National Defense Industrial Association

9th Annual Systems Engineering (SE) Conference

October 2006

The Value of Systems Engineering

What do we know about it?

How do we discover more?

- **Al Mink**
  Systems Value / GMU

Value of SE
Overview

1. **The Problem**
2. **What We Know Today**
3. **The Race to Discover More**
4. **Conclusions**

Value of SE

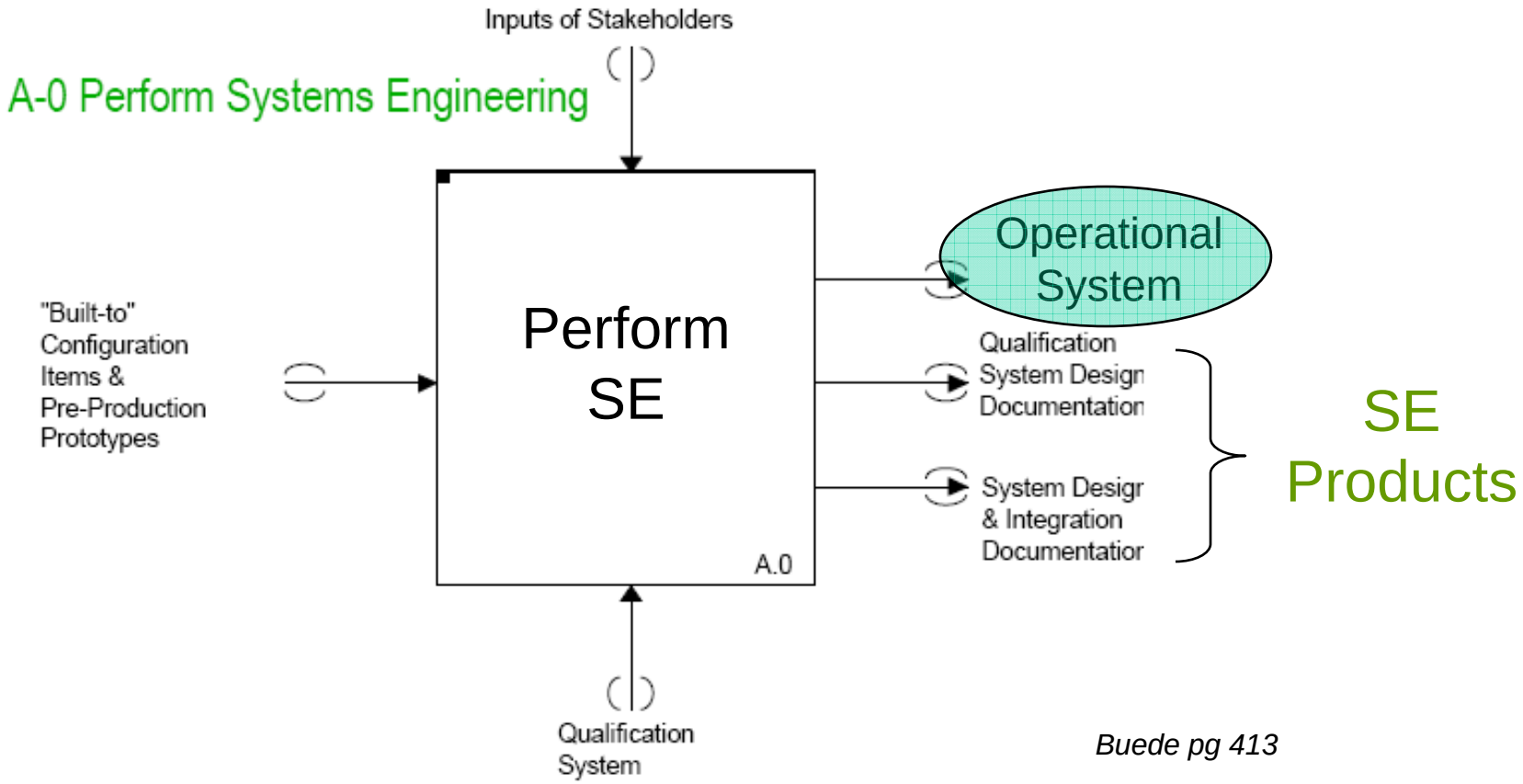
The Problem (Stakeholder Analysis)

What – and how much – SE is appropriate for a particular system development program?

- **Customers**
  - **Unsure of how to evaluate bids**
  - **May not receive best value for the systems they acquire**
  - **DoD #1 SE Issue – "Inconsistent SE Practices across life cycle"**
- **Industry (System Developers & Integrators)**
  - **Unsure of what to bid, and later loath to add SE costs**
- **Associations & Academia**
  - **Unable to fully satisfy their members and students**
- **SE professionals**
  - **Lack rigorous justification for their recommendations**

Value of SE

The Problem (IDEF 0 View)

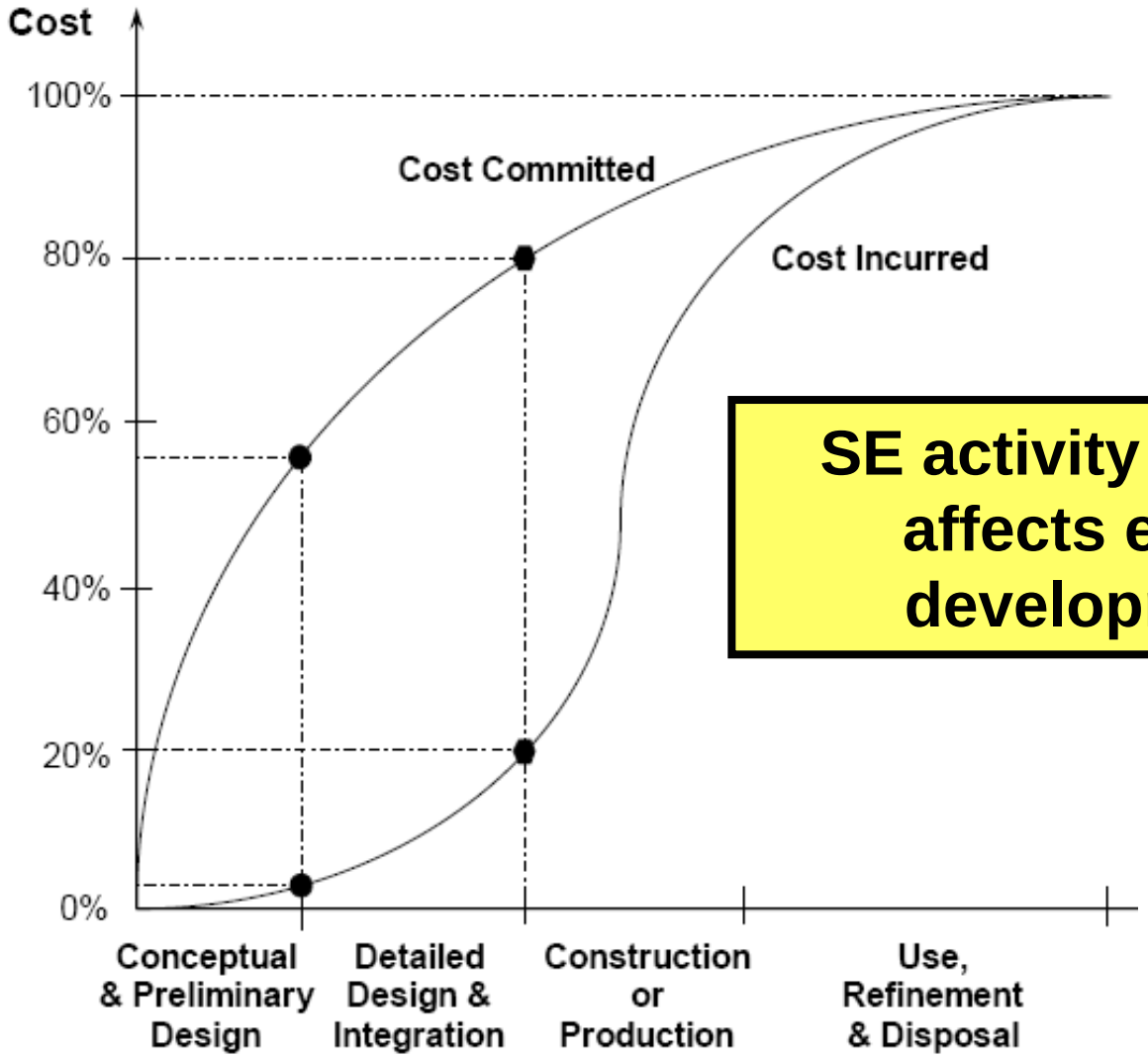


Buede pg 413

SE produces more than products -- It affects the value of operational system produced

Value of SE

The Problem (Pareto View)



SE activity upfront affects entire development

Buede, Figure 1.2

Value of SE

What we know today – Studies & Models

Gruhl, National Avionics and Space Administration (NASA), 1992

Compared upfront expenditures to eventual cost growth

Herbsleb, Software Engineering Institute (SEI), 1994

Studied ROI on process improvement in software

Honour, International Council on Systems Engineering (INCOSE), 2002

Surveyed industry to compare SE Effort to cost & schedule

Valerdi & Boehm, Constructive System Engineering Cost Model (COSYSMO), 2004

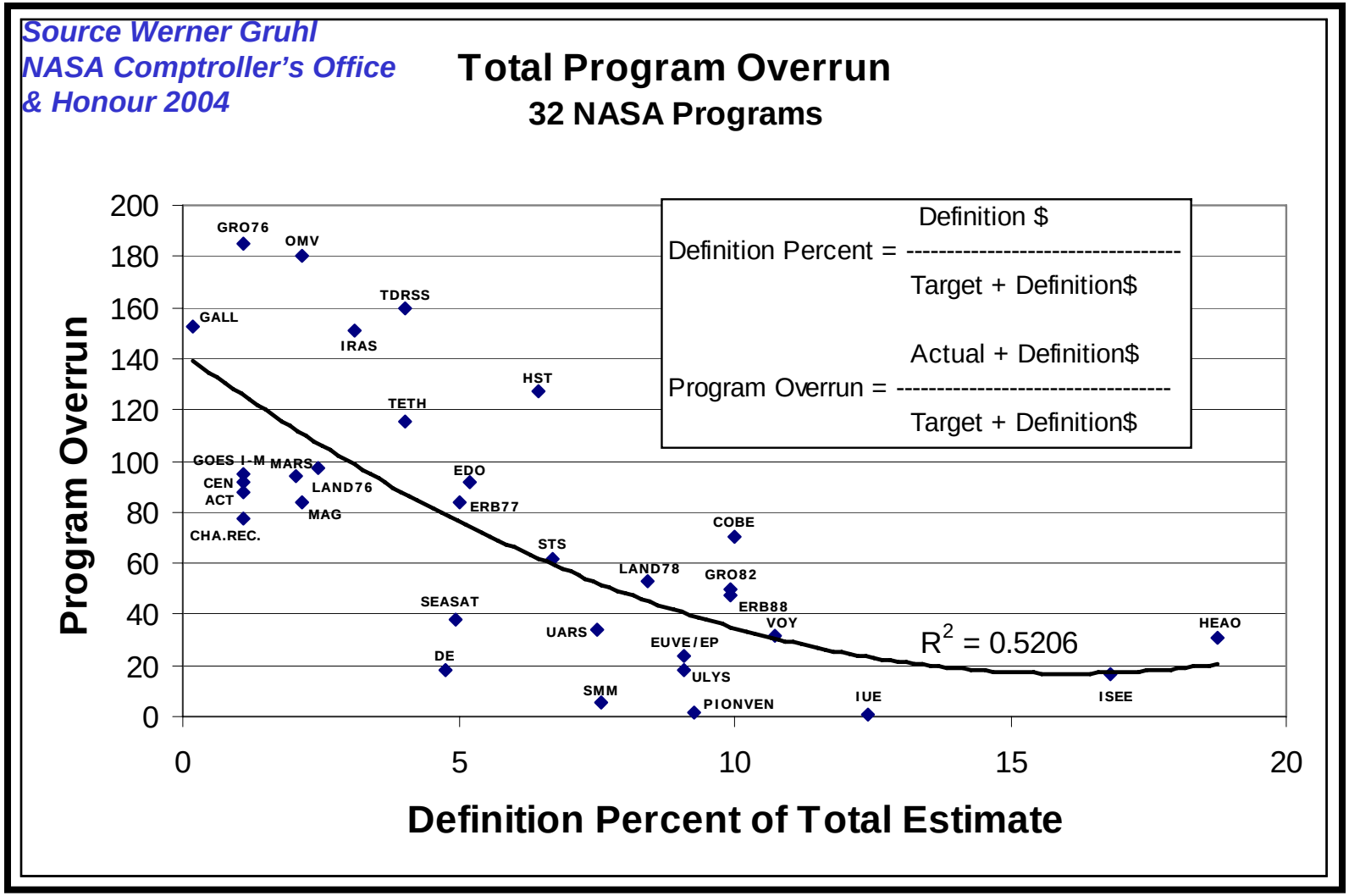
Developed parametric estimation model similar to COCOMO

Others…

Value of SE

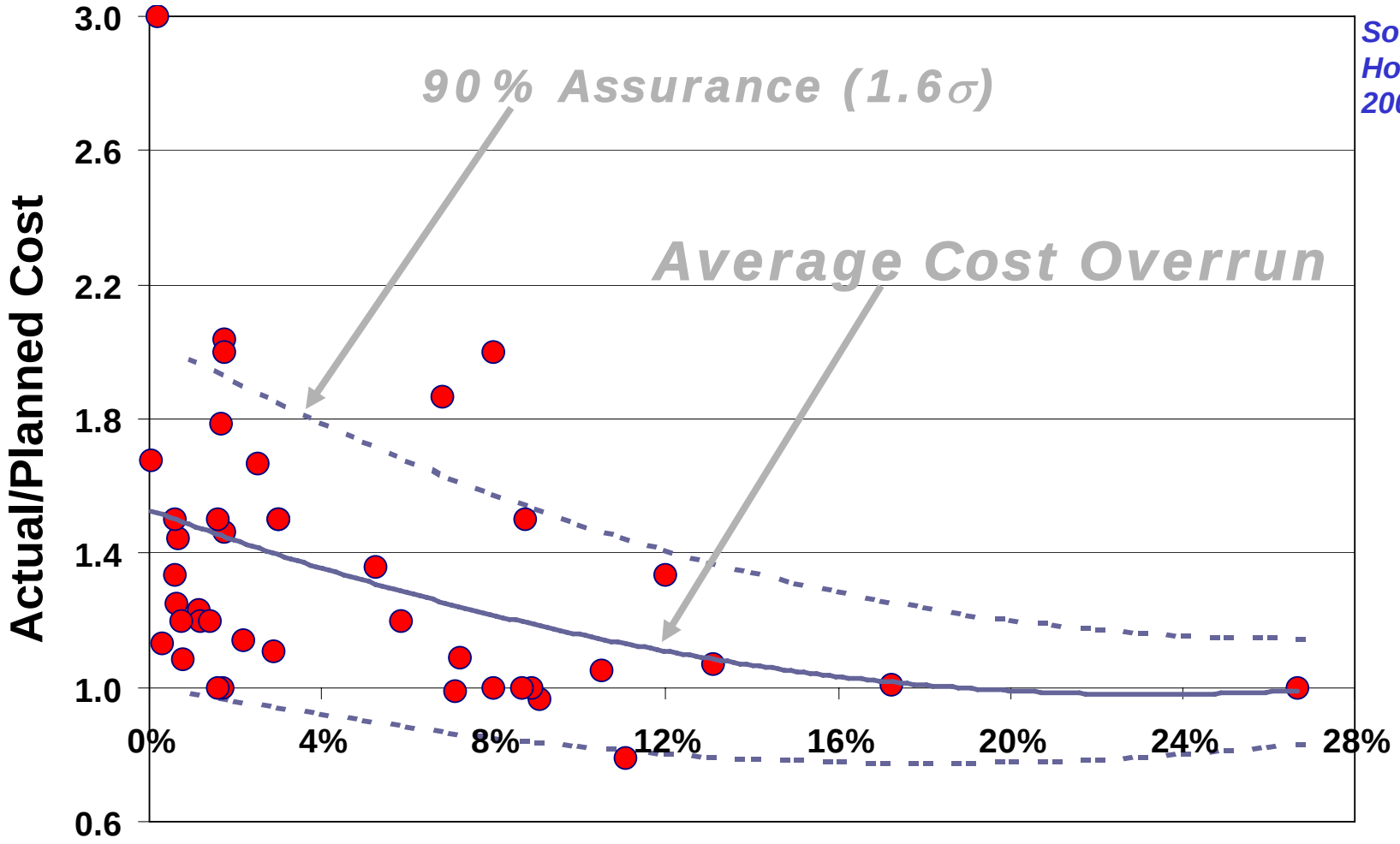
What we know today – NASA Study

Source Werner Gruhl
NASA Comptroller's Office
& Honour 2004



Value of SE

What we know today – INCOSE Study



Source: Honour 2004

SE Effort = SE Quality * SE Cost/Actual Cost

Value of SE

What we know today – ROI of SE

SE ROI by Software Size of System

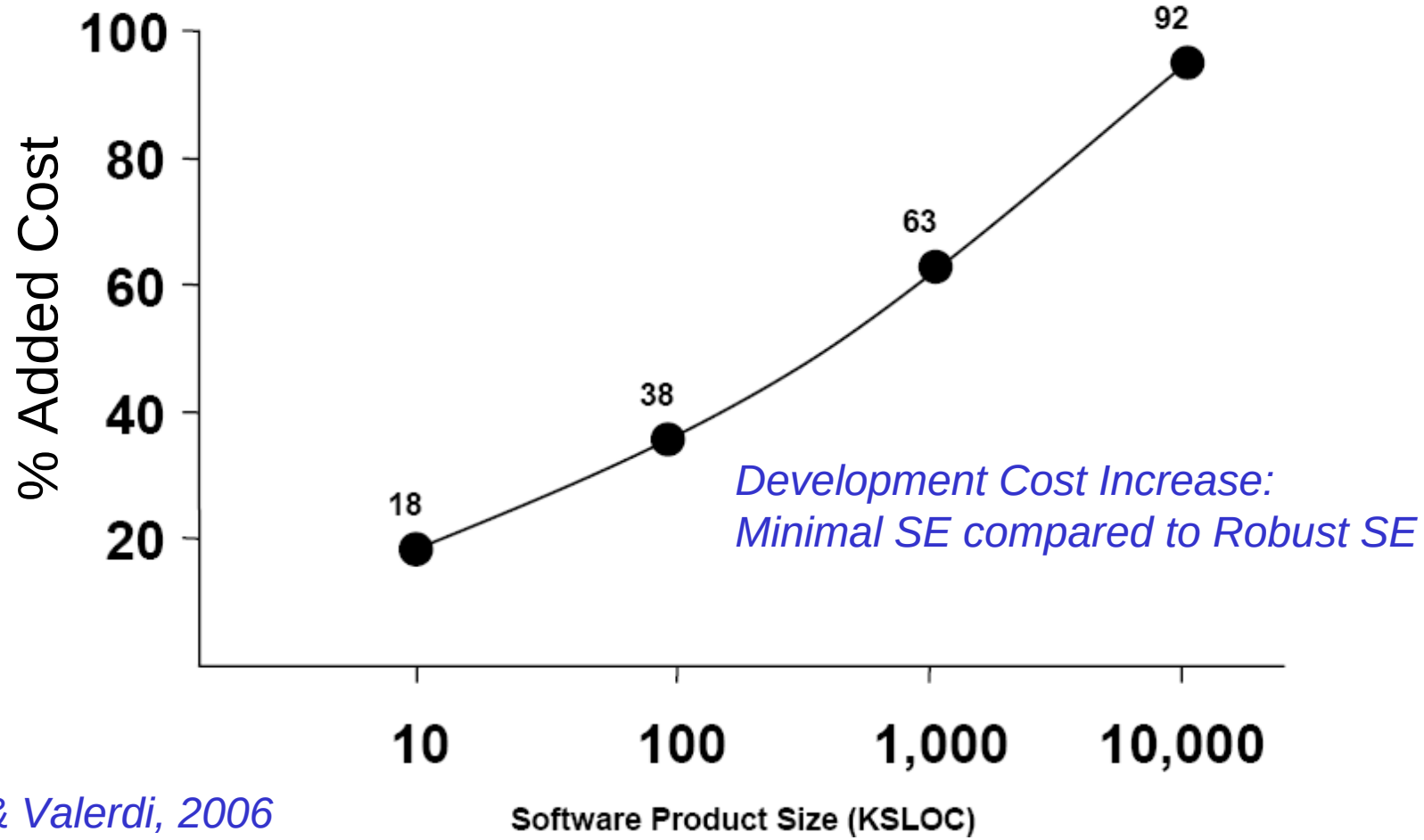
KSLOC	Very Low	Low	Nominal	High	Very High	Extra High
10	-	52%	-20%	-45%	-58%	-77%
100	-	248%	80%	18%	-10%	-54%
1,000	-	512%	204%	91%	42%	-30%
10,000	-	840%	356%	177%	99%	-4%

Boehm & Valerdi, 2006

Value of SE

What we know today – ROI of SE

SE Activities Affect Software Development

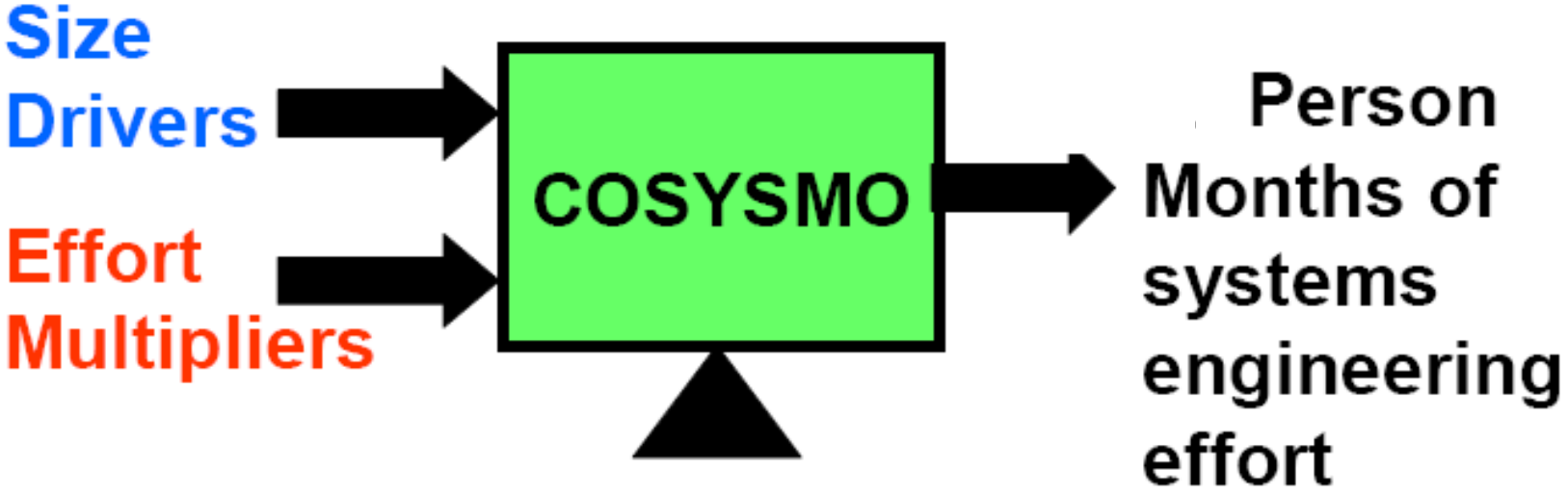


Boehm & Valerdi, 2006

Value of SE

What we know today – COSYSMO

Limited ability to estimate "effort"



Pred(30) 50% uncalibrated

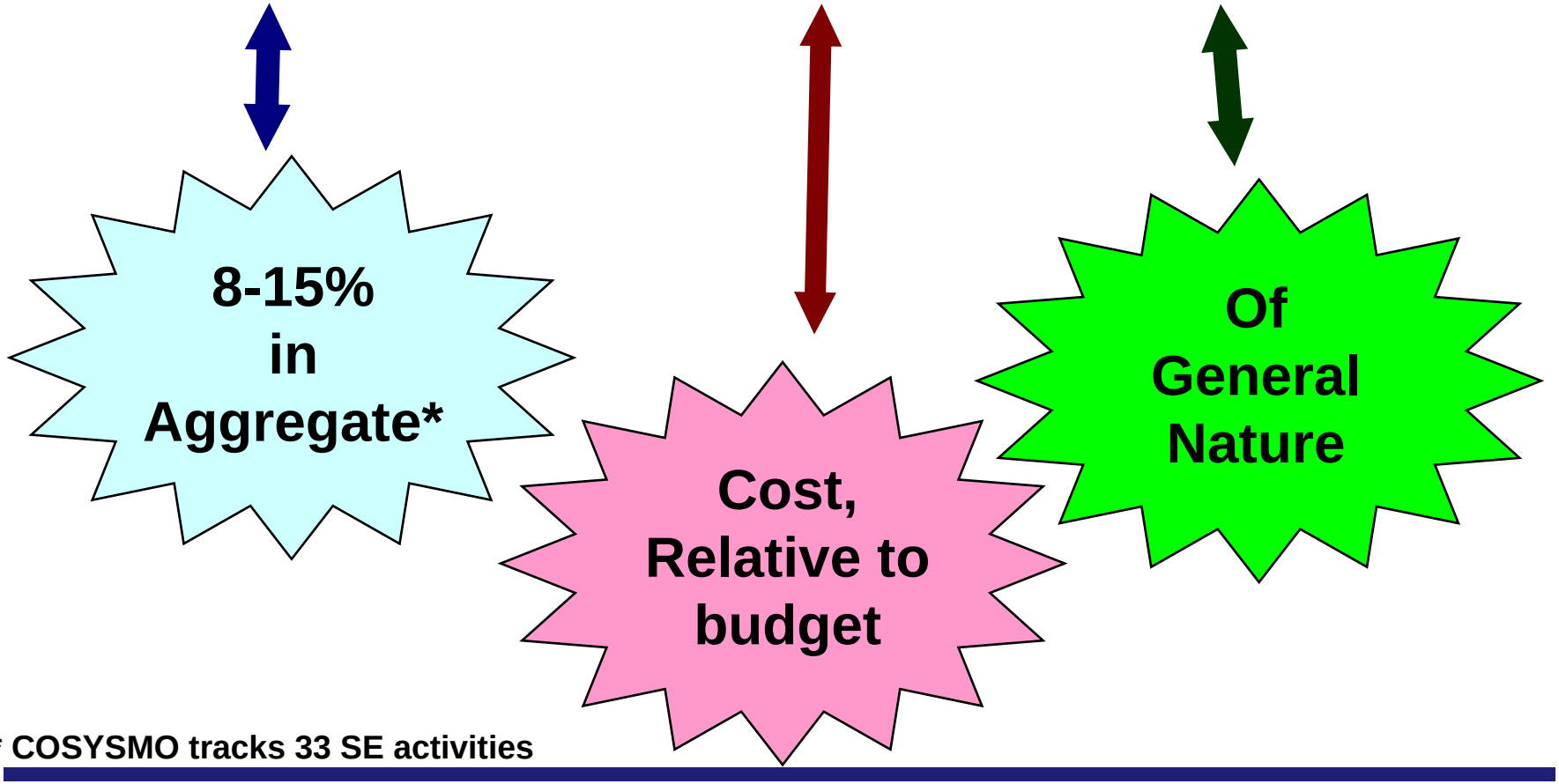
Pred(30) 70% calibrated

Valerdi, 2005

Value of SE

What we know today – Summary

Today we posses a *limited* understanding of the SE effort required for success of a project

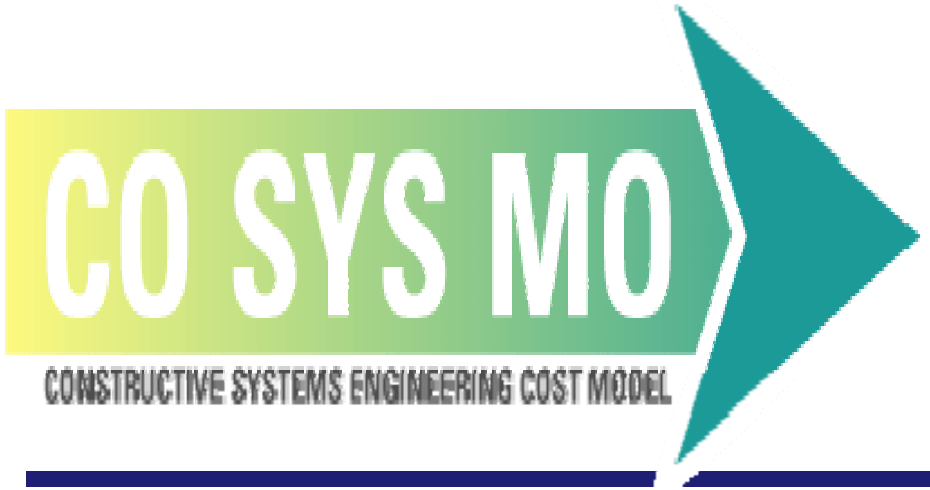


* COSYSMO tracks 33 SE activities

Value of SE

The Race to Discover More

Four Separate Efforts Underway

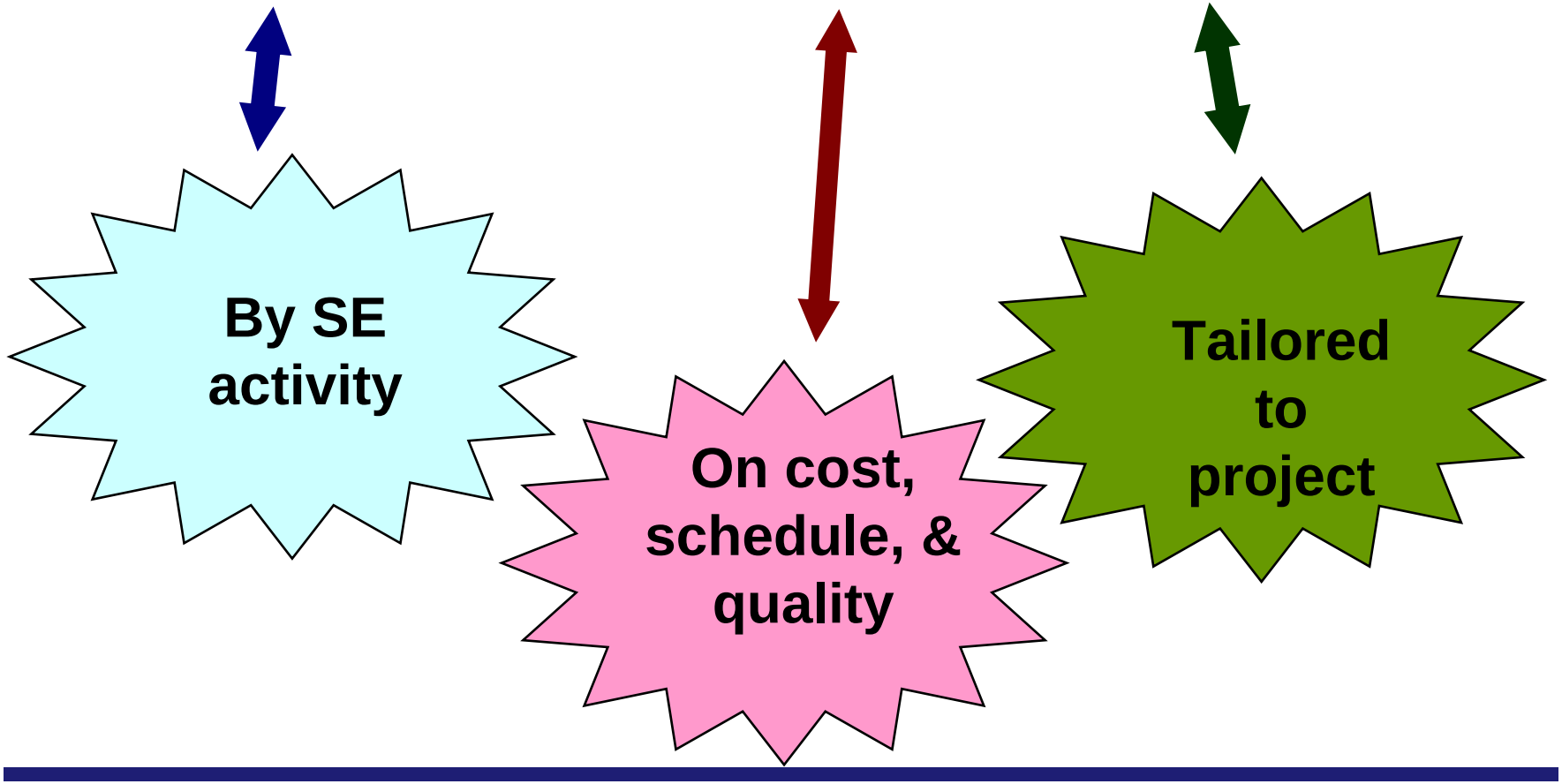


Honourcode, Inc.

Value of SE

The Race to Discover More

All four should increase our understanding of the SE effort required for success of a project



Value of SE

The Race to Discover More - Methodology

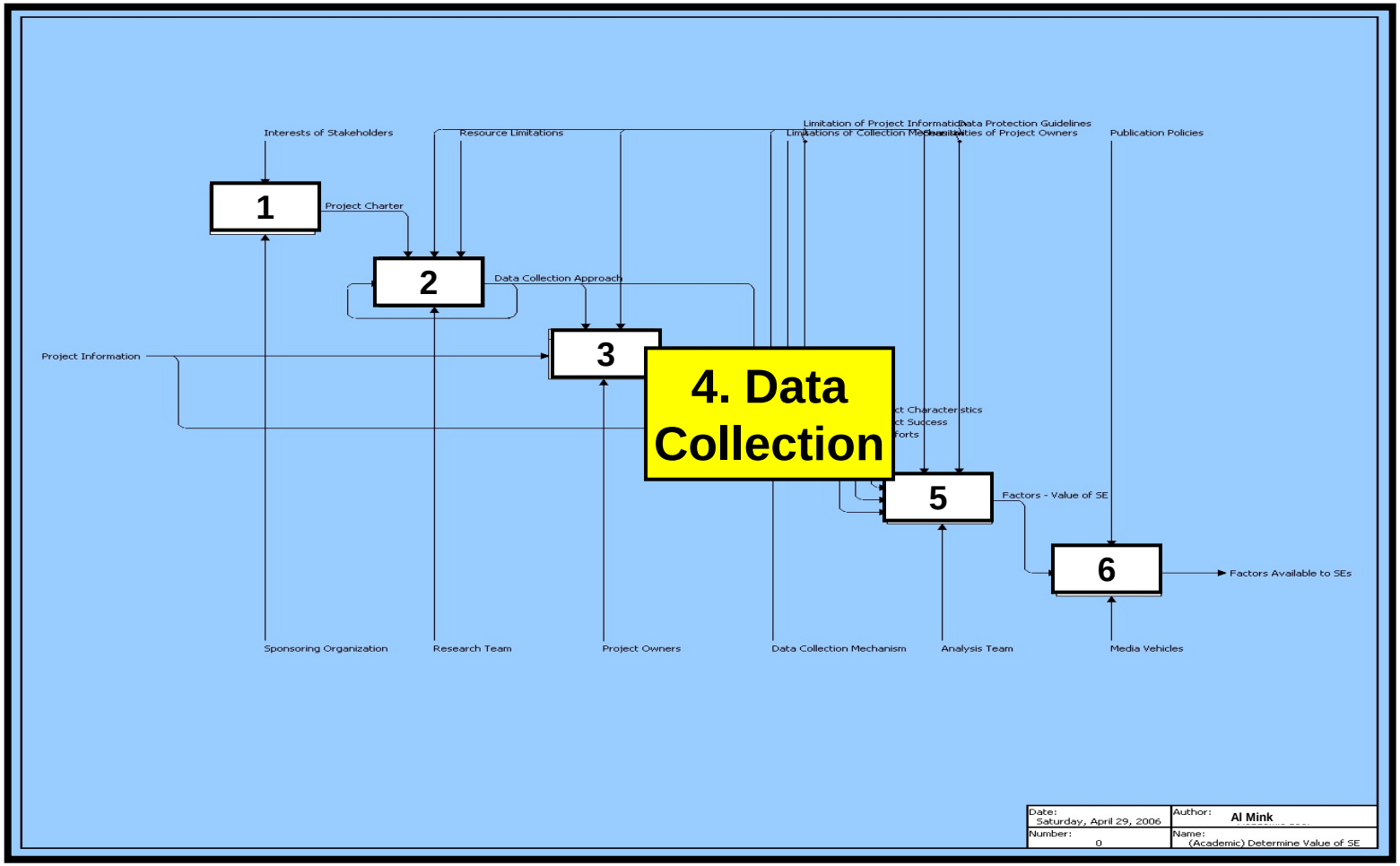
All Four Appear to Follow a General Approach

1. **Form Team**
2. **Develop Approach**
3. **Identify Projects**
4. **Collect Data**
5. **Analyze Data**
6. **Publish Results**

Value of SE

The Race to Discover More - Methodology

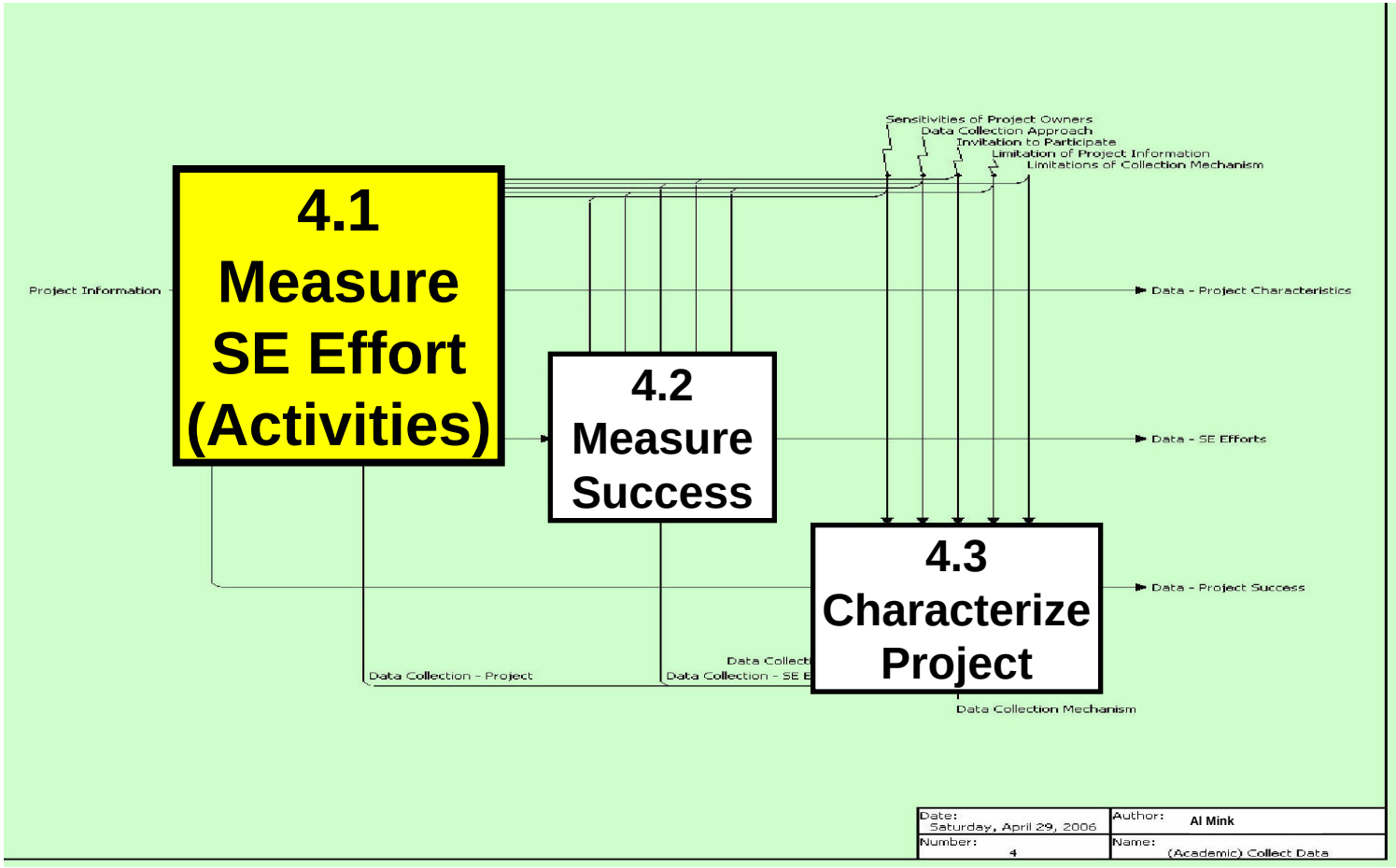
How the pieces fit together



Value of SE

The Race to Discover More

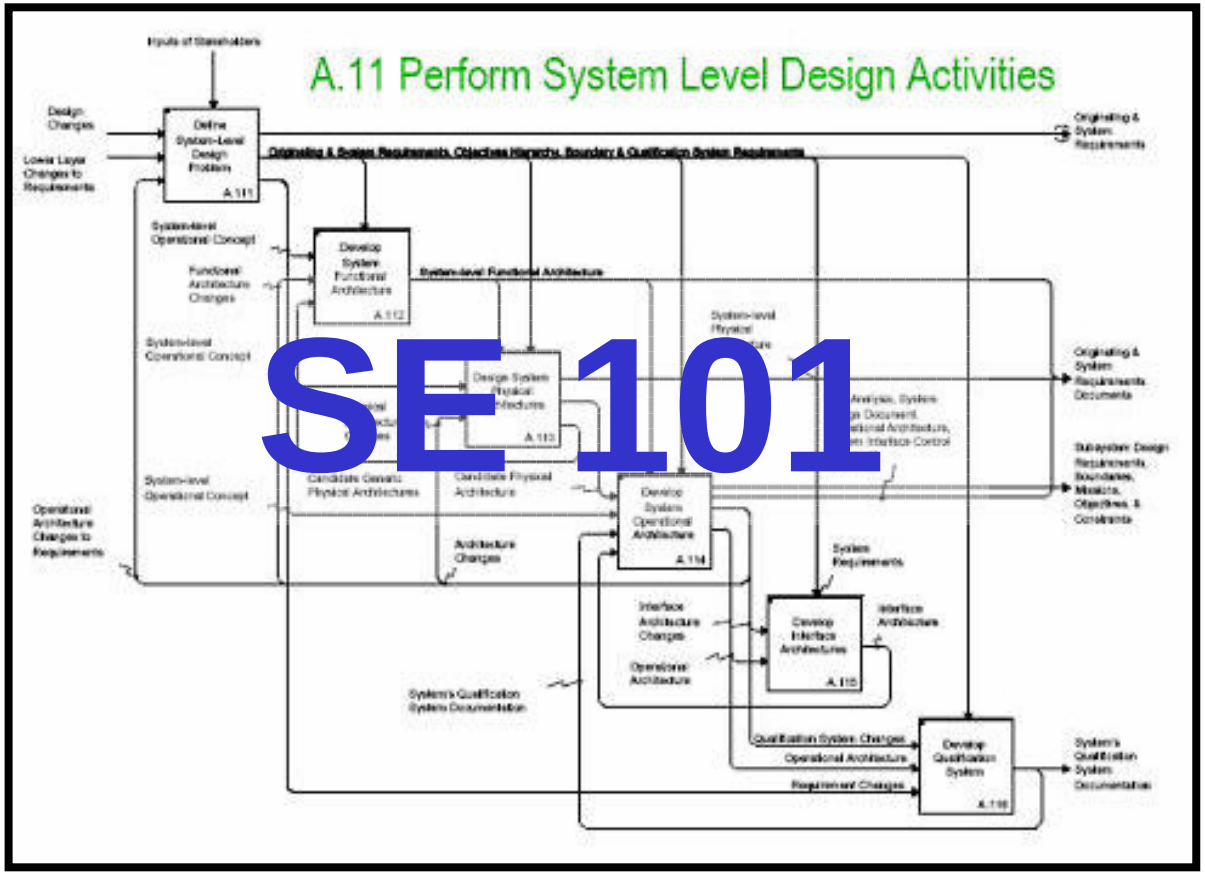
Capturing Data – Three Categories



Value of SE

The Race to Discover More – Define SE Activities

Defining "SE Activities" – One View



Buede pg 416

Value of SE

The Race to Discover More – Define SE Activities

Defining "SE Activities" – Many Views

Fragmented by domain opinions
- Military – DOD/MOD
- Space - NASA/ESA
- Commercial products
- Aircraft
- Automobiles
- Nuclear waste
- Process engineering
- Tool vendors
- Etc. Etc. Etc.

Fragmented by discipline opinions
- Technical leaders
- System architects
- System analysts
- Requirements engineers
- Operations analysts
- Design engineers

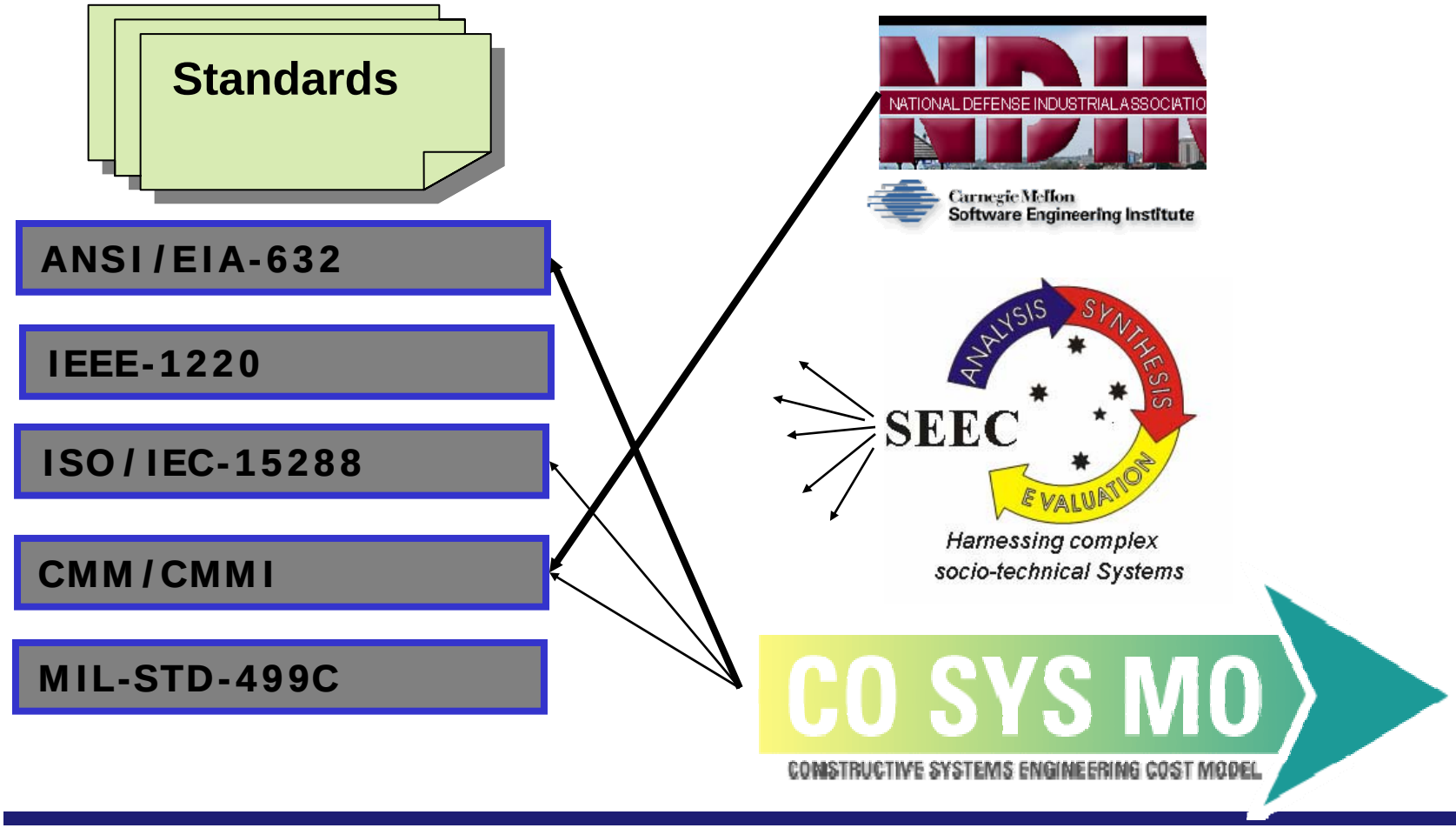
Fragmented by standards
- ANSI/EIA-632
- IEEE-1220
- ISO-15288
- CMMI
- MIL-STD-499C

Honour 2005

Value of SE

The Race to Discover More – Define SE Activities

How the Different Efforts Define "SE Effort"



Value of SE

Emerging Approaches to Move Forward – Define Other Measures

In addition to defining & measuring SE Effort…

Cost, schedule, & quality

Success factors

- *EVMS*
- *Award Fee*
- *Requirements Trace*
- *Others…*

Tailored to project

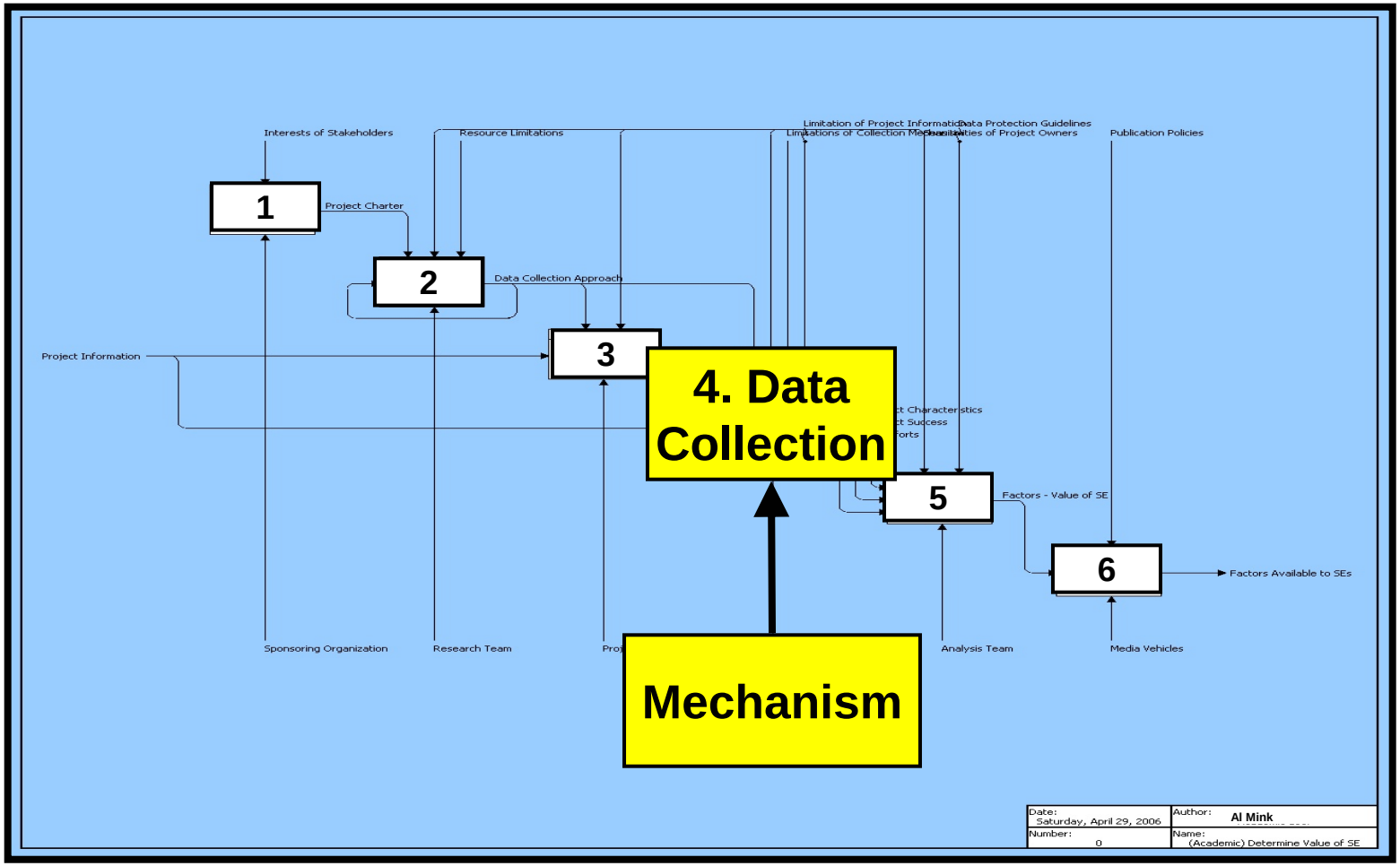
Project characteristics

- *Size ($)*
- *Size (hours)*
- *Technology*
- *Complexity*
- *Others…*

Value of SE

The Race to Discover More - Methodology

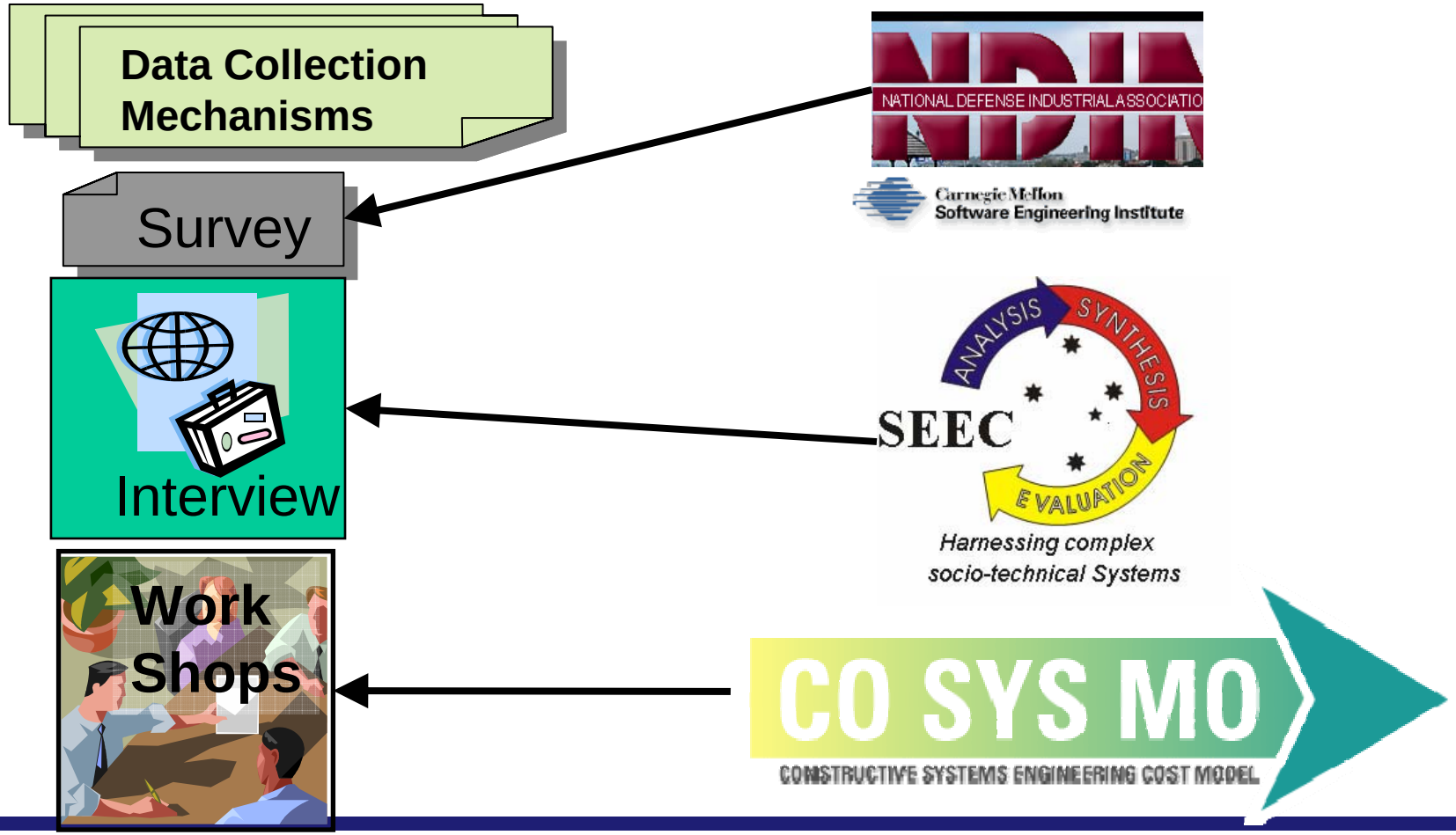
One Other Difference – Collection Mechanism



Value of SE

The Race to Discover More – Define SE Activities

How the Different Efforts Collect Data



Value of SE
Conclusions

- ***Value of SE***
  - **Remains fundamental to furthering SE as a respected discipline**
- **Four approaches underway to determine SE Value**
  - **With a fifth – Bob Bruff – on the horizon…**
- **They share commonalities, but also differ:**
  - **Differing types of projects**
  - **Differing SE Activities & Deliverables**
  - **Differing success factors (cost, schedule, quality, etc.)**
- **Challenges Remain**
  - **Useful project data – may not be widely available**
  - **Four separate projects – what if they report different results?**
  - **Success may be elusive – "The Shangri-La of ROI" (Sheard 2000)**
- **Make a difference! Support these approaches**

Value of SE
Conclusion

Points of Contact

Al Mink
almink@systemsvalue.com

Joe Elm
jelm@sei.cmu.edu

Sue Rose*
rose@systemsandsoftware.org

Ricardo Valerdi
rvalerdi@mit.edu

Eric Honour
ehonour@hcode.com

Value of SE

Questions?

Al Mink
amink@systemsvalue.com
571 212-4778