

estimate

estimate • analyze • plan • control

IT Affordability, Estimation, Planning & Control for More Successful Projects For RANEPA Moscow Feb 2014

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Key Points Plus a Case Study

US
healthcare.gov
problems
highlight the
need for
estimation,
planning &
control



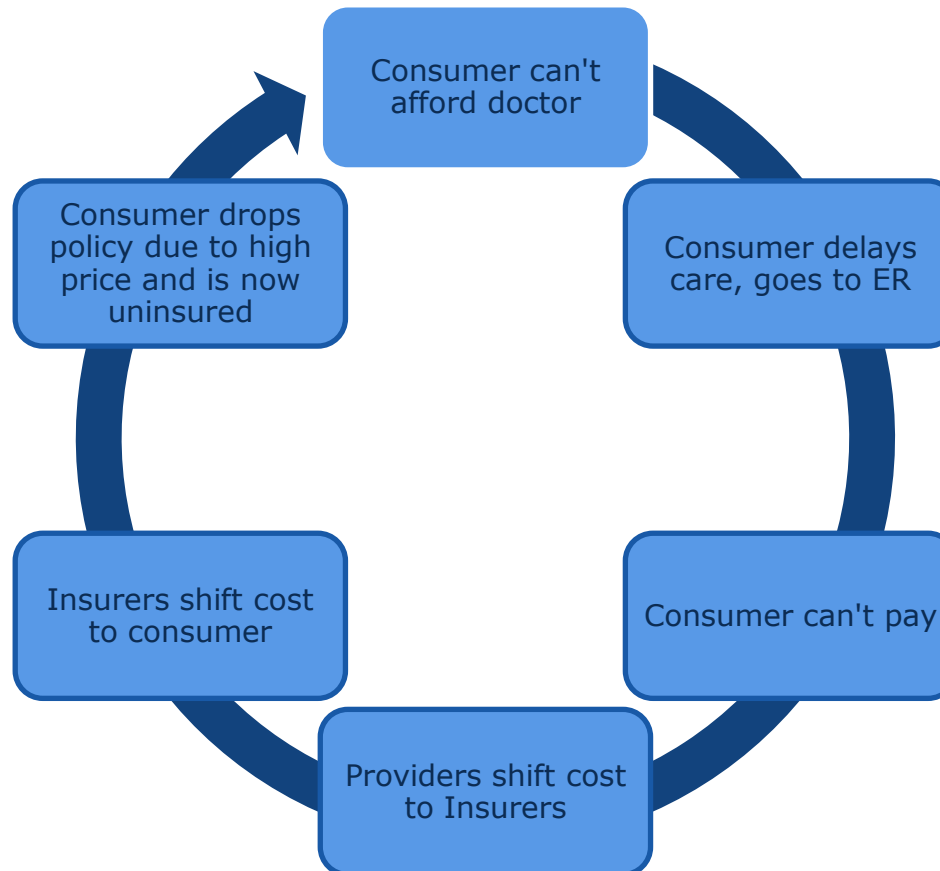
Estimation
is critical
and Should
Be A Core
Process

Viabile
Estimation Can
help achieve
affordable
systems with
optimal ROI



ObamaCare (Affordable Healthcare Act)

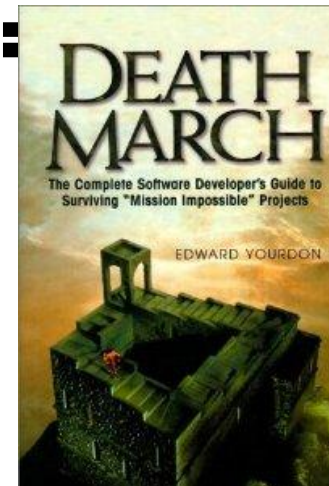
- ❖ Health care coverage to 32 million uninsured
- ❖ Slow rising health care cost
 - ❖ 18% of 2014 Gross Domestic Product (GDP)



Healthcare.gov Lessons Are Not Surprising But Can Help Future Systems

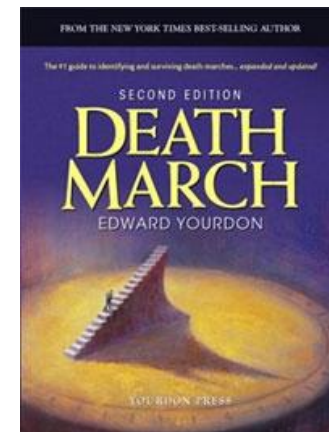
Most IT Calamities have common threads:

- **Decisions at the top created a cascade of problems**
- **These decisions usually involved trying to:**
 - do too much
 - in too little time
 - on a limited budget



Healthcare.gov suffered from:

- **Delayed policy and requirements decisions**
- **Requirements changes until shortly before release**
- **Complex sourcing and re-integration paradigm**
- **SEVERELY truncated testing**
- **Functional flaws in logic and computation**
- **30+% of system unbuilt (payment components)**
- **Problems for all state sites**



The IT Challenge



HealthCare.gov Production Problems



News

HealthCare.Gov: Experts Declare it Insecure

Bungle of Joy: HealthCare.gov can't handle info on newborns

Posted: Friday, January 3, 2014 10:45 AM EST
Updated: Friday, January 3, 2014 10:45 AM EST

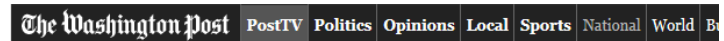
By FOX News

Enrollees at Health Exchanges Face Struggle to Prove Coverage

The New York Times



Under Construction: HealthCare.gov's Payment System



Health & Science

In the News Justin Bieber NSA Eugenie Bouchard Hassan Rouhani Seattle Seahawks



Floating aircraft raise privacy worries



COLUMN | These Games have a dangerous ring



HealthCare.gov defects leave many Americans eligible for Medicaid, CHIP without coverage



Healthcare.gov Operating Without a Safety Net

3

How much has been spent on Healthcare.gov?

CORRECTION

Initial Reporting



Table 4: CMS Obligations for Contracts That Support Federally Facilitated Exchanges (FFE) and Data Hub Establishment by Largest Contractor, through March 31, 2013

Contractor	Examples of activities	Amount obligated (dollars)
CGI Federal Inc	FFE information technology and healthcare.gov	\$87,997,938
Quality Software Services Inc	Data hub	55,098,237
Booz Allen Hamilton	Enrollment and eligibility planning and state grant technical assistance	37,737,550
National Government Services Inc	Consumer call center and Small Business Health Options Program (SHOP) premium aggregations	31,590,846
The Mitre Corporation	Project management and Information technology security	22,028,672
Logistics Management Institute	Health plan management, rate analysis, and benefit package review	19,107,667
DEDE Inc DBA Genova Technology	Information technology	16,026,915
Terremark Federal Group	Cloud computing services	15,539,713
IDL Solutions	Enterprise data and design support	9,342,512
Navigant Consulting Inc	Outreach and collection activities	8,949,560

NOW



The Fact Checker

The Truth Behind The Rhetoric | By Glenn Kessler

The Fact Checker

How much did HealthCare.gov cost? (Part 2)

4 How much does \$150M buy?

Assuming....

10-30 major systems



\$18K average monthly contractor cost (government rates)



About 1.3
MILLION
HOURS



2.7m HOURS

Taking
just over
2 YEARS

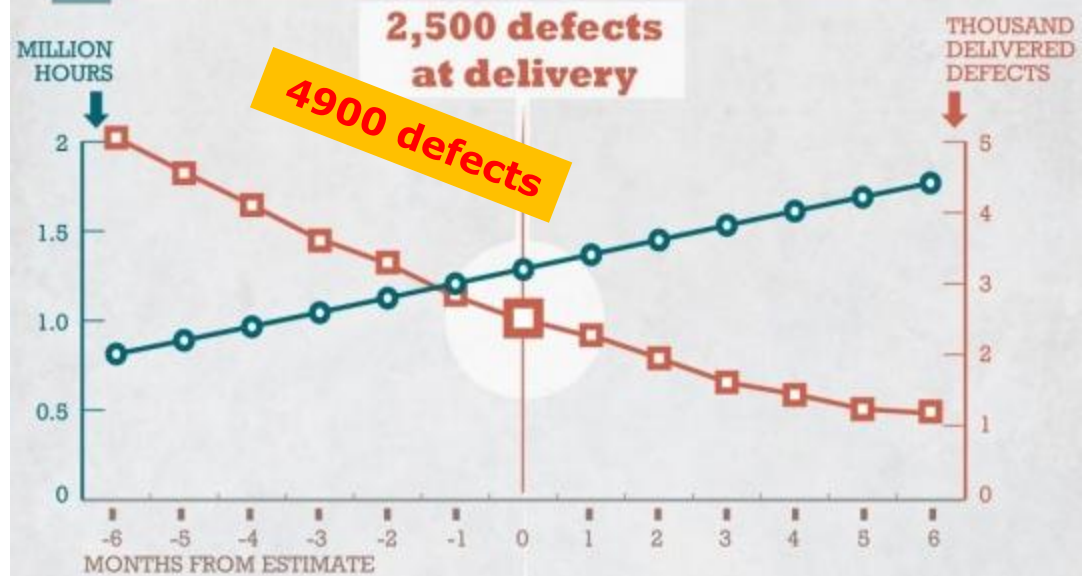


3 YEARS

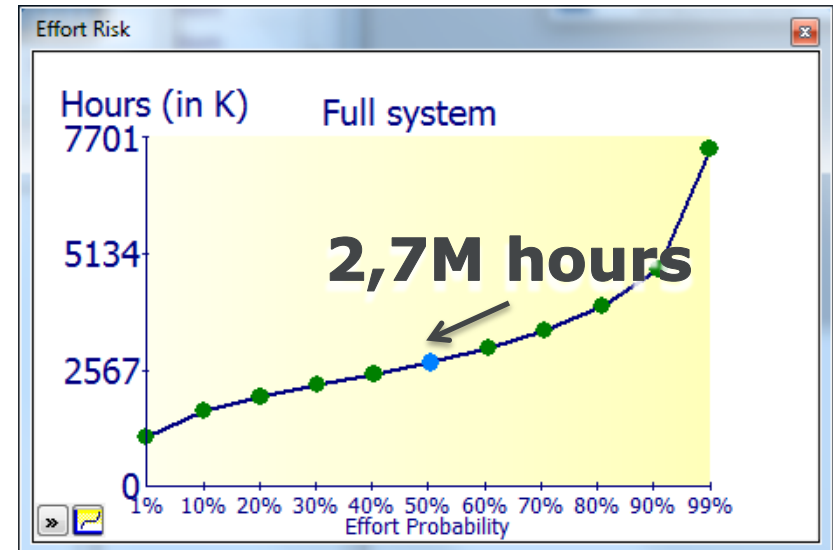
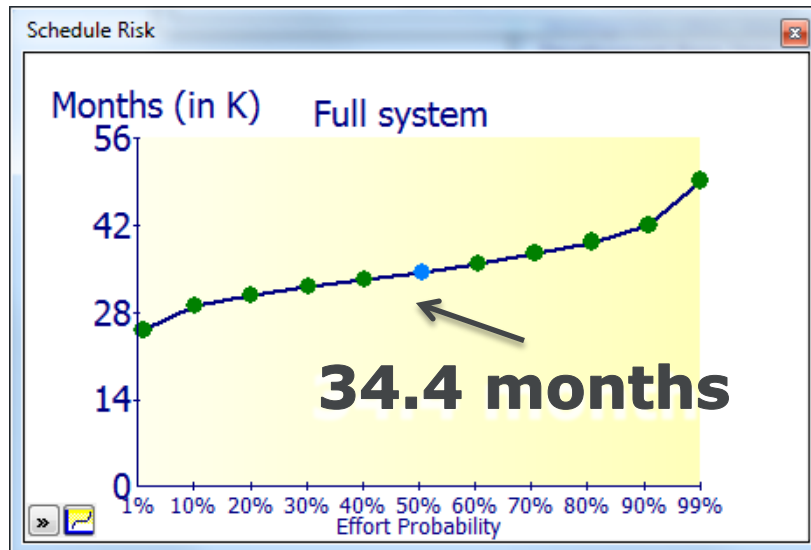
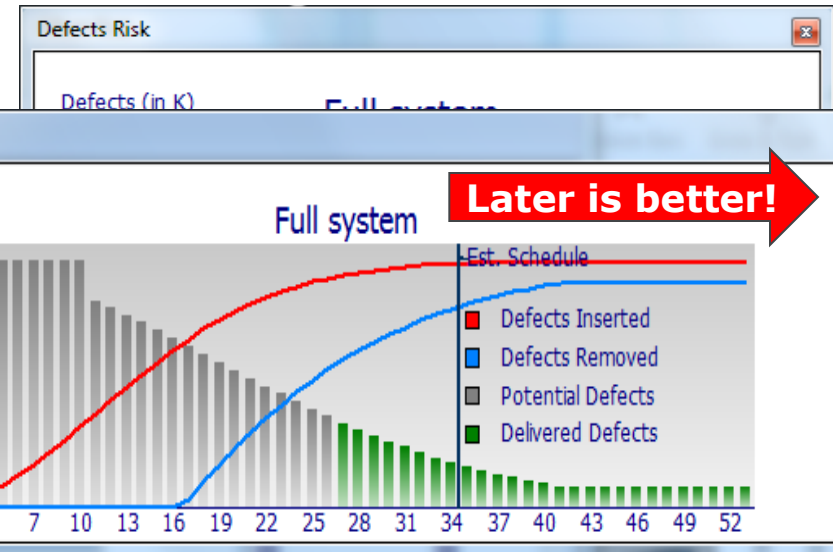
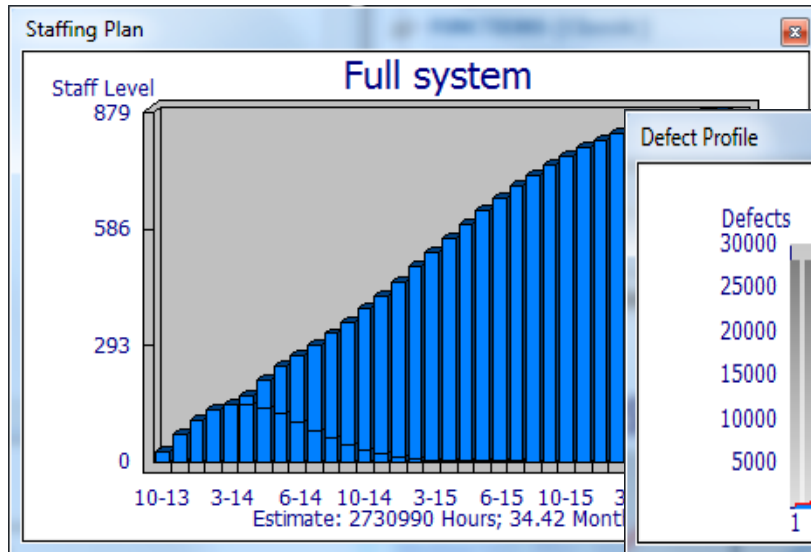
Source: Galorath's SEER-SEM Estimation Model



5 What kind of quality is delivered on delivery day?

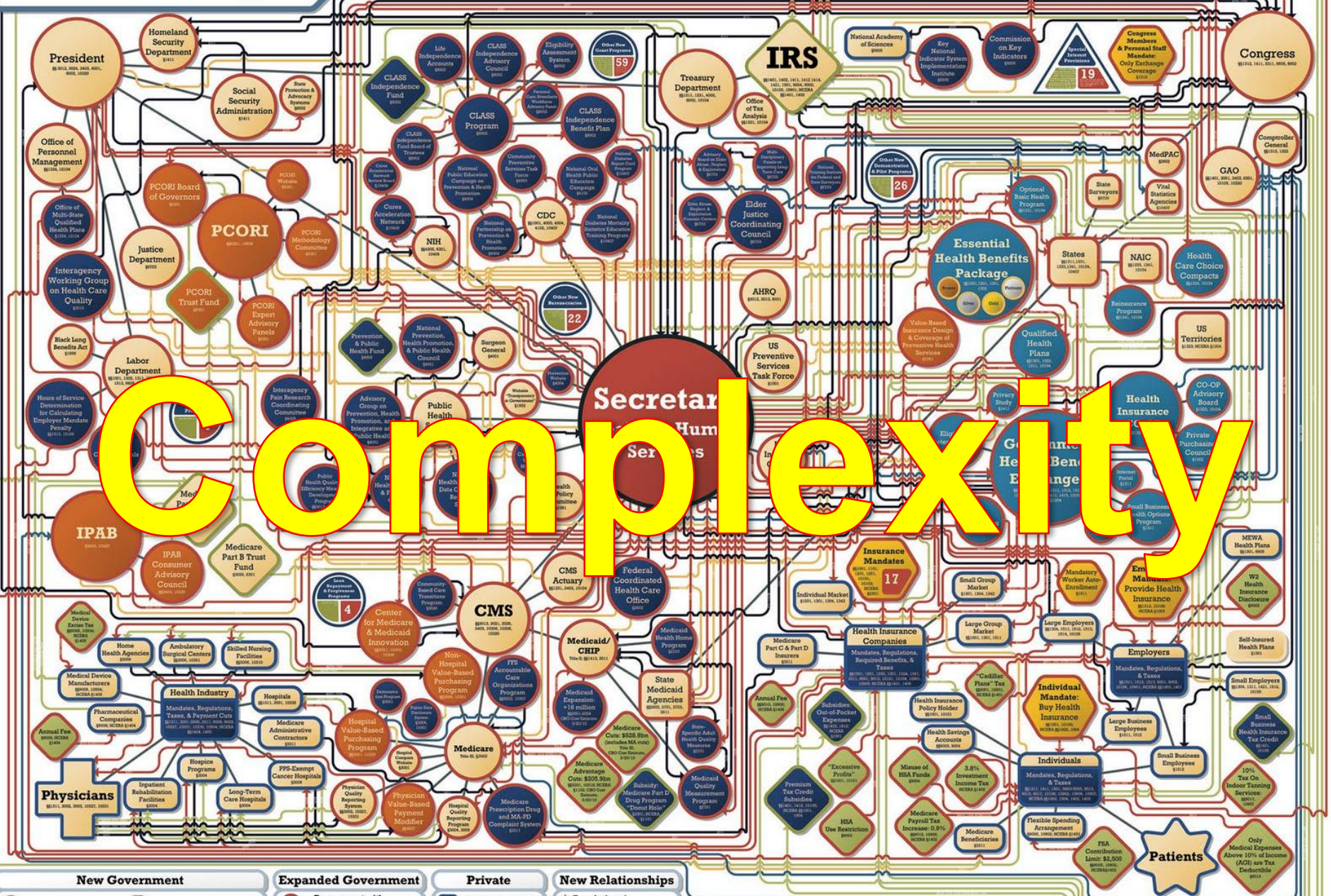


\$300M Buys About 1M Lines of Code (or 40K Function Points)



A photograph of Barack Obama sitting in a circle of ornate chairs in a formal room, surrounded by several other men in suits. The room features patterned wallpaper, framed portraits, and a blue patterned carpet. The text 'REQUIREMENTS' and 'VOLATILITY' is overlaid in yellow on the image.

REQUIREMENTS
VOLATILITY



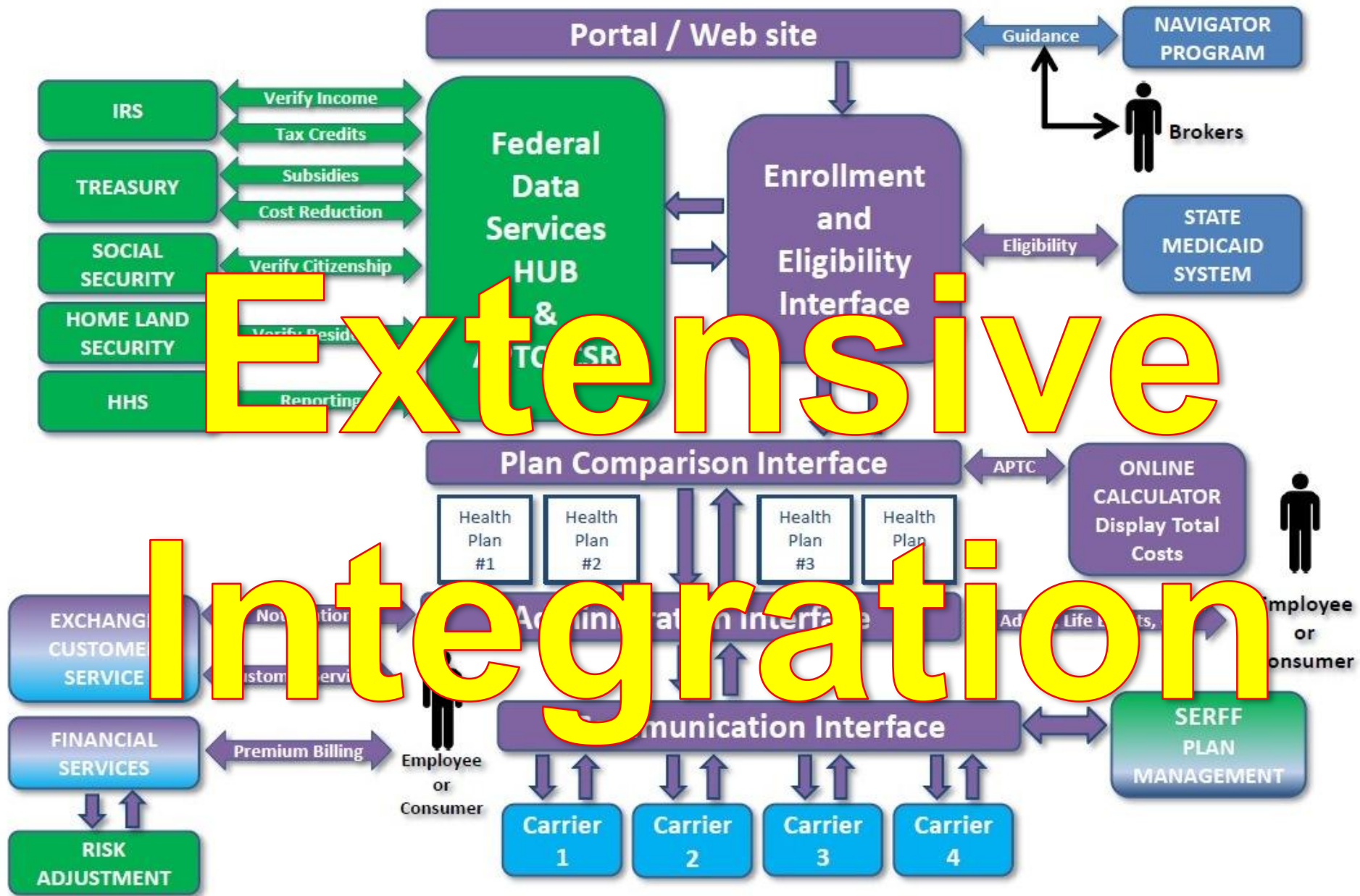
Complexity

- | New Government | Expanded Government | Private | New Relationships |
|--|--|---|--|
| <ul style="list-style-type: none"> Rationing Potential Involvement in Health Insurance Market Other Expansions Represents Bundles of Additional Entities | <ul style="list-style-type: none"> Mandates Taxes & Monetary Fees/Penalties/Cuts Trust Fund (Rationing Potential) Other New Trust Funds/ | <ul style="list-style-type: none"> Private Entity with New Mandates/Responsibilities Unchanged Private Entity Special Interest | <ul style="list-style-type: none"> Regulations/Mandates Reporting Requirements Oversight Money Flows Consultation/Advisory/Info Sharing Structural Connections |

AGL: Adjusted Gross Income
 AHRQ: Agency for Healthcare Research and Quality
 CDC: Centers for Disease Control and Prevention
 CHIP: Children's Health Insurance Program
 CLASS: Community Living Assistance Services & Supports
 CMS: Centers for Medicare & Medicaid Services
 CO-OP: Consumer Operated & Oriented Program
 FFS: Fee-for-Service
 FSA: Flexible Spending Arrangement
 GAO: Government Accountability Office
 HCERA: Health Care & Education Reconciliation Act
 HSA: Health Savings Account
 IPAB: Independent Payment Advisory Board
 IRS: Internal Revenue Service
 MA-PD: Medicare Advantage Prescription Drug
 MedPAC: Medicare Payment Advisory Commission
 MED: Medical Early Risk Detection
 ELM: CMS Executive Liaison Office Regional Teams
 MEWA: Multiple Employer Welfare Arrangement
 NAC: National Association of Insurance Commissioners
 NIH: National Institutes of Health
 PCORI: Patient-Centered Outcomes Research Institute

Patient Protection & Affordable Care Act, P.L. 111-148;
Health Care & Education Reconciliation Act, P.L. 111-152
 Prepared by: Joint Economic Committee, Republican Staff
 Congressman Kevin Brady, Senior House Republican
 Senator Sam Brownback, Ranking Member

Exchange Functions



Legacy Systems

Part 1
Health
Insurance
Marketplace

Part 2
October 1,
2013

Part 3
January 1,
2014

Part 1

Health Insurance Marketplace

Forced Deadline

There are 3 key dates you'll want to mark on your calendar:

- **October 1, 2013:** Marketplace open enrollment started

UAT	CCIO	█	Open E&E UAT - Testing involving analysis of the information dependent on the 22 logic drivers of eligibility and enrollment. Testers will use QSSI Test Scripts delivered to walk through a logical progression of as many screens as possible in an effort to validate the functionality delivered.	10/01/2013 - 10/04/2013
UAT	OC	█	UAT for E&E Consumer Web Experience and Functionality - JOLT 11	
UAT	SHOP	█	No report (testing not started)	

Lessons Learned





**MAINTAIN
STRONG AND ENABLED
LEADERSHIP &**

**Ensure each large IT project
has a senior person personally
accountable for success
or failure**





**Communicate
Constantly and Completely**

AT ALL LEVELS



Keep Requirements Stable

OR...

Trouble Starts By Ignoring Project / Program Iron Triangle Realities

- Typical Trouble: Mandated features needed within specific time by given resources

Scope (features, functionality)

Resources



Schedule

- At least one must vary otherwise quality suffers and system may enter impossible zone!



GoHealth[®]

eHealth

 GetInsured

Buy It Off the Shelf When

TOWERS WATSON



Feasible  Microsoft





Don't always

Blame

the Contractors

Front End Problems Appeared First (Source: CAST Software)

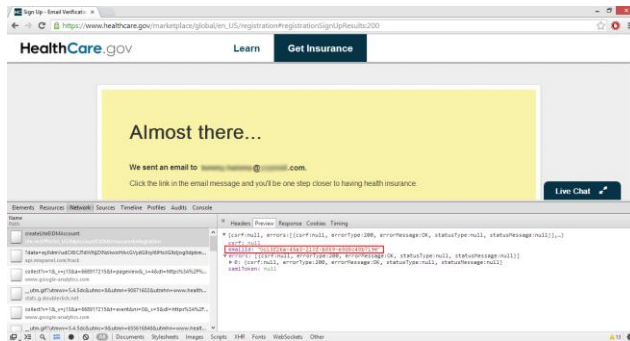
```
view-source:https://www.healthcare.gov/marketplace/global/en_US/registration#signUpStepOne
45 <![endif]-->
46 <!--[if lt IE 8]>
47 <script type="text/javascript" src="js/fonts-ie7.js"></script>
48 <![endif]-->
49
50 <!-- load the JQuery UI JS . Back to 1 file. -->
51 <script type="text/javascript" src="js/jquery-ui.js"></script>
52
53 <!-- load Base UI files under marketplace -->
54 <script type="text/javascript" src="js/underscore-1.3.1.full.js"></script>
55 <script type="text/javascript" src="js/ison2.js"></script>
56 <script type="text/javascript" src="js/backbone-0.9.2.full.js"></script>
57 <script type="text/javascript" src="js/cryptio-min.js"></script>
58 <script type="text/javascript" src="js/backbone.validations-fork.js"></script>
59 <script type="text/javascript" src="js/backbone-nested-1.1.2-fork.js"></script>
60 <script type="text/javascript" src="js/cms-common.js"></script>
61 <script type="text/javascript" src="js/jquery.alerts.js"></script>
62 <script type="text/javascript" src="js/jquery.blockUI.js"></script>
63 <script type="text/javascript" src="js/jquery.formatCurrency-1.4.0.js"></script>
64 <script type="text/javascript" src="js/jquery.collapsible.js"></script>
65 <script type="text/javascript" src="js/wait.js"></script>
66 <script type="text/javascript" src="js/jquery.hmode-detection.js"></script>
67 <script type="text/javascript" src="js/jquery.ui.widget.js"></script>
68 <script type="text/javascript" src="js/jquery.fileupload.js"></script>
69 <script type="text/javascript" src="js/jquery.iframe-transport.js"></script>
70
71 <script type="text/javascript" src="js/datenpicker.js"></script>
72
73 <script type="text/javascript" src="js/tabsv.js"></script>
```

Five times more Javascripts loaded than for a typical commercial website

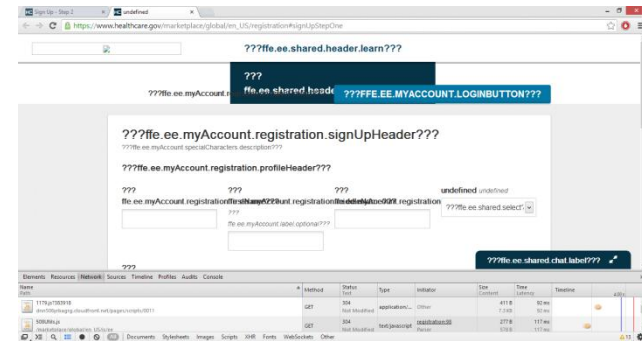
Many Javascripts not optimized to website responsiveness

Heavy custom font loaded rather than using those already available

Five analytics loaded compared to 1 or 2 for a typical commercial website



Verification key exposed without going to email

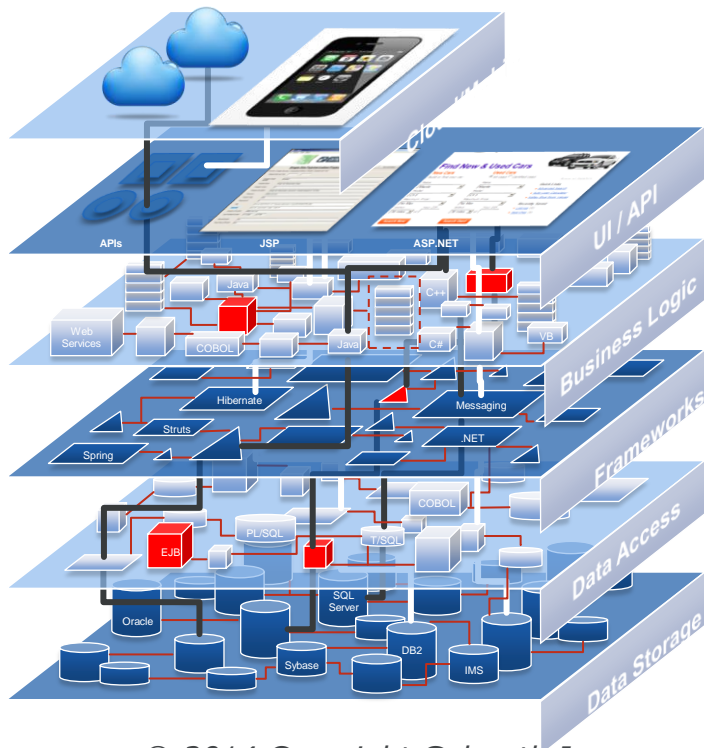


Text injection problem causing overwritten text

What Should Have Been Done (Source: Cast Software)

Continual analysis of quality:

- Component and system-level static analysis (*structural quality*)
- Full end-to-end testing (*primarily functional*)
- Dynamic analysis & stress testing (*performance and capacity*)
- Penetration testing (*security*)



System-wide structural analysis is imperative in large IT systems to detect the most critical killers of availability, security, performance — *Architecturally complex defects*

Start With A Reliable Estimate

"In the software world, we have ample evidence that our estimates stink, but virtually no evidence that people in general don't work hard or intelligently enough"

- Tom DeMarco, Why Does Software Cost So Much?

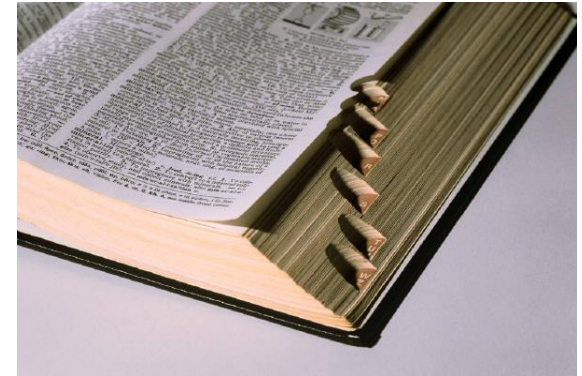
Key Points

Estimation
is critical
and Should
Be A Core
Process

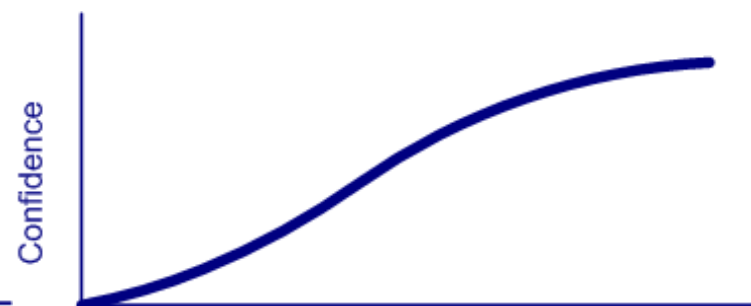
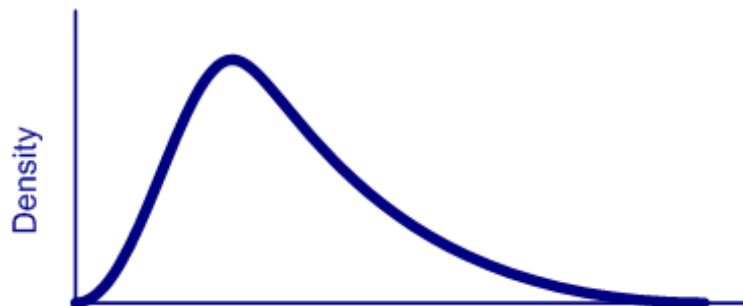
ESTIMATION & PLANNING:

An Estimate Defined

- An **estimate** is the most knowledgeable statement you can make **at a particular point in time** regarding:
 - Effort / Cost
 - Schedule
 - Staffing
 - Risk
 - Reliability

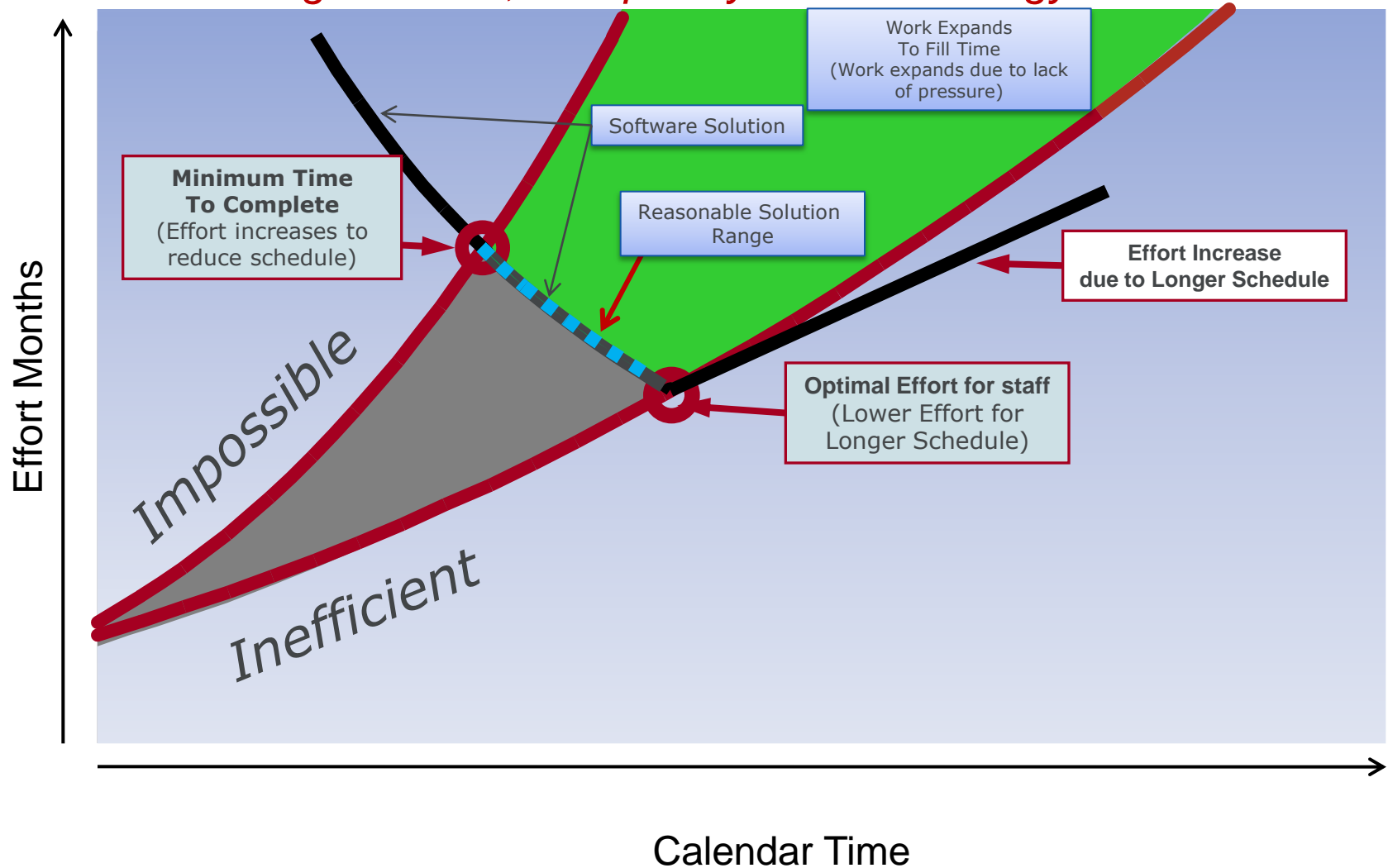


- Estimates more precise with progress
- ***A WELL FORMED ESTIMATE IS A DISTRIBUTION***



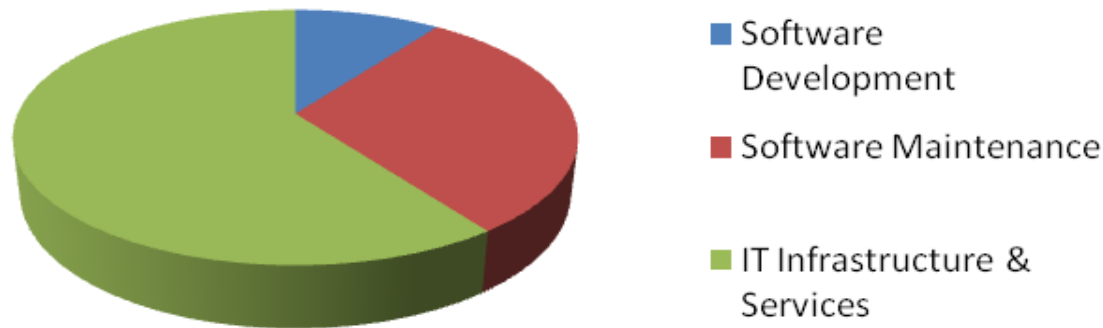
Sophisticated Schedule Modeling: Trading Effort and Schedule (Software Example)

For a given Size, Complexity and Technology



Evaluate Total Ownership Costs, Not Just Developments: IT Systems Total Ownership Costs; 60+% Can Be Infrastructure & Services

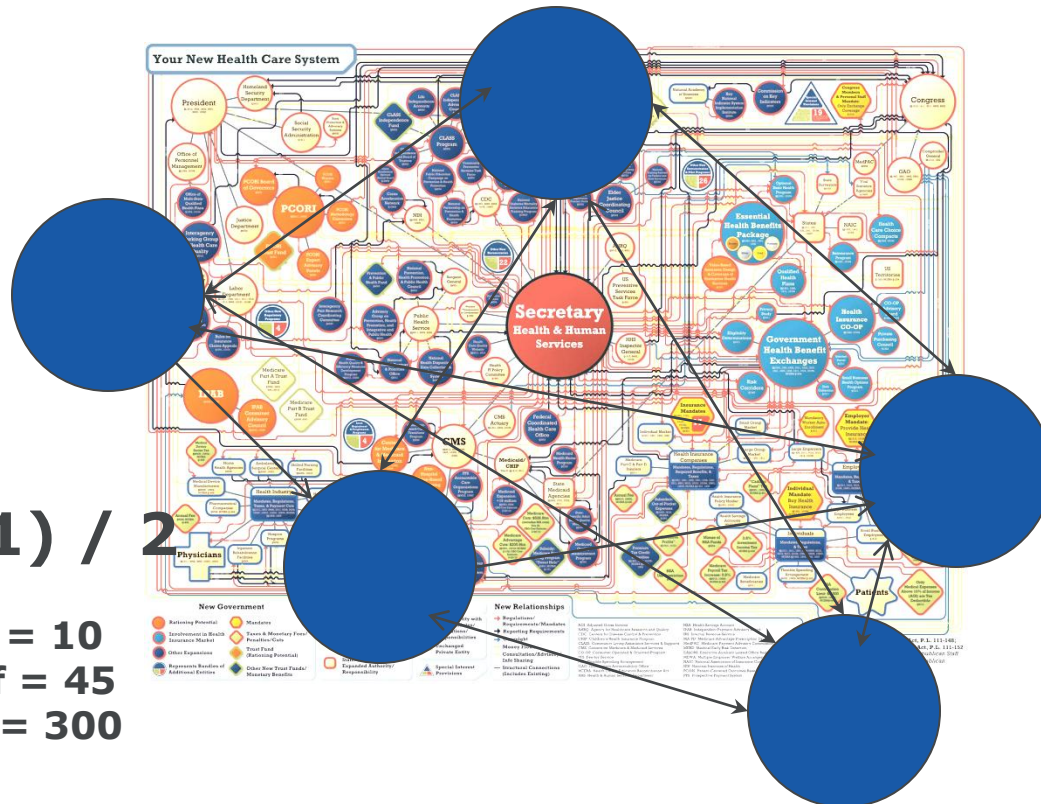
Total Ownership Cost: Typical Relative Cost By Activity



Software Development is about 6-10% of total ownership cost...But much more of the risk

Assume \$300m development could be over \$3b total ownership... But it must be done

Communications Are Challenging and Get Worse as Number of Organizations & Staff Increase



$$n(n - 1) / 2$$

5 Staff = 10
 10 Staff = 45
 25 Staff = 300

Why should we care: You can't usually make up schedule by adding staff

Problem Worse As Staff AND As Organizations Increase

Shipping Early Is Disastrous

Defects Analysis - Program: Data Analyzer

Time Phased Defects

Months From Estimate	Delivery Date	Hours	Est. Cost	Delivered Defects	Defect Density	Cost	Marginal Cost /
-8	6/30/08	28,330	3,187,117	268			
-7	7/30/08	31,121	3,501,165	230			
-6	8/30/08	33,996	3,824,578	197	5.6		
-5	9/30/08	36,938	4,155,528	167	4.79	701,316	11,033
-4	10/30/08	39,930	4,492,138	140	4.03	1,364,707	12,701
-3	11/30/08	42,956	4,832,523	117	3.36	-1,024,322	14,678
-2	12/30/08	45,998	5,174,829	97	2.78	-682,015	17,029
-1	1/30/09	49,042	5,517,264		2.29	-339,581	19,838
Estimate	3/02/09	52,061	5,856,845	65	1.87	0	23,120
1	3/30/09	55,073	6,195,760		1.51	338,916	27,366
2	4/30/09	58,033	6,528,697	42	1.21	671,853	32,171
3	5/30/09	60,938	6,855,538	34	0.56	998,694	38,131
4	6/30/09	63,778	7,175,022	27			
5	7/30/09	66,542	7,486,020	21			
6	8/30/09	69,223	7,787,538	16			

Example early ship shows 400%+ more defects than recommended

Example deferred ship shows fewer defects. Can't get to zero

Packaged Applications Still Require Significant Testing

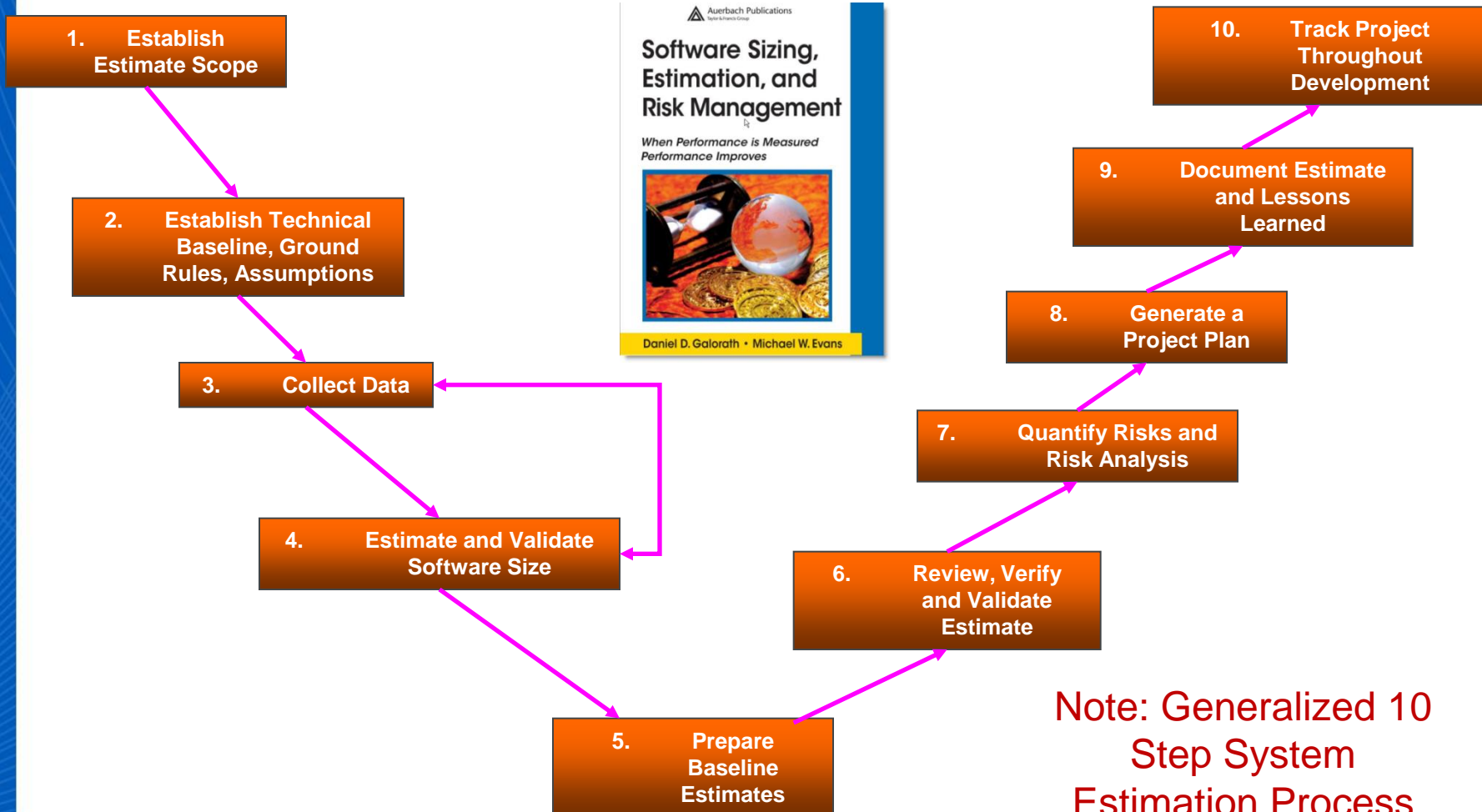


- Definition: "Commercial application program or collection of programs developed to meet needs of a variety of users, rather than custom designed for a specific organization"
- Many are enterprise applications
- Often allows / requires customization
- Examples: SAP; Rational PPM, SEER for Software; Microsoft Excel, CA Clarity, Oracle Business Suite

"One-third [of the budget] has to go to testing. Don't ever short change testing. Everyone always underestimates it, and says it's the last thing to worry about. Don't do that!"

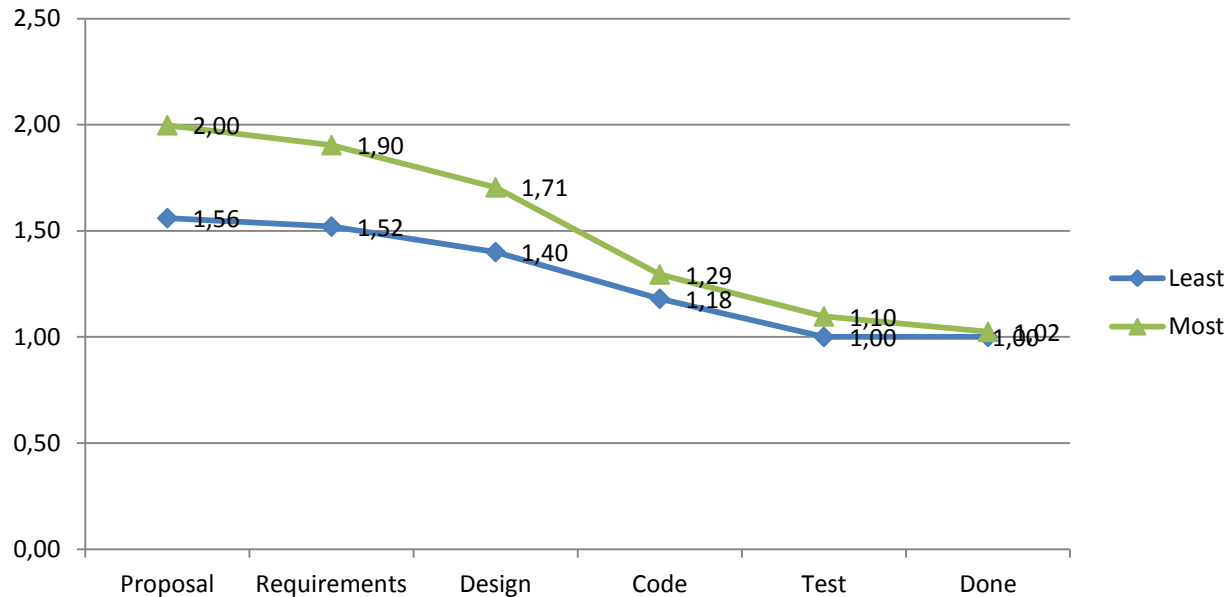
- Jim Larson, consultant for communications solutions provider

10 Step Software Estimation Process: Consistent Processes = Reliable Estimates = Successful Programs



Note: Generalized 10
Step System
Estimation Process
Also Available

Estimates and Plans Must Consider Functional Growth To Be Viable



- Growth Range From Initial Sizing To Delivery
- Probable Growth is often early 2 to 1 for systems during early concept
- Many tools & Databases to estimate size (e.g. ISBSG)

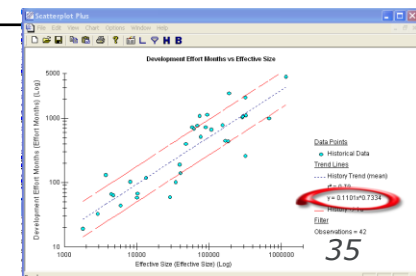
Why should we care: If functional growth (requirements creep) not considered overruns are likely

Estimation Methods - 1 of 2

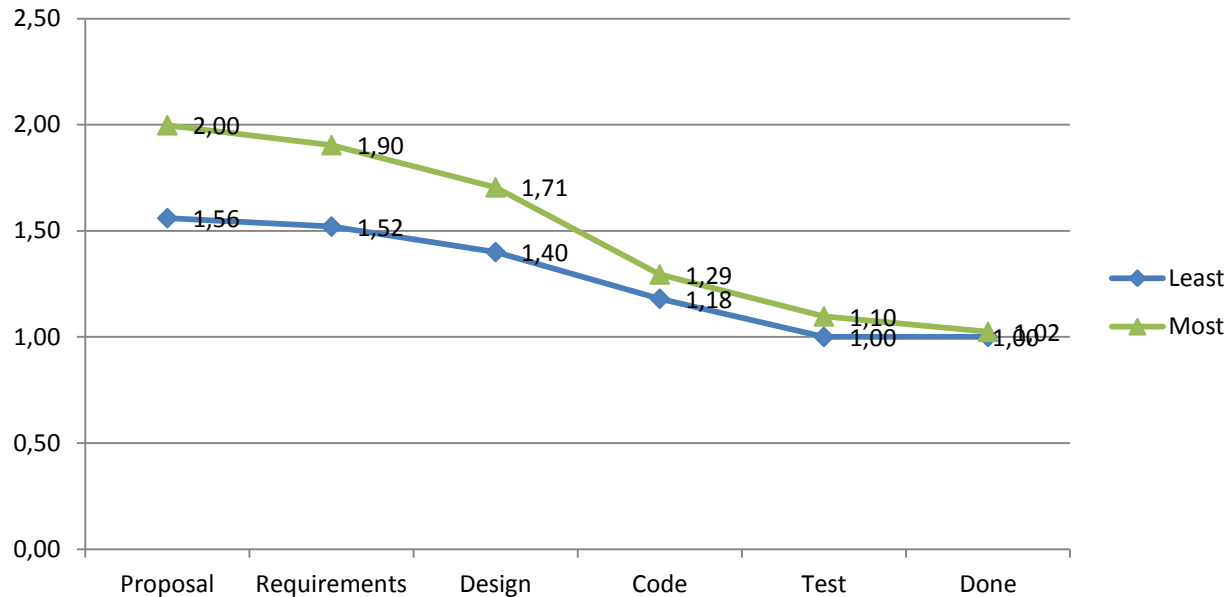
Model Category	Description	Advantages	Limitations
Guessing	Off the cuff estimates	Quick Can obtain any answer desired	No Basis or substantiation No Process Usually Wrong
Analogy	Compare project with past similar projects.	Estimates are based on actual experience.	Truly similar projects must exist
Expert Judgment	Consult with one or more experts.	Little or no historical data is needed; good for new or unique projects.	Experts tend to be biased; knowledge level is sometimes questionable; may not be consistent.
Top Down Estimation	A hierarchical decomposition of the system into progressively smaller components is used to estimate the size of a software component.	Provides an estimate linked to requirements and allows common libraries to size lower level components.	Need valid requirements. Difficult to track architecture; engineering bias may lead to underestimation.

Estimation Methods - 2 of 2

Model Category	Description	Advantages	Limitations
Bottoms Up Estimation	Divide the problem into the lowest items. Estimate each item... sum the parts.	Complete WBS can be verified.	The whole is generally bigger than the sum of the parts. Costs occur in items that are not considered in the WBS.
Design To Cost	Uses expert judgment to determine how much functionality can be provided for given budget.	Easy to get under stakeholder number.	Little or no engineering basis.
Simple CER's	Equation with one or more unknowns that provides cost / schedule estimate.	Some basis in data.	Simple relationships may not tell the whole story. Historical data may not tell the whole story.
Comprehensive Parametric Models	Perform overall estimate using design parameters and mathematical algorithms.	Models are usually fast and easy to use, and useful early in a program; they are also objective and repeatable.	Models can be inaccurate if not properly calibrated and validated; historical data may not be relevant to new programs; optimism in parameters may lead to underestimation.



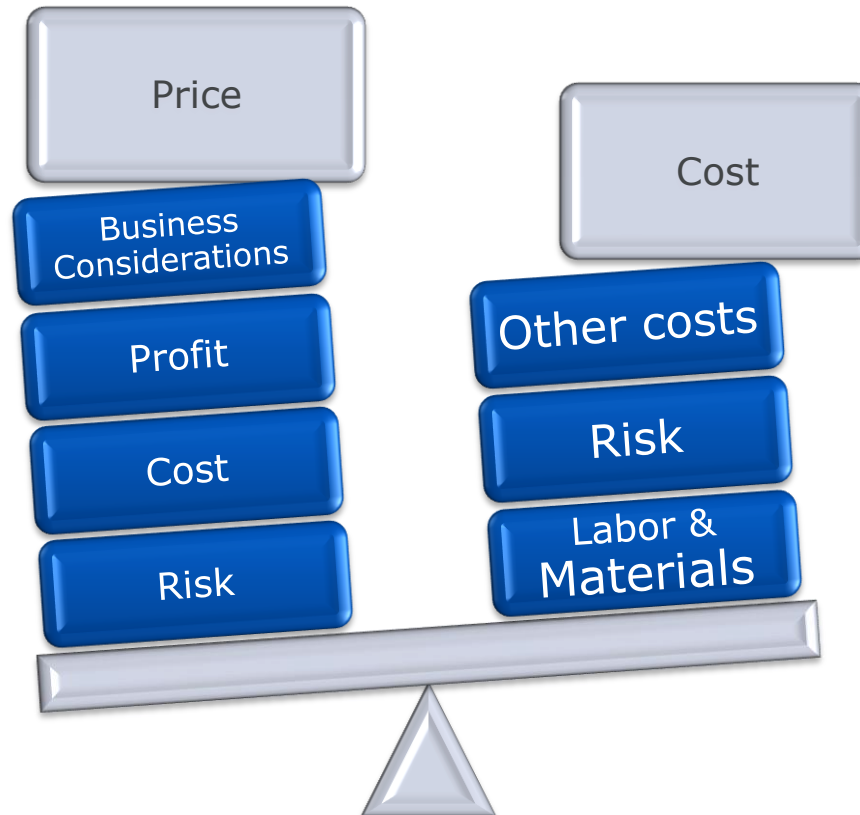
Estimates and Plans Must Consider Functional Growth To Be Viable



- Growth Range From Initial Sizing To Delivery
- Probable Growth is often early 2 to 1 for systems during early concept
- Many tools & Databases to estimate size (e.g. ISBSG)

Why should we care: If functional growth (requirements creep) not considered overruns are likely

Remember Cost and Price Are Different (Adapted from Morton)



- **Price:** Amount Charged to Customer (considering cost, profit, risk, Price to win, business considerations, etc.)
 - e.g. New Car - Discounts
 - e.g. Machinists - Idle
 - e.g. Golden Gate Bridge - Cables

Human Nature: Humans Are Optimists



HBR Article explains this Phenomenon:

- Humans seem hardwired to be optimists
- We routinely exaggerate benefits and discount costs

Delusions of Success: How Optimism Undermines Executives' Decisions (Source: HBR Articles | [Dan Lovallo](#), [Daniel Kahneman](#) | Jul 01, 2003)

**Solution - Temper with “outside view”:
Past Measurement Results, traditional forecasting, risk
analysis and statistical parametrics can help**

**Don't remove optimism, but balance optimism and
realism**

Dishwashing Experiment

You have just had a dinner party and the stir-fry, salad, fresh bread, apple pie and coffee were all great. Your guests have gone and it is time to clean up. Your dishwasher is broken and you need to hand-wash the dishes, silver, and pans listed below; and put them in the drying rack next to the sink. The dishes have been sitting randomly stacked in the sink and on the counter for a couple of hours, but no food is burned on.



You need to clean:

- 4 large dinner plates
- 4 desert plates
- 4 sets of silver (2 forks, knife and spoon)
- 4 sets of coffee cups and saucers
- 4 salad bowls
- 2 serving bowls
- Salad tongs

- Bread knife
- Pie serving knife
- 1 wok
- 1 sauce pan
- A pie pan
- A bread pan
- A cream pitcher
- Serving spoon

You have a sponge, scrub brush, dish washing soap and plenty of hot and cold water. After stacking the clean dishes in the drying rack, you need to make sure the 40 in (100cm) square counter top and sink are clean also.

Psychological Effects Tested (Source: JPL

<http://www.slideshare.net/NASAPMC/arthurcmielewski>)



1. Anchoring: Train the managers **not to anchor**
 2. Question & Answer Mismatch: Establish **proper Estimation Language** so questions compatible with common interpretation
 3. Decomposition: Deep **decompositions may not improve accuracy**
 4. Reserve Comfort Calculate the **reserve based on risk**
 5. Planning Fallacy: People plan for likely case instead of including risk
- 507 volunteers
 - 142 JPLers, 305 college students and 60 other adults. ~2300 data points were collected

Anchoring Causes Flawed Estimates

Objective: Test how easily influenced people may be by wrong answer – “the anchor.”

The anchor set asked:

“Estimate how many minutes it will take you to clean the kitchen. One respondent estimated that it will take about 10 minutes to finish cleaning up. He may be wrong of course.”

- Nominal 30 min, anchored case 25 min
- Best case estimate was 27 min
- 2 min LONGER than the anchored result
- Conclusion: easy to dramatically skew estimates by asking anchored questions, such as:
 - “We would like you to come in around \$6M”
 - “I have a target of \$400k for you”
 - “the last robot arm we built cost \$7M”...

Question & Answer Mismatch R (Source:

JPL <http://www.slideshare.net/NASAPMC/arthurcmielewski>)



- Test for mismatch between expected and provided
- Different participants were asked:
- “Estimate how many minutes it will take you to clean the whole kitchen”
 - There is a 50% chance you will finish within ___ min
 - There is a 75% chance you will finish within ___ min
 - There is a 99% chance you will finish within ___ min
- 50% confidence estimate 31 min
- nominal estimate 30 min
- People interpret nominal 50% case (Meaning you will exceed estimate in half the cases)
- But manager probably more reliable result, probably in the 70%-90% confidence range...

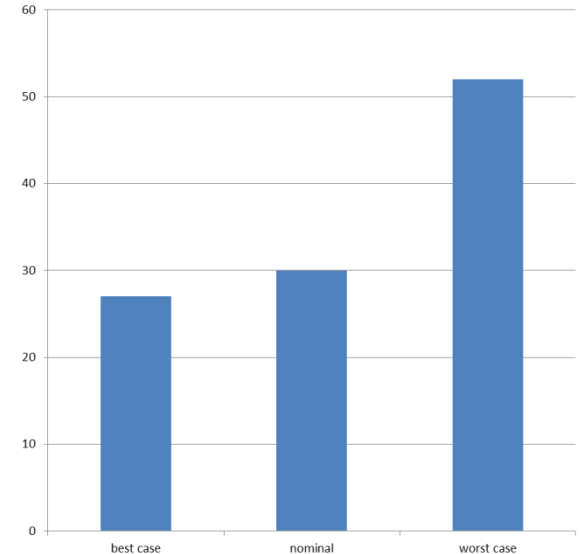
This is why we say a complete estimate must include a probability

Planning Fallacy Results (Source: JPL)

<http://www.slideshare.net/NASAPMC/arthurchmielewski>



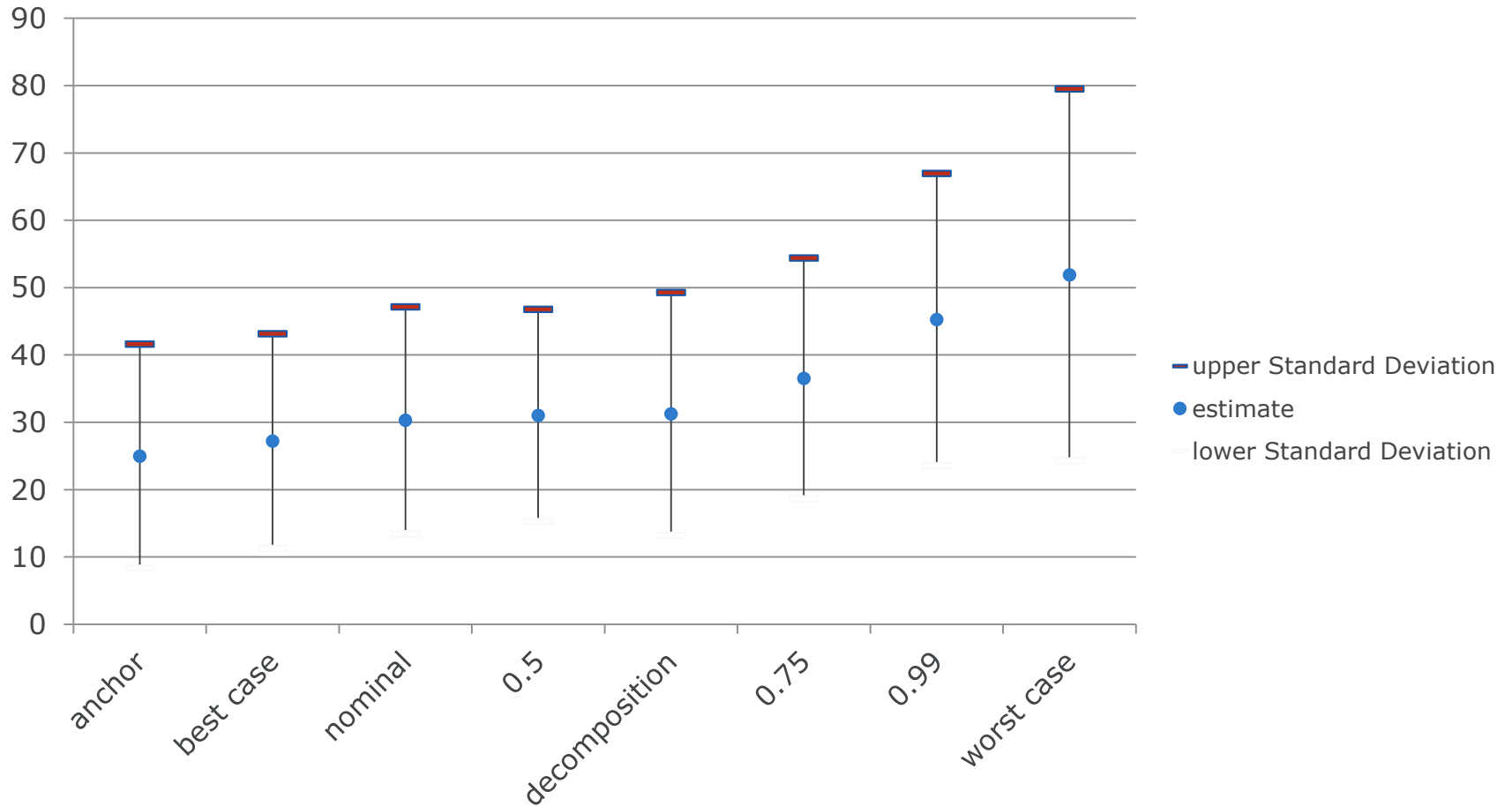
- The following results were obtained:
 - 51 min worst case
 - 45 min 99% confidence
 - 30 min nominal
 - 27 min best case
- People skewed people toward optimism
- Nominal estimate 10% longer than best case but 70% shorter than the worst case



People are so optimistic that it was easy to anchor them down but anchoring up failed

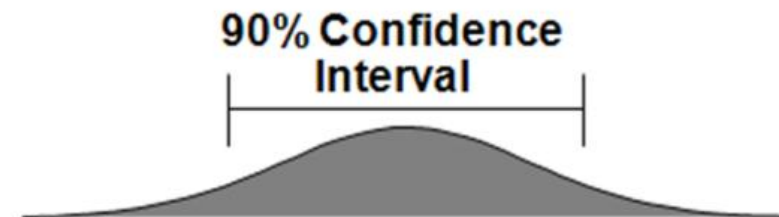
Answers Analysis (Source: JPL

<http://www.slideshare.net/NASAPMC/arthurchmielewski>)



Assumptions, Change Drivers & Expert Judgment Need Caution (Source: Hubbard)

- Most people are significantly **overconfident** about their estimates ... especially educated professionals



Group	Subject	% Correct (target 90%)
Harvard MBAs	General Trivia	40%
Chemical Co. Employees	General Industry	50%
Chemical Co. Employees	Company-Specific	48%
Computer Co. Managers	General Business	17%
Computer Co. Managers	Company-Specific	36%
AIE Seminar (before training)	General Trivia & IT	35%-50%
AIE Seminar (after training)	General Trivia & IT	~90%

(AIE = Hubbard Generic Calibration Training)

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Key Points

Viabile
Estimation Can
help achieve
affordable
systems with
optimal ROI



Galorath Affordability Process 1.3: Use An Affordability Process To Determine Best Value



Pricing strategies assumed in step 7. Since price is a figure of merit

Step 1 Key Performance Parameters (KPPs)

Step 1. Procure
Key Performance
Parameters that
are inviolate



- **Key Performance Parameters Defined:** Critical subset of performance parameters, capabilities and characteristics **so significant that failure to meet them can cause concept or system selected to be reevaluated or the project reassessed or terminated.** (Adapted from Glossary of Defense Acquisition)



Should These Have Been KPP's (Cloud Black Swan Examples)



<http://www.datacenterknowledge.com/archives/2012/12/05/the-cloudy-side-of-cloud-computing/>

- **Security & Breaches:** Anticipate growing Malicious attacks and accidental data loss
- **Outages:** 2007- late 2012 **568 hours downtime** between 13 major cloud carriers. Cost the customer base about **\$72 million** (International working group on cloud computing resiliency)
- **Learning curve:** Successful cloud model takes knowledge around multiple technological disciplines. Once in place, however, managing can also be issue
- **Vendor lock-in:** Migrating cloud environment to another provider difficult... Not often considered
- **Data portability and porting costs**
- **Software modification Costs (PaaS)**
- **Software Setup (SaaS)**

Step 2. Identify Weighted Affordability Goals & Figures of Merit

- **Figure of merit:** A quantity used to characterize the performance of a device, system or method, relative to its alternatives e.g.
 - Cost
 - Response time of a computing action
 - Survivability
 - Calories in a serving
 - digital camera resolution
 - Battery life
 - Coverage
 - Is the cloud secure enough?
 - Is the cloud fast enough?
- Other figures of merit for this system?

Used to compare alternatives
For example more cheaper UAVs may provide better coverage for the same \$ than fewer more powerful UAVs

Building Weightings

- Allocate weights to each figure of merit IN advance
 - KPPs should be ok'ed to get here
- Gives appropriate priority to each
- Consider using expected value when decisions are financial
- Intuition can be valuable but is not repeatable

Step 3 Gather Requirements, Features, Performance

Step 3. Gather
Requirements,
Features,
Performance



- Functional requirements:
Describe interactions between the system environment independent of implementation
 - Watch system must display time based on location
- Nonfunctional requirements: User visible aspects of the system not directly related to functional behavior
 - Response time must be less than 1 second
 - Accuracy must be within a second
 - Watch must be available 24 hours a day except from 2:00am-2:01am and 3:00am-3:01am
- Groundrules: Imposed by the client or the environment in which the system will operate
 - The implementation language must be COBOL.
 - Must interface to the dispatcher system written in 1956

Step 4. Define Technical Baseline Alternatives & Assumptions

Step 4. Define
Technical Baseline
Alternatives &
Assumptions



- Functionality included in the estimate or range must be established
 - Defines technical goals, objectives, and scope and provides the basis for estimating project cost and schedule. is managed and communicated in a structured and planned way DAU
 - A living, revised document, set of documents, database, etc.
 - When detailed functionality is not known, groundrules and assumptions state what is and isn't included in the estimate
 - Issues of COTS, reuse, and other assumptions should be documented as well

Ground Rules & Assumptions

- Groundrule: given requirement of the estimate (e.g. software must support windows and Linux)
- Assumption: assumed to scope estimate
 - Early they are preliminary & rife with uncertainty
 - they must be credible and documented
 - Review and redefine these assumptions regularly as the estimate moves forward
- What's known, what's unknown
- Anything relating to scope
 - What's included, what's excluded
- Anything relating to modeling inputs
 - Who you interviewed and when
 - What you learned

Identify and Rate Risky Assumptions

Step 5 Perform Technical Design Analysis For Each Alternative

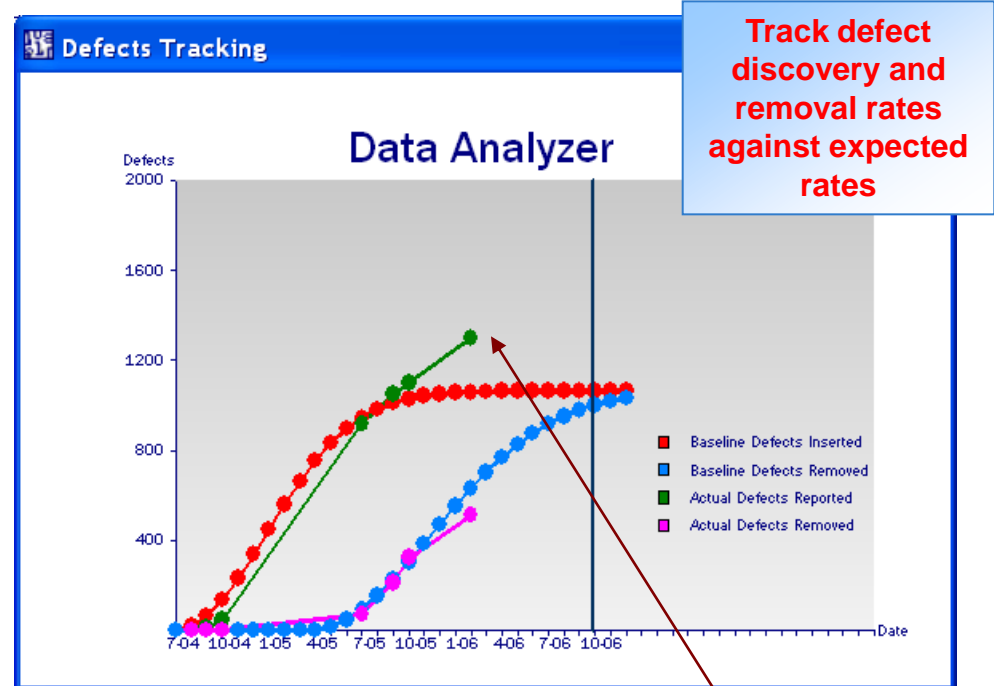
Step 5. Perform
Technical Design
Analysis for Each
Alternative



- Functions needed to satisfy requirements
- For example, to perform any science measurement you will need
 - Sensor (detector system)
 - Power the sensor (power system)
 - Read data from the sensor (data acquisition system)
 - Store data (data archive system)
 - Control sensor, readout, storage (control system)
 - Analyze data (ground data system)
- COTS, Reused, GOTS, New Development, etc.
- These functions will also need to have a set of requirements specified
 - Power system shall supply volts & milliamps to the sensor, data acquisition, archive and control systems

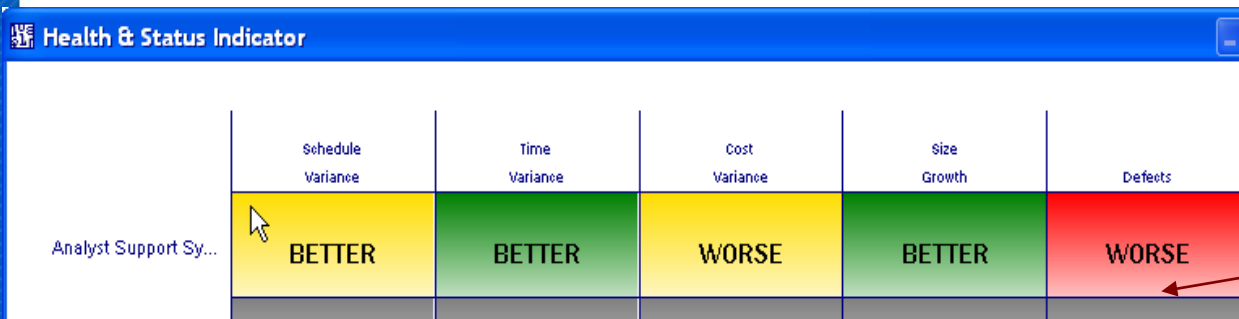
EXAMPLE: Software Progress and VIABLE SHIP DATE Can Be Determined By Defect Insertion & Removal

Health and Status Indicator shows status and trends from the previous snapshot
Thresholds are user definable



Track defect discovery and removal rates against expected rates

Increased defect reporting rate shows a worsening trend



EXAMPLE: IT Services Costs Must Consider Service Level Required

- High profile public system will have limited tolerance for down time
- Plan for equivalent of gold SLA when staffing operational support

Service Level Agreement (Application Support)

Notes: Maximize Note...

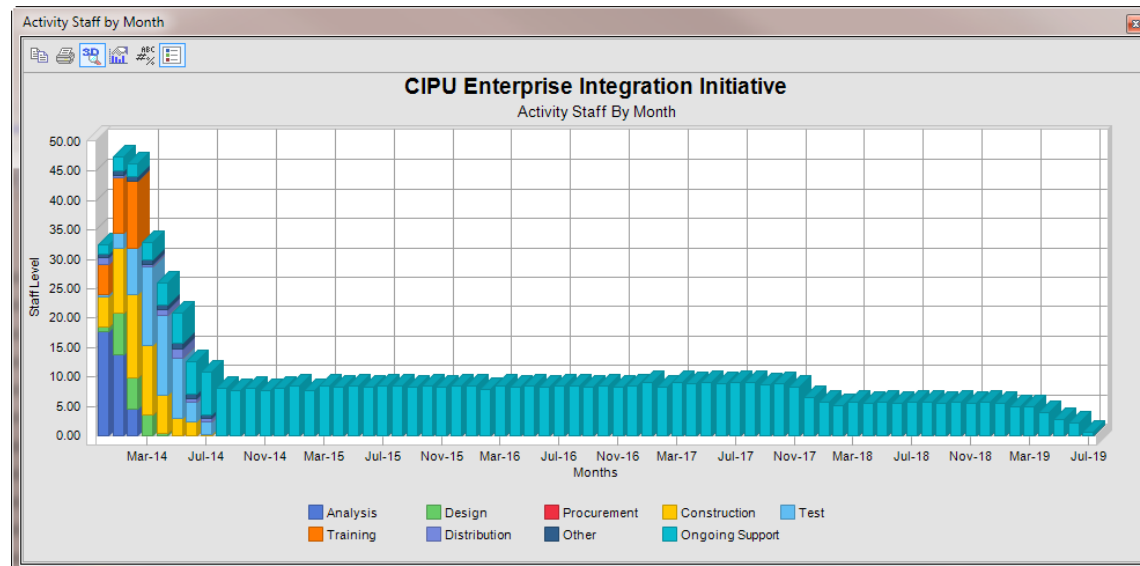
Least: HI, Likely: VHI, Most: VHI

OK, Cancel, KBase, Previous, Next, More Help

Service Level Agreement (Application Support)
Service level target benchmark for application support, often measured as a percentage of calls answered within a definite timeframe. Note that specific targets and SLA levels vary widely depending on the industry and the nature of the help desk.

Rating	Description
Very High	Acknowledged within 15 minutes and fixed within 2 hours (Gold).
High	Acknowledged within 1 hour and fixed within 4 hours.
Nominal	Acknowledged within 4 hours and fixed within 8 hours (Silver).
Low	Acknowledged within within 24 hours and fixed within 48 hours (Bronze).
Very Low	Acknowledged within 2 business days and fixed within 5 business days (Basic).

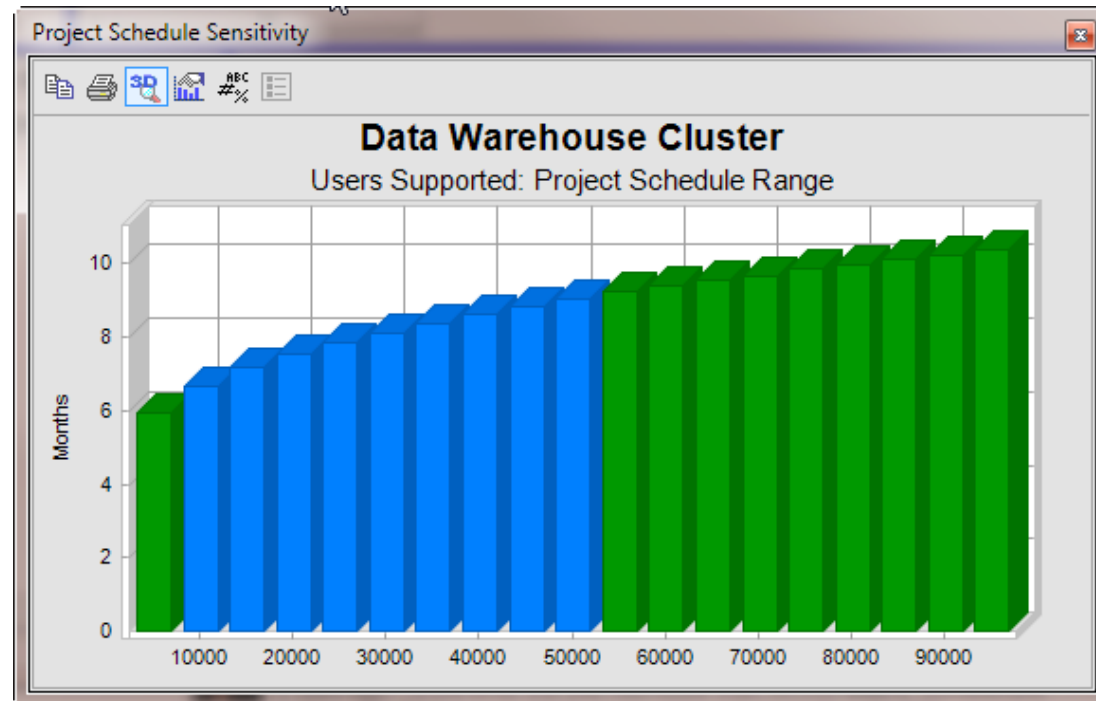
Each rating may be modified by a plus or a minus to indicate actual ratings that are slightly higher or lower than what is indicated on the scale. For example, Nominal+ would be slightly higher than Nominal and Nominal- would be slightly lower.



Up front testing needs more people.... Support must keep people ready to support users

EXAMPLE: Test In Production Environment To Avoid Surprises

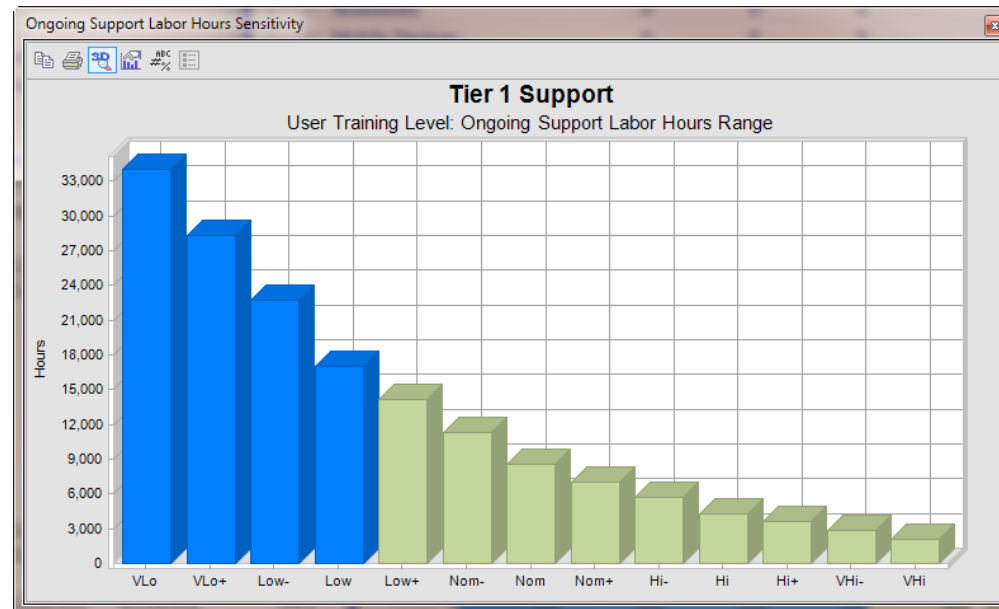
- High profile new site can expect a surge of concurrent users
- Don't field without knowing concerns
- Anticipated concurrent users increase test time dramatically



Example shows nearly 40% additional test time going from 10k to 50k concurrent users

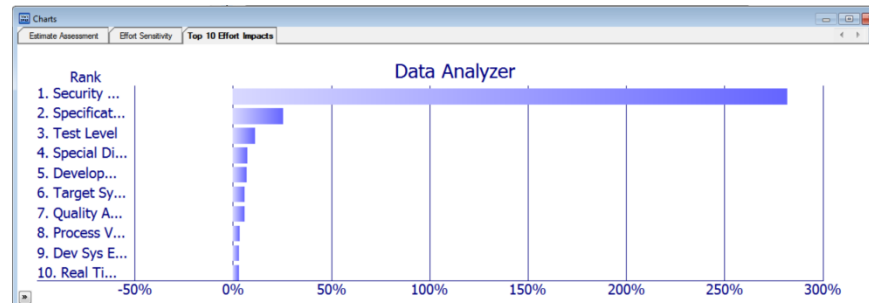
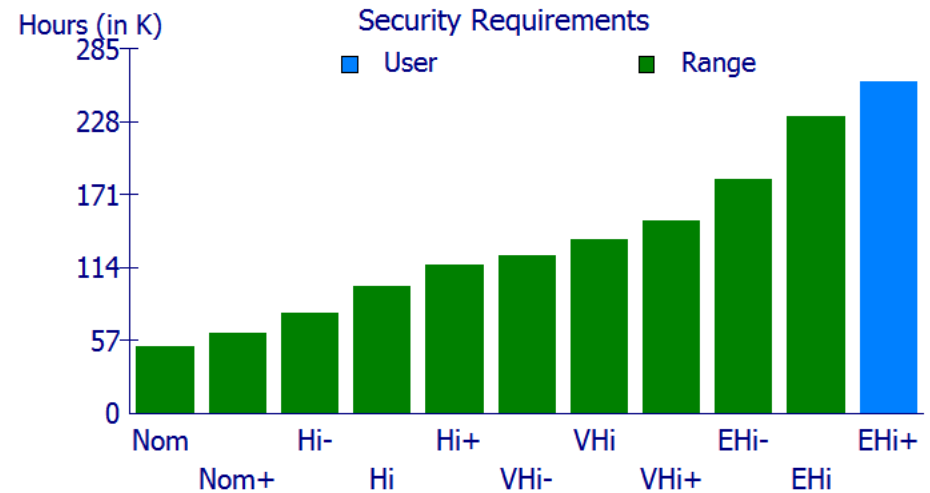
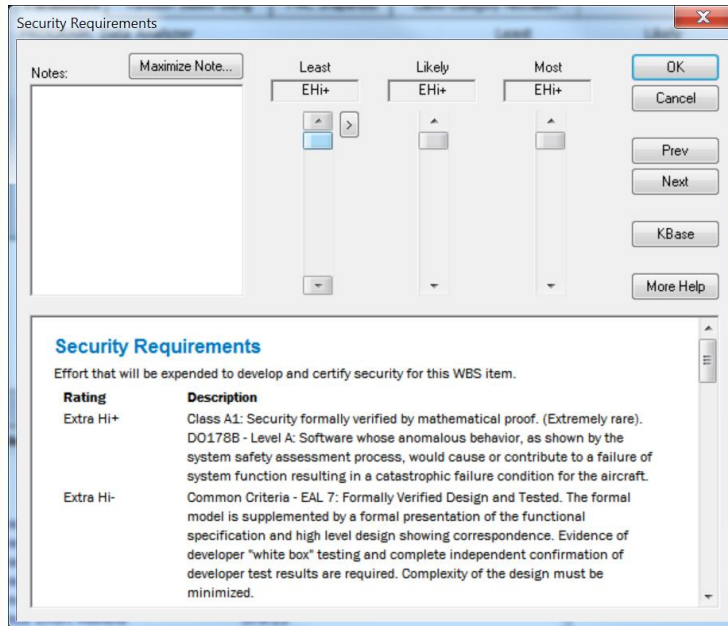
EXAMPLE: Minimal User Skill Increases Support Required

- Tier 1 support is inversely proportional to user training and skill
- Users will have no prior knowledge of system or procedures which will drive help desk staffing



Plan for this pain even
if the system runs perfectly

EXAMPLE: Software Implemented Security and Safety Requirements Add Significant Cost & Schedule



Why should we care: Software implemented security and safety requirements can drive costs thru the roof

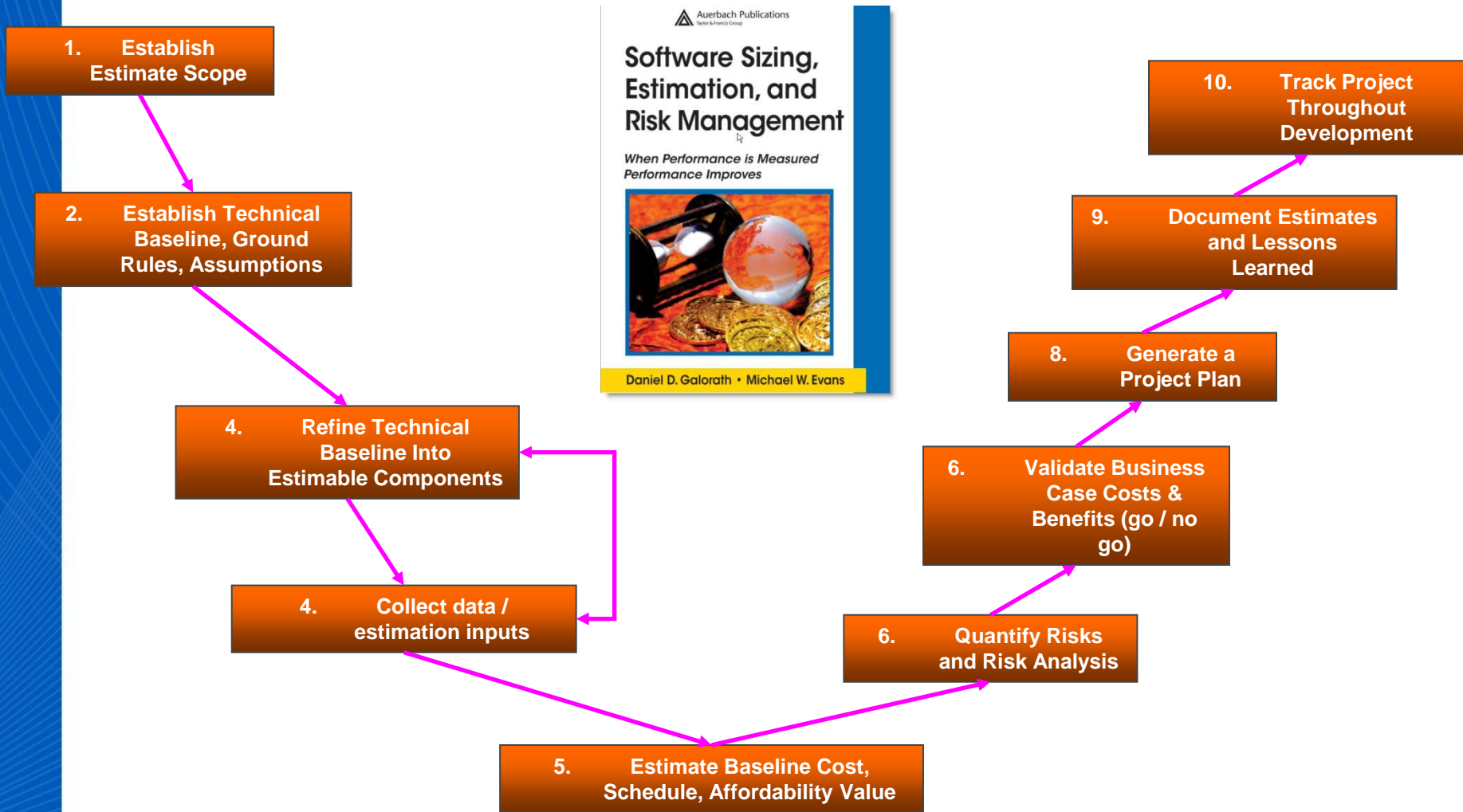
Step 6. Perform Cost Schedule Analysis of Each Alternative

Step 6. Perform
Cost Schedule
Analysis of Each
Alternative

- Estimating is critical for all kinds of systems
 - Yet many treat it as a second rate process
- Everyone estimates.... Just most get it wrong and don't have a process
- Having a repeatable estimation process is critical to both estimating AND to successful projects
- Estimation and measurement go hand in hand

Cost & Schedule was covered in previous slides

Use An Estimating Process (Generalized 10 Step System Estimation Process 2011)



Example: Project Cost Alone Is not The Cost of IT Failure (Source: HBR)

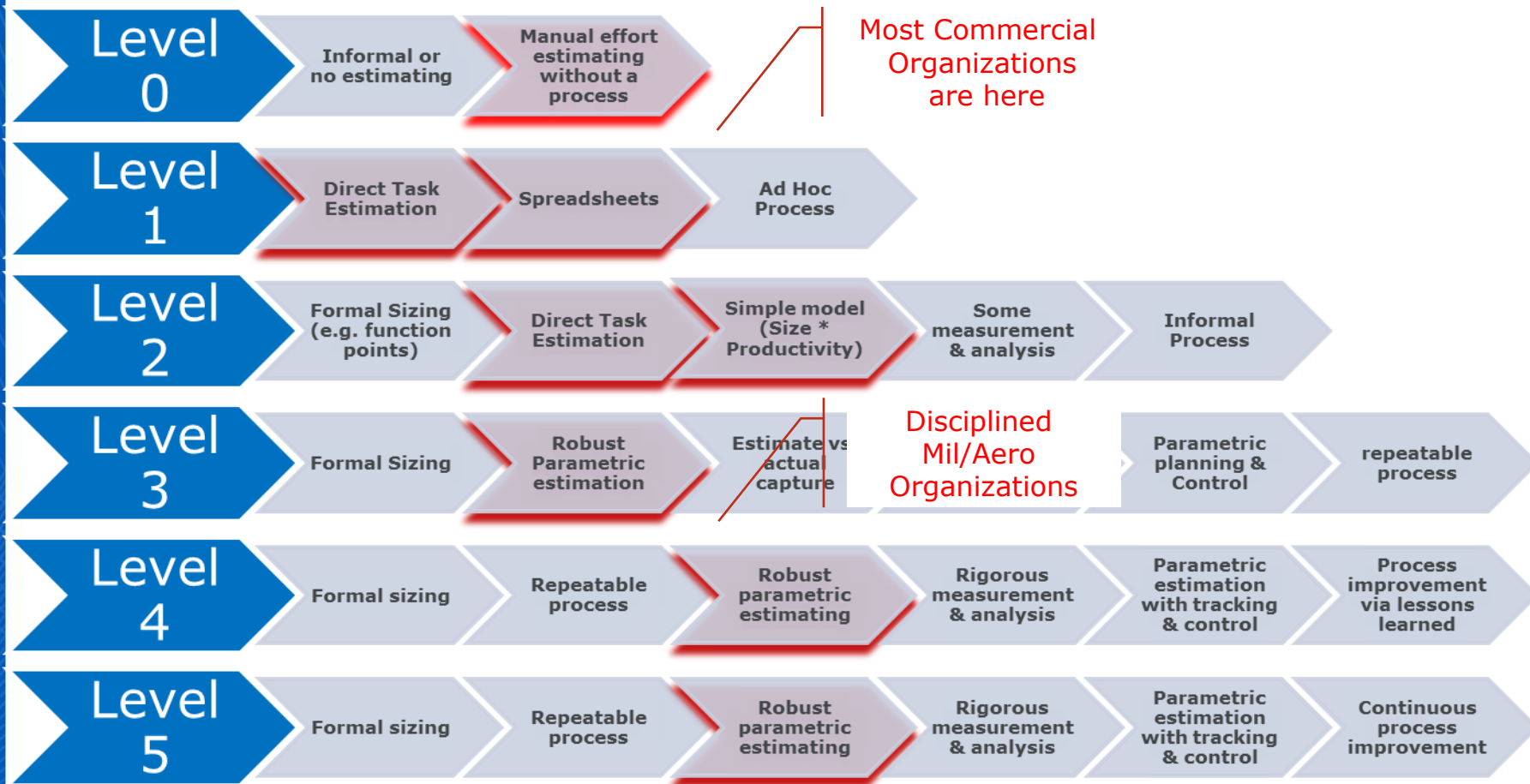


- Case Study: Levi Strauss
 - \$5M ERP deployment contracted
 - Risks seemed small
 - Difficulty interfacing with customer's systems
 - Had to shut down production
 - Unable to fill orders for 3 weeks
 - **\$192.5M charge against earnings on a \$5M IT project failure**

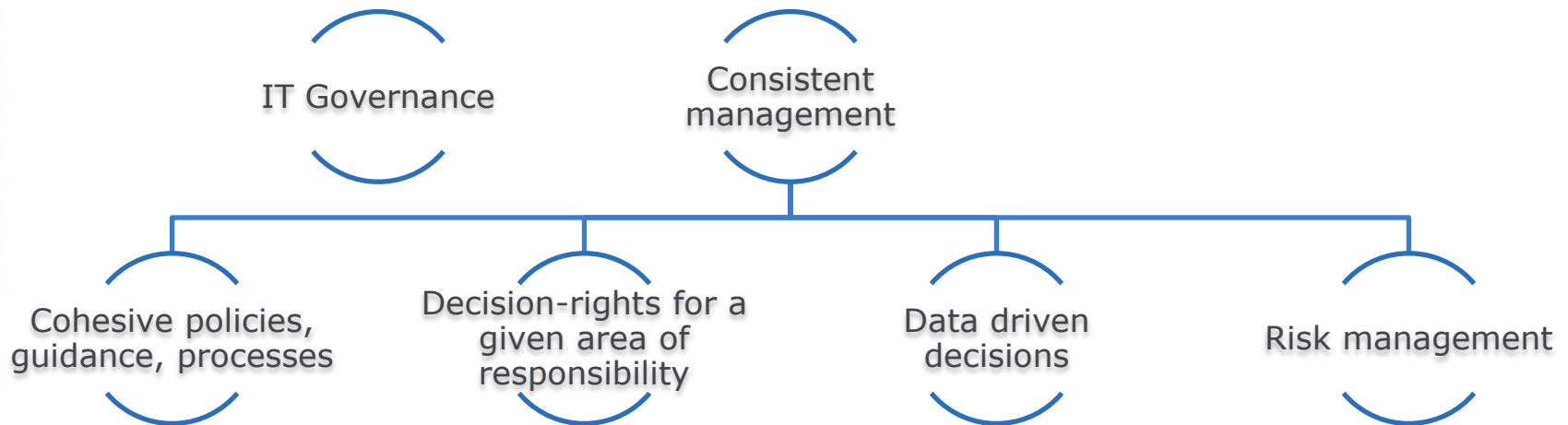


"IT projects touch so many aspects of organization they pose a new singular risk"

What Is the Galorath Estimation Maturity Scale?



Example: State-of-the-Practice IT Governance Needs Data For Decisions



Measurement and Tools are enablers for project success: The core goal of IT governance

Do Estimates And Measurements Really Drive Results?

Companies that measure:

On-time projects: 75%

Late projects: 20%

Cancelled projects: 5%

Defect removal: > 95%

Cost estimates: Accurate

User satisfaction: High

Software status: High

Staff morale: High

Companies that don't:

On-time projects: 45%

Late projects: 40%

Cancelled projects: 15%

Defect removal: Unknown

Cost estimates: Optimistic

User satisfaction: Low

Software status: Low

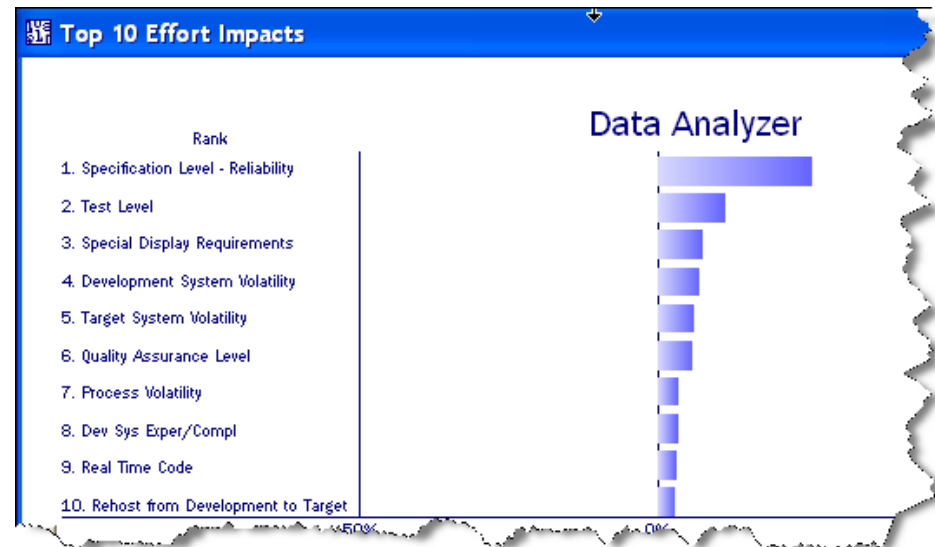
Staff morale: Low

- Software Productivity Research (2007)

Most everyone estimates... the problem is they are usually wrong... they guess, make it up, accept what they are told for delivery, etc...

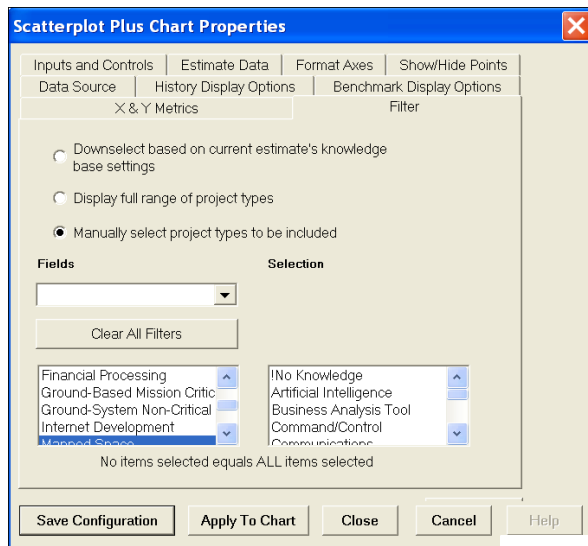
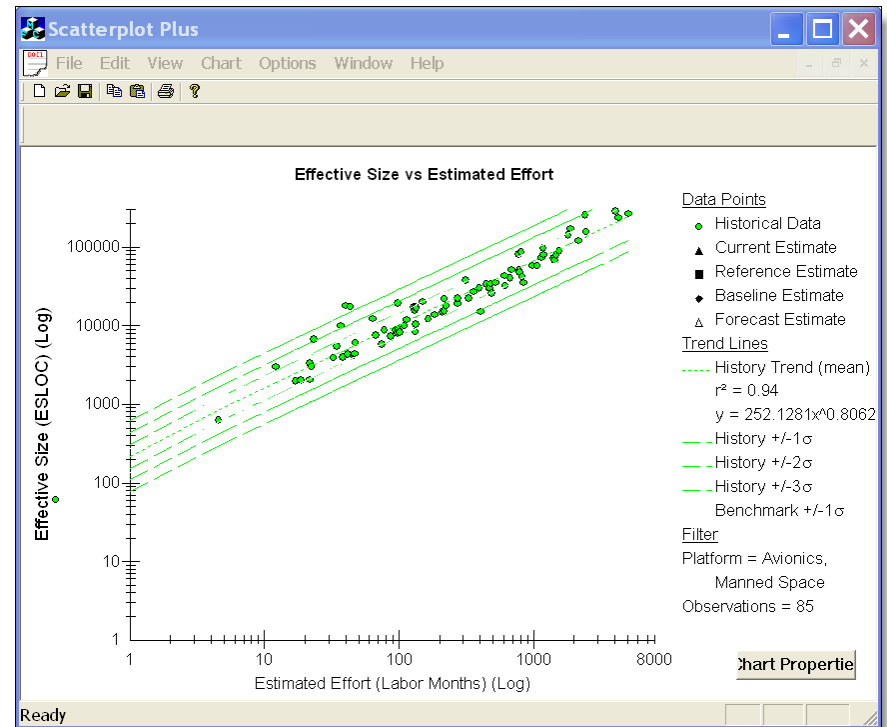
Generate the Estimate

- Using chosen methodology and tool, do a first run
- Never report preliminary results!
- Focus on the inputs
 - Verify completeness
 - Verify accuracy
- Focus on the outputs
 - Sanity check for reasonableness, completeness
- What's driving the estimate?
 - Top ten parameters
- Use "fresh eyes" to review
 - Ask a colleague for help
 - Set aside overnight



Compare Parametrics With Metrics and Sanity Checks

- Works with common repository
- Shows actual data, ranges, and correlations
- Plots parametric estimates and contrasts with data points
- Plots actual data and / or trends



Scatterplot Plus Chart Properties

Inputs and Controls | Estimate Data | Format Axes | Show/Hide Points

Data Source | History Display Options | Benchmark Display Options

X & Y Metrics | Filter

Downselect based on current estimate's knowledge base settings

Display full range of project types

Manually select project types to be included

Fields | **Selection**

Clear All Filters

Financial Processing	No Knowledge
Ground-Based Mission Critic	Artificial Intelligence
Ground-System Non-Critical	Business Analysis Tool
Internet Development	Command/Control
Manned Space	Communications

No items selected equals ALL items selected

Save Configuration | Apply To Chart | Close | Cancel | Help



"In God we trust,
all others bring data."

- W. Edwards Deming

Step 7. Assess Benefits Based on Figures of Merit

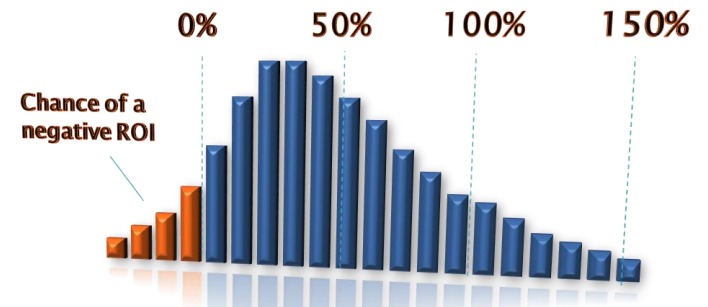
Step 7. **Assess**
Benefits Based on
Figures of Merit

- Return on Investment often main criterion in IT systems

ROI Analysis of A New System



ROI Forecast (over 5 years)



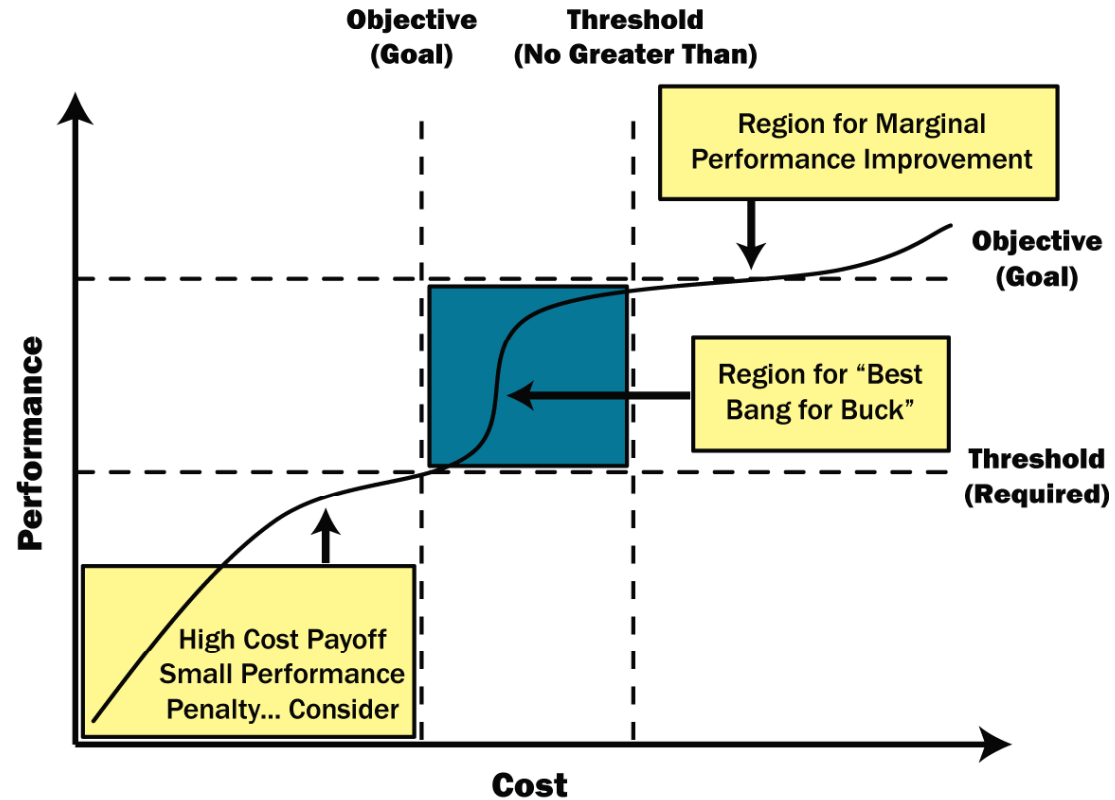
Cost of capital 8.0%

	Initial Investment	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total Ownership
Investment	\$100,000								\$100,000
Increase/(dec.) in revenue		(\$40,000)	\$60,000	\$110,000	\$100,000	\$100,000	\$150,000	\$150,000	\$630,000
Increase/(dec.) in op. exp.		\$90,000	\$70,000	\$70,000	\$22,000	\$24,000	\$27,000	\$28,000	\$331,000
Cash Flow	(\$100,000)	(\$130,000)	(\$10,000)	\$40,000	\$78,000	\$76,000	\$123,000	\$122,000	\$199,000
PV of Cash Flow	(\$100,000)	(\$120,370)	(\$8,573)	\$31,753	\$57,332	\$51,724	\$77,511	\$71,186	\$60,563
NPV	60,563								\$60,563
IRR	13.5%								13.5%
ROI	121%								121.1%

A Complete ROI analysis should analysis risk and uncertainty as well as likely

Affordability Trades (Source NASA Space Systems Engineering)

“Best Bang for the Buck”



Augustine’s Law of Insatiable Appetites
The last 10 percent of performance generates $\frac{1}{3}$ of the cost and $\frac{2}{3}$ of the problems.

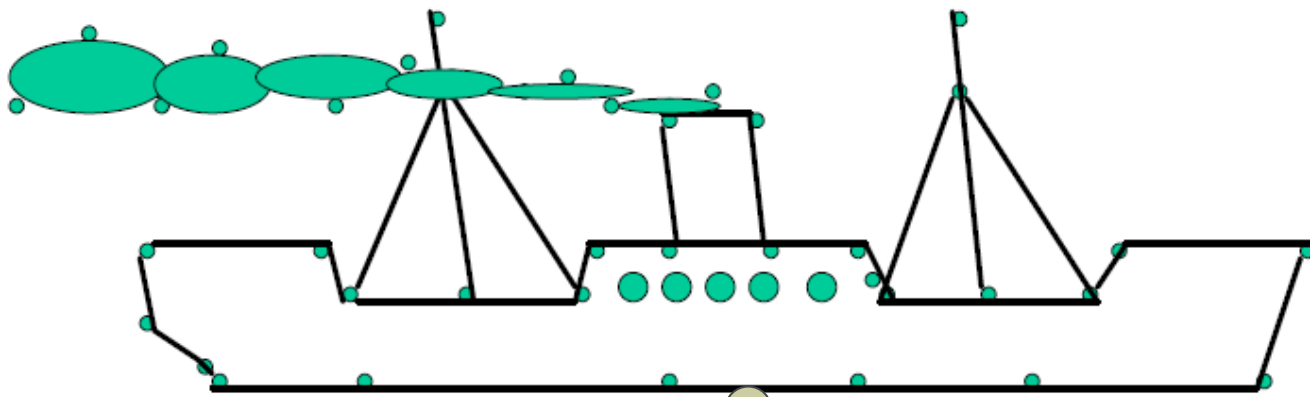
Step 8 Perform Risk Analysis

- A viable risk analysis may point out different decisions than simple analysis

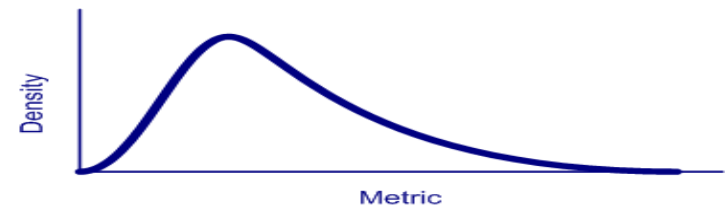
Step 8. Perform
Probabilistic Risk
Analysis

System Description (Parametrics Can Estimate More, Earlier) Adapted from CEBOK

“If you can’t tell me what it is,
I can’t tell you what it costs.”
-Mike Jeffers



“If you can tell me the range of
what it might be, I can tell you the
range of cost, schedule &
probability.”
-Dan Galorath



Risk and Risk Analysis Must Be Included In Project Estimates & Plans

- Both Schedule and Cost risk must be considered
- If every item in the plan is 90% probability the total project probability is much lower
 - $P(N \text{ elements Successful}) = (A_{\text{prob}}) (B_{\text{prob}}) \dots (N_{\text{prob}})$
 - For just 3 independent elements each with a 90% probability
 - $P(3 \text{ Elements Successful}) = (.9)(.9)(.9) = .729$
- For massive systems sophisticated risk analysis should be performed and dependencies considered
- Sophisticated (Monte Carlo Type) analysis should be used



Why should we care: Software & IT Systems are full of risks (and some opportunities)

Just a Single Point Usually Doesn't Reflect Reality (Adapted From SEI)

Process	Durations		
Step		Expected	
1		30	
2		50	
3		80	
4		50	
5		90	
6		25	
7		35	
8		45	
9		70	
10		25	
		500	

What would you forecast the schedule duration to be?

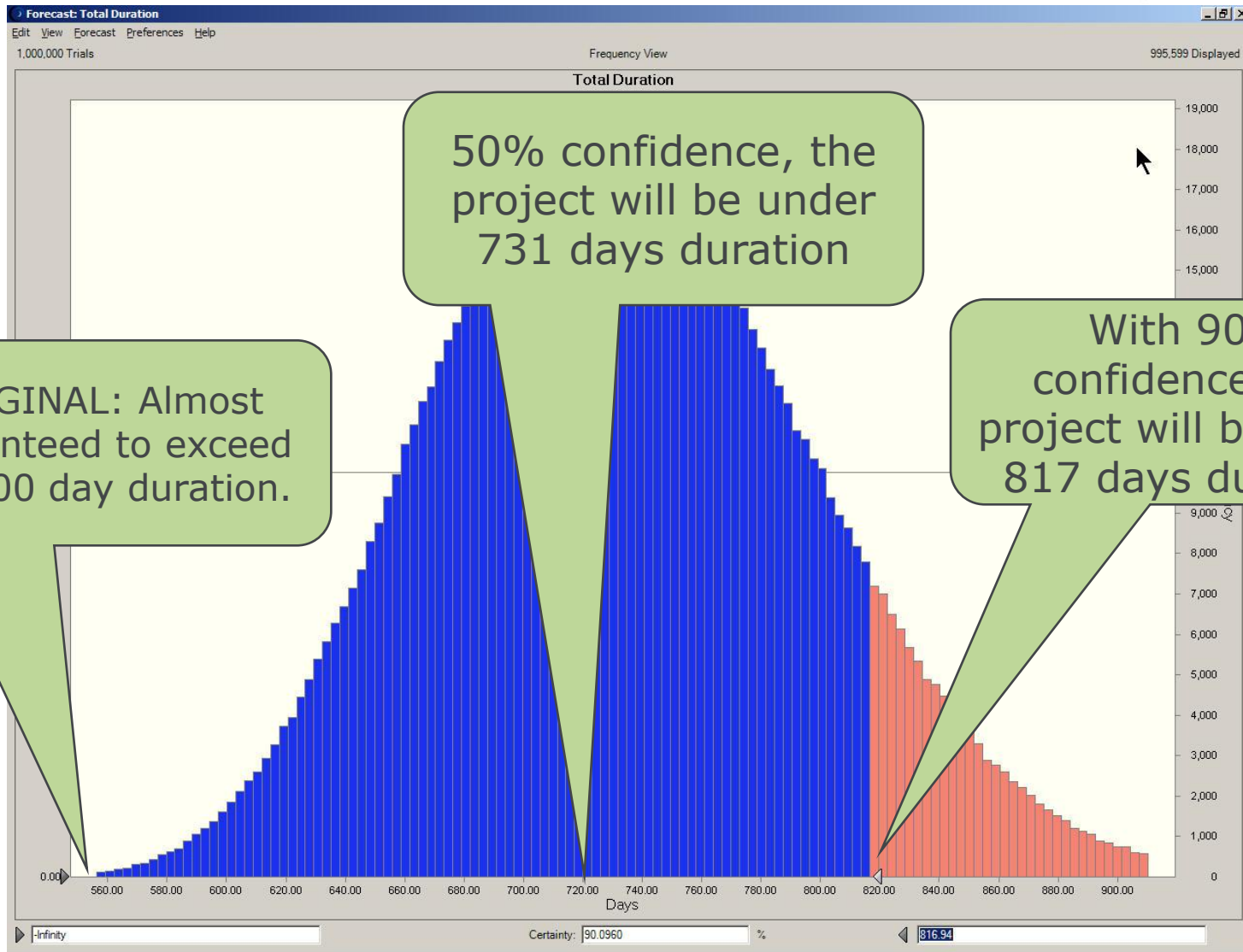
Range Clarifies Risk -2 (Adapted from SEI)

Process	Durations		
Step	Best	Expected	Worst
1	27	30	75
2	45	50	125
3	72	80	200
4	45	50	125
5	81	90	225
6	23	25	63
7	32	35	88
8	41	45	113
9	63	70	175
10	23	25	63
	452	500	1252

What would you forecast the schedule duration to be now?

Capture of uncertainty is a major improvement

Risk Analysis Makes Projects More Successful – 3 (Adapted from SEI)



Step 9 Assess Alternatives & Select

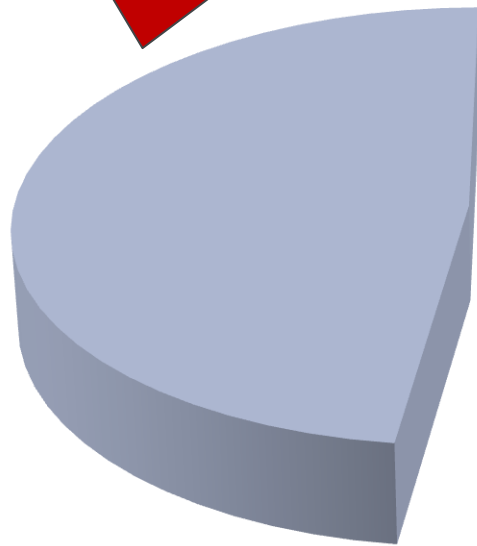
Step 9. Assess
Alternatives &
Select Optimal
Alternative

- Use the figures of merit to determine which is the best
 - Lowest risk
 - Highest value
 - Scored Weighted importance

Example: Traditional On Premises Software Total Ownership Cost Allocation

IT Services & Infrastructure Are Situational but Generally 60% of TOC

Development = Biggest Risk



- Software Development
- Software Maintenance
- IT Infrastructure
- IT Services

Software Development is about 6-10% of total ownership cost...
But much more of the risk
Assume \$10m development could be over \$100m total ownership

Step 10 Document Analysis and Lessons learned

Step 10.
Document
Analysis and
Lessons Learned

- Document estimate complete AND project complete
- Lessons learned ASAP while memories are still fresh
 - Provides evidence that your process was valid
 - Can substantiate or calibrate your estimation models
 - Provides opportunity to improve estimating process
- Missing or incomplete information & risks, issues, and problems the process addressed & any complications that arose
- Key decisions made during the estimate & results
- Dynamics that occurred during the process e.g.
 - Interactions of your estimation team
 - Interfaces with clients
 - Trade-offs made to address issues during the process

Conclusions: IT Systems Are Hard

- Healthcare.gov Environment Was difficult
 - Requirements Volatility
 - Complexity
 - Extensive integration
 - Legacy systems
 - Forced deadline
- Lessons learned yet again
 - Maintain strong & enabled leadership... Executives need viable information
 - Communicate constantly and completely at all levels
 - Iron triangle rules: Keep requirements stable or... defer features... to keep the date
 - Include risk in plans and Practice extensive risk management
 - Test early, often and end to end
 - Don't just blame the developers
 - Use commercial off the shelf when possible when viable

**Estimation, planning, control can help but....
Mandate the possible**

US
healthcare.gov
problems
highlight the
need for
estimation,
planning &
control



Estimation
is critical
and Should
Be A Core
Process

Viabile
Estimation Can
help achieve
affordable
systems with
optimal ROI



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