

Measure Twice, Cut Once

A Possibly Sensible View

Thomas Conrad - June 2009

Abstract

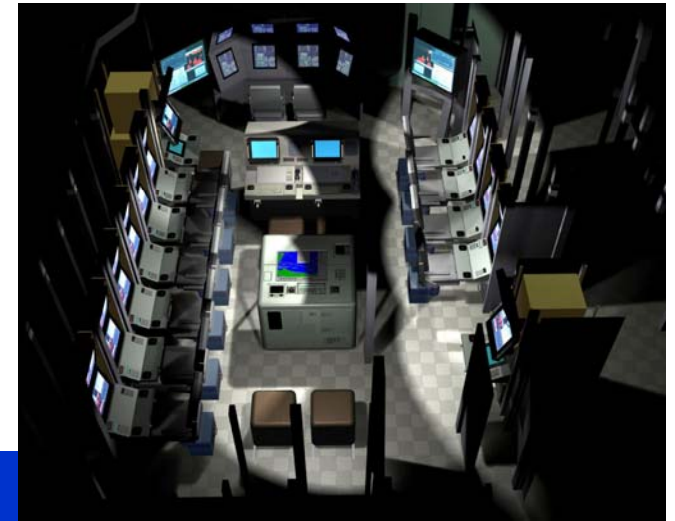
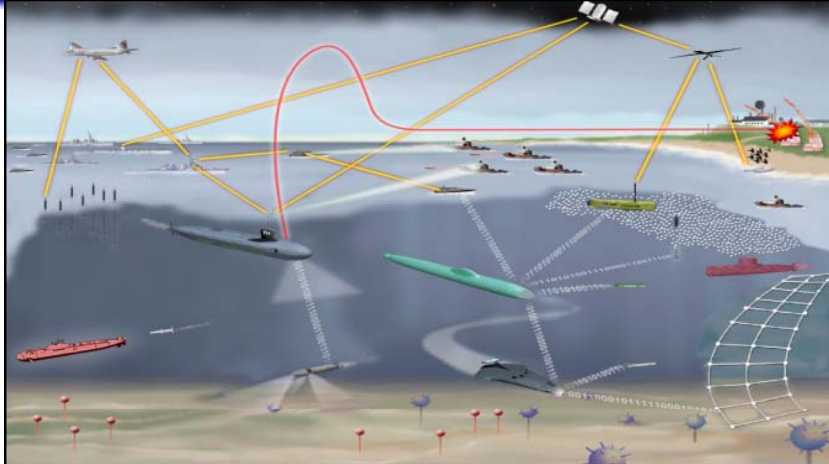
- ◆ Based on a four decade journey in search of seaworthy software, the story is told of the evolving nature of measurement as observed in the world of complex, real-time, mission-critical, interactive systems of vast scope.
- ◆ My Problem Domain
- ◆ The Resistance
- ◆ Data & Information: Understanding, lack thereof
- ◆ Observations and Insights
 - Estimation
 - Completeness & Quality
 - Information Presentation & Trend Analysis
 - Volatility
- ◆ Picture This



(PSM)³

**Pretty Serious Matter:
Perfectly Sensible Measurement for
Parsimonious Skeptical Managers**

Nature of The Domain



- **Mission-Critical System of Systems**
- **Long Mission Times (Months)**
- **Reliability Requirement – Four Nines**
- **Real-Time, Event-Driven**
- **Highly Interactive**
- **High Stress Decision-Making Oriented**
- **Vast Information Space**
- **Bandwidth-Constrained Communications**

Measurement



Why Bother?

- ◆ **Costs money**
- ◆ **Takes time away from actual development work**
- ◆ **Results open to interpretation**
- ◆ **May cause rework**
- ◆ **May degrade relationships**

Manager Think

- ◆ **Don't bother me with all the details. Just give me the WIGO report.**
- ◆ **On the other hand, collect all the details so we'll be able to prove anything we want through selective data presentation.**
- ◆ **And we'll be able to prove due diligence.**
- ◆ **Of course, we will have to charge the customer for such activity on his behalf.**
- ◆ **The schedule is a living document. Re-baselining is a natural event.**

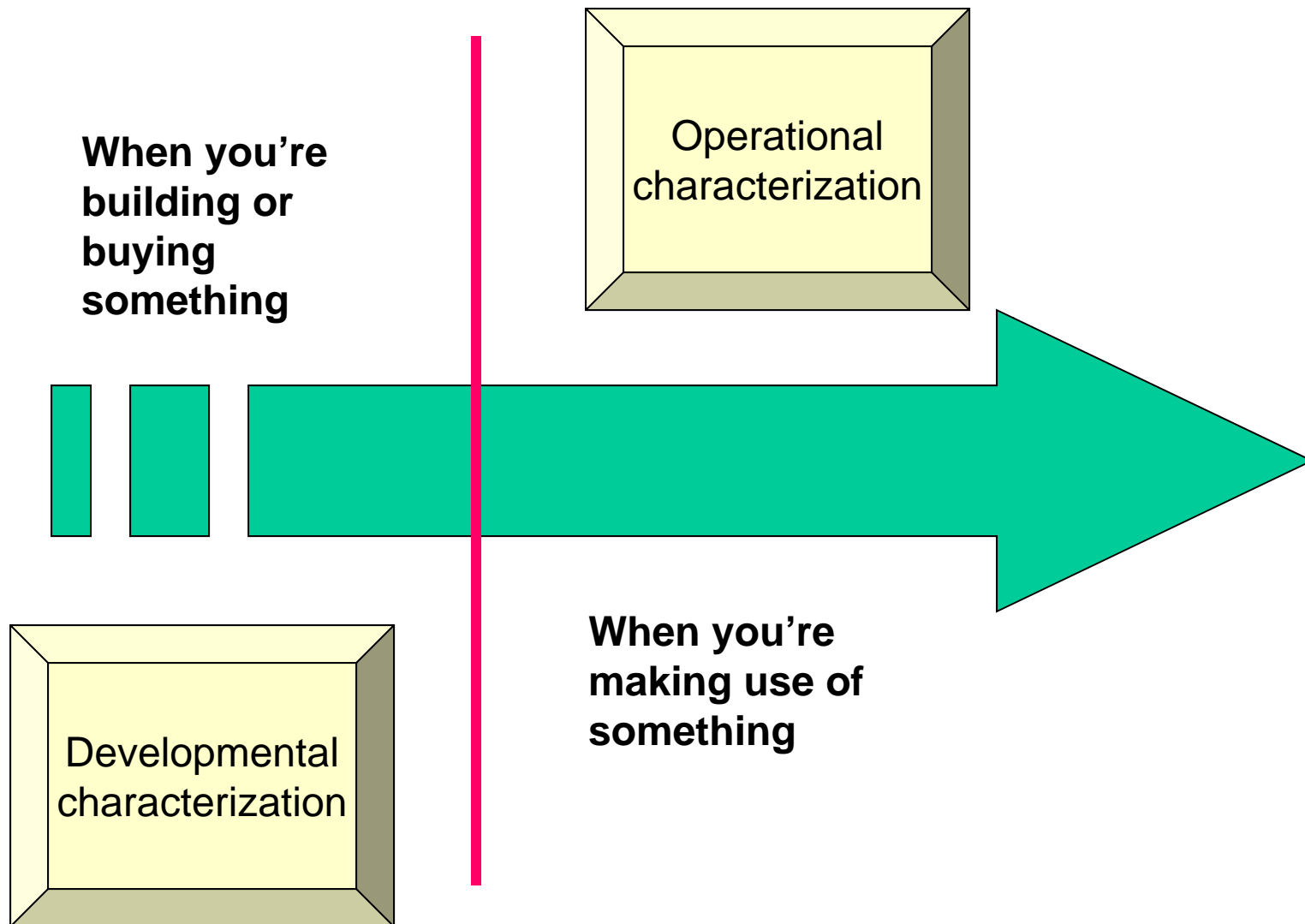
Faith – Alive in America

Observations on the Cultural Characteristics of American Program Managers

1. They enjoy an adrenalin rush
2. Back in the day they understood technical stuff
3. They are convinced *they* can make it happen
4. If they can't, they are convinced it was someone else's fault
5. It is an article of faith that, no matter how poorly something is designed or built, we will always be able to find somebody who can make it work.

The only failure is failure to find that guy

Time to Measure



Analysis is not Optional

[A] Collecting data

is not the same as



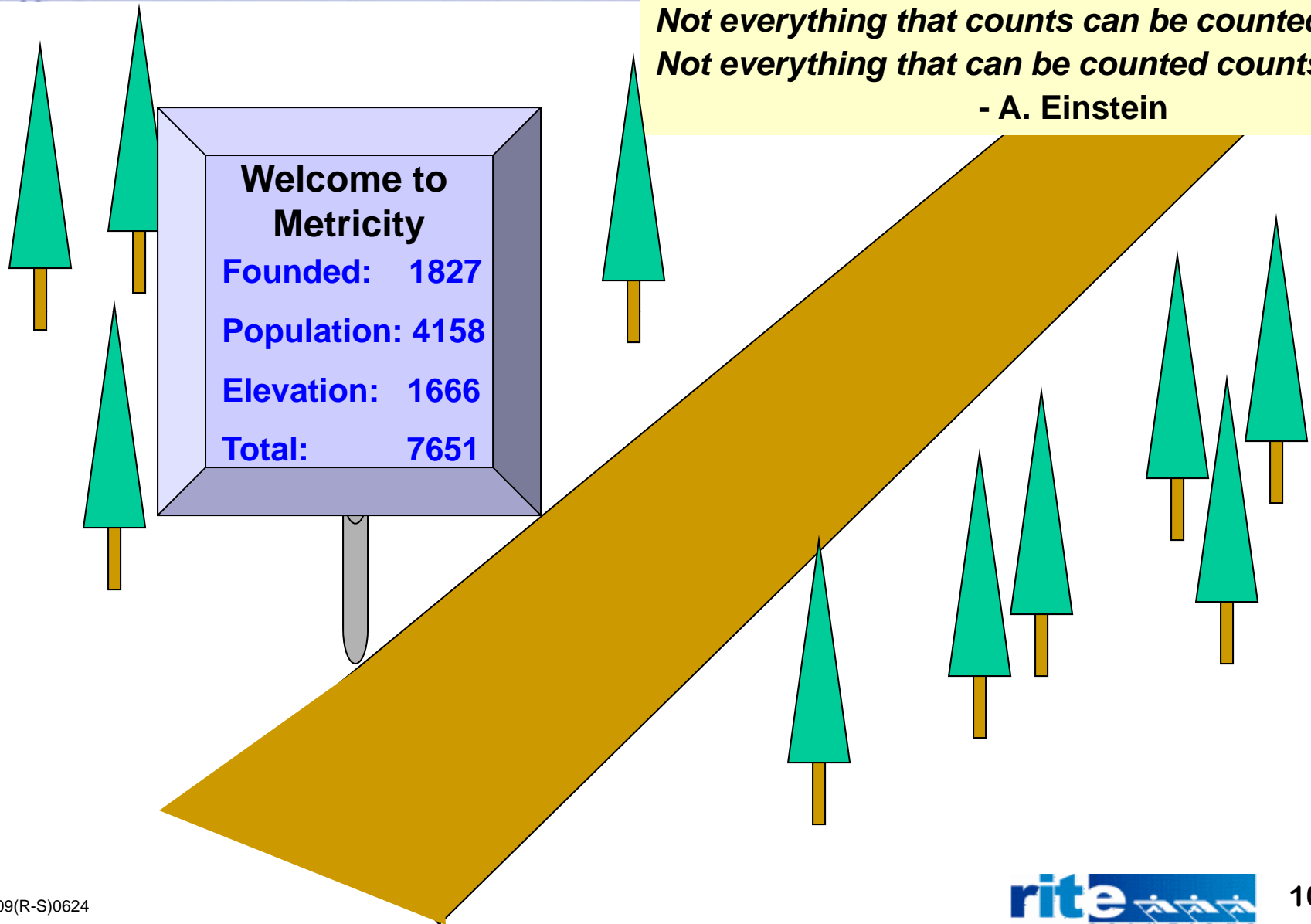
**[B] Having the information
you need to make
decisions**

However, you are not likely to achieve [B] without doing [A].

Understand What It Means

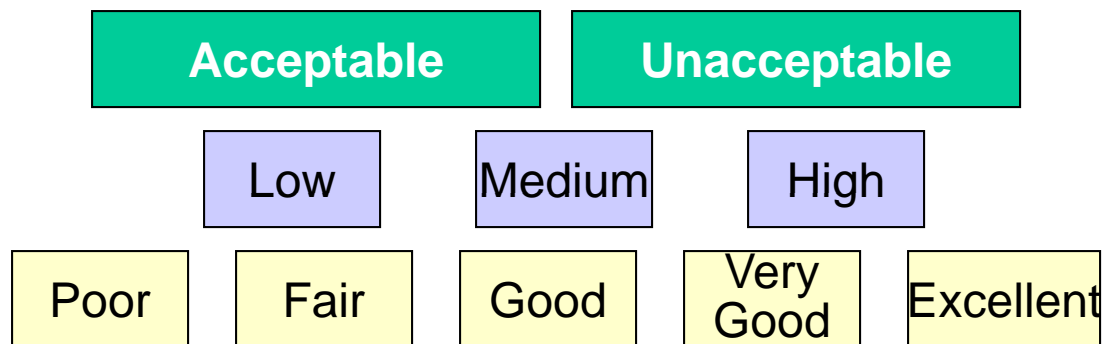
*Not everything that counts can be counted.
Not everything that can be counted counts.*

- A. Einstein



Can We Get Better Than Triage?

- ◆ Perhaps it is too hard to measure or know things precisely.
- ◆ Maybe the best we can expect is to group things into broad classes for comparison.



Even then – Who defines the adjectives?

The Hard Part of Measurement

**The trick is knowing
what is really required**

The 5 Orders of Ignorance:

Lack of Ignorance

Lack of Knowledge (No answer)

Lack of Awareness (No question)

Lack of Process (No way to know)

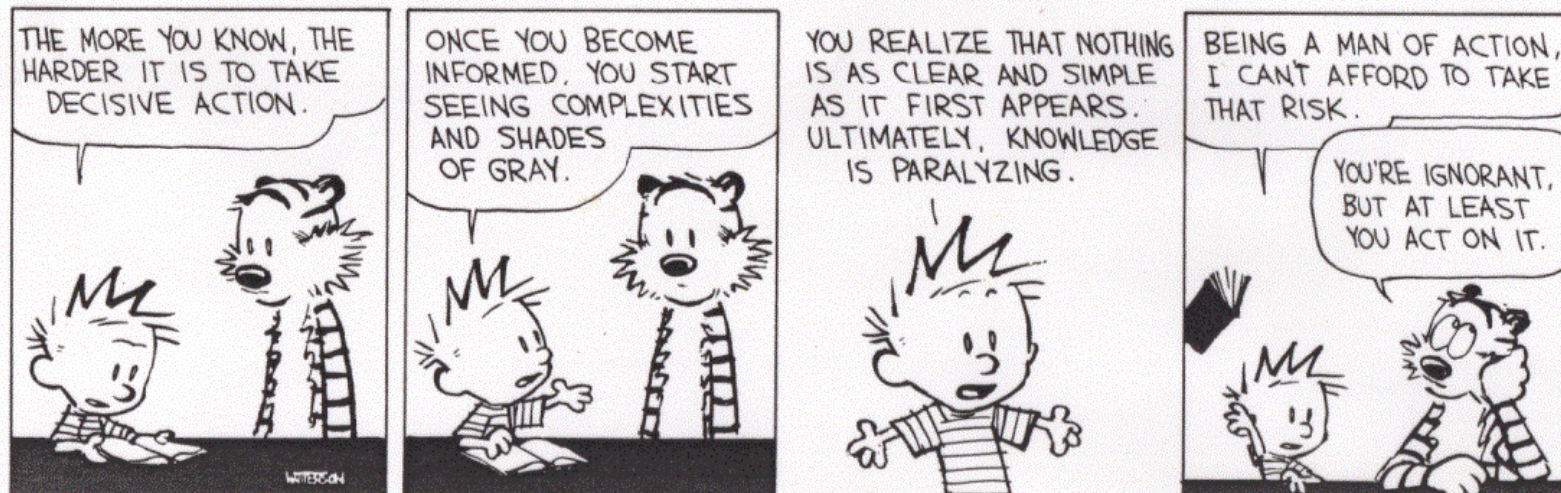
Meta-Ignorance

- Phillip Armour, CACM Vol 43 No. 10

**And realizing that 'better' is
The enemy of 'good enough'**

Effective measurement hurries a program to good enough.

Knowing Too Much



The Coming of the A-Metrical Manager

Estimation

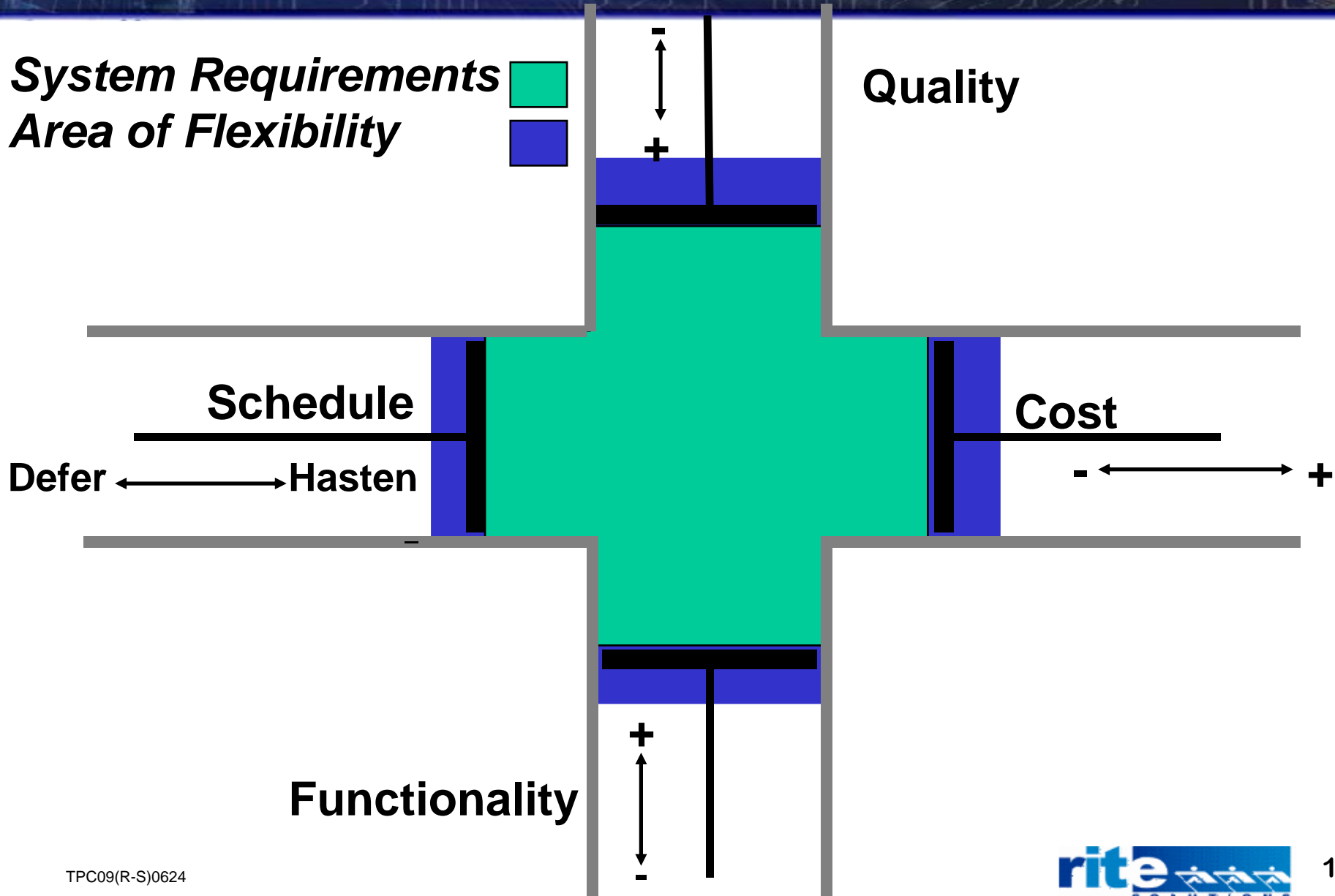
- ◆ Measurement by Crystal Ball
- ◆ It is difficult to make a good estimate for an unprecedented system
- ◆ It is often easier to subsequently make the estimate good
 - But rare for schedule, cost, and quality estimates all to be made good for the same system

Popular Shibboleth:

“Faster, Better, Cheaper”

Hydraulic Model of System Development

System Requirements
Area of Flexibility



How Bad It Can Get

Case Study: Littoral Combat Ship

Original Navy Cost Estimate:		\$220M
Congressionally Mandated Cost Cap:		\$460M
Cost to Date	LCS-1	\$537M
	LCS-2	\$575M
Projected Cost (incl Outfitting & Post-Delivery Costs, etc)		
	LCS-1	\$637M
	LCS-2	\$704M

Why?

“Changing requirements, poor cost estimates, inexperienced program managers and poor supervision of the contractors’ performance are among the causes of the cost overrun”

-- Senator Carl Levin

The author of the CRS report, naval analyst Ronald O'Rourke, cites six reasons for the cost growth in the LCS program:

Poor cost estimation up front – Some observers argue this figure was never realistic.

Changes to Naval Vessel Rules applied to LCS, which included stricter guidelines for survivability caused rework.

Incorrectly manufactured reduction gear required the construction sequence to be reordered for other sections of the ship on LCS-1.

Rising costs of materials.

Combination of a Navy emphasis on meeting the ship's **aggressive construction schedule** and the Navy's use of a **cost-plus contract** to build the ship.

Shipyard performance and supervision of the LCS shipyards by the LCS team leaders and the Navy.

The Problem of Granularity

- ◆ If you look at every detail every day, there will be a lot more bad days than good.
- ◆ Large, complex systems are deployed with thousands of known errors.
 - Those are just the ones we know about!
- ◆ Remember the definitions:
 - *Hardware is something that, if you use it long enough, it stops working.*
 - *Software is something that, if you use it long enough, it starts working.*
 - That's why legacy systems stick around for so long!

The Definitive Commercial Software Warranty

Mathematica License Agreement, Wolfram Research, Inc.

(seller) “makes no representation with respect to ... fitness for a particular purpose.”

(seller) “does not warrant that the software is free from bugs & omissions ...”

“... All complex software & ... documentation contains errors & omissions.”

(seller) “shall not be responsible under any circumstances for providing information on, or corrections ... whether they are aware or not ...”

(seller) “does not recommend ... use (that) could threaten life, injury or significant loss.”

The Problem Of Scale

**Manpower,
Error-Rates,
And Complexity
Relationships
Place Limits On
The Size Of
Software
Systems Which
Can Be Feasibly
Built**

Software System Size SLOC (Power Of 10)					
Man-Months Required For Main Build Phase (Power Of 10)					
Errors Or Defects (Power Of 10)					
Main Build Time In Months (Power Of 10)					
Potential Code Interactions (Power Of 10)					
0	0	0	0	0	Single Line Of Code
1	0	0	0	2	Functions
2	0	0	0	4	Small Applications
3	0	0	0	6	Limit To What One Individual Can Keep In Head
4	1	1	1	8	Team Development
5	2.5	2	1	10	Large Teams
6	4	3	1.5	12	Multiple Teams, Organizations (Football Stadium)
7	5.5	4	2	14	City Population Needed To Build System
8	7	5	2	16	State Population Needed To Build System
9	8.5	6	2.5	18	Nation Population Needed To Build System

Source: NTU Satellite Network - Software Manufacturing In Japan

Measurement By Command



Maybe it's time for me to schedule a Loin Event

I can't believe it!
Even as king I can't
get anybody to tell
me when this
project will really be
done.

**Can
Measurement
Data Be
Made
Illuminating
to Managers?**

Getting Proper Attention



Measurement means numbers and numbers really excite me.

**Can
Measurement
Data Be
Made to
Excite?**

Like, in your dreams.

Avoiding the Really Bad Day



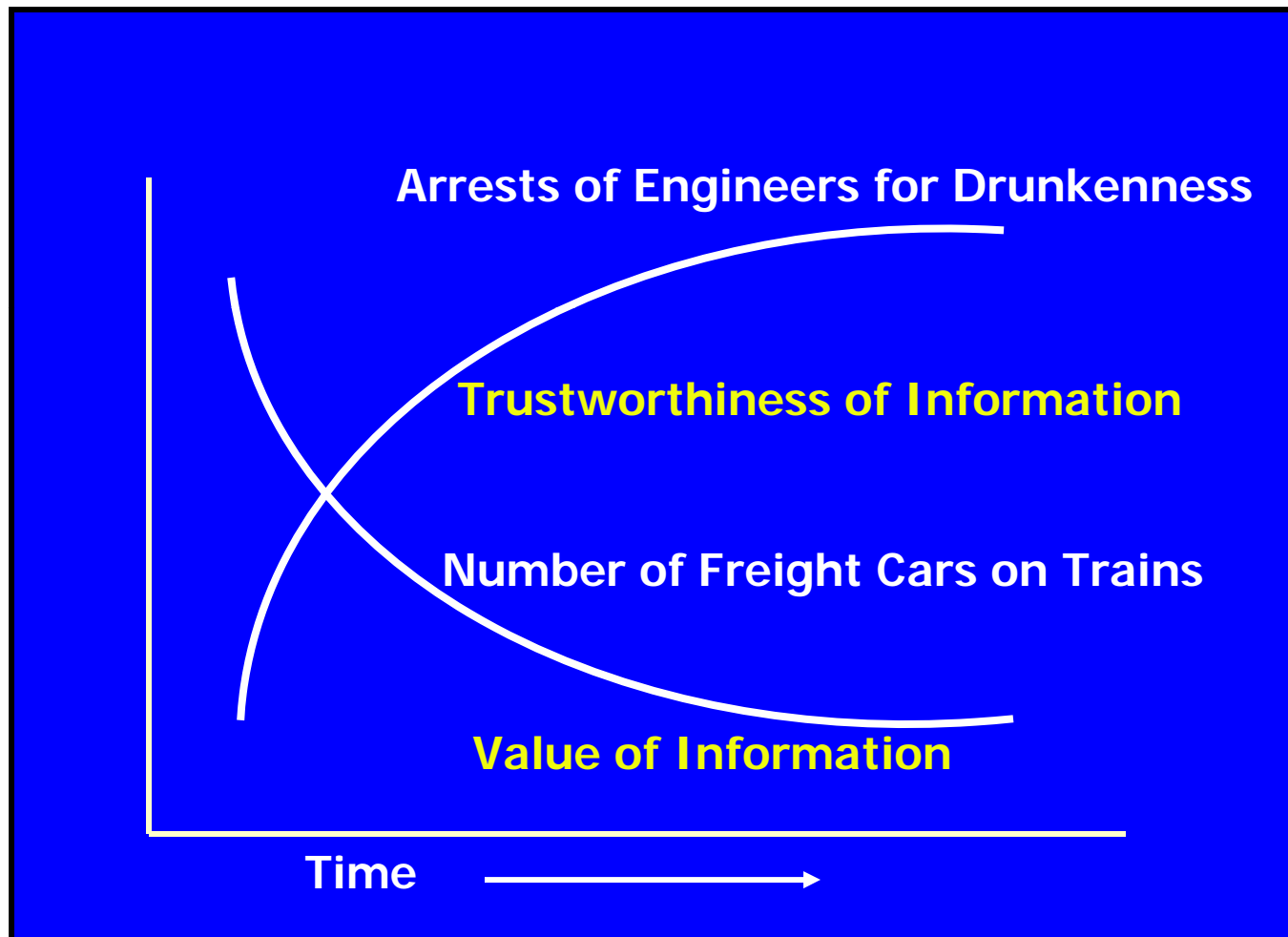
This does not look good.

Measurement is just for people from the “no surprises” school of doing business.

**Can
Measurement
Data Make
the
Significant
Obvious?**

There is no good reward for failure to understand risks.

Trend Curves



Van Trees' Uncertainty Law

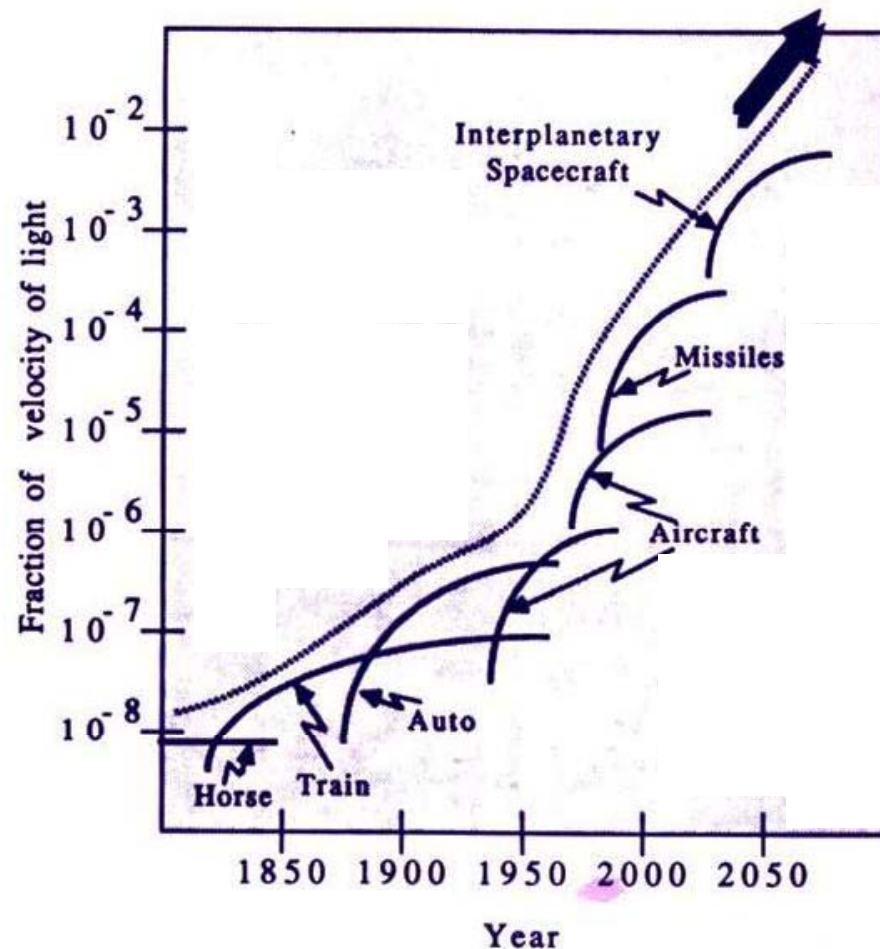
The Uncertainty in a C2 System generally reaches an acceptable level after the required action time is past.

Extrapolation: Cum Grano Salis

In the 1970s, the speed trend curve indicated that manned spacecraft would achieve speed of light accelerations by 1998.

The life-expectancy-at-birth curve promised immortality, barring accidents, for anyone born after 2000 AD.

The population growth trend curve suggests that by 3900 AD an expanding solid mass of humanity will be enlarging in all directions at the speed of light.



Past Performance is no guarantee of the future.

Things We are Really Not Good at Measuring

- ◆ Openness
- ◆ Interoperability
- ◆ Net-centricity
- ◆ Value of Information
- ◆ Effectiveness of Information Presentation
- ◆ Agility
- ◆ Effectiveness of collaboration
- ◆ Leadership
- ◆ Risk
- ◆ Resistance to cyber-attack
- ◆ Where “Good Enough” is

The problem is not just finding the right data to gather.

It's transforming the data so it can be presented in an effective decision-coordinating way.

Changing What's Most Important

- ◆ Using Military Standard computers and languages
- ◆ Adhering to the TADSTANDS
- ◆ High Order Languages
- ◆ Ada
- ◆ Software Engineering Environments
- ◆ COTS/NDI components
- ◆ IV&V
- ◆ Performance-Based Specifications
- ◆ Systems of Systems
- ◆ Open Systems
- ◆ Service-Oriented Architecture

*Acquisition
Reform*

And none were measurement

**None
of these
were
the mission**

Change is Good. You Go First.

- There is something to be said for stability of process.
 - Change implies a learning curve.
- There is also something to be said for continuous improvement.
 - Even if you are on the road to success, you'll get run over if you don't keep moving.
- Volatility can be a useful measure.

DoD 5000 Example of Volatility

Naval Acquisition Enterprise View

ASN (RD&A) Goals

- Expedite GWOT acquisition programs as much as possible without compromising safety.
- Reduce volatility in ongoing and current acquisition programs.
- Develop and investment/transition strategy for Science and Technology (S&T) to ensure future technological edge.
- Lead the Acquisition Enterprise component of the Naval Enterprise, in collaboration with OPNAV/HQMC and the fleet.

Meaning of Acquisition Volatility

- ◆ **Definition – tending to vary often or widely**
- ◆ **Program characteristics that affect acquisition program volatility:**
 - **Program complexity**
 - **Requirements fluctuation**
 - **Budget instability**
 - **Schedule demands**
 - **Contractor/PM optimism**

Measures of Success – Flag View

- ◆ **NAVAIR – Aircraft and carriers ready for tasking at reduced cost**
- ◆ **NAVSEA – Ships ready to deploy**
- ◆ **SPAWAR – Metrics being developed**
- ◆ **MARCORSSYSCOM – Ability to deliver equipment**

*How would
you depict
progress
toward such
goals?*

Critical Processes and Behaviors

- ◆ Identify Domains and assign Single Process Owners.
- ◆ Assemble the right Enterprise teams and gain commitment .
- ◆ **Operate in support of a Single Fleet-Driven Metric (*what the Enterprise values*).**
 - ***Agreement on scope, outputs, and linked metrics***
 - ***Transparency of data to promote trust and monitor performance***
 - ***Shared knowledge on issues and key problems affecting the Domain***
 - ***Recognize, nurture and respect technical authority***
 - ***Identified entitlements (what's needed, when, how much, and no more)***
- ◆ Agree on desired output (e.g., Readiness over Cost), with focus/ trade-space involving current and future readiness.
- ◆ Operate with discipline, governance, and a regular (timely) drumbeat.
- ◆ Baseline every dollar, all the people, all the stuff, and all the capability within the domain, with assigned accountability for outcomes.
- ◆ Establish entitlements. Continually measure gaps-to-entitlement.
- ◆ Remove barriers to productivity.

What Does It All Mean?

- ◆ **Is Measurement, like Medicine, an Art rather than a Science?**
- ◆ **Is the real issue with Measurement how to present information?**
- ◆ **If the goal is to use measurement to inform decisions,**
 - **How do we get the right amount of the right measurement information to the right decision maker in the right format at the right time?**

Measure Twice, Cut Once

- ◆ **Measurement is a good thing. It is better to measure than not.**
- ◆ **Measurements are not answers unless they address real questions.**
- ◆ **What's important depends on whom you are talking to.**
- ◆ **Measurement information must be presented with that in mind.**
- ◆ **Knowing what is “right” to present is critical to making a measurement program a success.**
- ◆ **You rarely get more than one chance to get that right.**

Contact

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