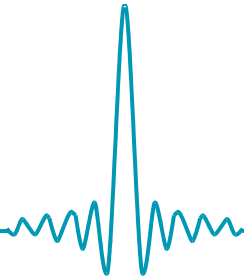


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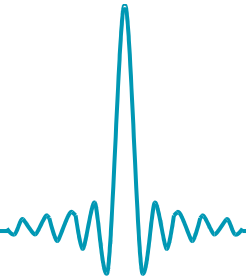


Systems Engineering Value @ a Small Tech-Biz

presented to the INCOSE Enchantment Chapter

***Bob Pierson
Applied Technology Associates (ATA)***

9 November 2005



For a Small Technology Business:

- *Is SE a Wise Investment or a Fool's Errand?*
- *Where's the ROI?*
- *Can SE be Right-Sized?*
- *Can We Have "SE on a Shoestring?"*

"Most methods and tools in systems engineering are used because someone found them useful." – Eric Honour

ATA

SETTING CONTEXT: WHO IS ATA?



- *Small High-Tech Business*
- *“Precision Sensing, Measurement, and Control”*
- *Established in 1975 (30 Year Anniversary!)*
- *R&D Services Customers Include USAF, Sandia NL, US Army, MDA, NASA, etc.*
- *Commercial Sales of Inertial Sensors & Actuators, and IRU’s to Government and Industrial Customers*
- *Approximately 75 Employees*
- *8(a) Certified SDB (Hispanic American)*



Awards and Distinctions

- **Contractor Awards**
 - ✓ **2004 SBA Region VI and National Prime Contractor of the Year**
 - ✓ **2005 NM Innovator of the Year**
 - ✓ **USAF Small Business R&D**
 - ✓ **SBA Administrator’s Award**
- **NM Governor’s VIVA Award**
- **Technology Achievement Awards**
 - ✓ **AF Phillips Laboratory**
 - ✓ **SPIE – Relay Mirror Experiment**

Technology Commercialization

- ✓ **38 SBIR Contracts**
- ✓ **13 Patents Plus Several Pending**
- ✓ **Sensors and Systems Product Line**
- ✓ **ISO-9000 Certified**

ATA

SETTING CONTEXT: WHO IS ATA?



Fundamental Research &
Development (R&D),
Test & Evaluation (T&E)

ATA

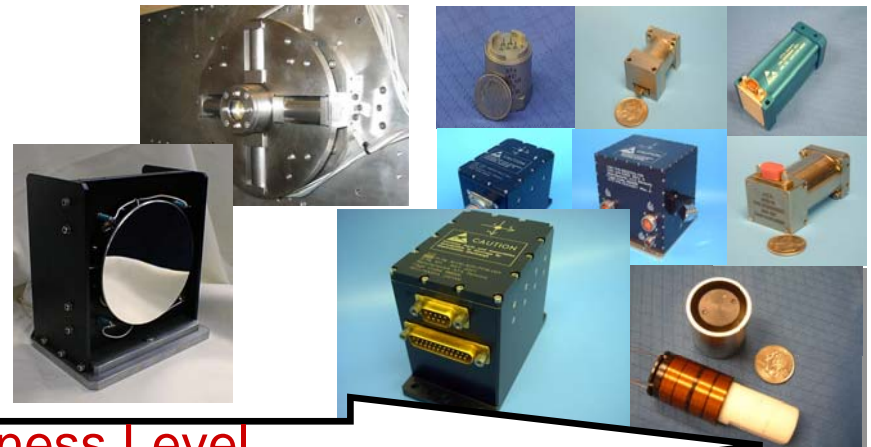
Product Sales
Product Development

R&D Services

Aerospace Test
Services

Optical FSMs
and IRUs

ATA Sensors



Increasing Technology Readiness Level

Systems

Components

ATA

WHAT MOTIVATED SE AT ATA?

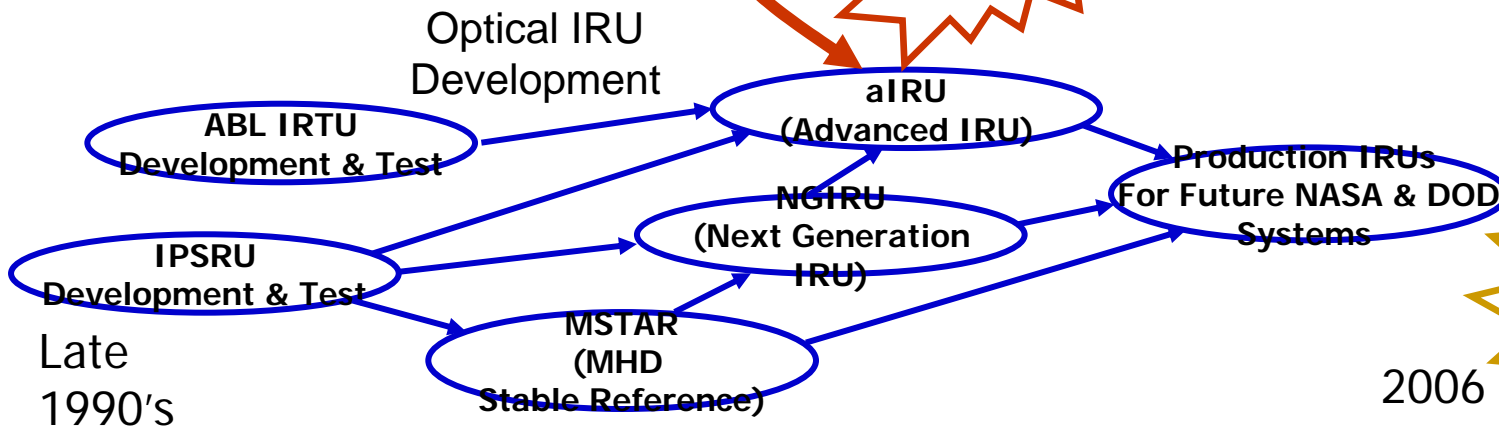


Fundamental Research & Development (R&D),
Test & Evaluation (T&E)

MS&A
AI&T
V&V

(but...few standards)

Product Sales
Product Development
Formal Specification
Formal Acceptance
Vendor Qualification
QA / CM / DM
Space Qual Level Test
ISO 9000
(rigorous standards)



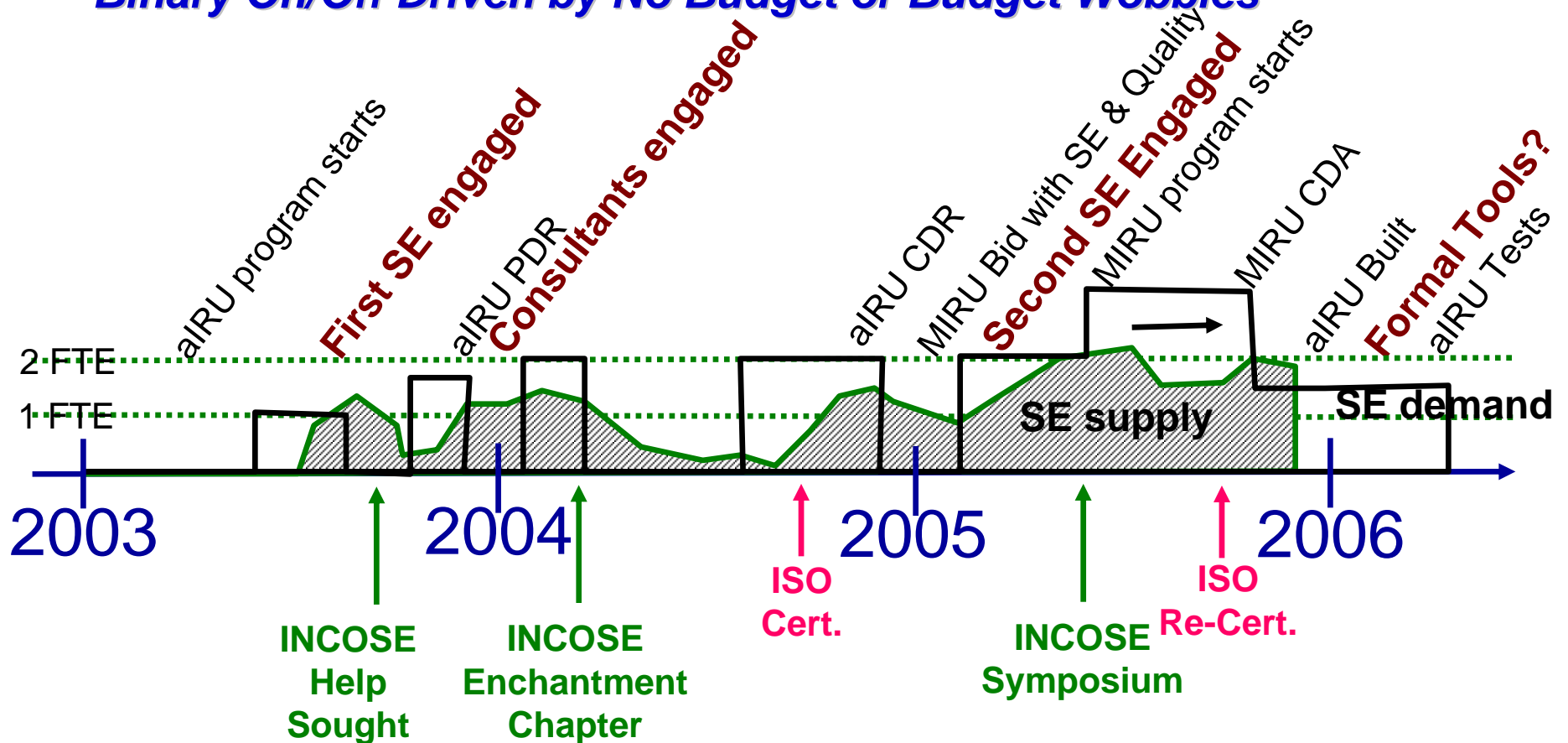
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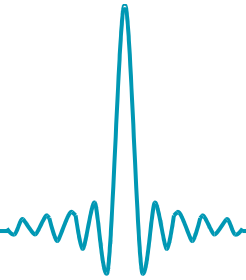
KICK-STARTING SE AT ATA



Kick-Starting SE at ATA:

- SE 'Supply' Always Lags the 'Demand' Curve
- Binary On/Off Driven by No Budget or Budget Wobbles



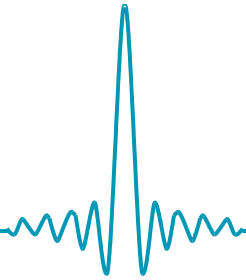


SETTING CONTEXT WHO IS BOB?



Background (How to Build a Systems Engineer):

- ***Formal Education in Geophysics***
 - (Physics, Geology, Math, Mapping, etc) –
 - Multidisciplinary, Multi-dimensional, Often an “Art”
- ***Technical Experience in***
 - Software, Controls, Electro-Optics, Data Proc. & Analysis
 - System Integration, Deployment and On-Site Operations
- ***Management Experience***
 - Project / Program Management
 - Corporate Operations, Marketing, Strategy
 - People Management / Crisis Intervention



GENERALIZING: WHO IS SE?



How to Build a Systems Engineer:

- **Broad Background**
- **Communications Skills**
- **People Skills AND Understands Organizational Dynamics**

Bad News:

- **Friends, this is not a commodity in broad supply...**

Good News:

- **Probably MORE likely in a small biz environment**

Bad News:

- **This talent pool is heavily raided for other purposes**

Multiple Sources Agree on Large ROI For ~10-15% SE Investment

- NASA Studies
- INCOSE Studies
- ‘Word of Mouth’

“Without a rich enterprise environment, project environments can be expected to be sparse and highly variable.”
 – Stephen Cook, U. of South Australia, *What the Lessons Learned from Large, Complex, Technical Projects Tell Us About the Art of Systems Engineering.*

OR

“Right size this!” – Curse of the Small Biz Systems Engineer (Bob P)

The Dilemma:

- **10% of Large Org. \$100M/yr Program:**
 - \$1M
 - Multiple Devoted SE Staff
 - “ilities” Experts At Hand
 - Multiple Programs Provides Stability
- **10% of Small Biz \$1M/yr Program:**
 - \$100K
 - < 1 person to do everything
 - Little to No Cushion or Stability
 - And \$1M/yr is a BIG program for us!
- **And of Course, We Start at Maybe 5%**
 - “just to see if it’s worth it...”

Woo Hoo !!

Uh Oh !!

Exacerbating Factors for Small Biz: (but wait, it gets worse)

- **Gov't / Big Organizations Issue Contracts to Small Biz:**

- They may HAVE TO flow down big program structure
- They may EXPECT quality / SE structure at their suppliers
- But they may also EXPECT cost savings from a small biz
- In the worst case, they may MANDATE both cost and method, requiring oversized quality / SE structures

- **What Small Biz Sees:**

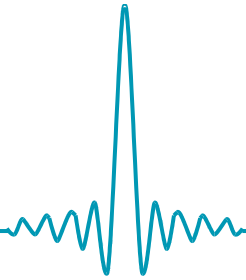
- Unmanageable inconsistency
- Interference in their internal process
- Opportunities to learn (one good byproduct)

“There are many, however, who view the effort required to produce even a minimal number of process products (plans, documents, models, etc) as being excessive, especially in smaller projects.” – Stephen Cook

- **This Problem Continues from Small Biz to Its Suppliers:**

- And the qualified supplier pool is very shallow...

“Fixed-price contracts have a detrimental effect on the ability of the parties to work as a team and hence on the value of the final product.” – Gabric (1993).



VALUE: SE AS AN EFFORT MULTIPLIER



COSYSMO Size Drivers & Effort Multipliers:

- **Size Drivers:**

- # Requirements
- # Interfaces
- # Scenarios
- # Algorithms

- **Effort Multipliers:**

- Application Factors
- Team Factors

Effort Multipliers: (critical list per experience)

- **Application Factors:**

- Requirements Understanding
- Architecture Understanding
- Technology Maturity
- Documentation Match to Life Cycle Needs

- **Team Factors:**

- Stakeholder Team Cohesion
- Personnel/Team Capability
- Personnel Experience / Continuity
- Process Maturity
- Multi-site Coordination
- Tool Support

*“You are a people multiplier.”
– manager at ATA*

The Standish Group Study (1995):

- 365 organizations, 8,380 applications
- Large US civil software based system developments

Outcome	Description	Percent of Projects
Type 1: project success	Project completed on time, on budget, with all features and functions as initially specified.	16.2%
Type 2: project challenged	Project completed but over budget, over time, with fewer features and functions than initially specified.	52.7%
Type 3: project impaired	The project was cancelled at some point during the development cycle.	31.1%

If 'success' is 'value:

- **Then the next slide gives the features that correlate with value**

The Standish Group Study (1995):

- This 'success' is 'value', then here's what correlates with value

Index	Success Criteria	Points
1	User Involvement	19
2	Executive Management Support	16
3	Clear Statement of Requirements	15
4	Proper Planning	11
5	Realistic Expectations	10
6	Smaller Project Milestones	9
7	Competent Staff	8
8	Ownership	6
9	Clear Vision & Objectives	3
10	Hard-working, Focused Staff	3
Total		100

Normal
Small Biz
Advantages SE Advantages

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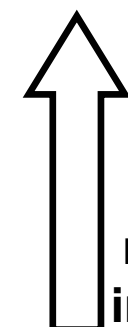
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net increase
in 'value' due
to SE

*This is my own entirely
not-unbiased evaluation*

There May Be Another Subtle but Real Value Related to SE:

- **SE [per Stephen Cook]**
 - Encourages holistic thinking
 - Recognizes a system as a hierarchy of subsystems
 - Recognizes the emergence of behaviors at particular levels
 - Recognizes interfaces between and across layers in the hierarchy
- **I believe**
 - It transitions naturally to Enterprise Engineering
 - And it helps breed Decision Champions (Per Rick Dove's book: Value Propositioning)

“A Champion’s focus needs to be on the Decision Maker and how decisions are reached, rather than the on the righteousness of the thing being championed.” – Rick Dove

“...value propositions that influence a specific Decision Maker must be custom fit to that Decision Maker’s situation, done so in real time, and redone continuously as the Decision Maker’s perceptions evolve.” – Rick Dove

For a Small Technology Business:

- ***Is SE a Wise Investment or a Fool's Errand?***
Probably both. It may take someone willing to be foolish.
NOT wise at all if it is inconsistent (not corporate wide and deep)
- ***Where's the ROI?***
Quality, which is measurable and directly relates to profit.
But that has to be recognized in the culture.
- ***Can SE be Right-Sized?***
Jury is still out. The hats/people ratio is very high.
If a \$100M program has a lead SE, does a \$1M program need 1/100?
- ***Can We Have "SE on a Shoestring?"***
Probably not, unless we can sell pre-packaged SE in volume
Or Yes, if we accept low quality, poor style, and some blisters

***"Remember kids: It's not just good, it's good enough!"
- Krusty the Clown product ad campaign***