Honourcode, Inc.

INCOSE International Symposium

Systems Engineering Return on Investment

SE-ROI Research
Major Results Jul 10

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

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2010 Chicago, IL USA

Agenda

- **SE-ROI Project**
  - **Motivation: How much is enough?**
  - **Goals and methodology**
- **SE-ROI Results**
  - **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 – optimum ~15%**
  - **more mission definition, more tech leadership**
- **All SE activities correlate 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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SE-ROI Project

Methodology
Industry support

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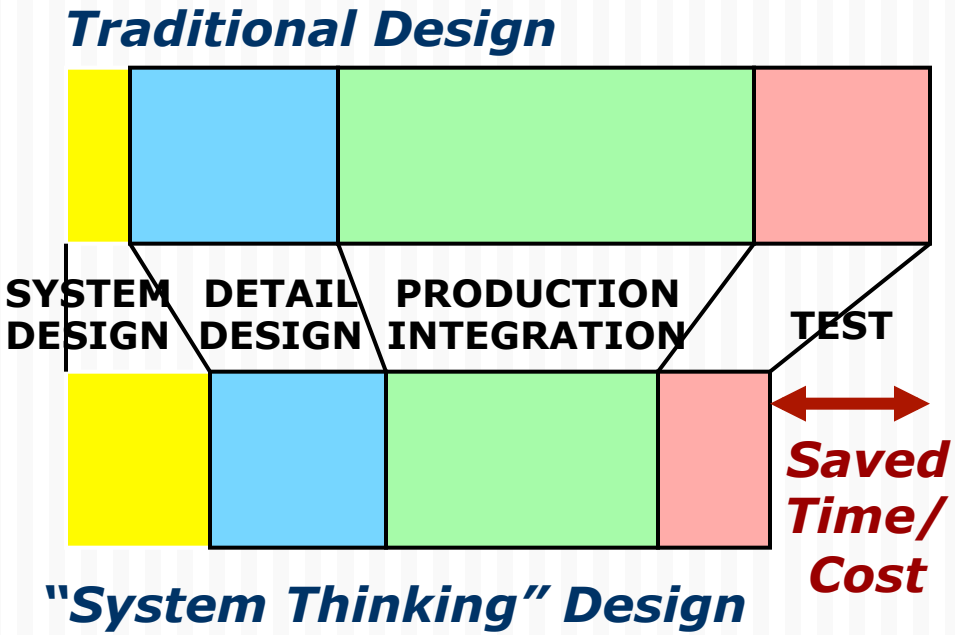
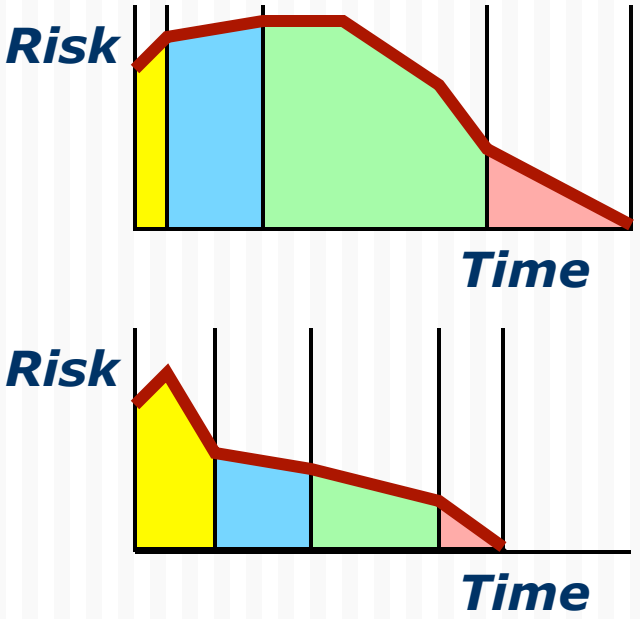
Heuristic Claim of SE

- **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

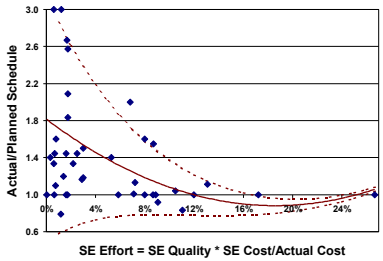
- **Key PM/SE/Admin**
- **Translate program data into project structure**

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

Desired Results

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

Statistical correlation



Company Participation

- **Data gathering** – ***minimal impact***
  - Select 2 to 4 programs
  - One day of interviews
  - 2-hour sessions with PM+SE of each program
  - Strong protection of proprietary data
- **Reports** – ***effective program benchmarking***
  - Benchmark report within 30 days of session
    - Compares programs against prior data
  - Quarterly reports from all prior data, all sources
    - *Correlations found*
    - *Leading indicators proven*
    - *SE practices proven*

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 – 10)	Values of 1 to 10 Median 5	**Values of 1 to 10** **Median 7**

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SE-ROI Results: Primary Relationships

SE effort correlates with 3 of 4 success measures

Optimum SE effort ~15% of total development cost

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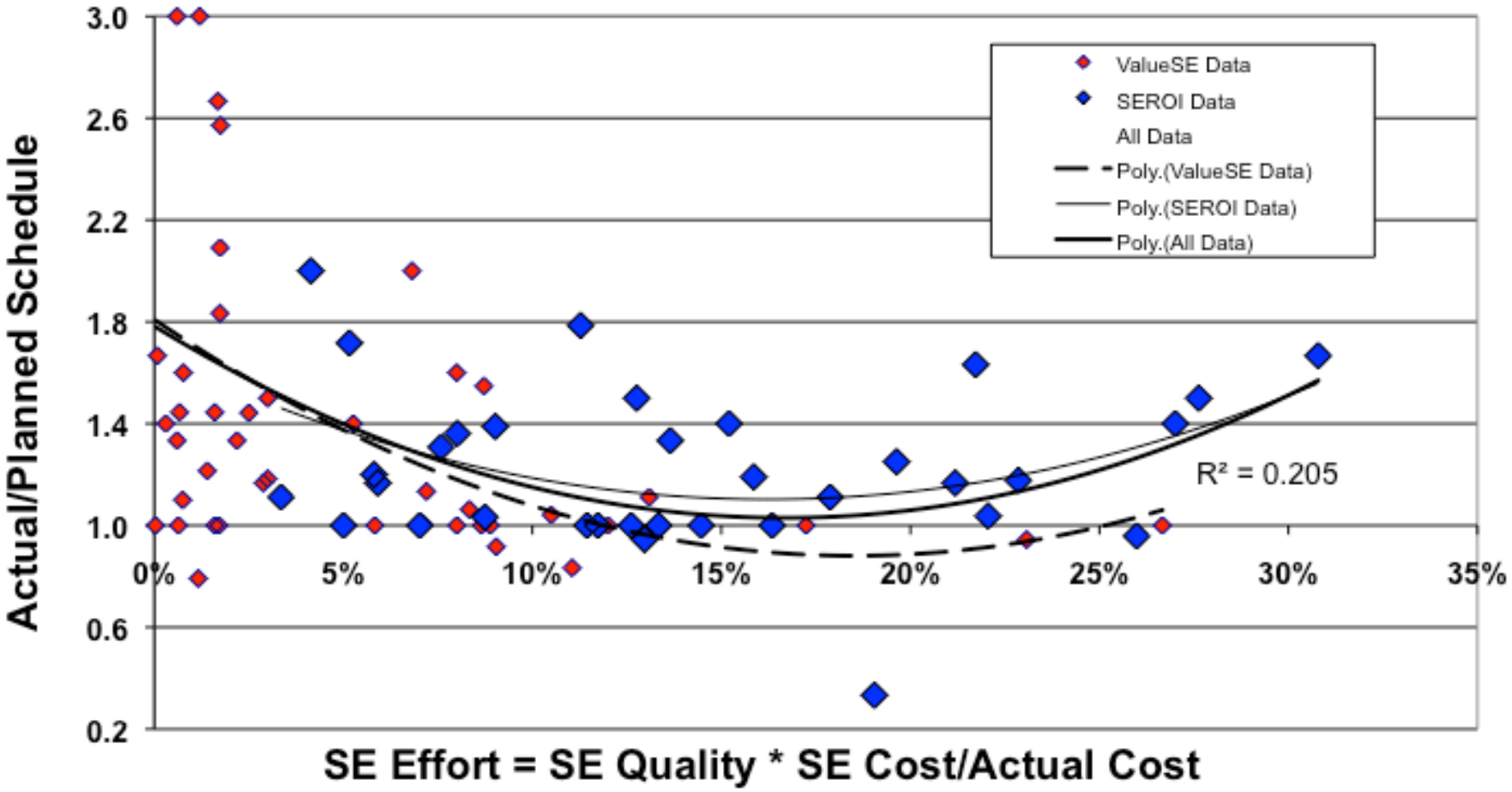
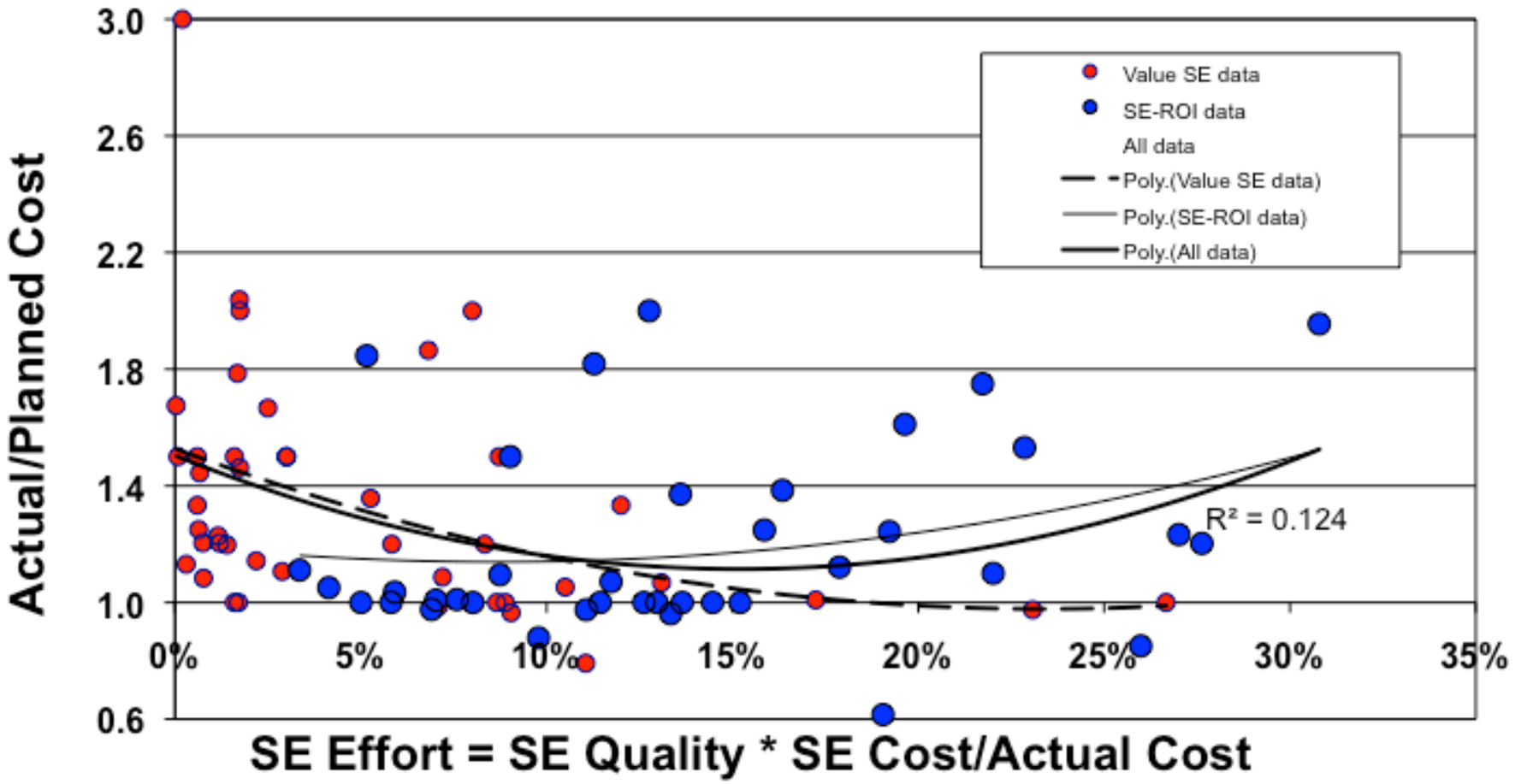
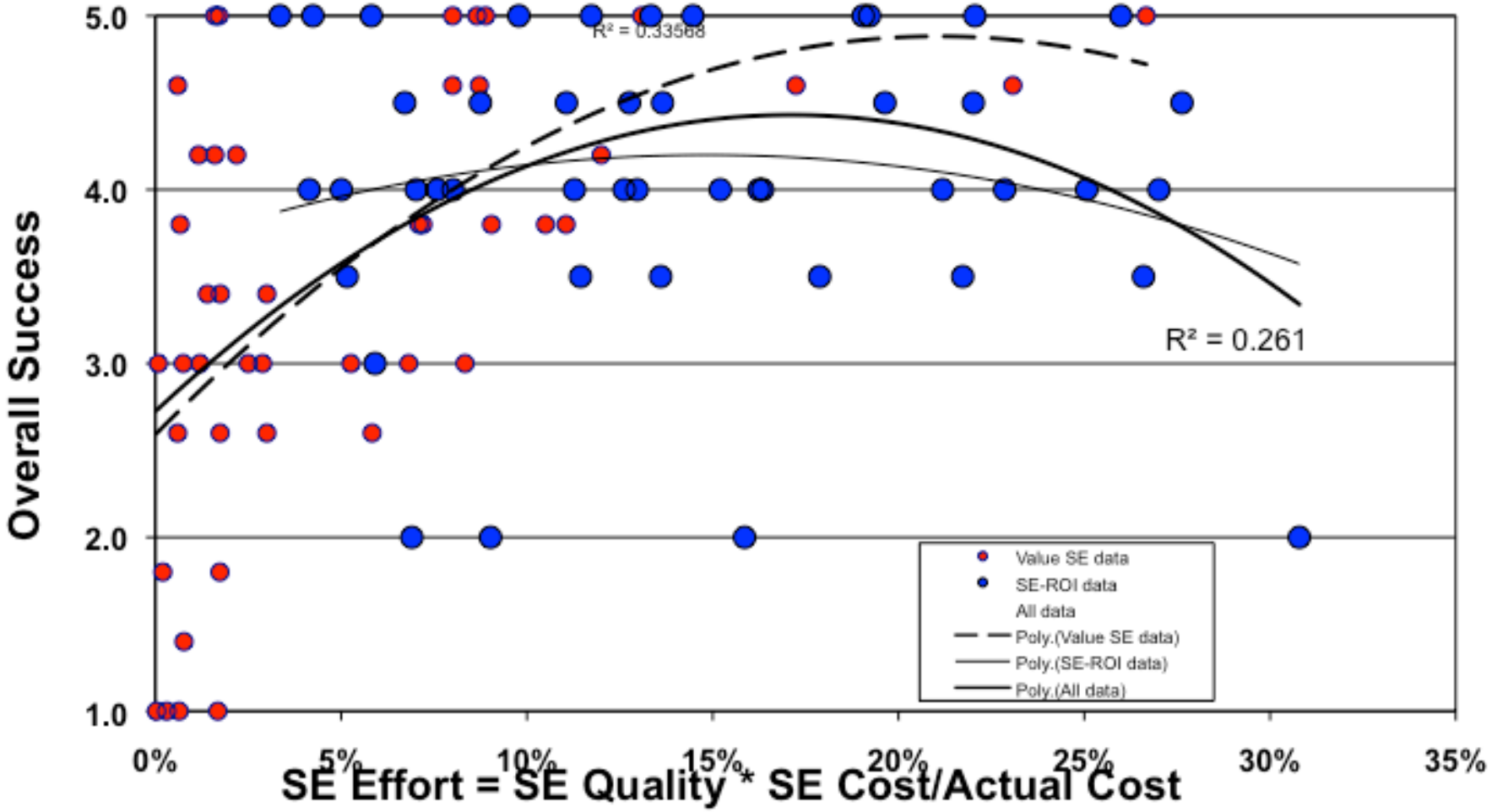
Schedule vs. SE Effort



Cost vs. SE Effort

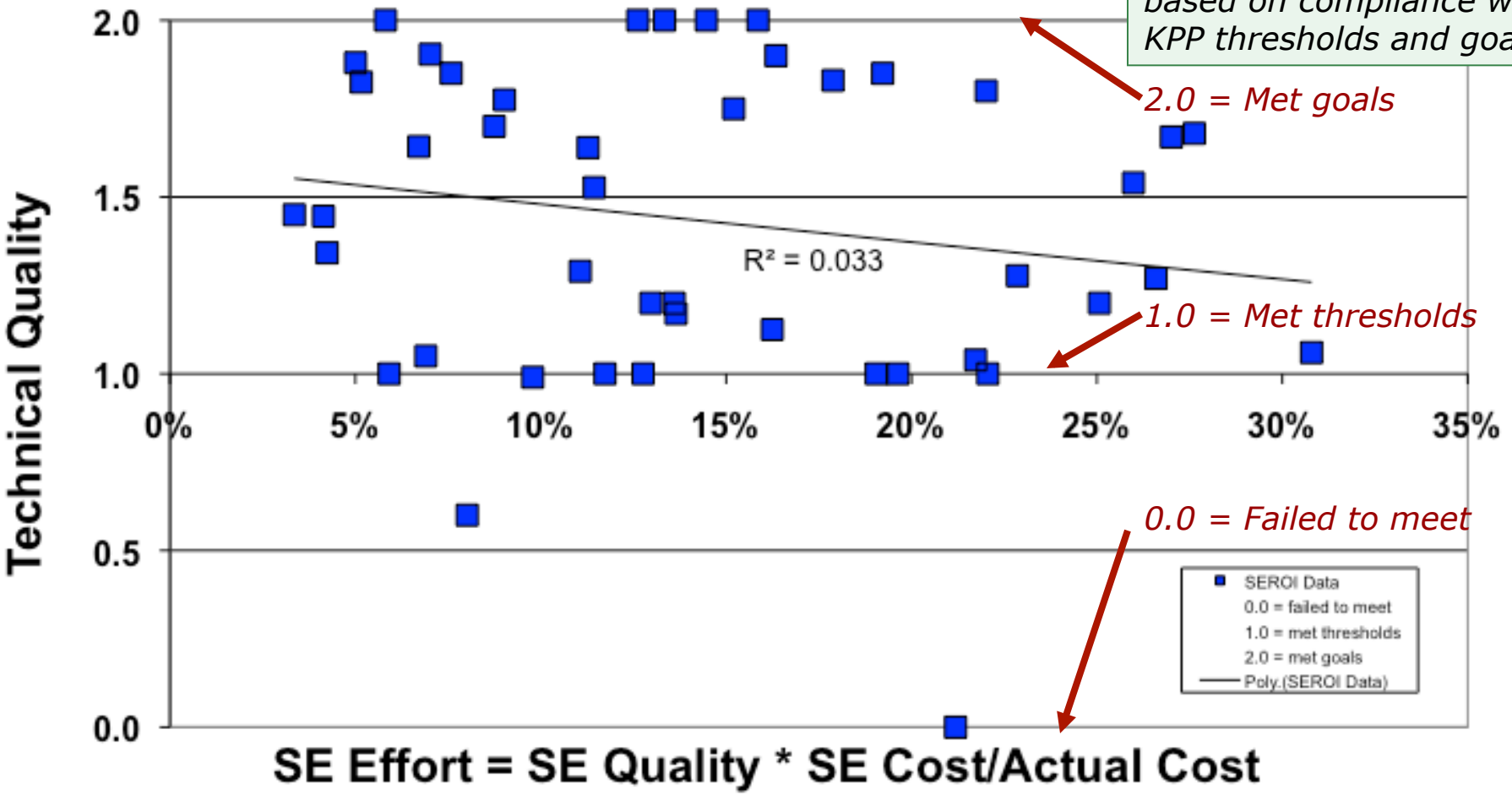


Overall Success vs. SE Effort



Technical Quality vs. SE Effort

"Technical Quality" is based on compliance with KPP thresholds and goals



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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

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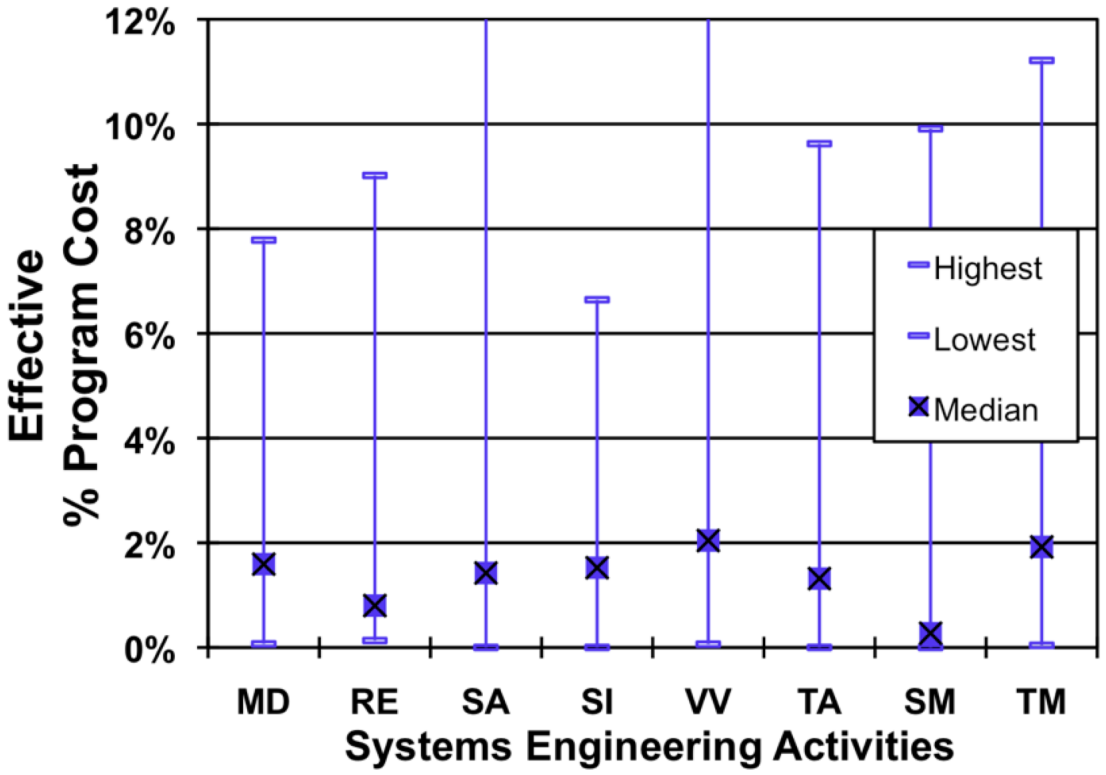
Breakout by SE Activities

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



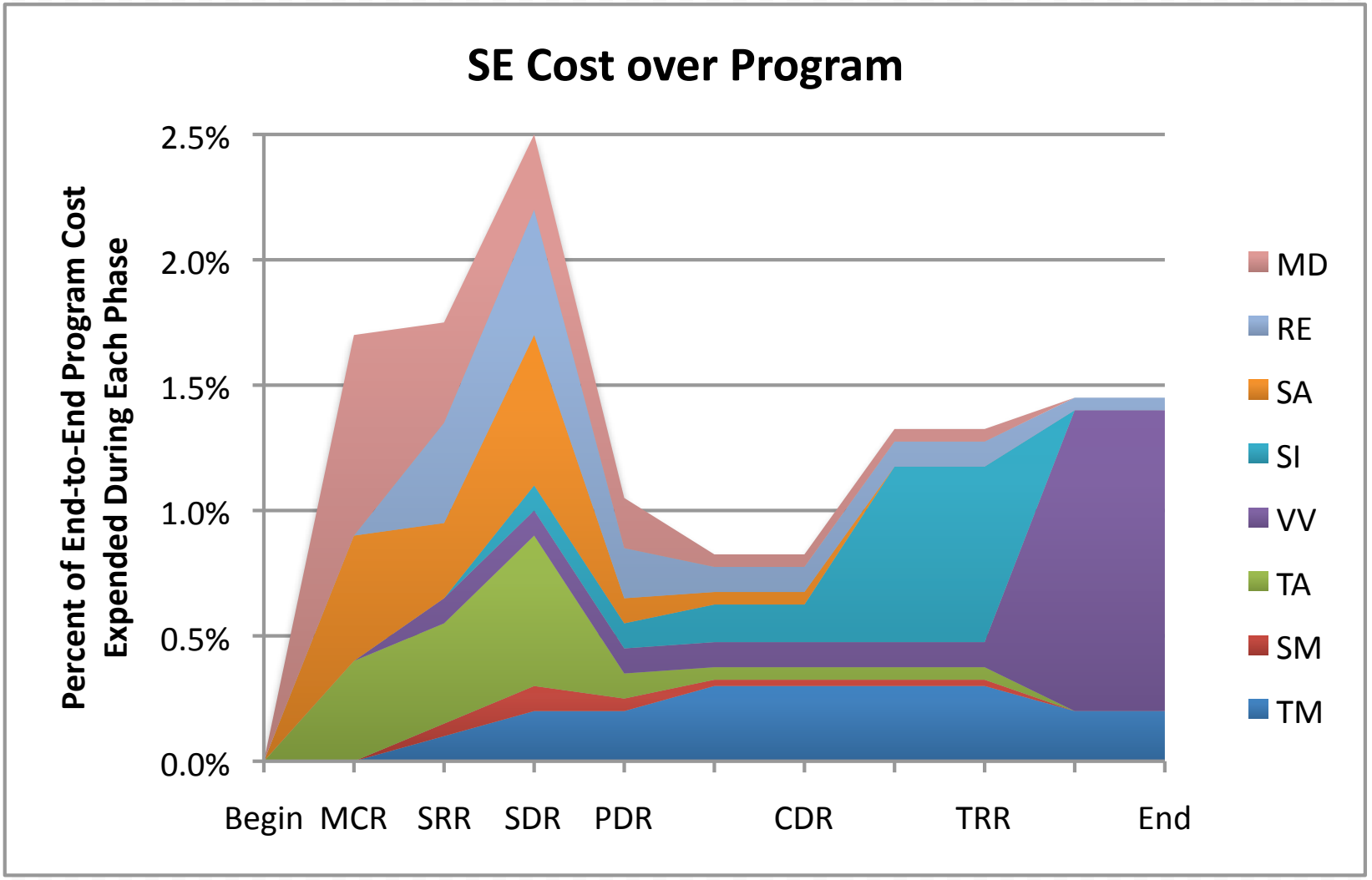
Effect of SE Activities

- **Which activities correlate to better quality?**

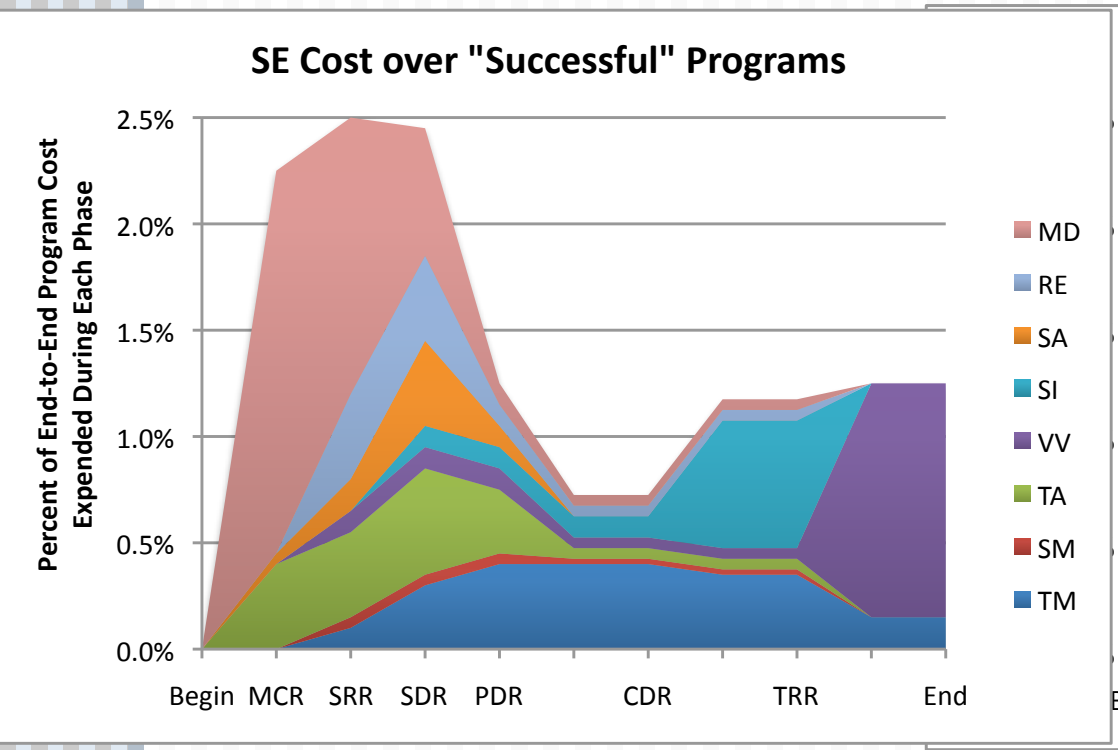
Activity	Cost	Schedule	Overall	Technical
Missn Defn*	Perhaps	Yes	Yes	No
Reqs Engr	Yes	Yes	Yes	No
Sys Arch	Yes	Yes	Yes	No
Sys Integr	Perhaps	Perhaps	Perhaps	No
Tech Anlysis	Yes	Yes	Yes	No
Tech Mgmt	Yes	Yes	Yes	No
Scope Mgmt	Yes	Yes	Yes	No
Ver & Val	Yes	Yes	Yes	No

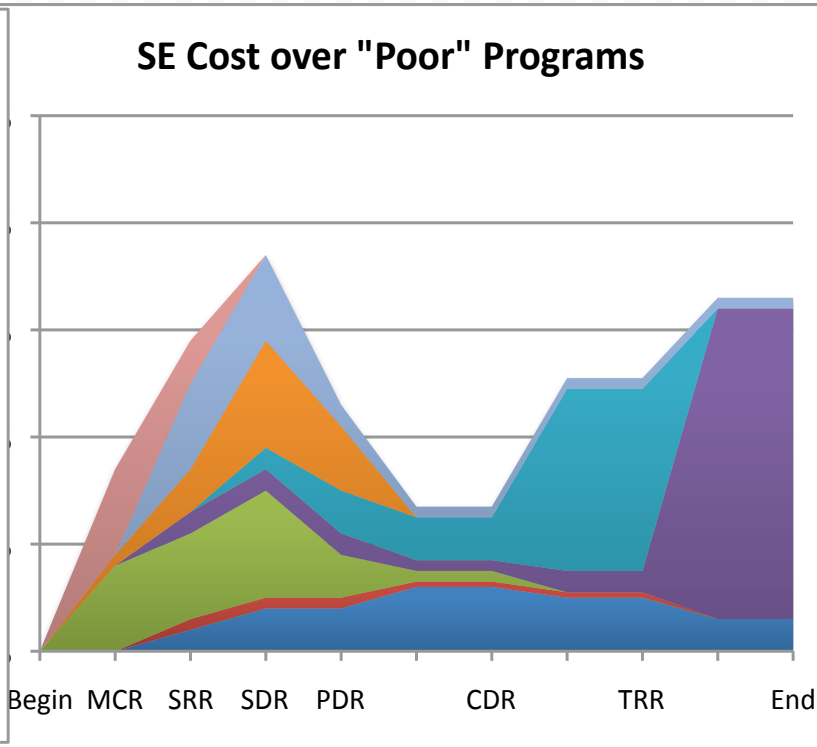
* *For most projects, MD was performed in an earlier phase*

Breakout by Phase



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

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SE-ROI Results: Right-Sizing SE

Results are further optimized using characterization parameters

Parametric sizing of SE to optimize success

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Adjustment to SE Effort

- Raw SE percent of program cost

$$SE\% = \frac{Cost_{SE}}{Cost_{PROGRAM}}$$

- "SE Effort" - adjust for quality of SE

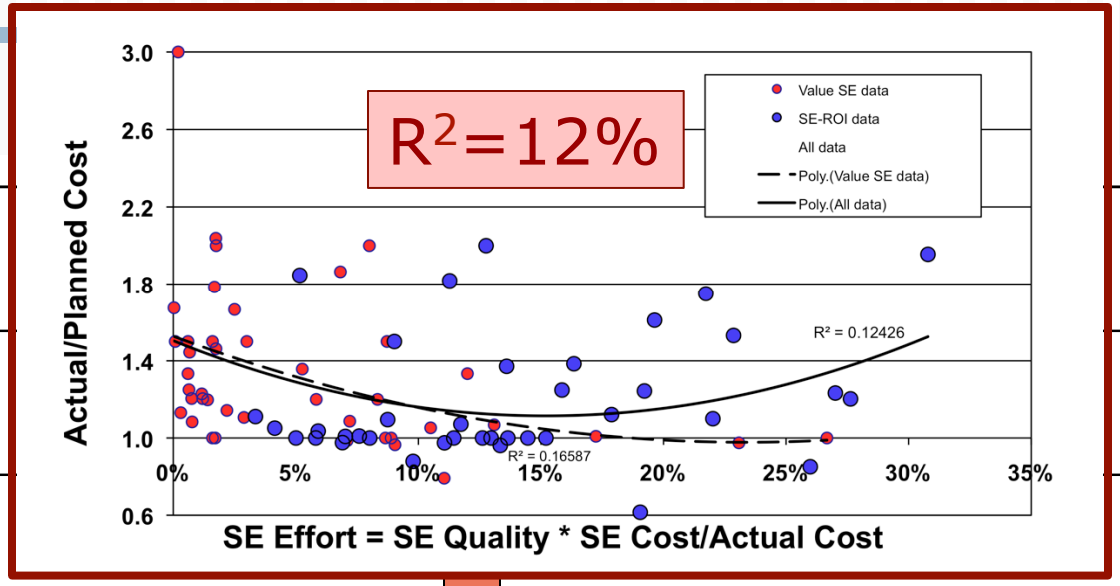
$$SEE = SEQ * SE\%$$

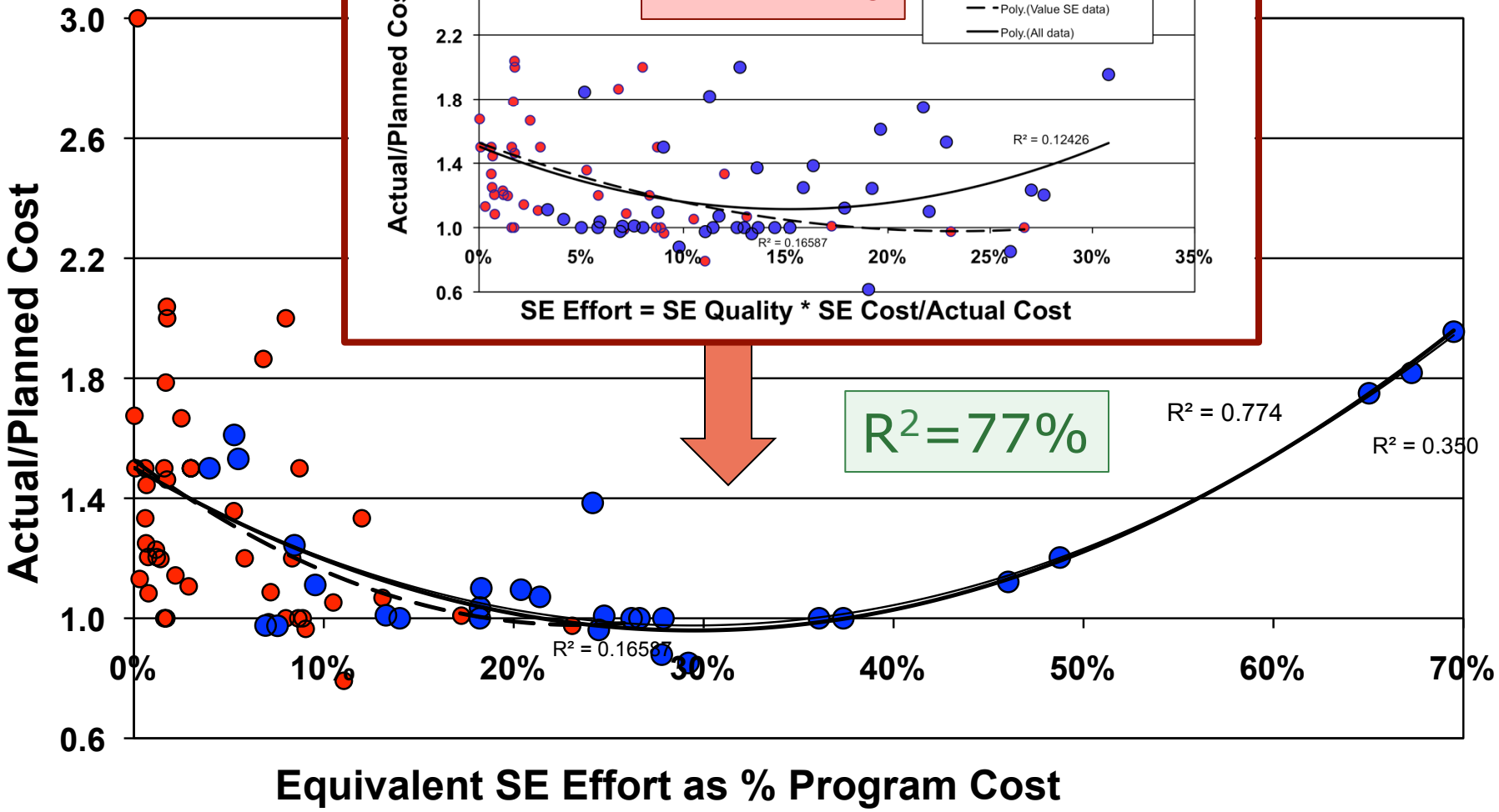
- **"Equivalent SE Effort" – adjust for 14 characterization parameters**
  - **Multiplicative factors as in COSYSMO**

$$ESEE = SEE * \prod_{j=1...14} \left(\frac{PP_j}{.5} \right)^{Weight_j}$$

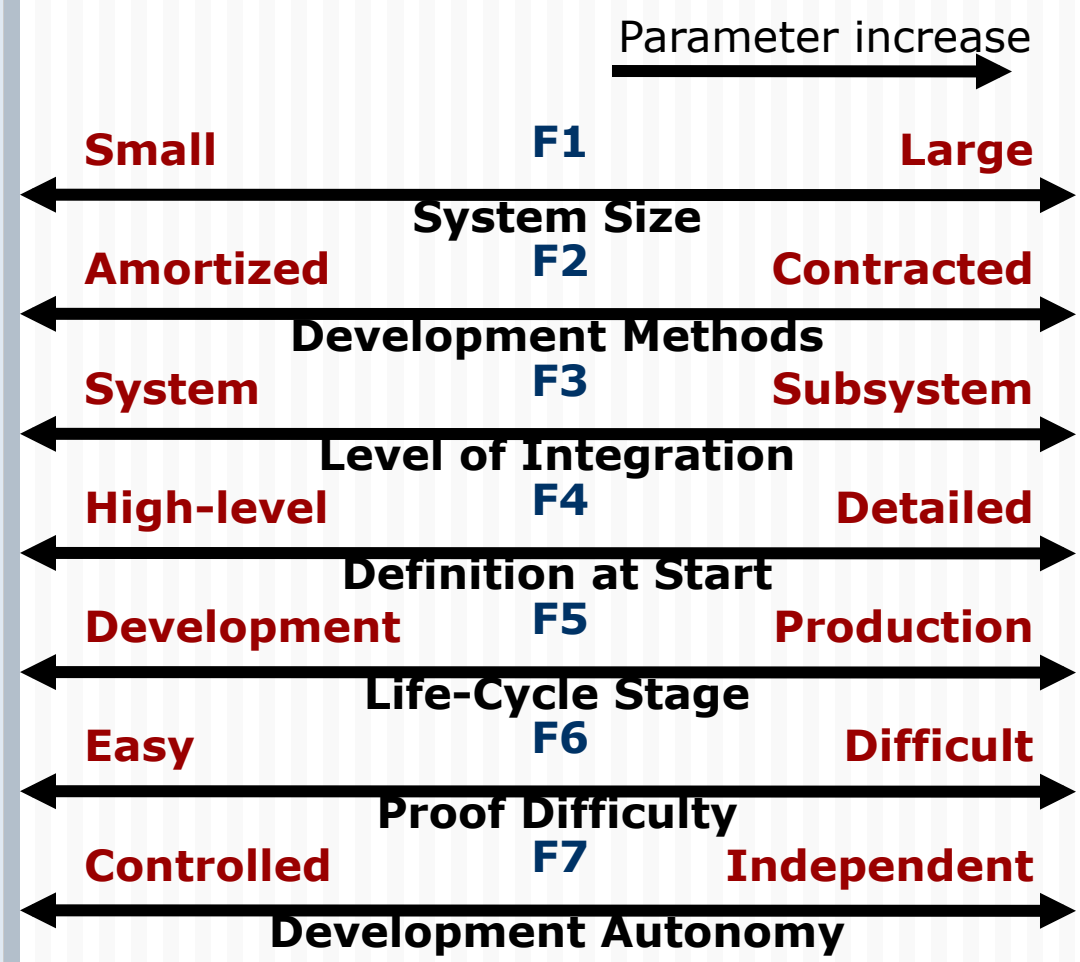
  - **weight=0 for no effect; >0 increase; <0 decrease**
  - **Select weights to optimize correlation**

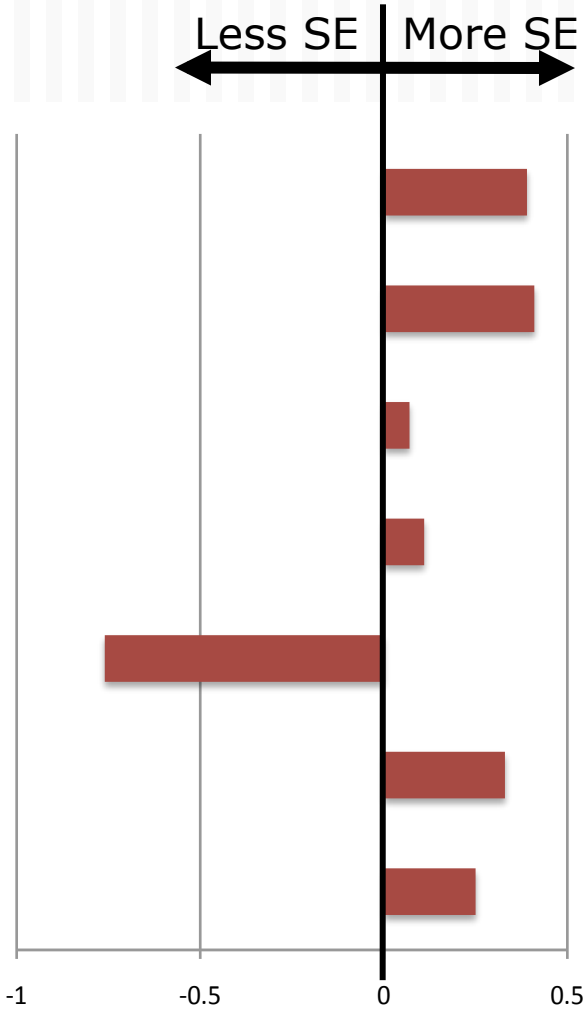
Effect of Characterization Parameters

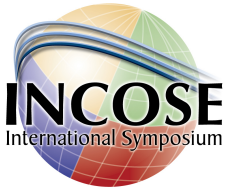




Quantified Parameter Weights







Summary

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Quantified, Proven Results

- **Better programs expend**
  - **more SE effort overall – optimum ~15%**
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- **All SE activities correlate well with**
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Questions?

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