE = SEE * \prod_{j=1\ldots14} \left(\frac{PP_j}{.5} \right)^{\frac{-Weight_j}{100}}$$

Typical effect of adjusting any $Weight_j$



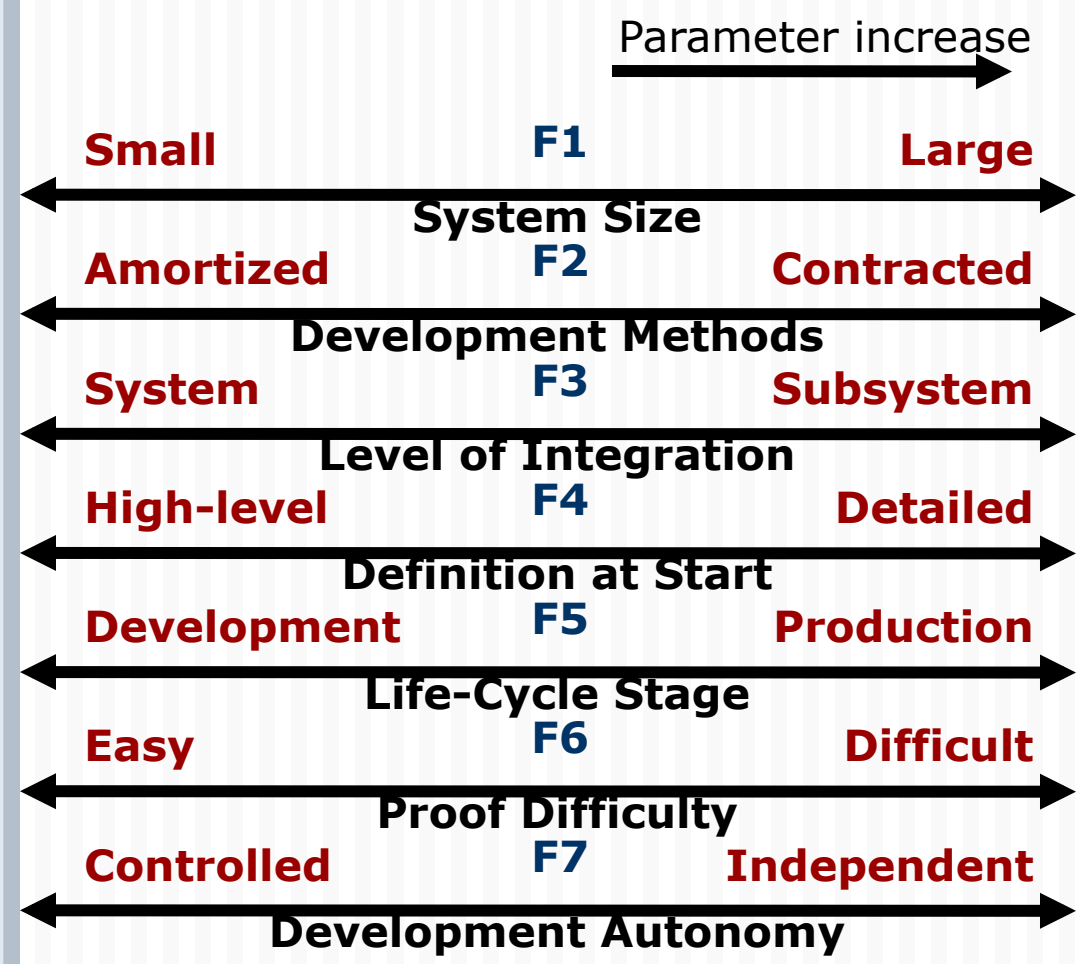
Effect of Characterization Parameters

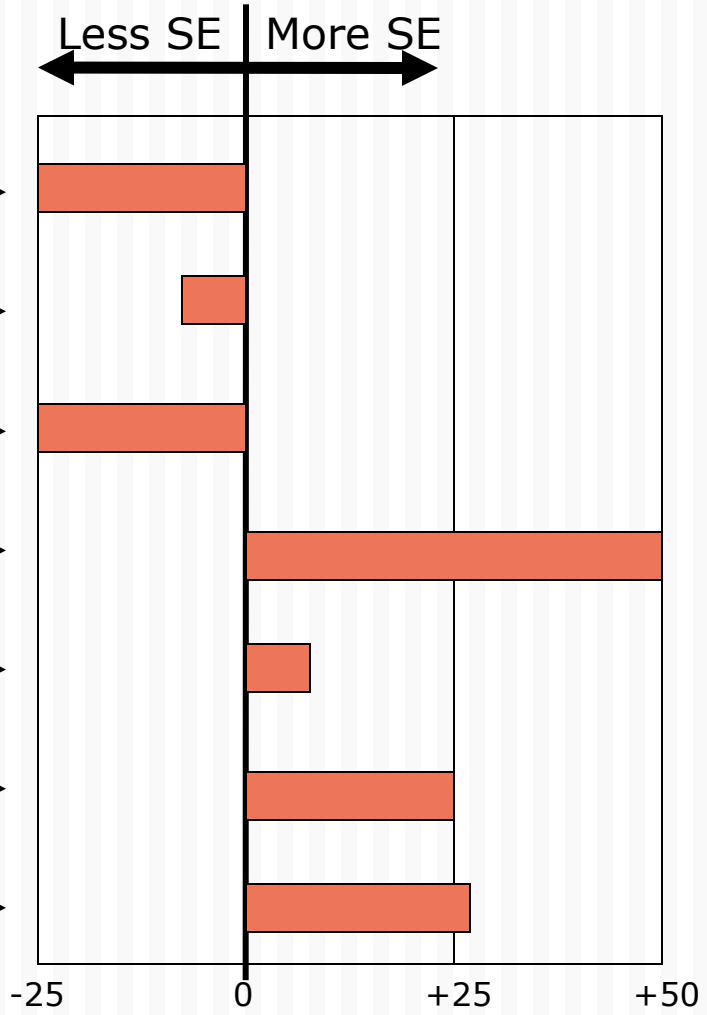




Quantified Parameter Weights

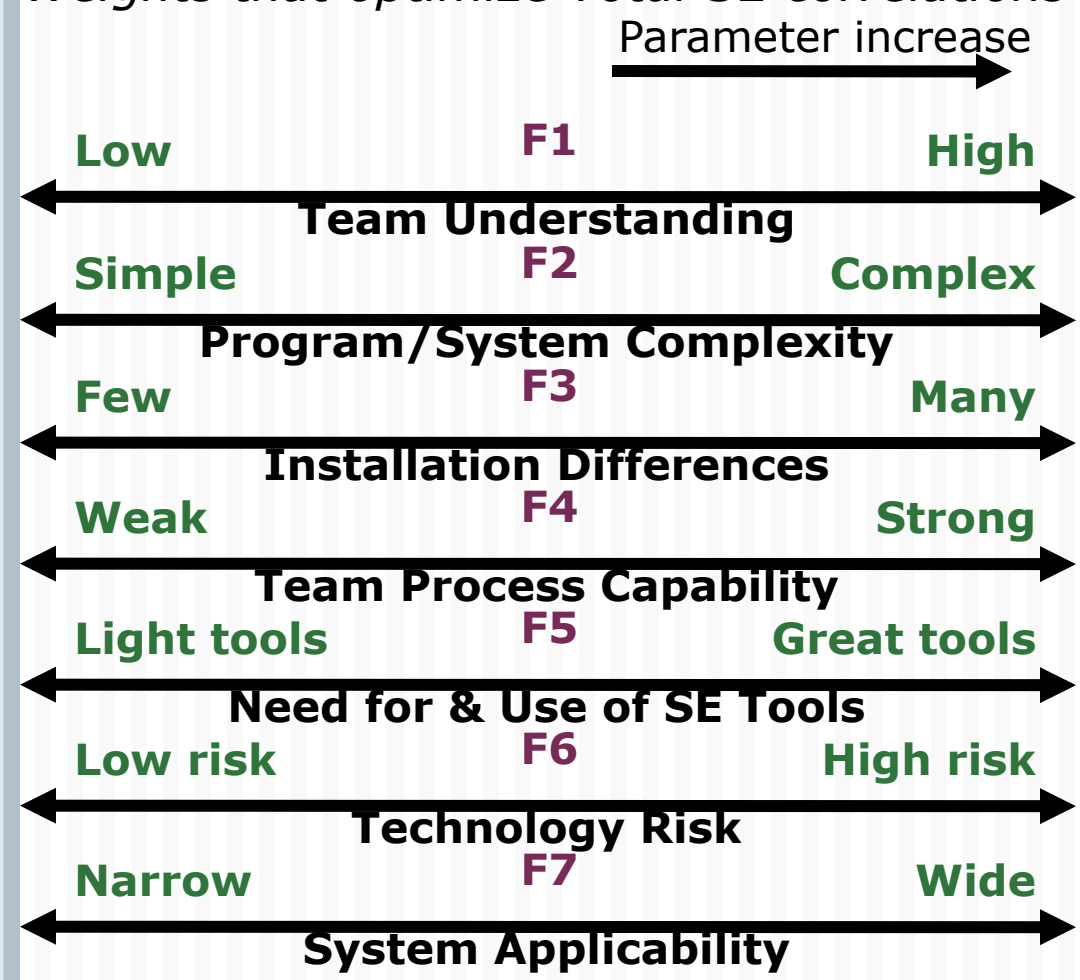
Weights that optimize Total SE correlations

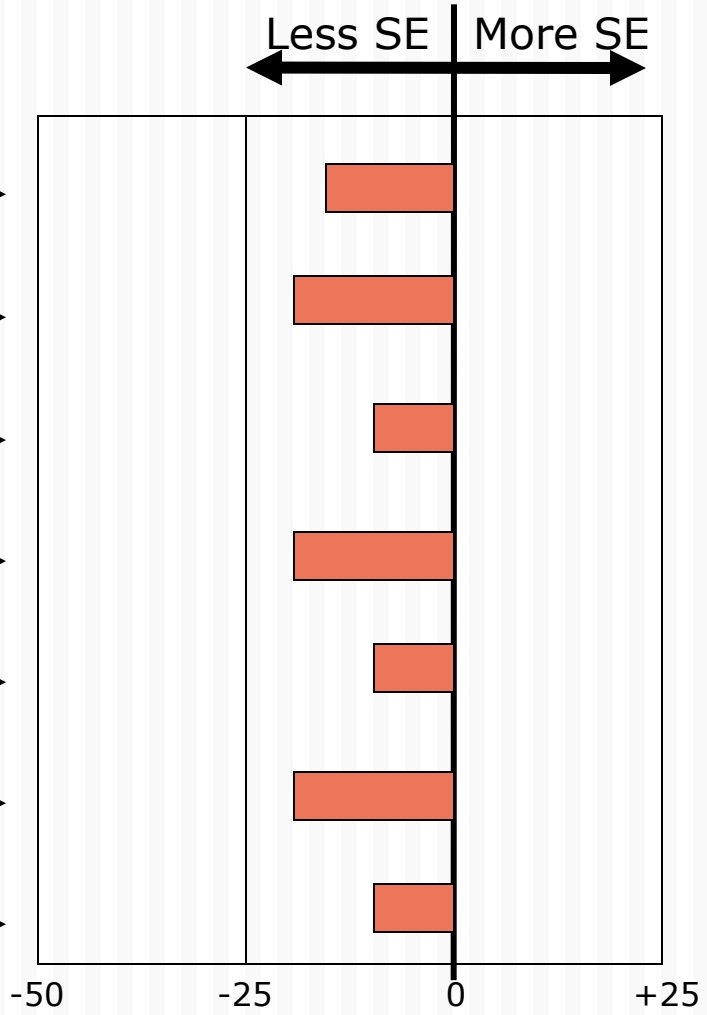




Subjective Parameter Weights

Weights that optimize Total SE correlations





Summary: SE Modifications

$$\frac{\text{SE Activity Cost}}{\text{Total Program Cost}}$$

→ SE%
R^2 ~8-12%

Each transformation improves the correlation of SE with success factors

SE Quality →

SE Effort (SEE)
R^2 ~15-20%

- Number of requirements
- Number of interfaces
- Number of algorithms
- Number of scenarios
- Number of components
- Number of test locations
- Number of developing orgs
- Number of customer agencies

PCA → System Size

...

14 adjustment factors →

Equiv SE Effort (ESEE)
R^2 ~40-80%

SE Activity Levels: "Should-Be" SE

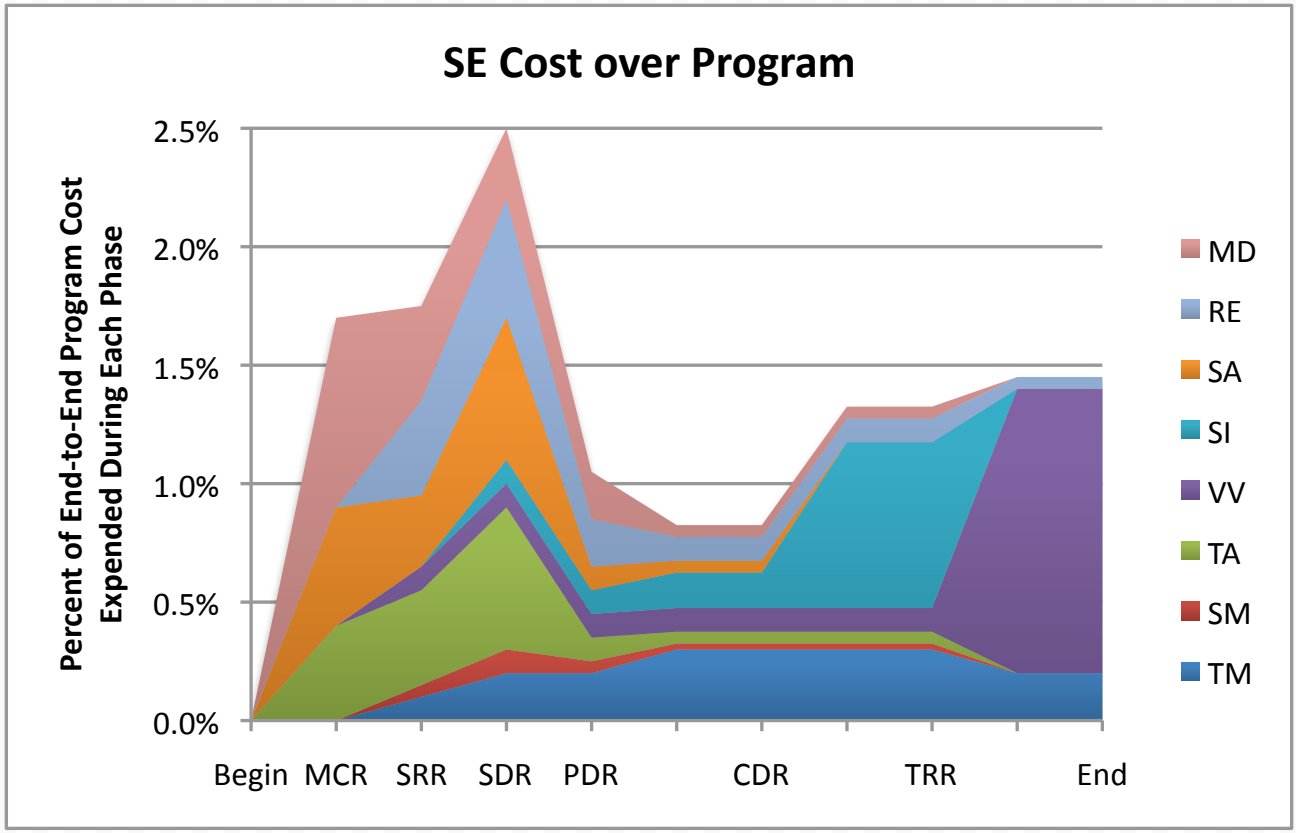
Improved correlation applied to eight SE activities

Parametric sizing of SE to optimize success

Breakout by SE Activities

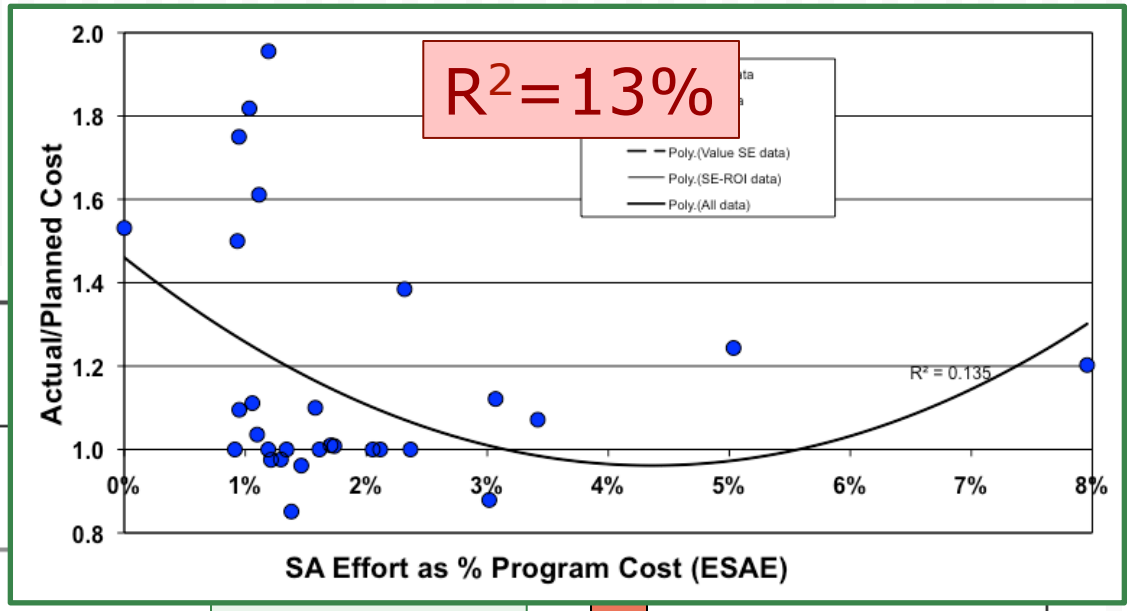
MD Mission/Purpose Definition
RE Requirements Engineering
SA System Architecting
SI System Integration
VV Verification & Validation

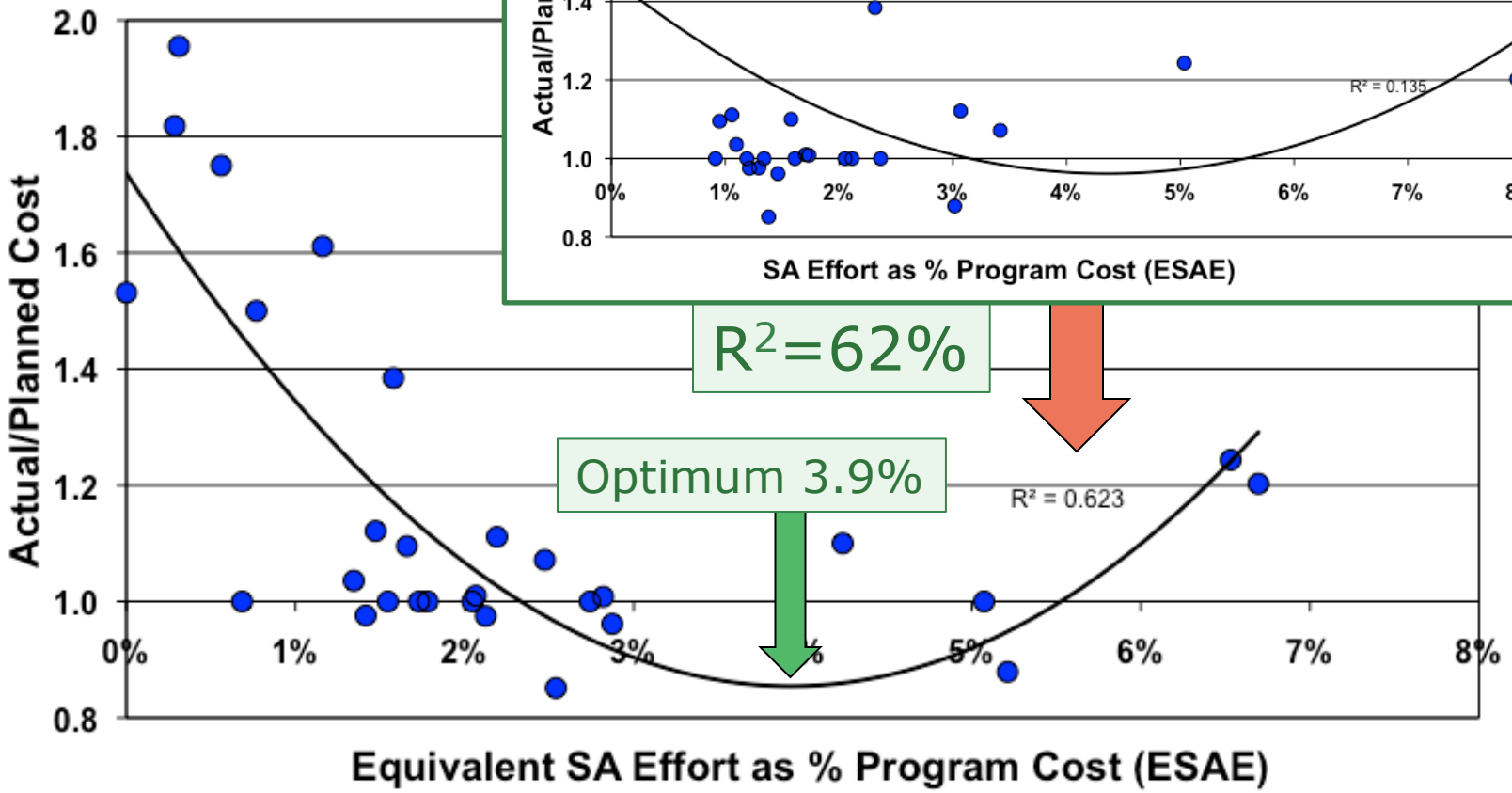
TA Technical Analysis
SM Scope Management
TM Technical Leadership/Management



Improve SE Activity Correlation

Typical activity: Cost overrun vs. System Architecting





Optimum SE Levels, Median Program

- **Improving correlation reveals optimum point on each relationship**
  - **Curve minimum can be calculated**
  - **Represents optimum value for a median program in all characteristics**
- **Optimum value of SE: 15.5%**
- **Optimum level of each activity:**

	MD	RE	SA	SI	VV	TA	SM	TM
Optimum Level, % of Program Cost	1.5%	2.2%	3.9%	3.0%	3.4%	2.1%	1.6%	3.5%

- **Note: Activities do not sum to SE due to local optimization at each activity**
- **Note: mathematical process has potential error of 20-30%**

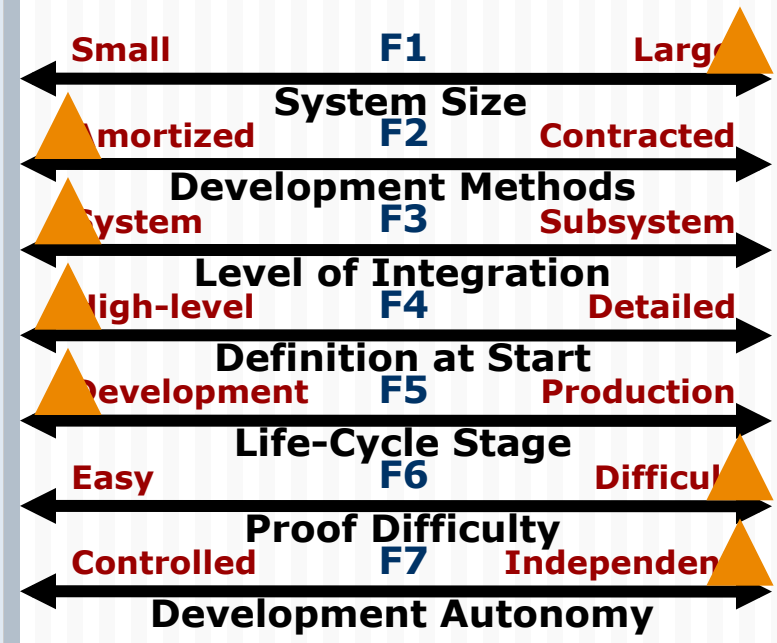
"Should-Be" values of SE

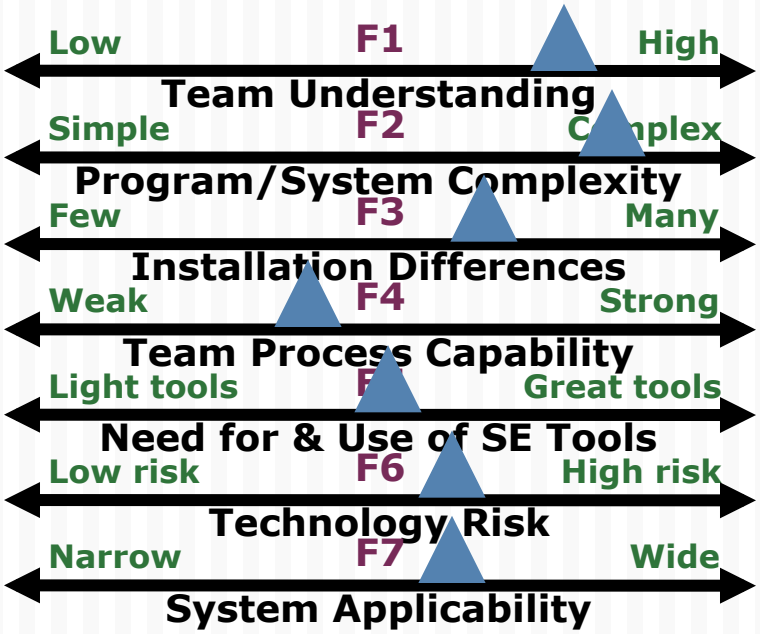
- Estimate 14 characterization parameters for a new program, or
  - Estimate the original 45 characterization params
  - Calculate the resulting values of the 14 params
- Start with median optimum values
- Adjust SE level for characterization
  - Calculate factors by using reverse equations
  - Apply weights to median SE level to determine "should-be" level

$$OSEE = OSEE_0 * \prod_{j=1\ldots14} \left(\frac{PP_j}{.5} \right)^{\frac{+Weight_j}{100}}$$

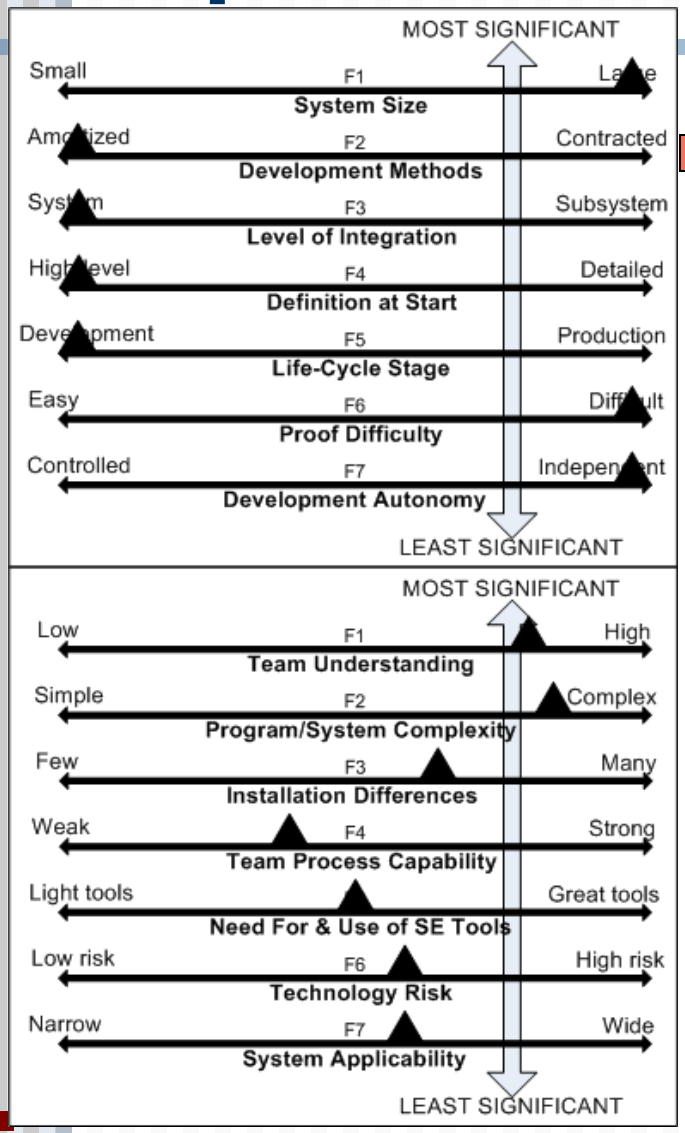
Ex 1 – 'President George'

- Development of a new ship from specs
- Extremely large program
- Moderately strong development team
- Low success: 25% cost over, 12% schedule over, stakeholder score of 2 on 1-to-5





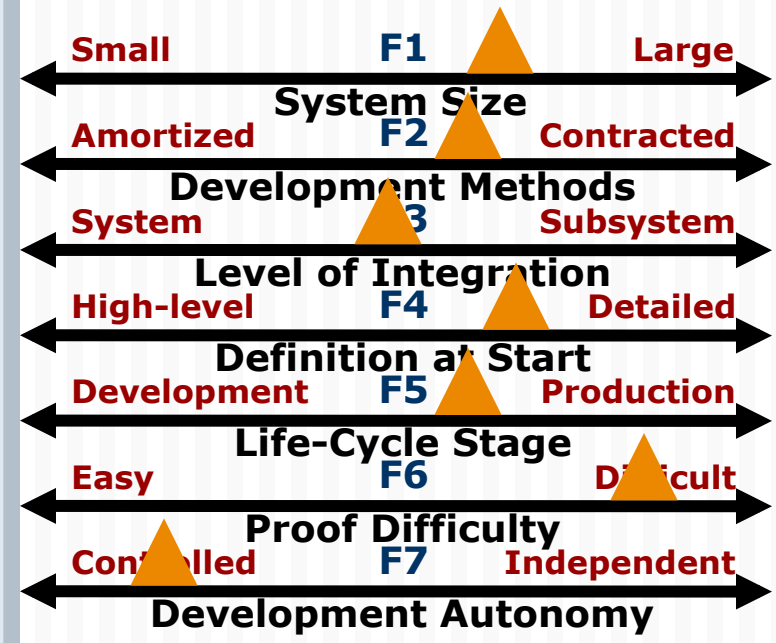
Optimum 'President George'

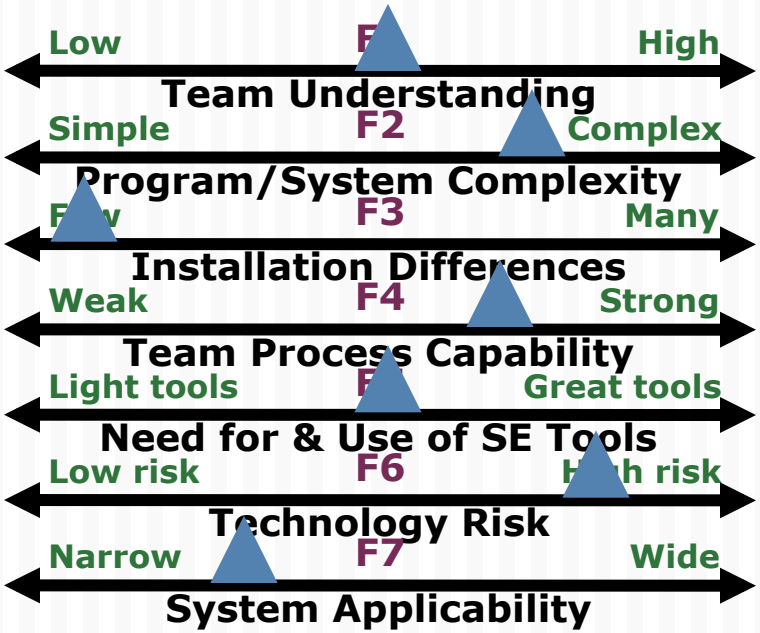


	Median Optimum	Adjust	Program Optimum	Program Actual
MD	1.5%	0.82	1.2%	1.6%
RE	2.2%	0.58	1.3%	1.2%
SA	3.9%	0.26	1.0%	5.6%
SI	3.0%	0.74	2.2%	4.2%
VV	3.4%	0.68	2.3%	1.4%
TA	2.1%	0.61	1.3%	1.7%
SM	1.6%	0.27	0.4%	0.2%
TM	3.5%	0.66	2.3%	1.4%
SE	**15.5%**	**0.76**	**12.0%**	**17.3%**

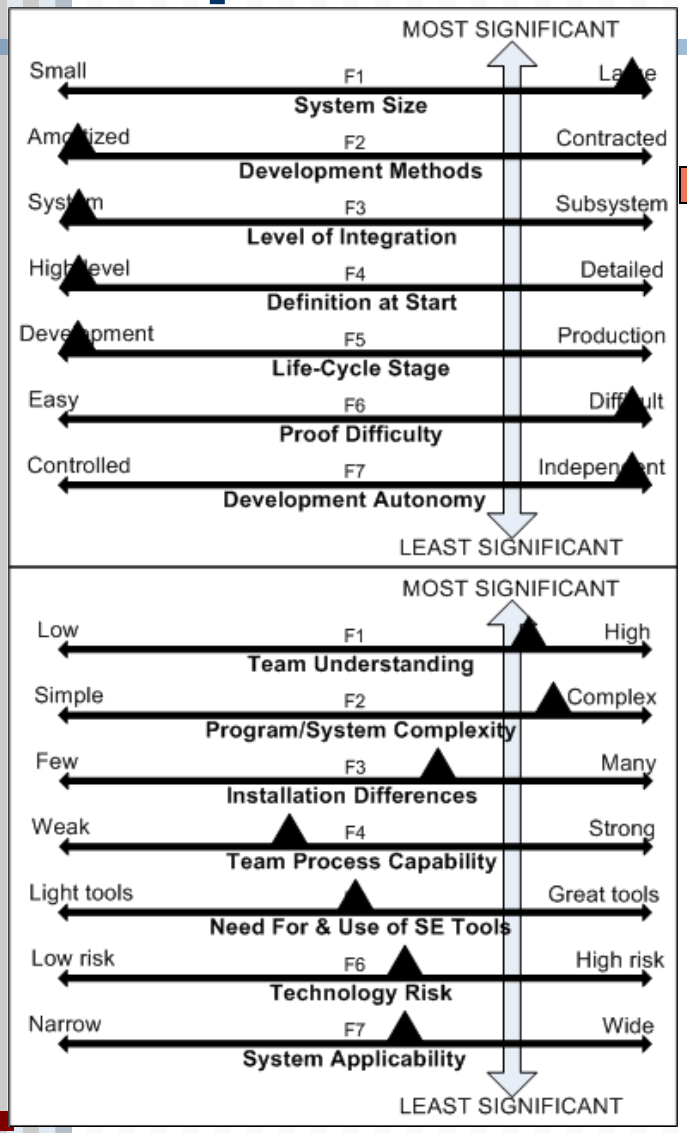
Ex 2 – 'Spark Sniffer'

- NASA-contracted development of a single-item space-certified measurement system
- Significant technology risk
- Mixed success: 50% cost over, 39% schedule over, but stakeholder score of 4.5 on 1-to-5





Optimum "Spark Sniffer"



	Median Optimum	Adjust	Program Optimum	Program Actual
MD	1.5%	0.68	1.0%	0.9%
RE	2.2%	1.02	2.2%	1.0%
SA	3.9%	0.33	1.3%	2.1%
SI	3.0%	0.77	2.3%	3.9%
VV	3.4%	1.09	3.7%	3.6%
TA	2.1%	0.95	2.0%	2.8%
SM	1.6%	0.51	0.8%	0.1%
TM	3.5%	0.17	0.6%	2.1%
SE	**15.5%**	**1.02**	**15.8%**	**17.3%**

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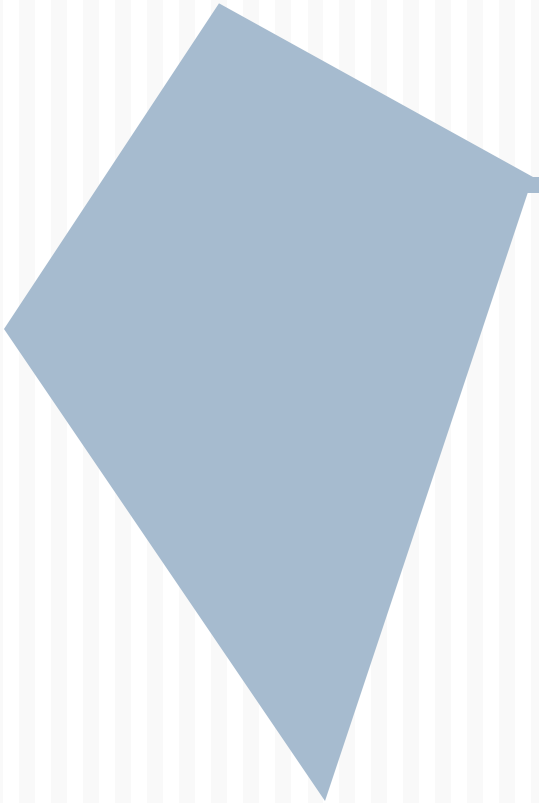
Summary



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Quantified, Proven Results

- SE-ROI project has proven that
  - SE activities correlate well with cost control, schedule control, stakeholder acceptance
- Outside factors can be characterized to improve the correlation
  - Correlation factors increase from ~10% to as much as ~80%
- Results can be used to determine "should-be" levels of SE activities

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Questions?

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