

# ***Headquarters U.S. Air Force***

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*Integrity - Service - Excellence*

## **Building a Cost Estimating Capability**



**ICEAA 2017 Workshop**

**John Fitch**



# ***Acknowledgements***

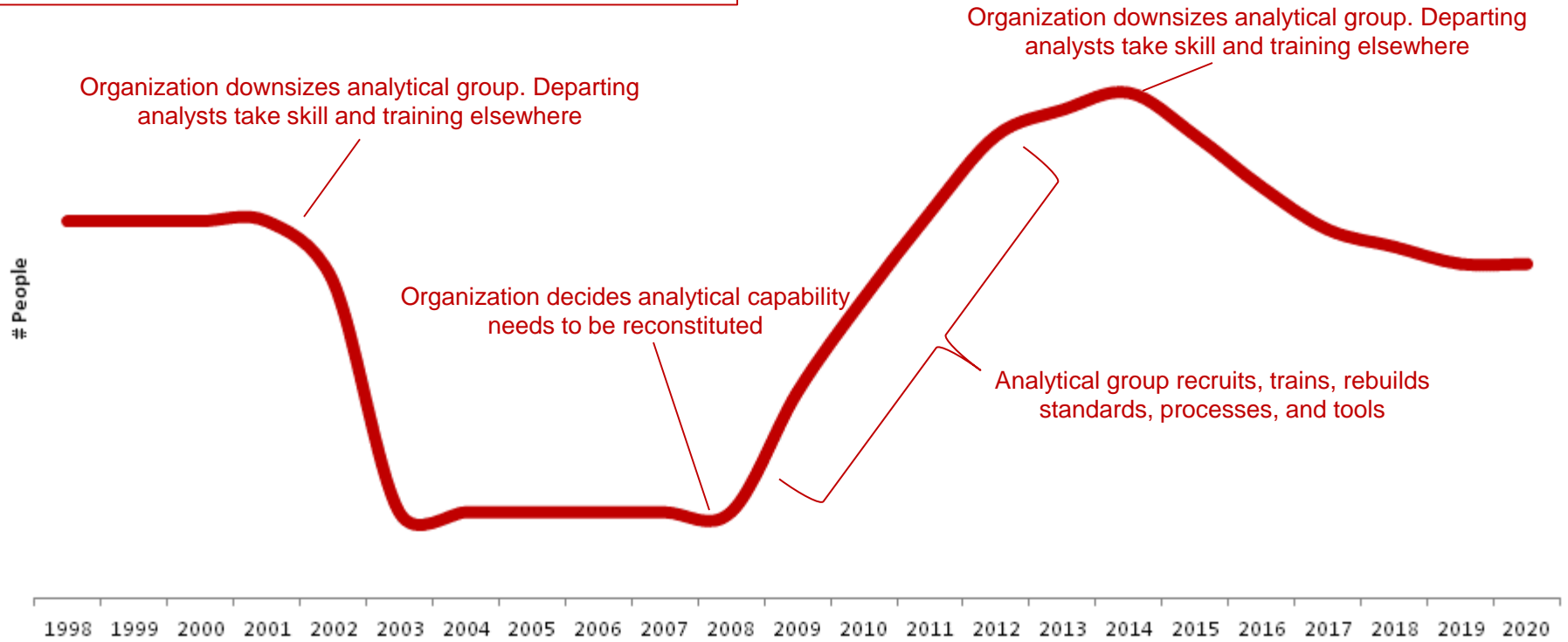
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- n This presentation was developed using materials and knowledge from the author's experience at the Air Force Cost Analysis Agency, the Naval Center for Cost Analysis, and NASA. The opinions herein are solely those of the author, and not the U.S. Air Force, U.S. Navy, or NASA.**
  
- n I want to thank all my colleagues and former colleagues who have helped me grow at various stages of my career into a better analyst and a better leader.**



# Motivation

This is a failed management strategy

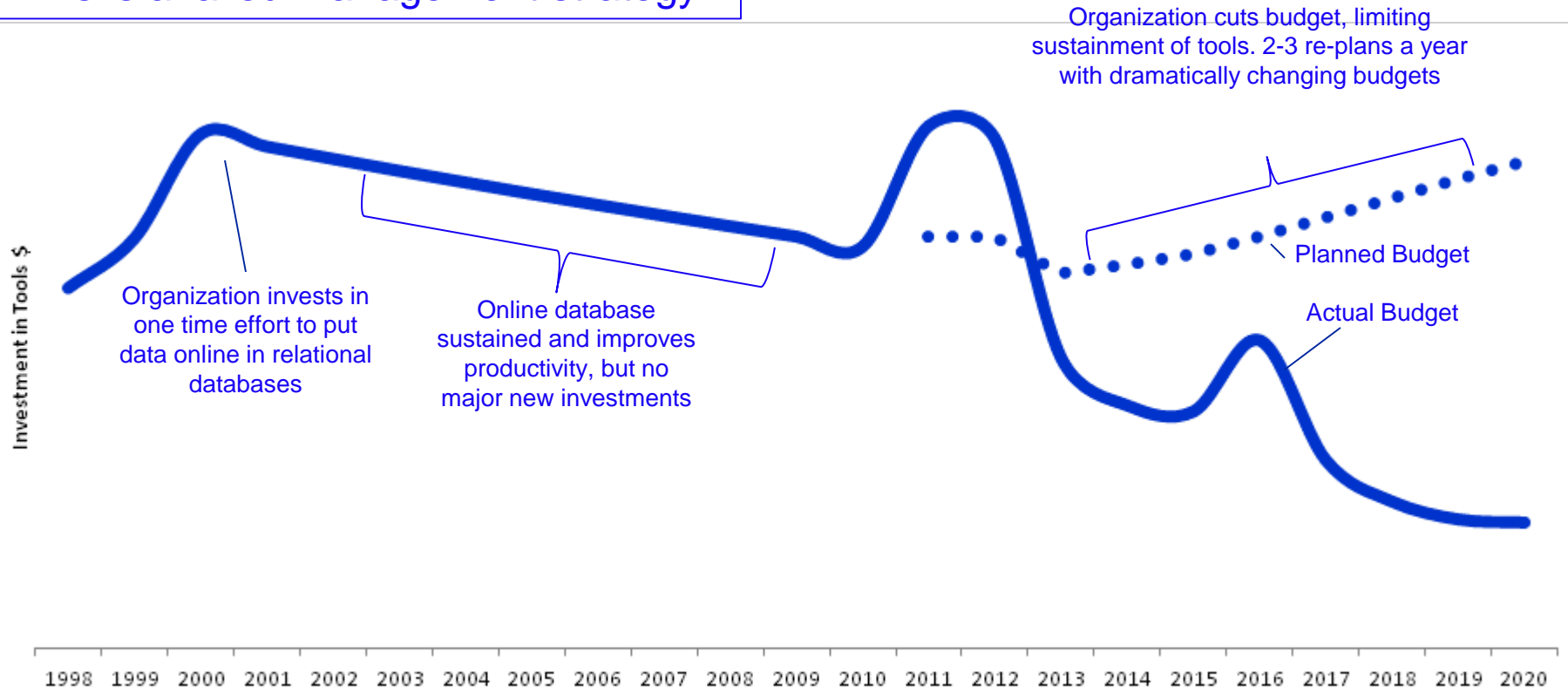


**An analytical community requires recruiting, training, tools, standards, and processes.  
Building an analytical community requires a sustained strategy and commitment**



# Motivation

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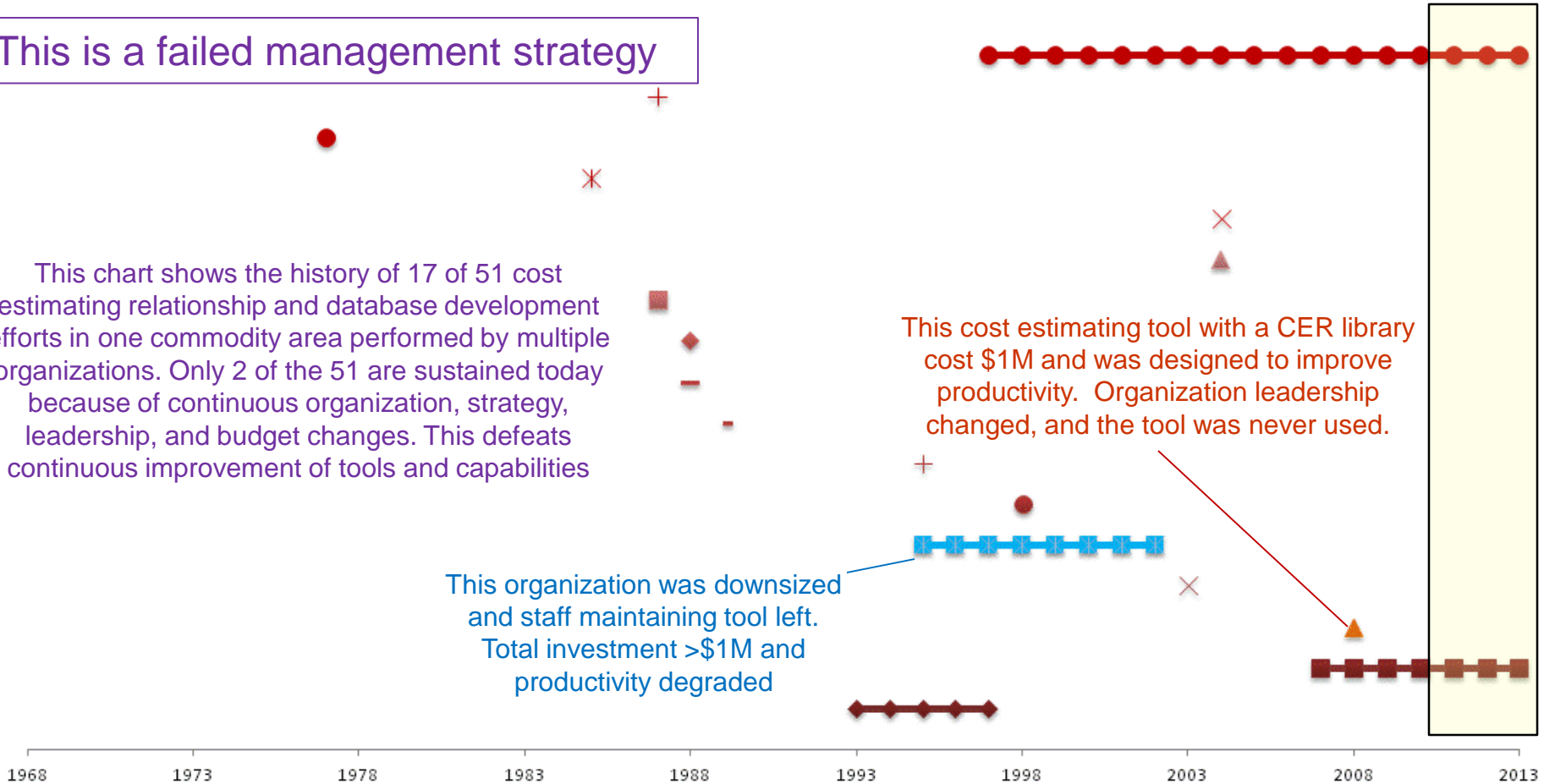
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# Motivation

This is a failed management strategy

This chart shows the history of 17 of 51 cost estimating relationship and database development efforts in one commodity area performed by multiple organizations. Only 2 of the 51 are sustained today because of continuous organization, strategy, leadership, and budget changes. This defeats continuous improvement of tools and capabilities



**Of 51 efforts during 1968-2013, just 2 still in use with ongoing improvements**  
**Investing in capabilities require sustained strategy and commitment**



# *The Idea*

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**Unified, long-term cost estimating people, database, technique, tool,  
process and training improvement strategy**

- n Integrates near-term planning with longer-term strategy**
- n Advocate more systematic, sustained investment to do best practices right**



# ***What we will talk about***

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- n Elements of a Cost Estimating Capability Strategy**
- n Resourcing the strategy**
- n Tying it together**
- n Key Points**



# ***Key Elements of Cost Estimating Capability Strategy***

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- n Know your customers and define your products**
- n Establish your standards and processes**
- n Establish your tools**
  - n Collect the data**
  - n Build the tools**
- n Build your team**
  - n Recruit, retain, train, and broaden**





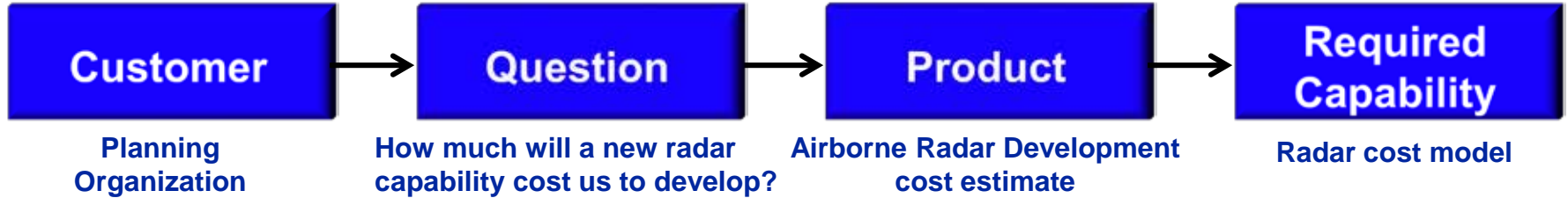
# *Customer and Products*

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- n Talk to your customers**
- n Determine questions they want answered**
- n Identify the capabilities and products to answer them**

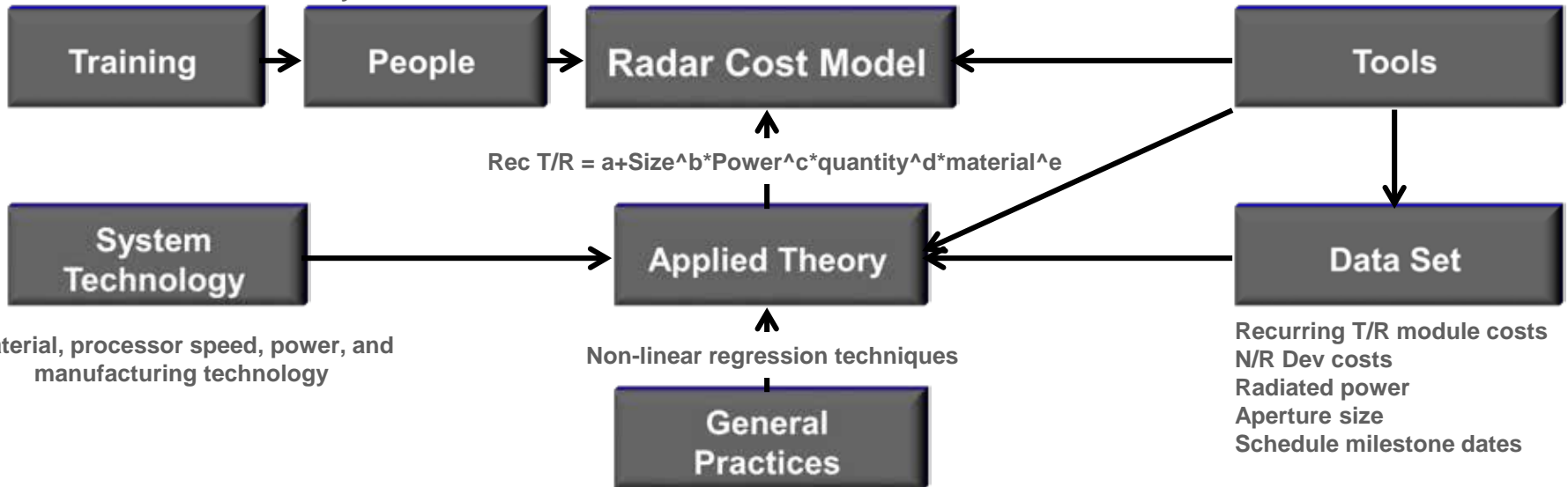


# Identifying Customer and Product



Principles of Airborne Radar, Software Development, Accounting Statistical Analysis

Excel/ACEIT, Risk, Database, Statistics, and Data Visualization Software



The specifics of the example are not as important as the thought process linking customer needs to products to the capabilities required to build the products



# *Establish your Standards and Processes*

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## **n Establish the Standard**

- n Ensures Product Satisfies Customer**
- n Drive Continuous Improvement**

## **n Build Processes that Repeatedly Achieve Standards**

- n Baselines**
- n Estimates**
- n Data Collection**
- n Methodology Development**
- n Training**

## **n Automate Processes for Efficiency**

- n Easiest do with high demand, uniform products**



# Setting Standards for Estimates

Subject		Grade	Grade Definitions			
Element	Sub-element	Grade	Excellent-3	Adequate-2	Inadequate-1	N/A-0
Purpose						
Personnel						
Baseline						
Estimate Work Breakdown Structure						
Data						
Cost Estimate						
	Point Estimate					
	Two Approaches for Major Cost Drivers					
	Use of tools					
	Completeness					
	Estimate Inputs					
	Estimate Outputs					
	Children sum to parent					
	Inflation					
	Budget Comparison Chart					
	Adaptability to Changes					
	Parametric Cross-check if not used as primary methodology					
	Depth (depends on purpose)					
	Assumptions					
	Traceability					
	Risk and Uncertainty (to include schedule as appropriate)					
	Sensitivity Analysis					
	Sensibility/Benchmarks					
Communicating Results						
Cost Reporting Plans						
Post-Estimate						

Each subject element loosely tied to GAO cost guide

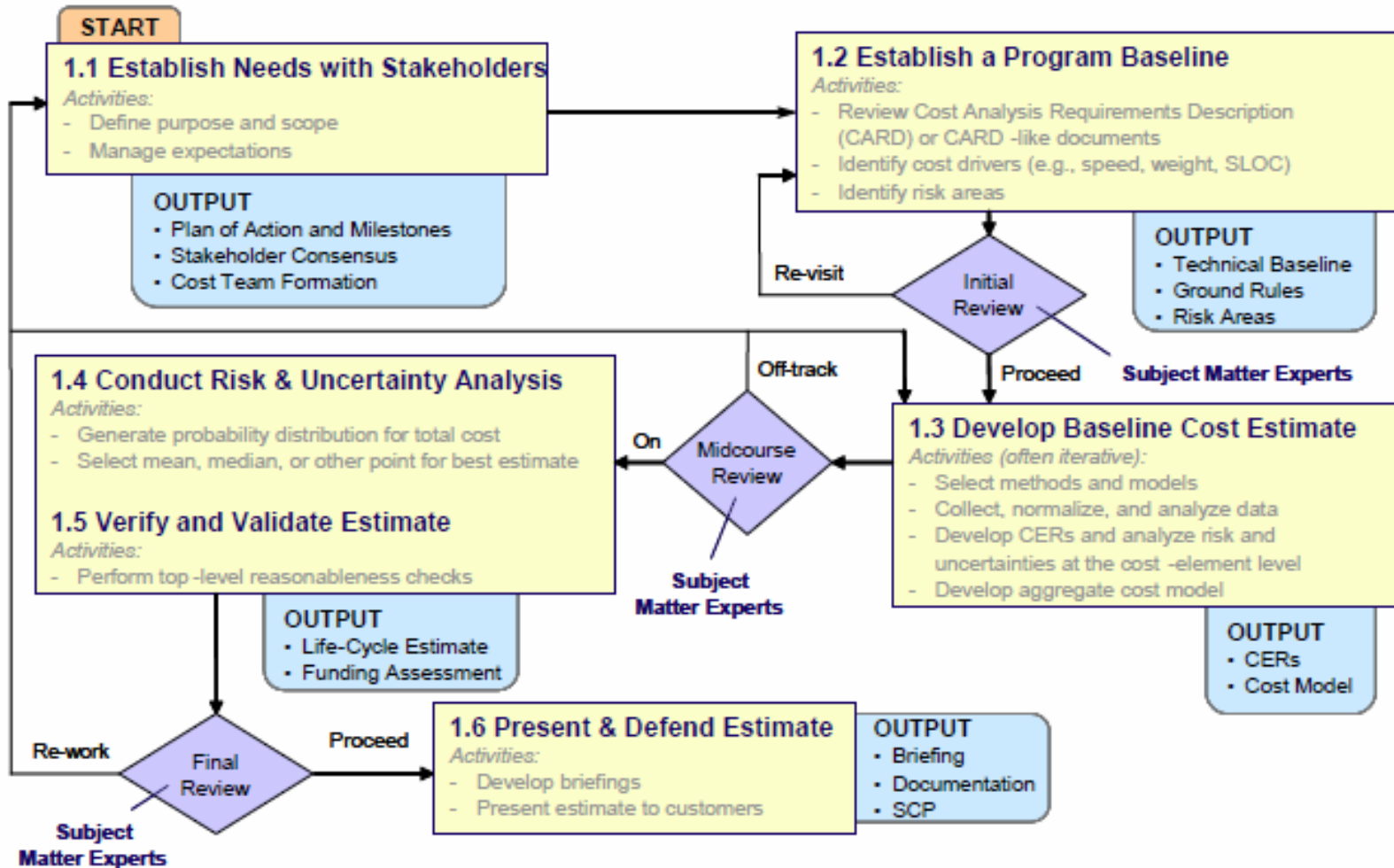
Each subject broken out into sub-elements

Each Grade Level Defined for Each Element

Sets standards entire capability, not individual analysts—  
helps detect areas for improvement in process, practices,  
tools, training, and recruiting



# Example Process Cost Estimating Process



Graphic from Department of Navy Cost Estimating Guide, 18 Oct 2010



# Example Process Risk and Uncertainty

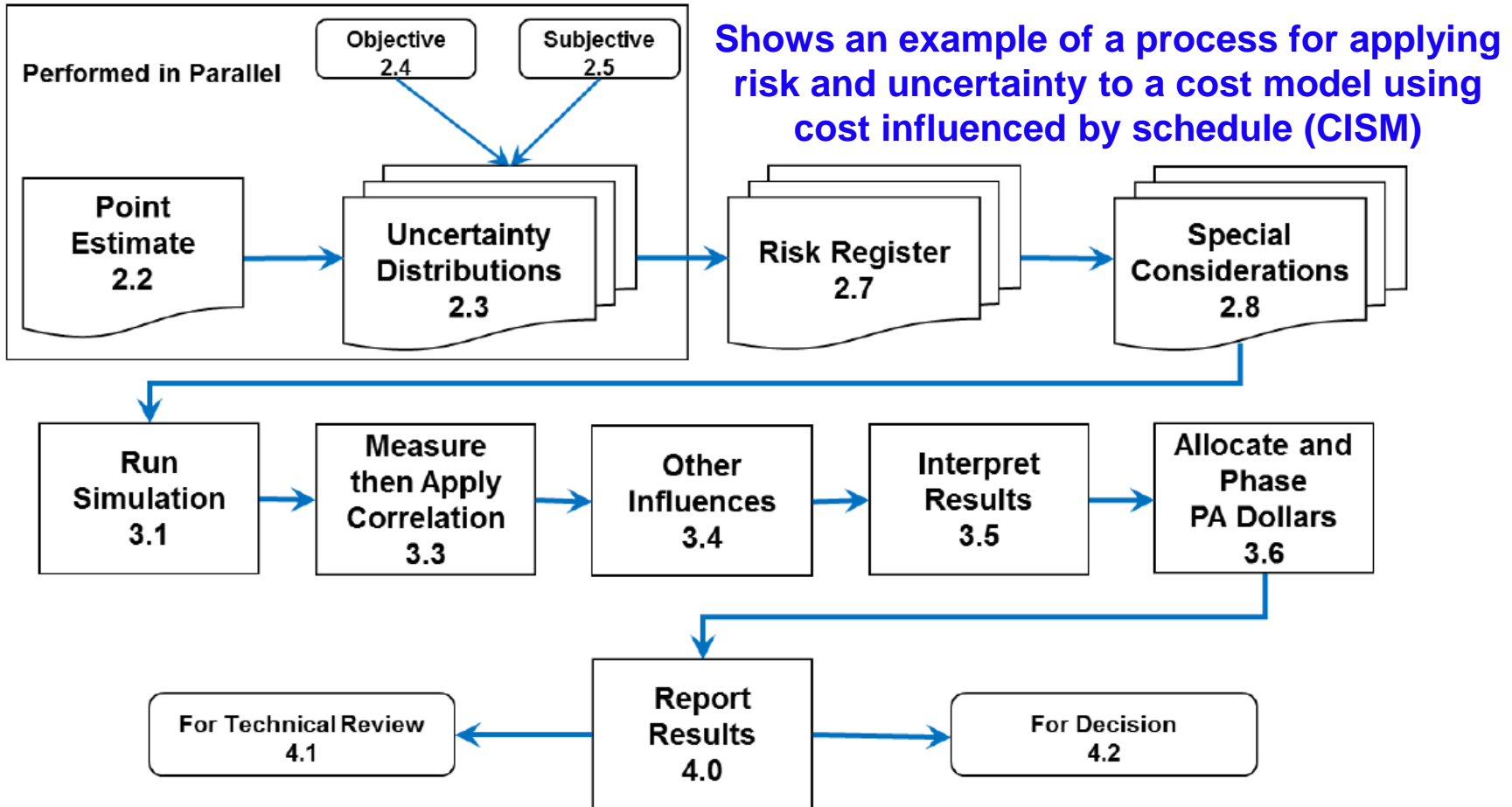
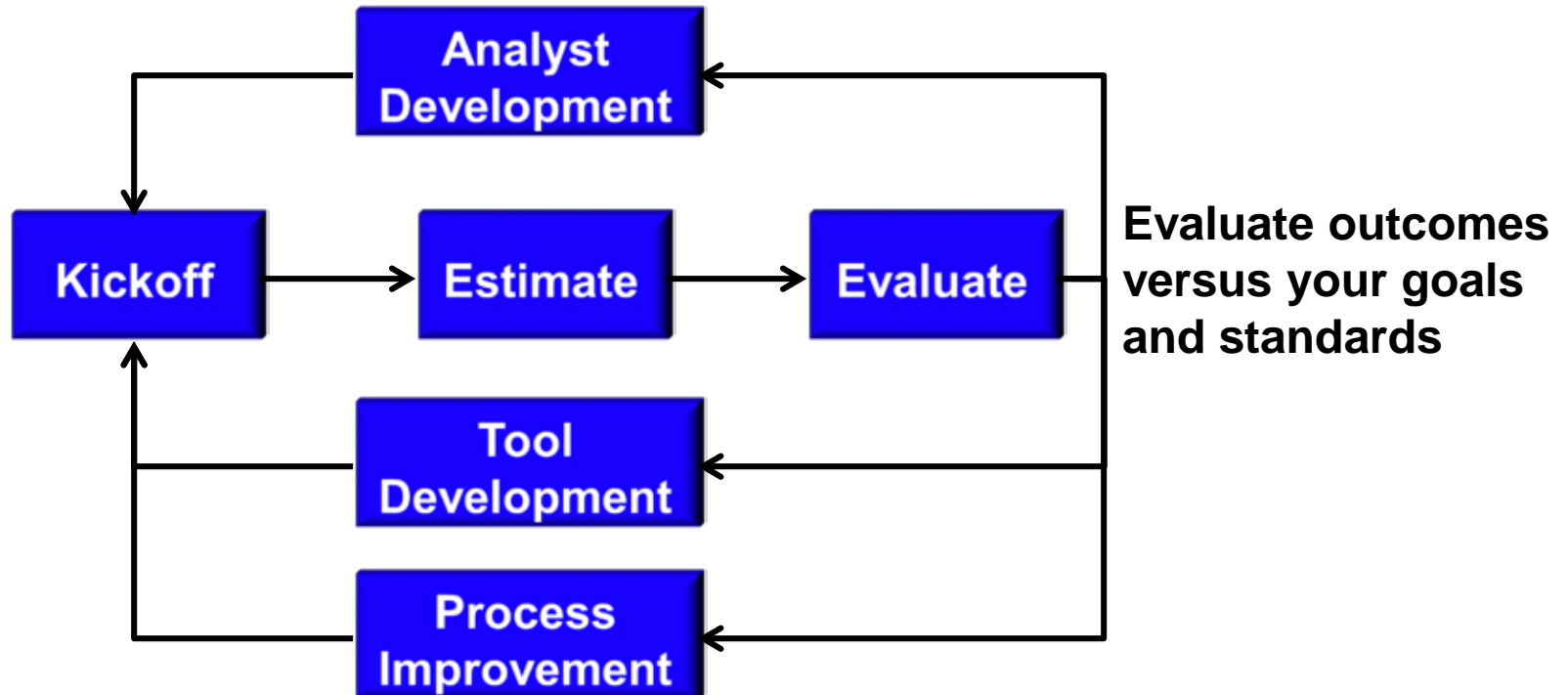


Figure 1-1 CISM Model Development Flow



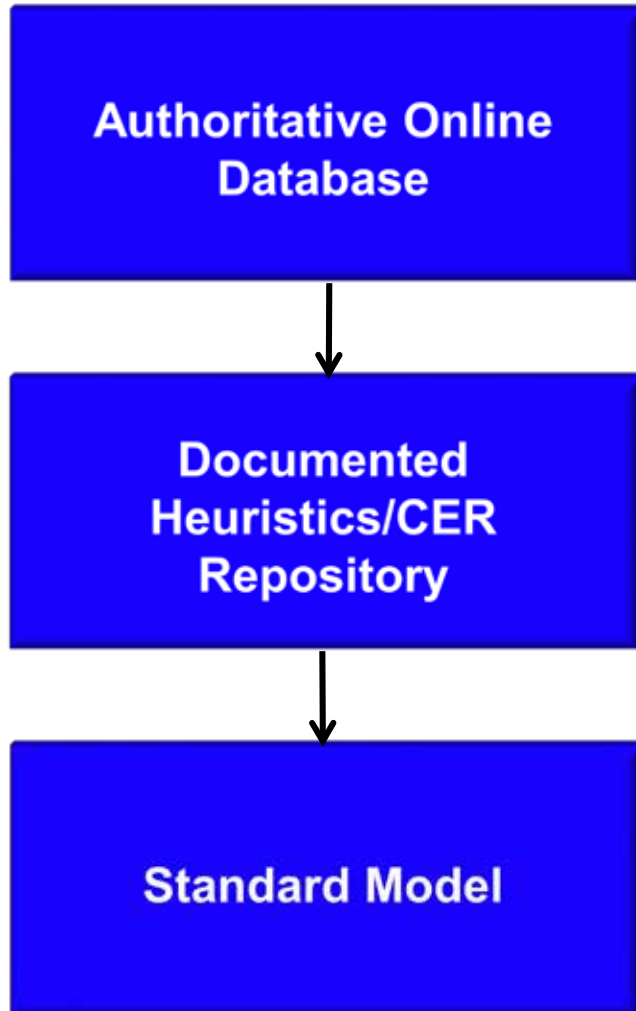
# Continuous Improvement

- n All processes should lead to continuous improvement
- n Fix your problem areas!





# Toolset Paradigm



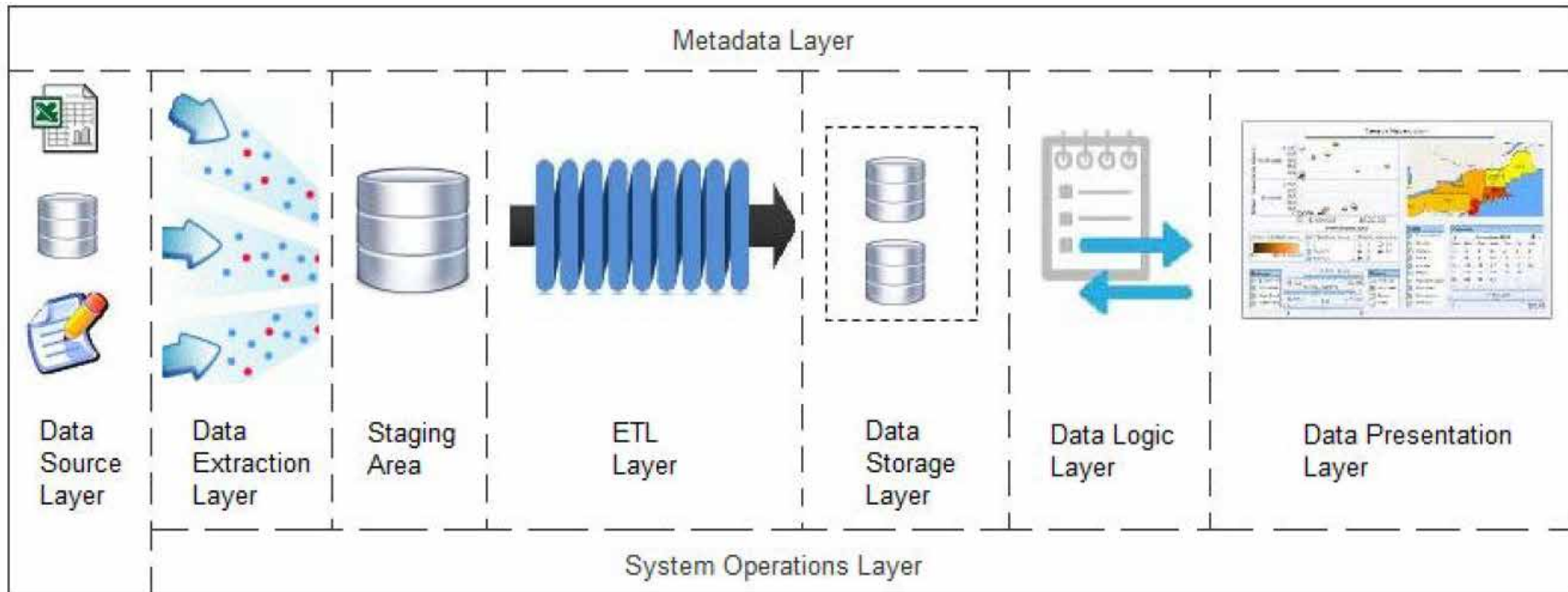
- n Establish Data Collection process to ensure well-defined data feeds database
- n Enforce database to maximize institutional utility of data
- n Leverage estimating process, literature reviews, and documented heuristics/CERs to ensure usage/continual improvement
- n For highly repetitive estimates, establish standard model with input/outputs, CERs, standard practices
- n Train analysts on processes, databases, repositories, and standard models





# Collect the Data

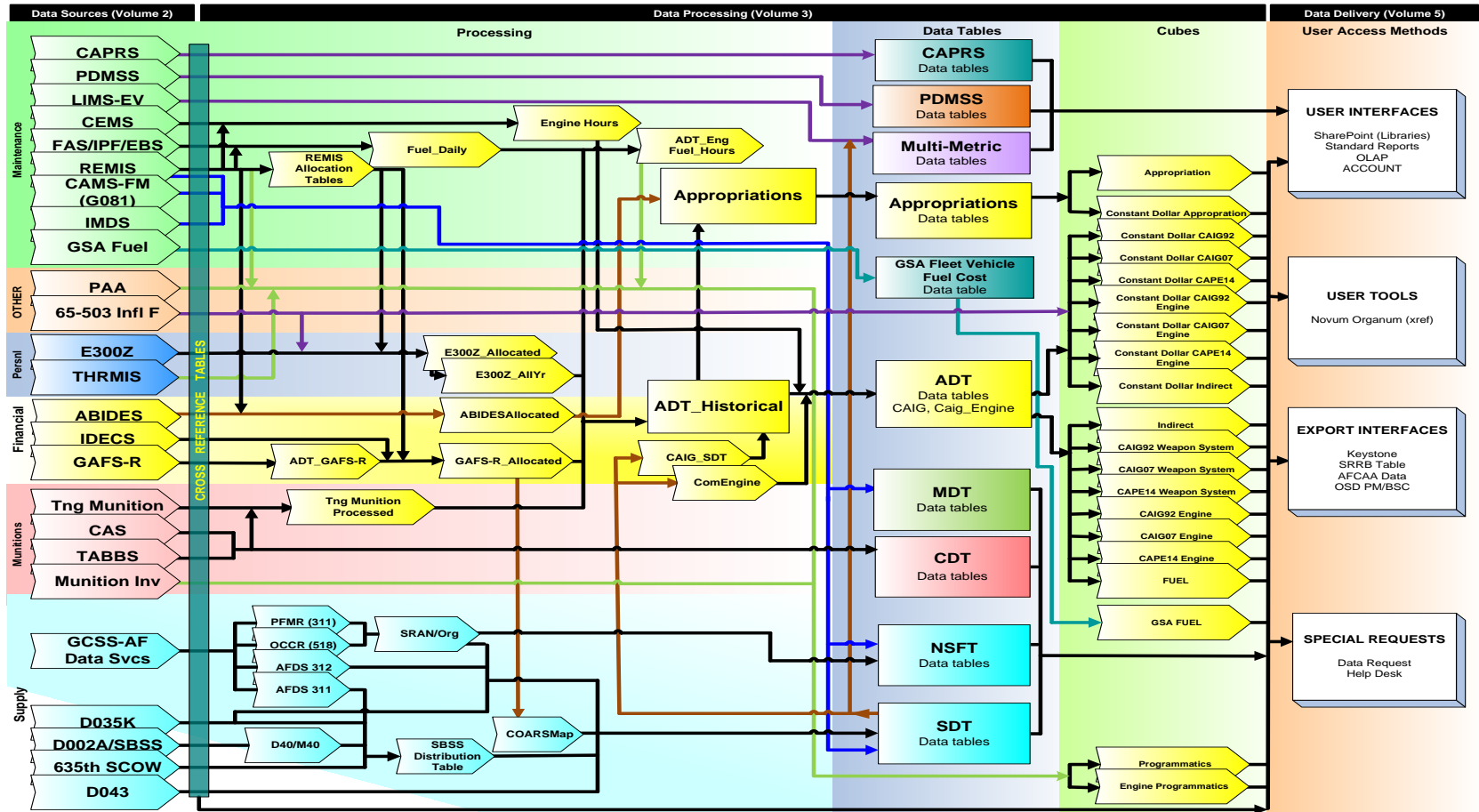
- n Identify Data Fields
- n Identify Authoritative Data Sources
- n Establish and Execute Data Collection Process
- n Stage Data
- Clean, transform, integrate data
- Apply Business Rules
- Display of Data
- Document Data Source, Transformation for Users



Graphic from "Building an Effective Data Warehouse" course, Learning Tree International. Reprinted with permission.



# AFTOC Example



Data Sources

Extraction, Transformation, Load

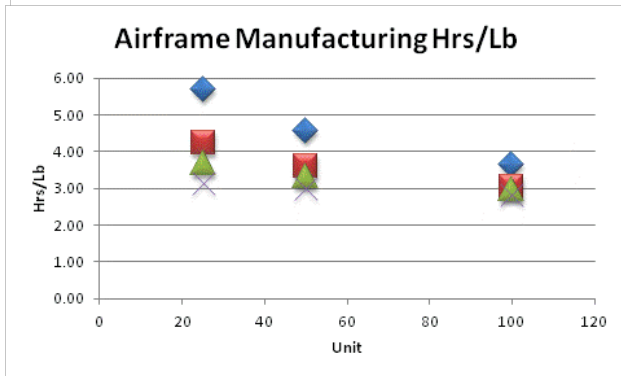
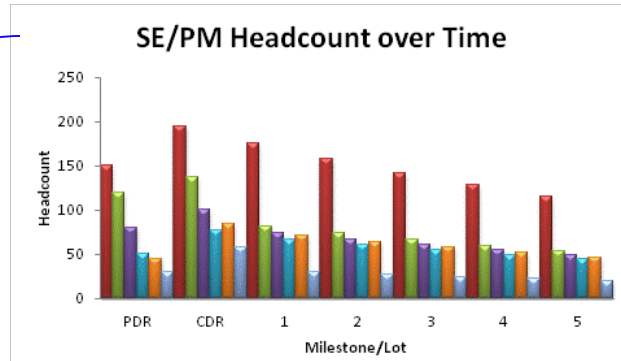
Data Storage

Data Presentation



# Establishing Heuristics

**Authoritative  
Online  
Database**



T1 Hrs/Lb	Unit Learning Curve
16	80%
9	85%
6	90%
4	95%

- n **Heuristics are benchmarks to crosscheck estimates**
- n **Usually consist of analogies, averages, medians, and data ranges based on programs drawn from historical databases**
- n **Document heuristics in handbooks and periodically update**
- n **Modern data visualization tools can potentially allow handbooks linkage to continually updated databases**



# Establishing Cost Estimating Relationships (CERs)

Table 38: Key Normalized Electronics Data

Observations	Cost (FY16\$K)	Power (kW)	Aperture (cm <sup>2</sup> )	Intensity (kW/cm <sup>2</sup> )	FFP (1) or T&M (0)
Project 1	390	10.0	8.7	1.1494	1
Project 2	200	5.0	8.0	0.6250	0
Project 3	240	5.2	8.2	0.6340	1
Project 4	300	7.0			0
Project 5	460	12.0	9.0	1.3330	1
Project 6	560	17.8	9.5	1.8740	0
Project 7	700	21.0	9.2	2.2830	0
Project 8	800	25.0	9.7	2.5770	1
Project 9	500	18.0			0

n Cost Estimating Relationships developed by rigorous process usually provide results with uncertainty than averages

n Multiple CERs may be developed to populate a cost element structure in a single model from same historical data set

n CERs are documented and periodically updated in a handbook available online.

n Some of this can be automated with right tools, but results must be reviewed and accepted

$$FY\$16K = 317.7 * (Intensity^{0.9088}) * (1.011^{FFP})$$

CERs & Heuristics

Cost Element Structure

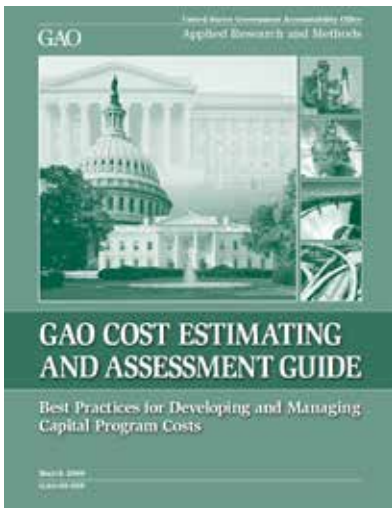
Electronics CER/Heuristics Repository

Examples from draft Cost Estimating Relationship (CER) Handbook Draft, 03 Feb 2017  
Naval Center for Cost Analysis



# Establish Best Practice Guides

## Cost Estimating Guide



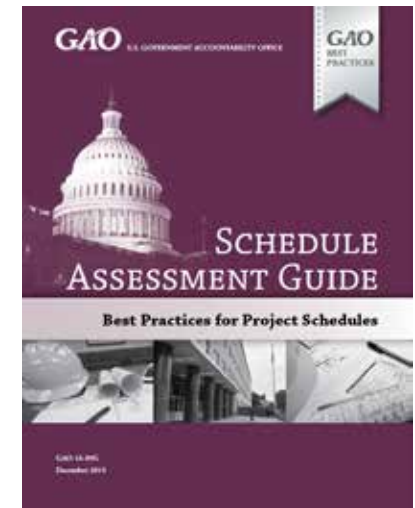
## Risk and Uncertainty Handbook



## CER Development Handbook



## Schedule Assessment Guide



- n Periodically update as practices evolve
- n Best Practices are similar across organizations, collaborate with joint products
- n Avoid sensitive information in a general practice guide
- n Publish online and widely distribute



# *Identify Tool Suite*

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- n **Identify list of tools needed by analysts to**
  - n **Develop estimates**
  - n **Collect data**
  - n **Maintain databases**
  - n **Build CER & heuristics**
- n **Ensure each analyst is trained on them and has access to them**
- n **Update list each year**
- n **Use list to identify required training**



# Example Tool Suite

Tool	Use	Cost/Seat	NMCI or ATO aproval	Package
Excel	Modeling	None	DoN	All
Crystal Ball	Uncertainty	\$283	NCCA	All
ACEIT Suite	Modeling/Schedule/Stats	\$58	Mixed	All
MS Project	Proj Planning/Schedule	None	DoM	All
JMP	Stats	\$311	NCCA?	Large data set users
R	Stats	None	SPAWAR	All
ERP	Acct Data	FM&C	DoN	All (training o/h)
SPIDER	Ship installation (retrofit) data	SPAWAR	SPAWAR (ATO)	IT/Ships/CT
CADE	Acquisition Data	OSD	OSD (ATO)	All
VAMOSC	O&S Data	NCCA	NCCA (ATO)	All
METEOR	Manpower	NCCA	NCCA (ATO)	All
OSCAM	Ship/Ship System/Aircraft O&S model	NCCA	NCCA	All (training required)
JCARD	Aviation/missile/propulsion database	NCCA/NAVAI R/AFCAA	NAVAIR (ATO)	All
IMS	Ship database	NAVSEA	NCCA (ATO)	All
EDA	Contracts	DoD CIO	DoD CIO (ATO)	CRT
GFM	Ship system estimates	NAVSEA	NCCA (ATO)	Ship
DAMIR	Acquisition program summary	OSD(AT&L)	OSD (AT&L)	All



# Survey of Available Resources

## n Develop summary document surveying available tools

- n Databases
- n Heuristics
- n CERs
- n Standard models
- n Best practice handbooks

Missile  
Cost Research Literature Review

Aug 2014



Naval Center for Cost Analysis  
1000 Navy Postagon, 4C40, 01ASN, 03M&C, NCCA  
Washington, DC 20390-1000

## n Include content from other organizations

## n Keep it short!

- n Front/Back 1-pager (perhaps separated by databases, handbooks, tools, etc.)

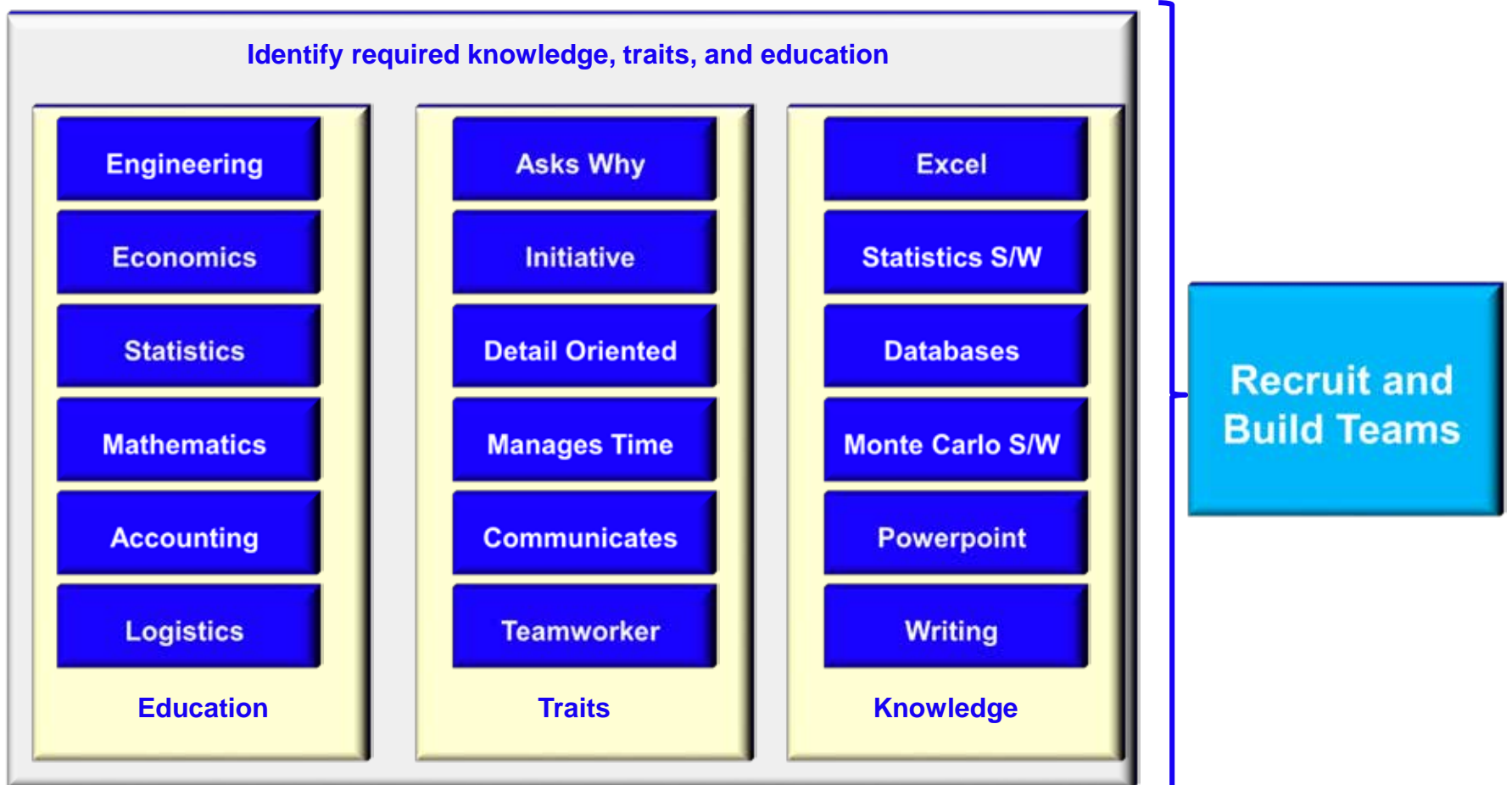
## n Publish online

## n Periodically update





# People

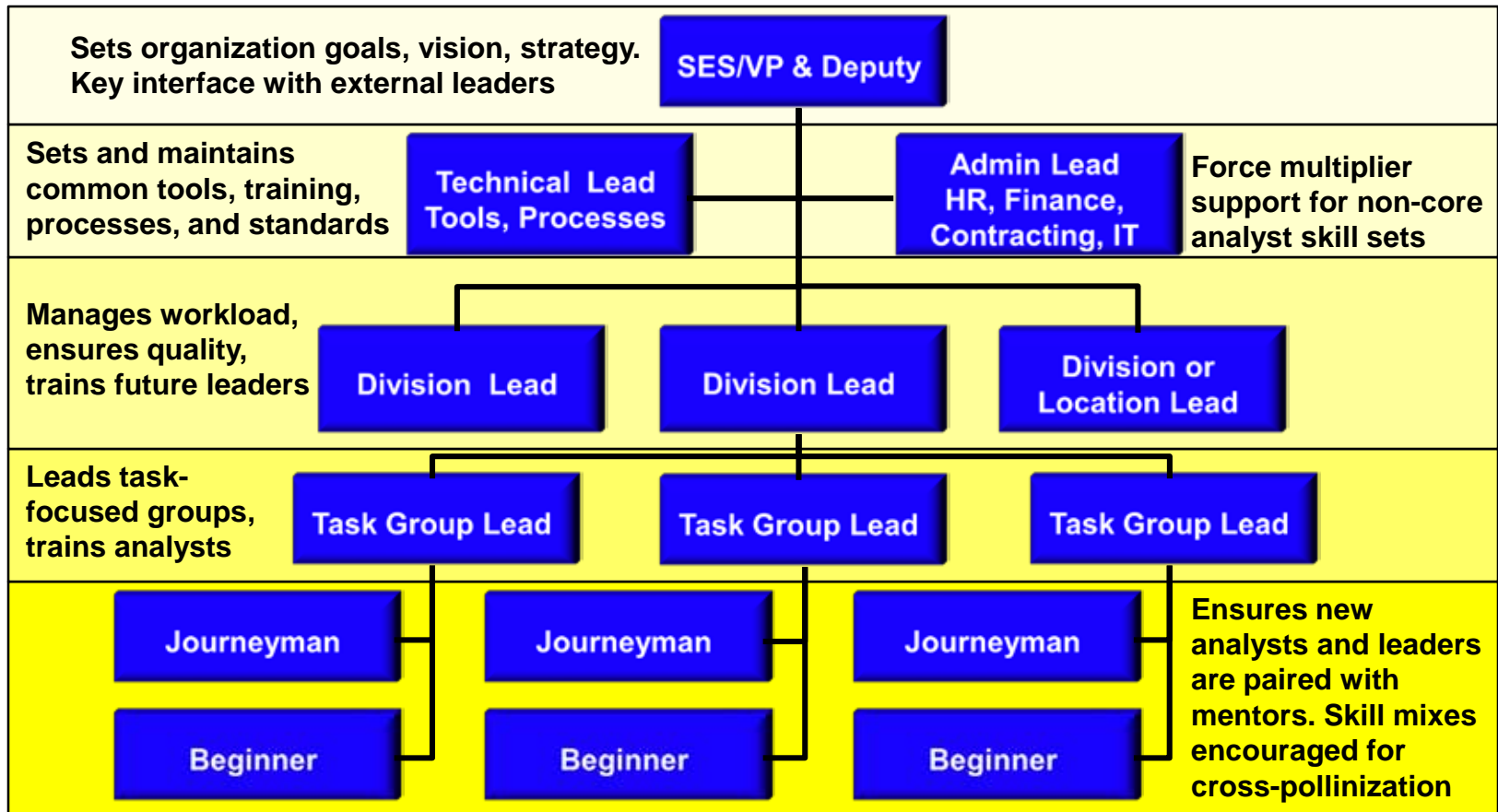


Not everyone will have the same education, traits, and knowledge.

Match/Combine skills and personalities for task at hand



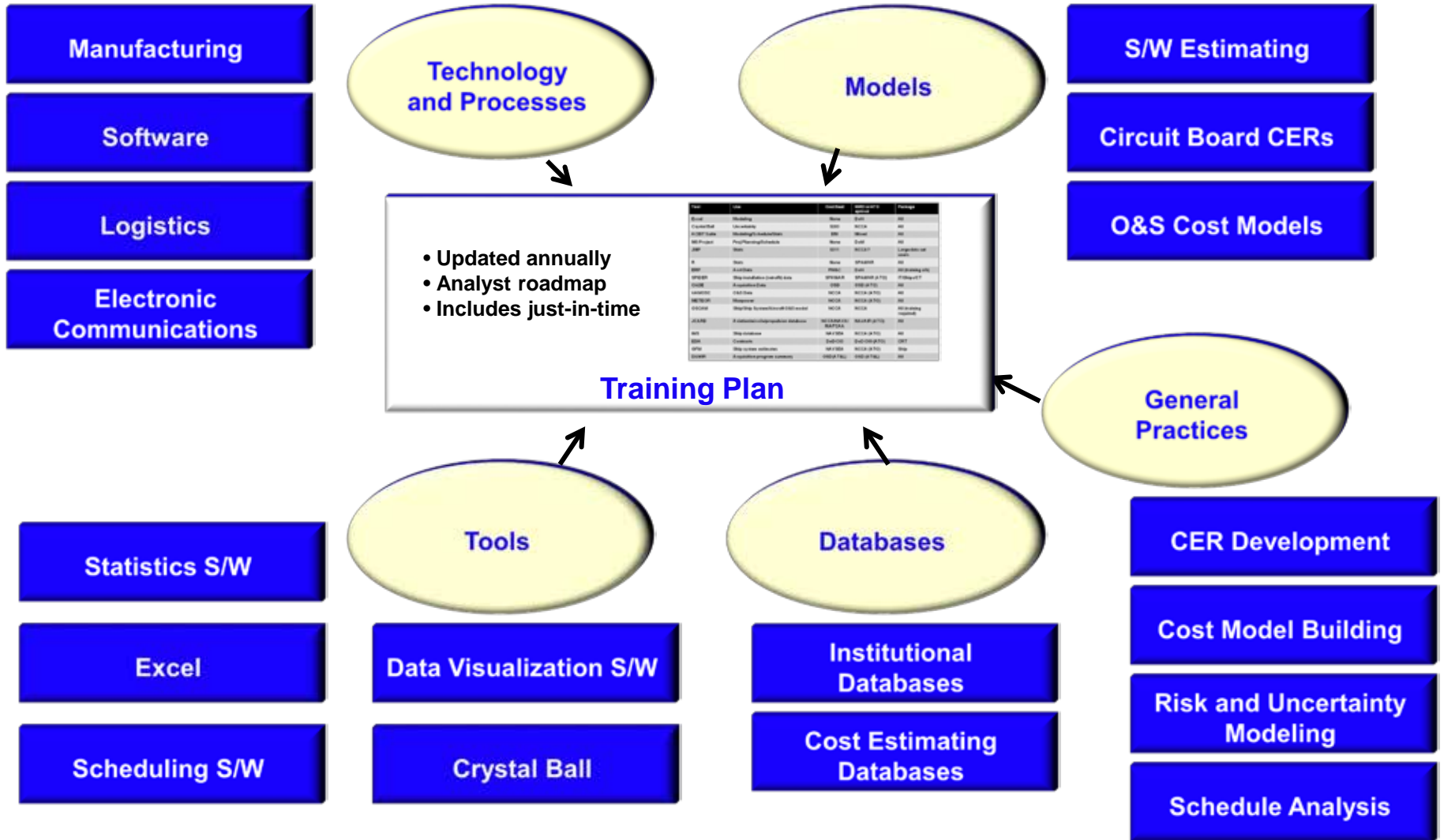
# Deploying People Effectively



The details will be different based on tasks and experience levels. The key is to ensure training, tools, and standards infuse the culture

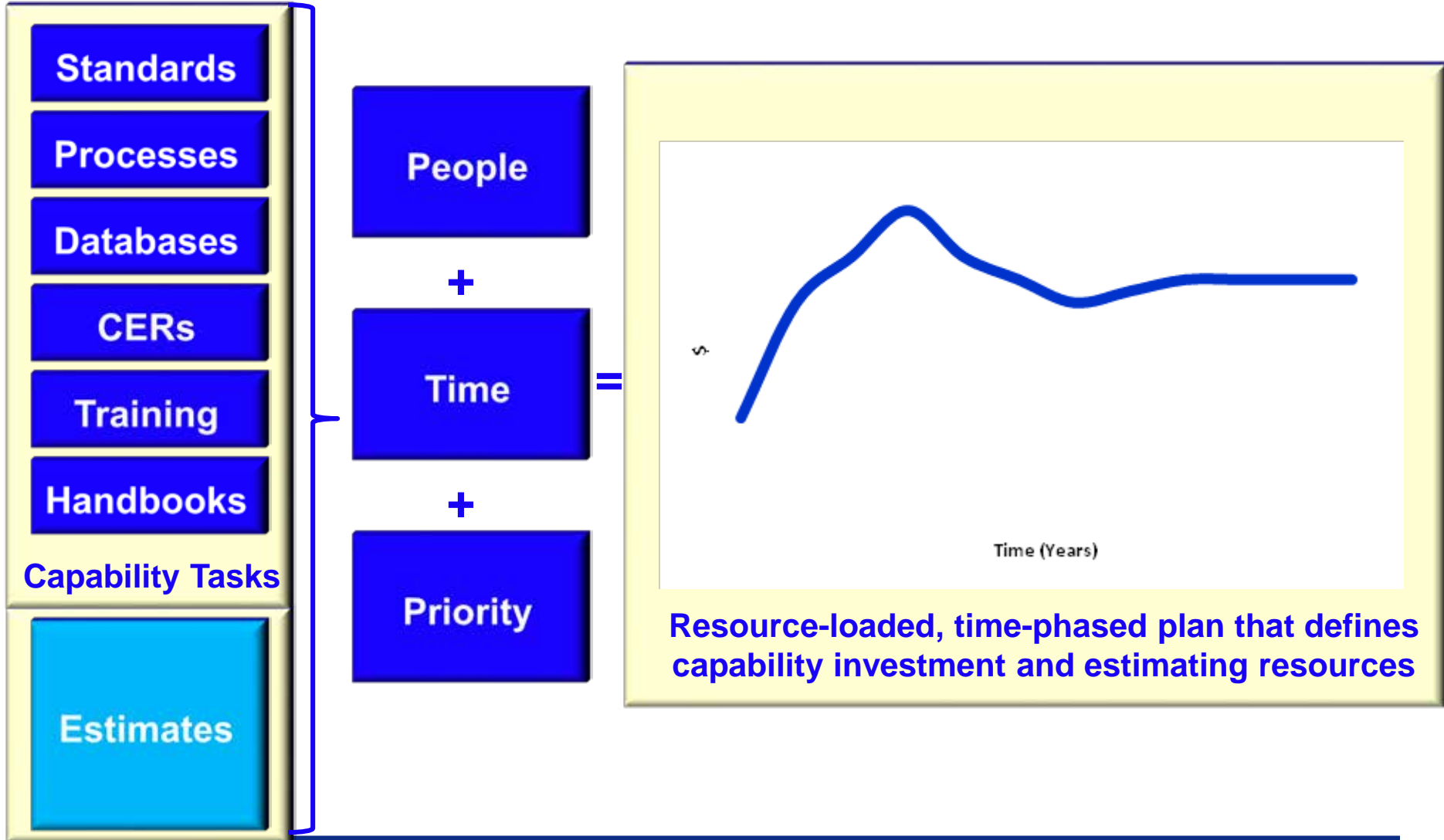


# Training





# Resourcing the Strategy





# *Tying your plan together*

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- n **Know your customer questions**
- n **Identify your products**
- n **Establish your standards**
- n **Establish your process**
- n **Establish your databases**
- n **Establish your tools**
- n **Recruit your people**
- n **Train your people**
- n **Form alliances outside organization**
- n **Resource your plan**



# ***Building a Cost Capability***

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## **n Success requires**

- n Sustained investment in capabilities and people over time,
  - n With a strategy, commitment, and culture
    - n that is sustained by successive leaders******