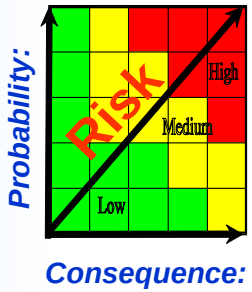
U.S. Aerospace Industry Cost Risk Analysis Survey

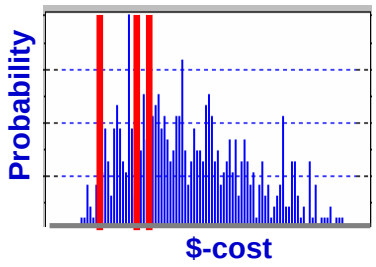
SCEA/ISPA 2008 Joint Annual Conference

Industry Hills, California

June 24-28, 2008

Hollis M. Black





Who's Hollis Black?

- **Born/raised in San Francisco and Bay Area**
- **Work experience**
  - **Focus on data-driven estimating methods and cost risk analysis**
  - **Diverse estimating platforms: Manned space, launch vehicles, weapon systems, missiles, communication systems, and satellites**
  - **Provide subject-matter expert advice across Boeing's Defense Systems**
  - **Honored to receive "Best Practice Champion" award for implementing new methods**
- **Education, professional associations**
  - **MBA University of Texas, 1967 (mgmt science)**
  - **Certifications CMA (IMA), CCEA (SCEA)**
  - **Former President Huntsville chapter of SCEA**
- **Presentations**
  - **"Risk Analysis Benefits" SCEA-ISPA conferences (Italy'04, Denver'05)**
  - **Cost Risk Analysis & Data-Driven Estimating (ISPA, SCEA, SSCAG, AIAA, NCMA)**
  - **"Desired Characteristics of a Senior Cost Estimator" (New Orleans'07)**
- **Work History**
  - **Boeing 27 years. 18 in Parametric Est'g, Missiles-Space, Huntsville**
  - **Monsanto Company, 14 years, St. Louis**

Agenda

- Back ground and objectives
- Survey overview
- Survey findings
- Ten-year trends since 1998 survey
- Summary

Survey Background

- Aerospace program cost overruns and schedule slides have caused many negative headlines
- DoD and NASA leadership increasingly emphasize the importance of cost risk analysis and "cost realism"
- Literature & professional conferences (SCEA, ISPA, SSCAG) offer improved training, techniques, and tools
- In 1998, SCEA and SSCAG supported initial survey of Aerospace cost risk practices. Published in 2000 "*Estimator*."

The author is deeply indebted to SSCAG Risk Sub-Group members who helped develop the questions, and to SCEA and SSCAG for distributing the survey to their membership

Objectives of Survey and Paper

- The cost risk survey and paper seek to …
  - Summarize how the U.S. Aerospace Industry (Government and industry) develops and applies cost risk analysis to aid business decisions.
  - Identify preferred tools and methods
  - Depict trends in methods and tools -- 1998 vs. 2008
  - Encourage cost analysts to be more proactive in assessing cost risk

Survey Overview

22 Survey Questions

12 new questions in 2008 (red)

Risk mgmt maturity?

Hurdles?

When?

How often?

Difficult?

Training?

$-threshold?

Who leads analysis?

Business benefits?

Mitigation strategy?

@RISK, Crystal Ball, ACE-IT?

Target risk confidence level?

Log-normal? Triangular?

Display results?

Specialized?

What's included?

Quantify uncertainty?

Monte Carlo or Analytic?

Integral part of cost est?

References?

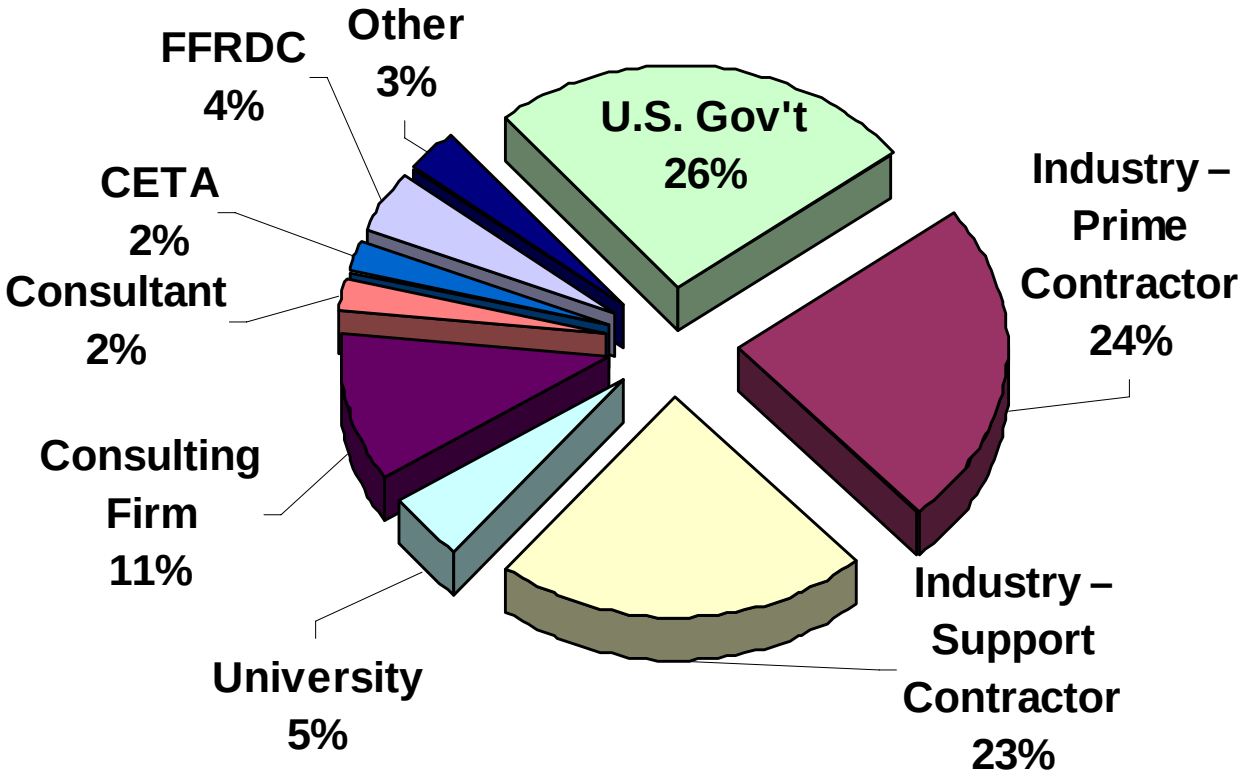
Report by WBS? Phase?

Survey Comparison

	2008	1998
• Questions	22	12
• Multiple choices & write-ins/survey	160	60
• Surveys distributed	2,000	300
• Organizations participating	SCEA, SSCAG	SCEA, SSCAG
• Survey instrument	e-mail	paper
• Survey responses	105	62
• Primary organizations	32	26
• Total responses, all surveys	17,000	4,000

2008 survey contains 4 times as much data as 1998 survey

Organizations Responding to Survey

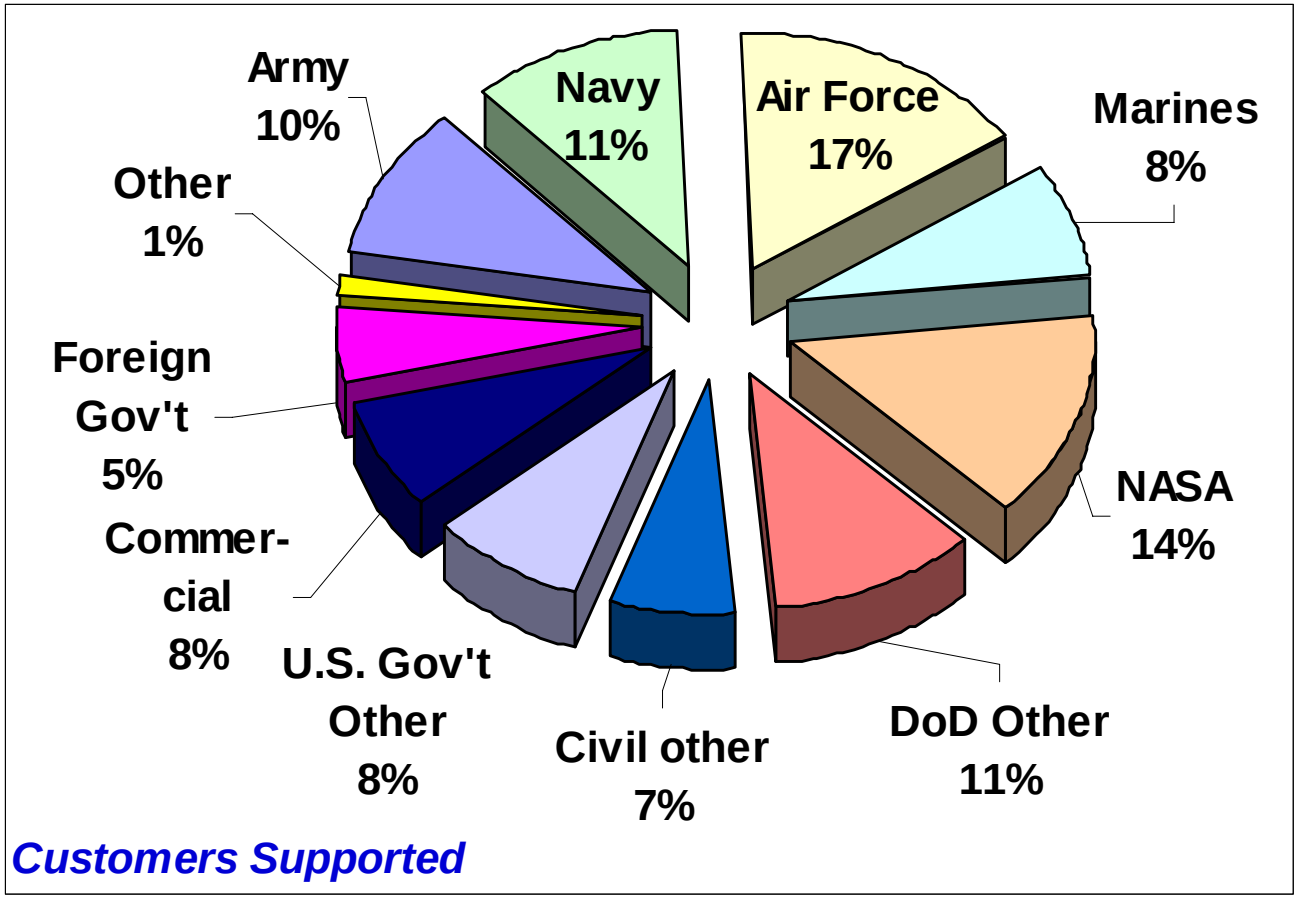


Organizations Responding to Risk Survey

Surveyed organizations …

26% U.S. Government, 54% industry, 13% consultant, 5% university

Customers Supported



Customers Supported

Customers … 79% U.S. Government, 15% commercial, 5% foreign

Participating Organizations

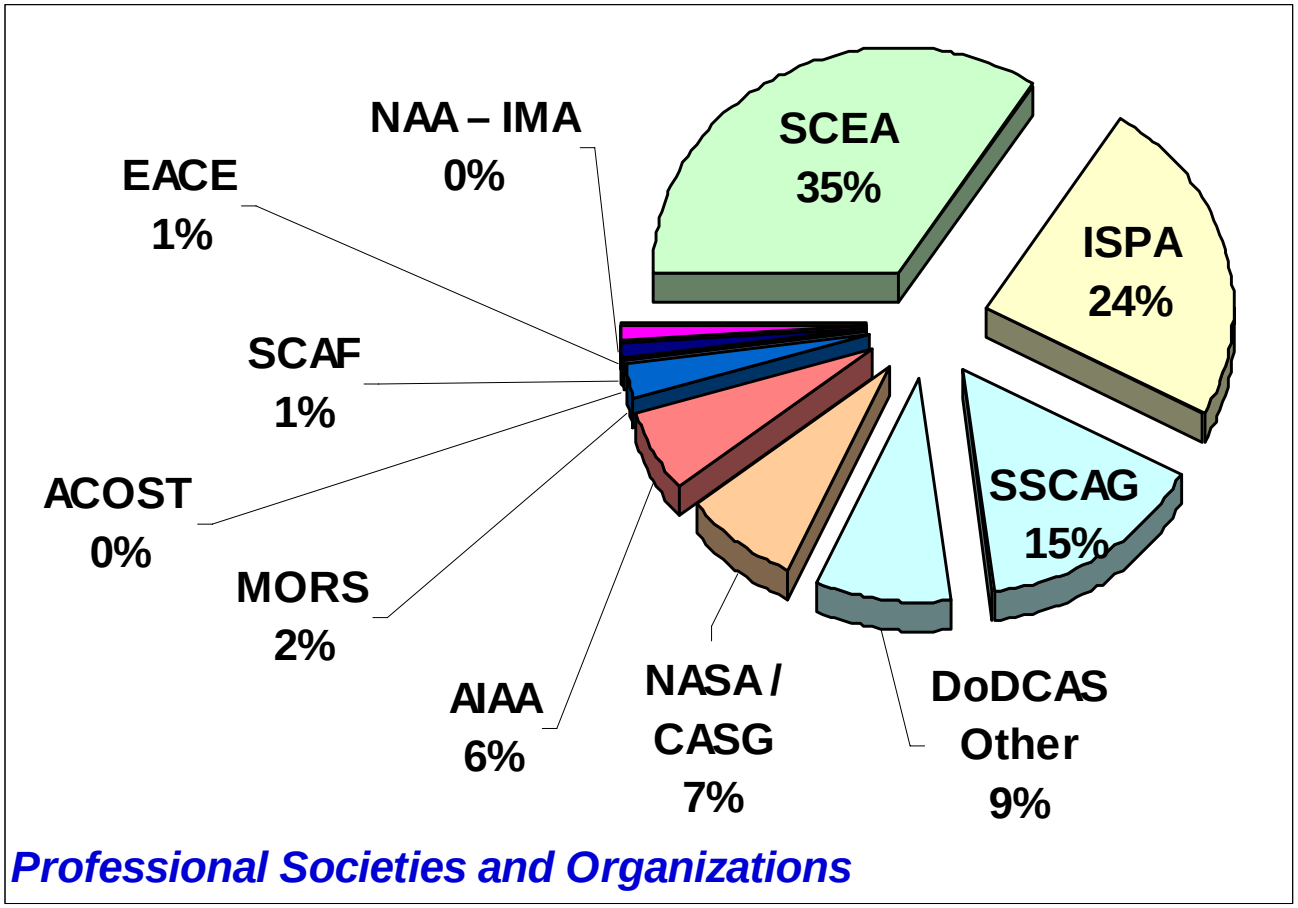
32 organizations … 63 sites

- Aerojet Propulsion
- Aerospace Corp - Concept Design Center
- Air Force (Hanscom, CAIG, Robins, SMC, Pentagon)
- Army (AMCOM)
- AT&T Gov't Solutions
- BAE Systems
- Ball Aerospace
- Boeing
- Booz Allen Hamilton
- Cubic Defense Applications
- Ernst & Young
- ESA - European Space Agency
- J.F. Taylor, Inc.
- Lockheed Martin Space Systems
- Logapps
- MCR Federal
- Missile Defense Agency
- MITRE
- Modern Industries, Inc.
- NASA (JPL, Dryden, Hdqtrs, SMD, PAE, IPAO)
- Navy (NAVAIR)
- Northrop Grumman
- Pratt & Whitney Rocketdyne
- Raytheon
- SAIC
- Self Employed Consultant
- Sikorsky Aircraft Corporation
- Technical Resource Solutions
- Tecolote Research Inc
- Tybrin Corporation
- United Kingdom MoD
- Wyle, Inc.

2008 survey drawn from 63 Government & Industry Organizations and Sub-Organization Sites (vs. 26 for 1998 survey)

Professional Organizations

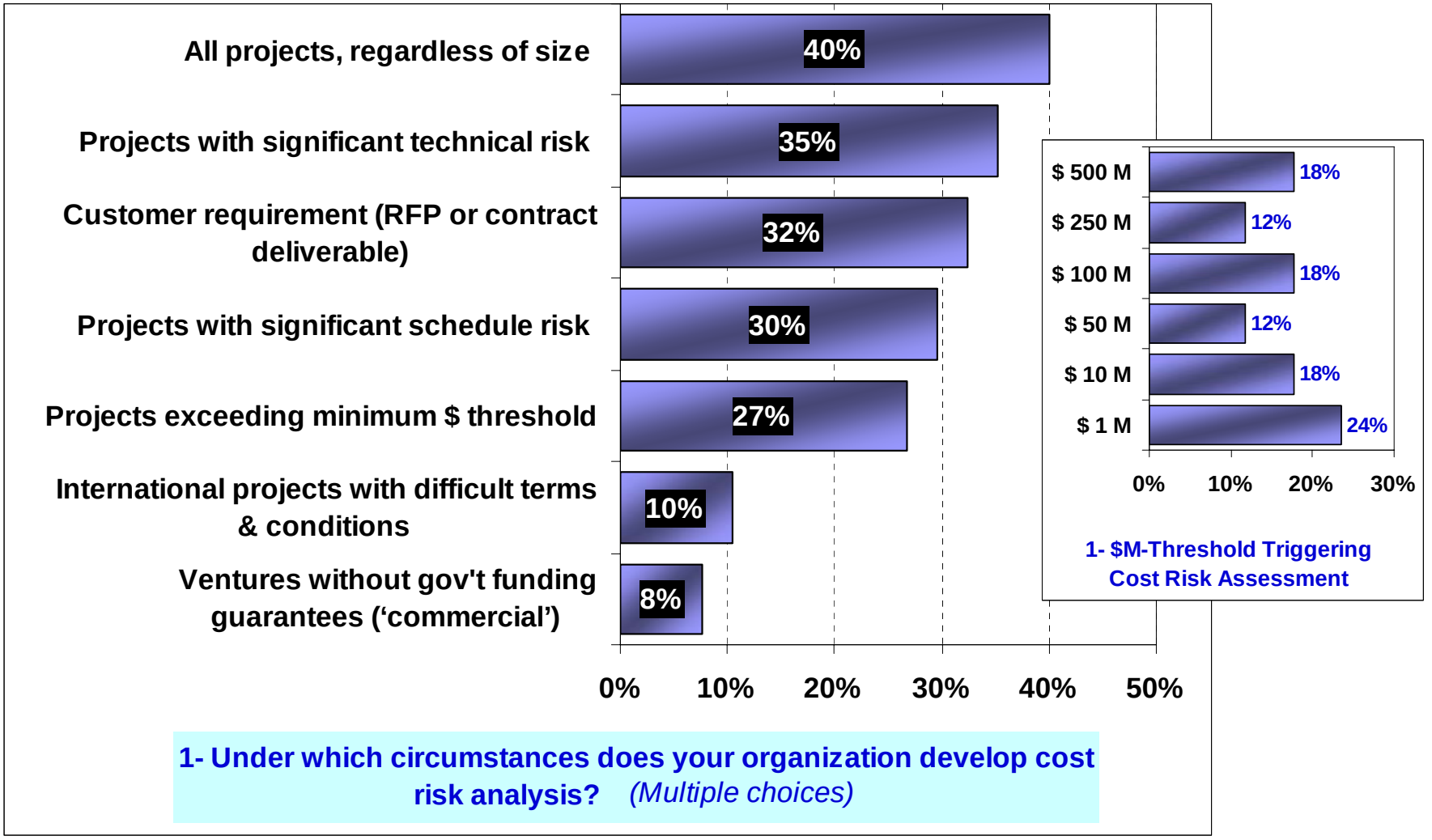
Supported by Survey Respondents



SCEA, ISPA, and SSCAG associations provided main support to survey

Survey Findings

1 – When Cost Risk Is Assessed

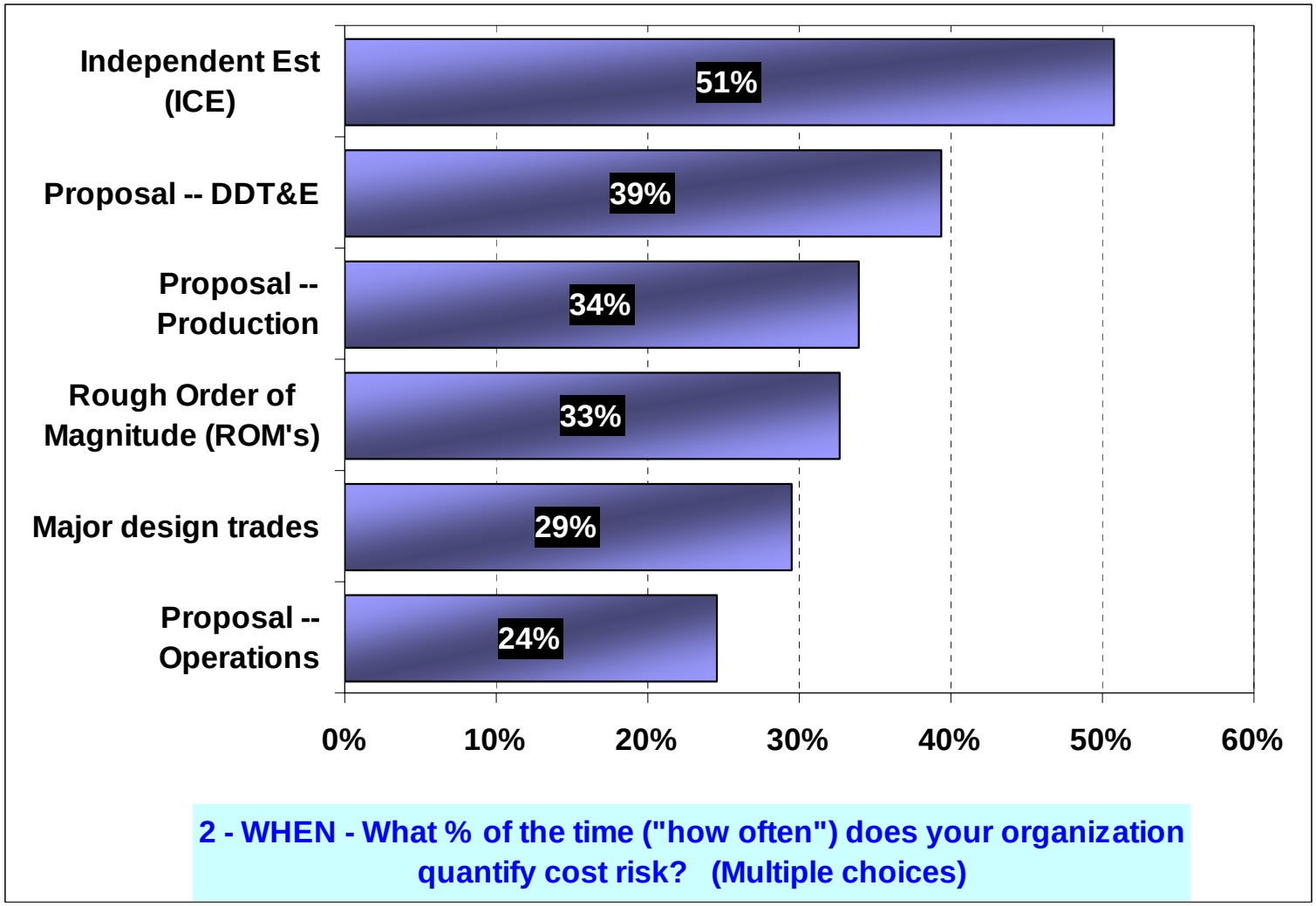


1- Under which circumstances does your organization develop cost risk analysis? *(Multiple choices)*

New 2008 question. Not in 1998 survey

Project size, obvious risk, and customer direction are key motivations to assess cost risk

2- How Often Is Cost Risk Assessed?

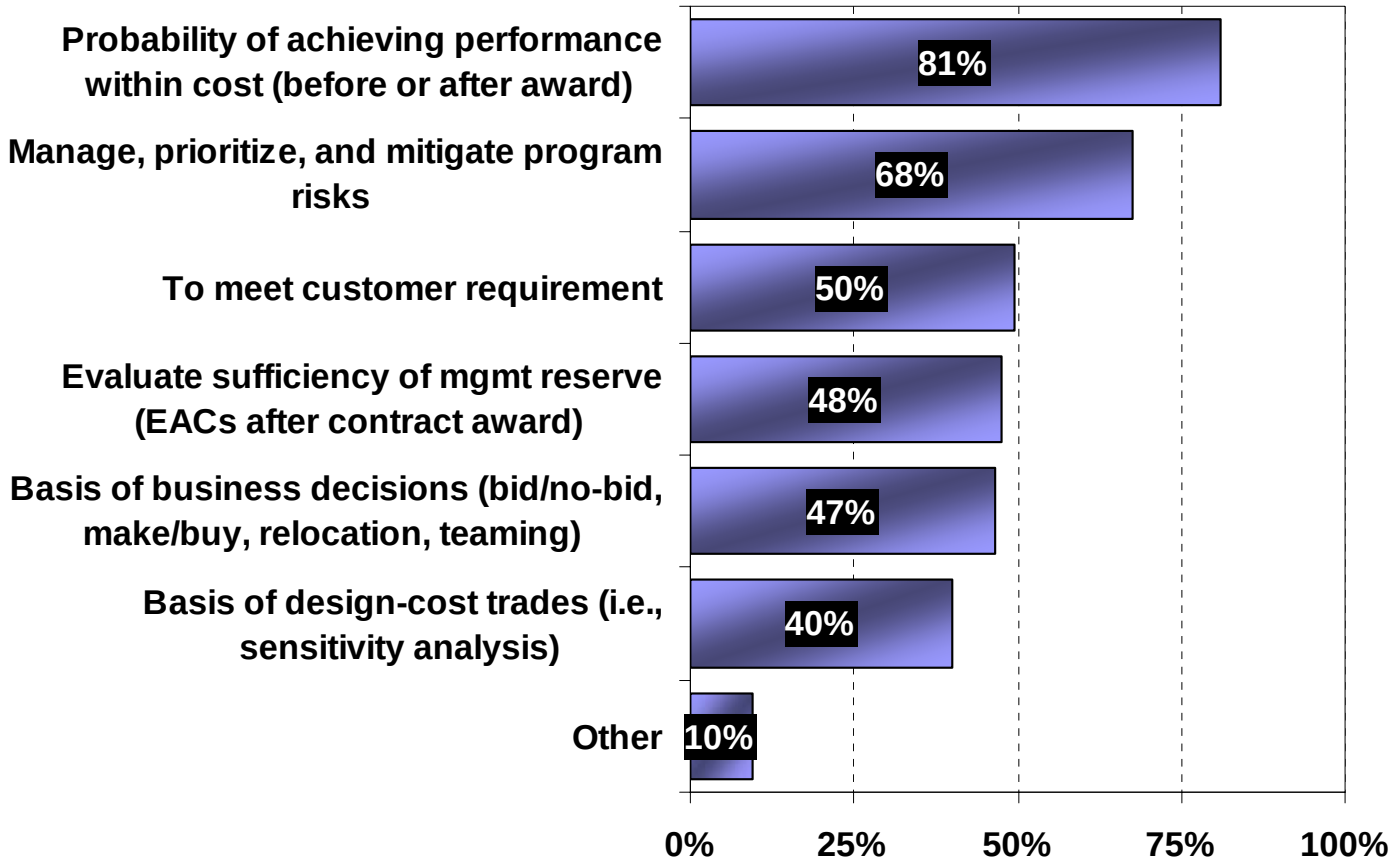


2 - WHEN - What % of the time ("how often") does your organization quantify cost risk? (Multiple choices)

New 2008 question. Not in 1998 survey

ICE & firm proposals, most frequently prompt cost risk analysis, due to impact on business decisions

3 – Benefits of Cost Risk Analysis



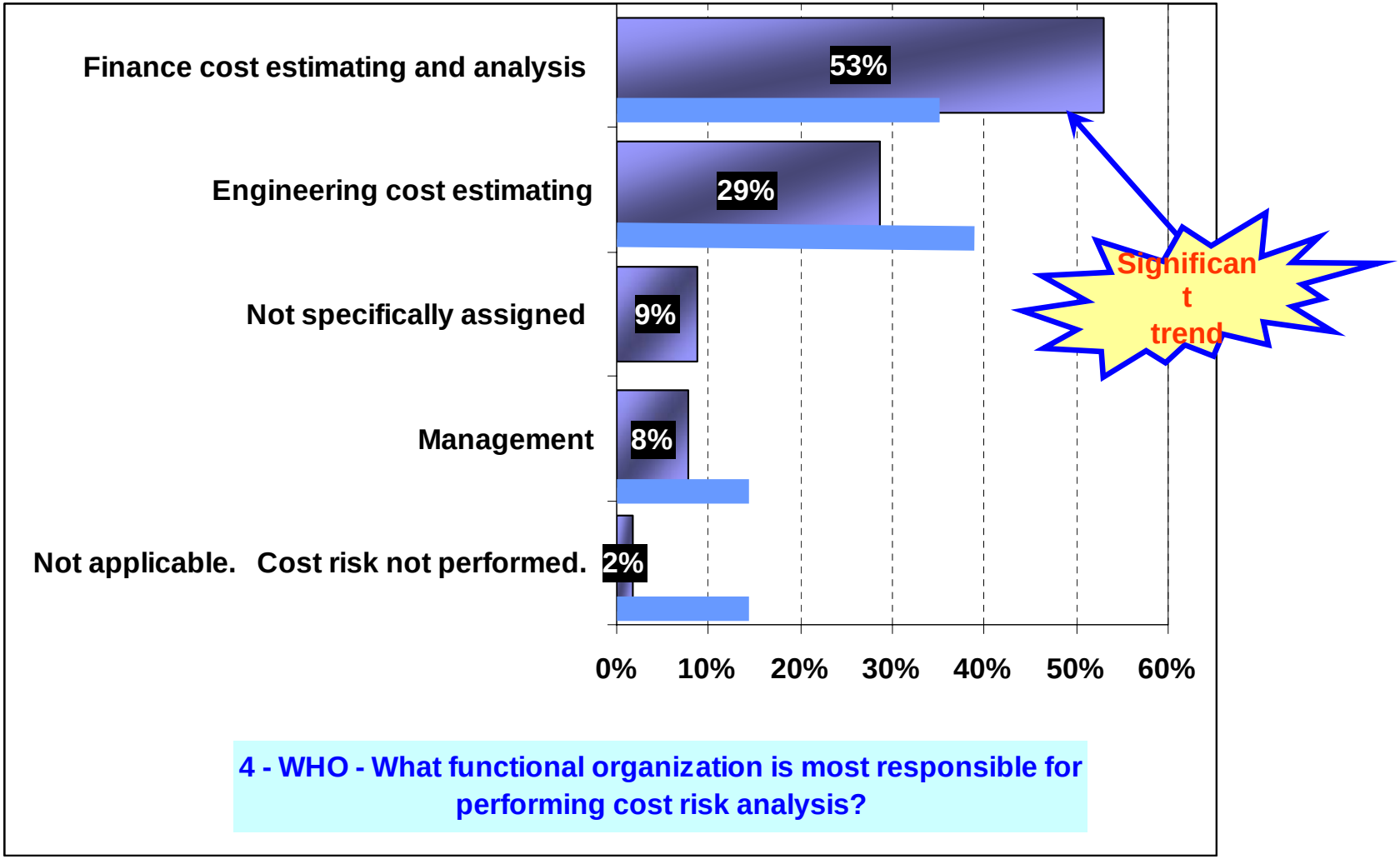
3 - BENEFITS - Which of the following does your organization see as key benefits of Cost Risk Analysis? *(Multiple choices)*

Important survey question

New 2008 question.
Not in 1998 survey

Key benefits … Likelihood of success, cost control, customer direction, business decisions

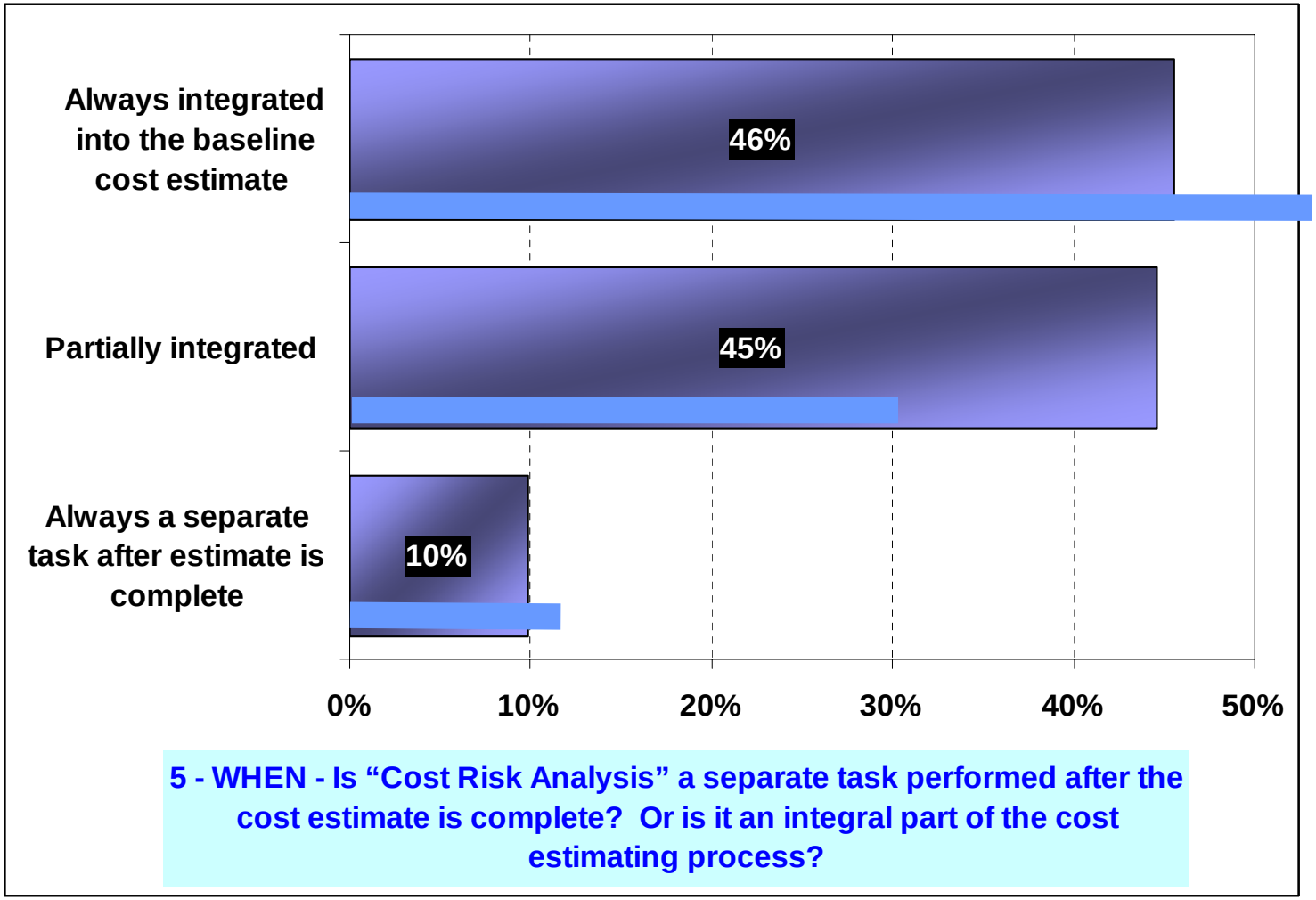
4 - Focal Point to Assess Cost Risk?



1998 survey

Finance Estimating is increasingly responsible for cost risk assessment

5 – Risk Integral to Cost Estimate?

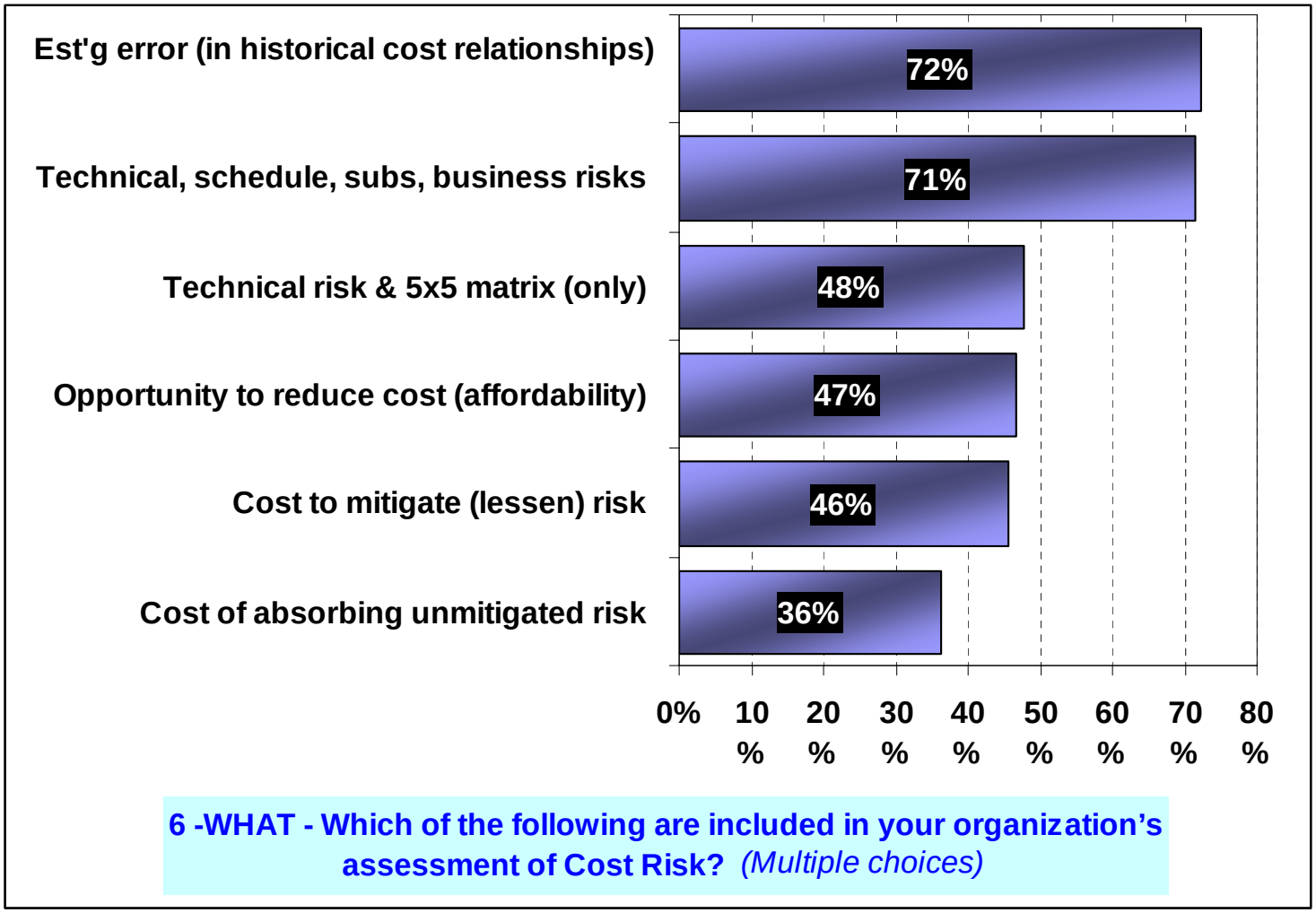


5 - WHEN - Is "Cost Risk Analysis" a separate task performed after the cost estimate is complete? Or is it an integral part of the cost estimating process?

1998 survey

90% of cost risk analyses are integrated into the baseline estimate

6 – What's Included in Risk Analysis?

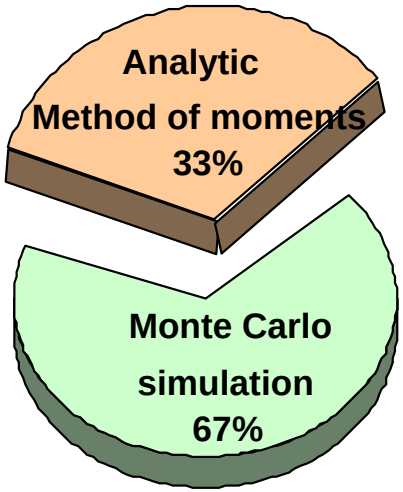


6 -WHAT - Which of the following are included in your organization's assessment of Cost Risk? *(Multiple choices)*

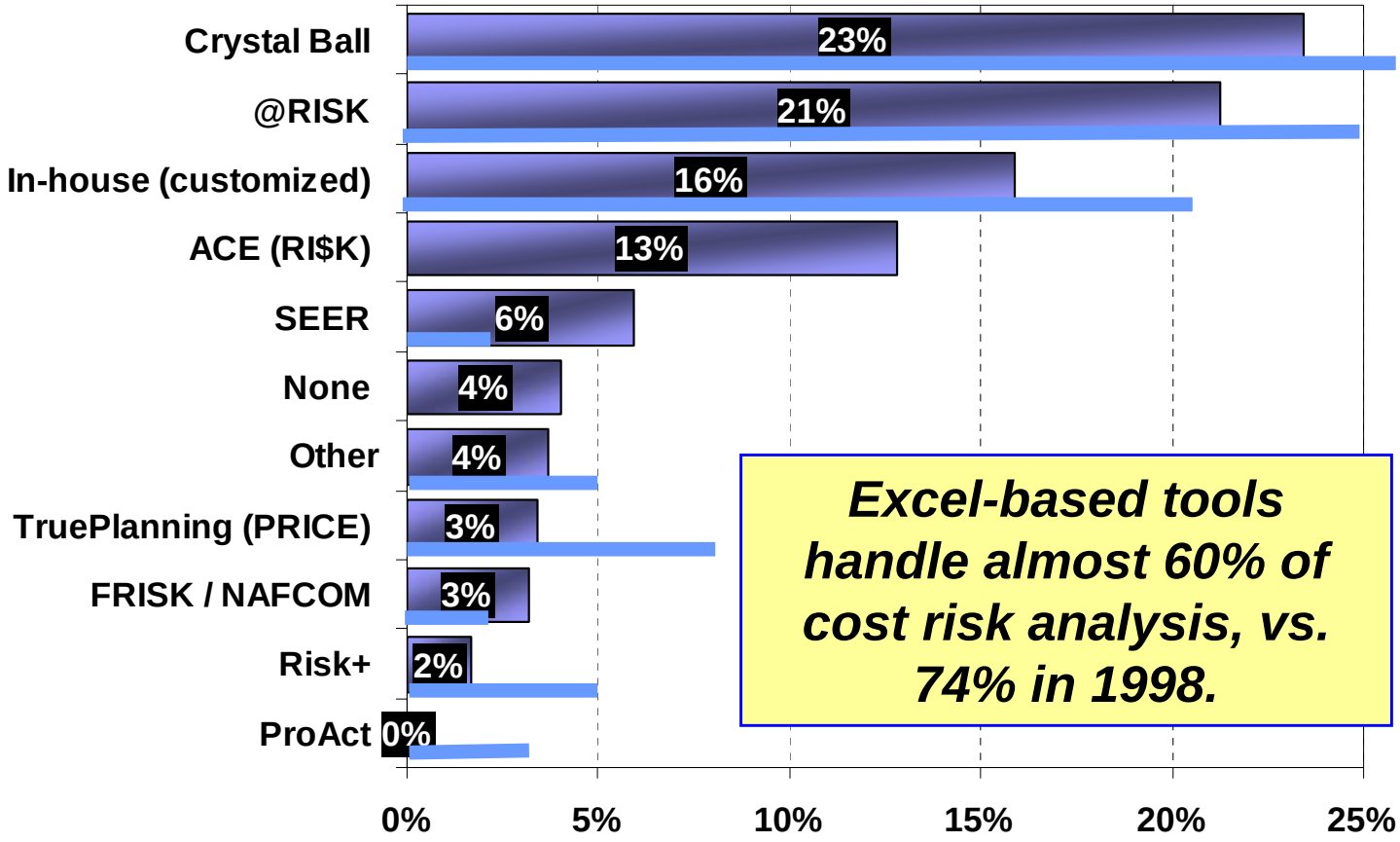
New 2008 question. Not in 1998 survey

Typical cost risk analyses are comprehensive

7-Methods ... *and* ... 8-Tools



7 - METHOD - Please identify the methods your organization typically uses to perform cost risk analysis. *(mixed average)*

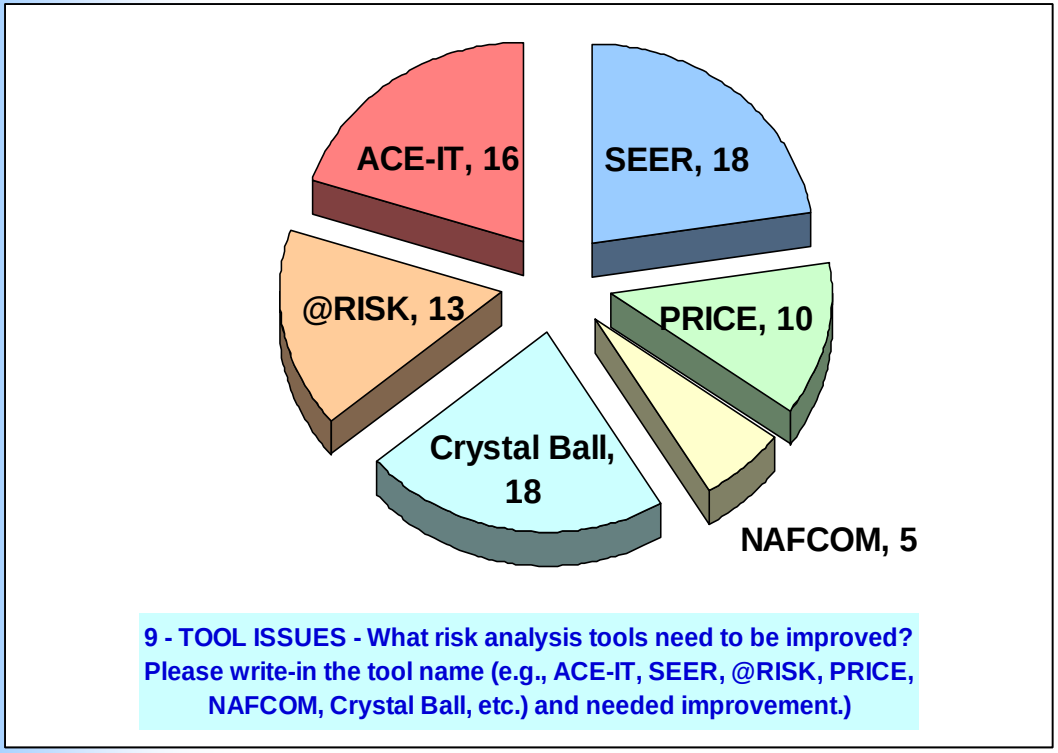


Excel-based tools handle almost 60% of cost risk analysis, vs. 74% in 1998.

8 - TOOLS - Please identify the tools your organization typically uses to perform cost risk analysis. Indicate percent of time each used.

1998 survey

9 – Risk Tool Suggestions

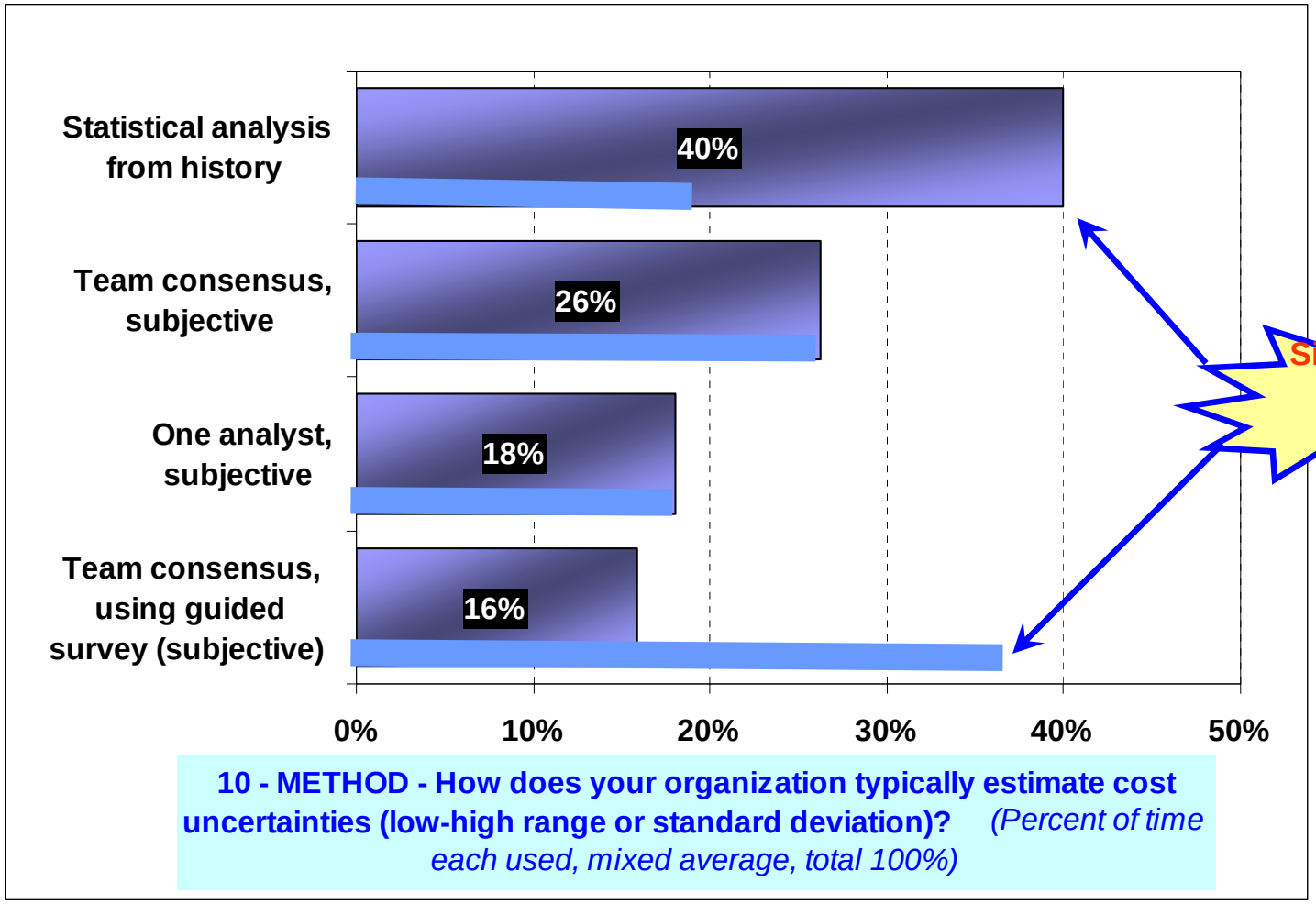


Pie chart indicates number of suggestions per model.

- **Survey respondents made 80 suggestions to improve industry cost risk models.**
- **Key issues: Treatment of correlation, handling schedule risk, ease of use vs. confusion, and setting uncertainty ranges.**
- **Since suggestions relate to tools (not cost risk analysis), they are being provided to the tool developer, and are not included in this paper.**

New 2008 question.
Not in 1998 survey

10 – Estimating Cost Uncertainty

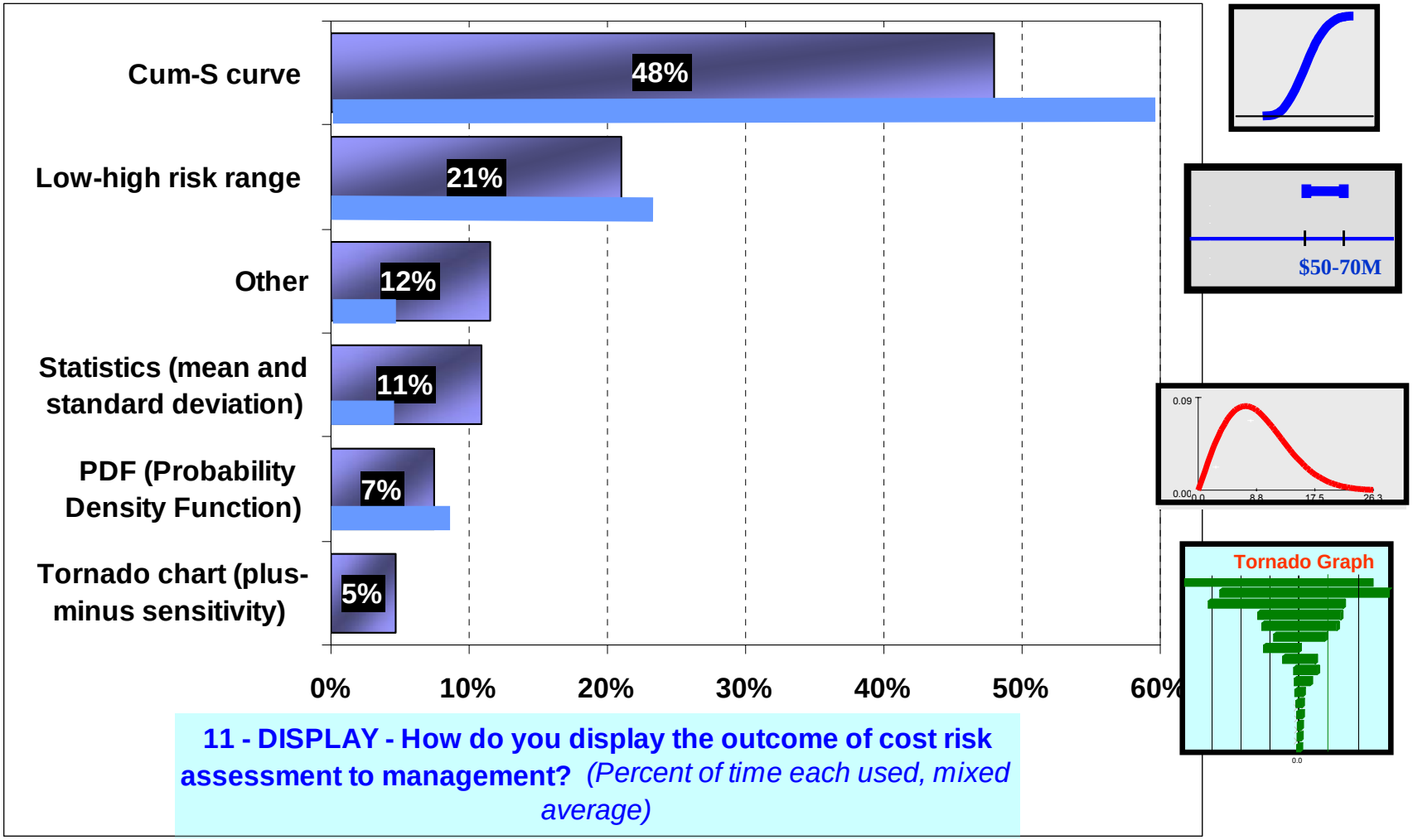


10 - METHOD - How does your organization typically estimate cost uncertainties (low-high range or standard deviation)? *(Percent of time each used, mixed average, total 100%)*

Statistical cost analysis from history has dramatically increased in 10 years. Team consensus is far less prevalent.

1998 survey

11 - Displaying Risk & Uncertainty

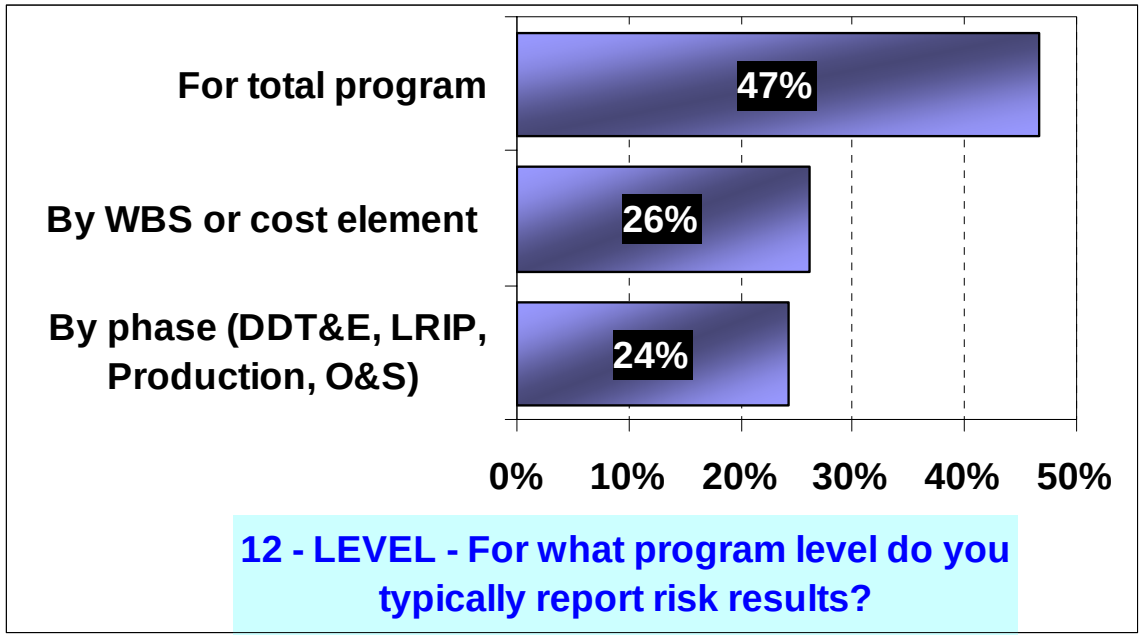


11 - DISPLAY - How do you display the outcome of cost risk assessment to management? *(Percent of time each used, mixed average)*

1998 survey

Cum-S curve is increasingly popular

12 – Level of Risk Reporting

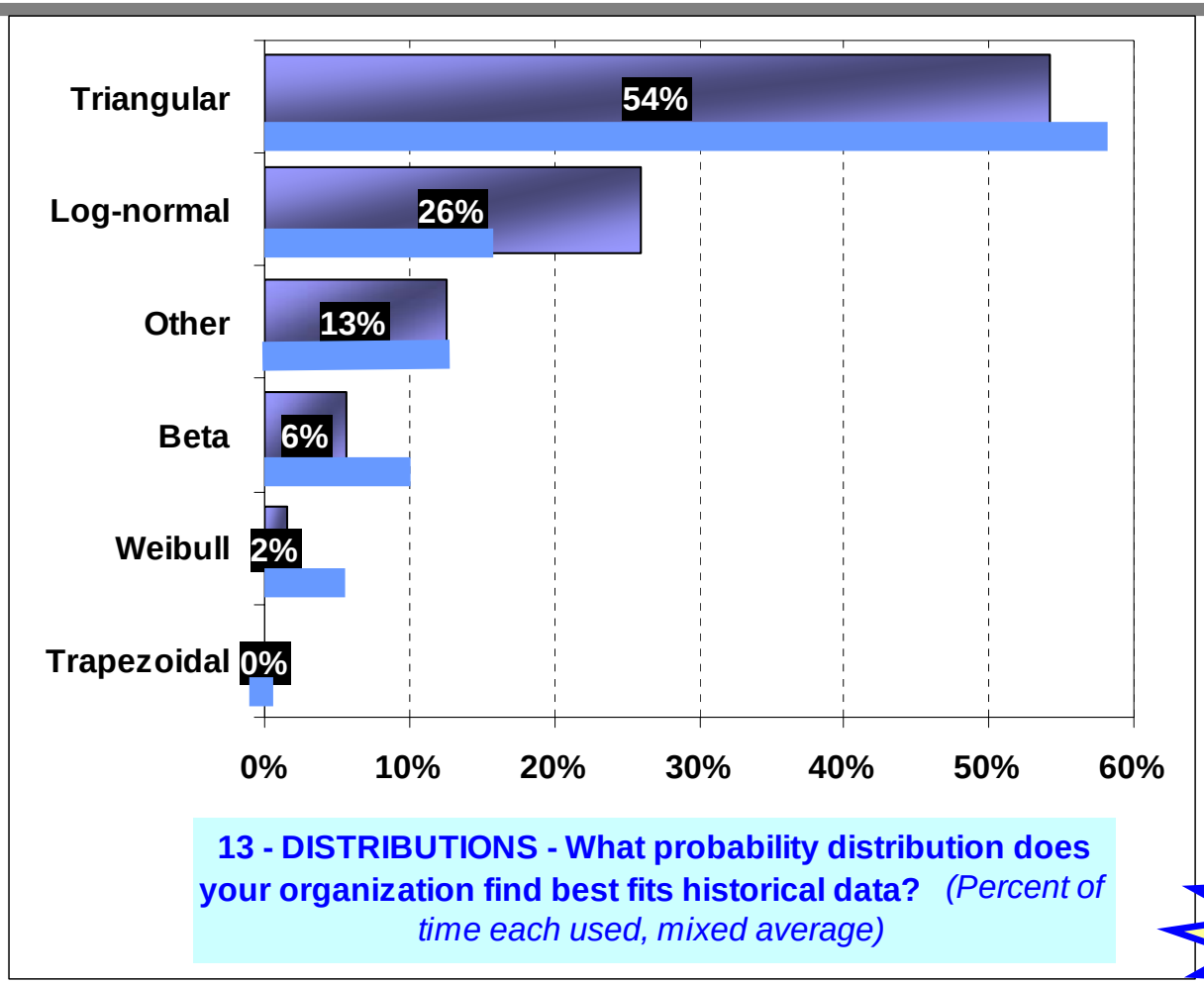


Cost risk analysis is typically reported for total program.

Less often by WBS or phase.

New 2008 question.
Not in 1998 survey

13 – Preferred Data-Curve Fits



13 - DISTRIBUTIONS - What probability distribution does your organization find best fits historical data? *(Percent of time each used, mixed average)*

Significant trend

Lognormal distributions increasingly popular

1998 survey

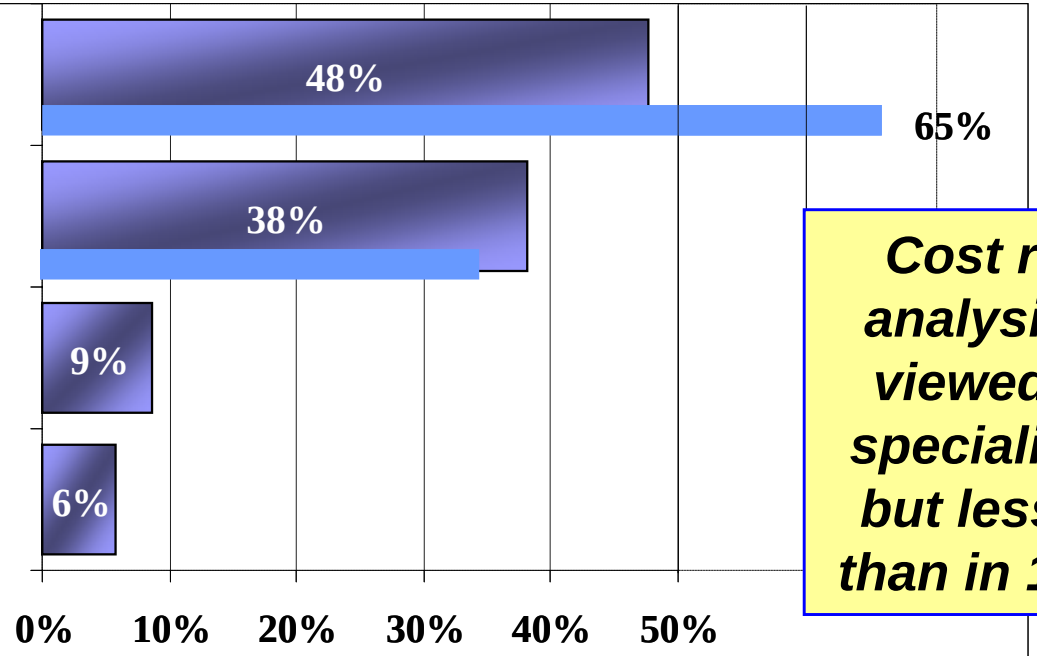
14 – Specialized?

Highly specialized …
Only a few can do it.

Somewhat specialized …
Many can do it.

Not highly specialized ...
All should be able to do it.

Somewhat difficult. Few do it well.
More estimator training needed.



Cost risk analysis is viewed as specialized, but less so than in 1998.

14 - SPECIALIZED - Is cost risk analysis considered to be a highly specialized skill?
(Totals to 100%)

Survey comments …

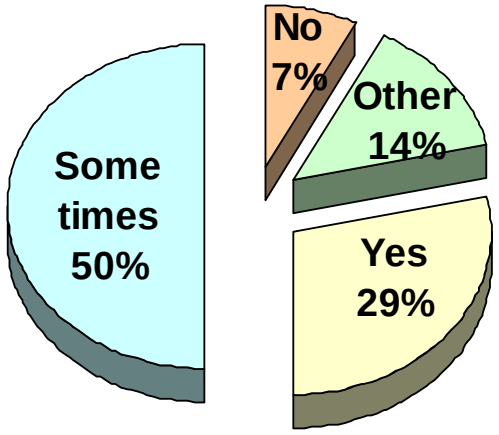
* "Yes … highly specialized, and only a few can or want to do it. "
* "Many think they can do it, but only a few can do it well."
* "Guidance is available for the interested & competent Estimator."
* "Training is greatly needed."

1998 survey

15 - Difficult?

2008 survey comments …

* Difficult to do well ... easy to do poorly.
* Difficult without training and experience.
* Not technically difficult, but hard to explain.
* Difficult in absence of good data & cost models.
* Difficult unless one has the right mindset.
* Gets hard, very fast ... need resident advisor "Nerd."
* Difficult challenge is to explain meaningfully to mgmt.

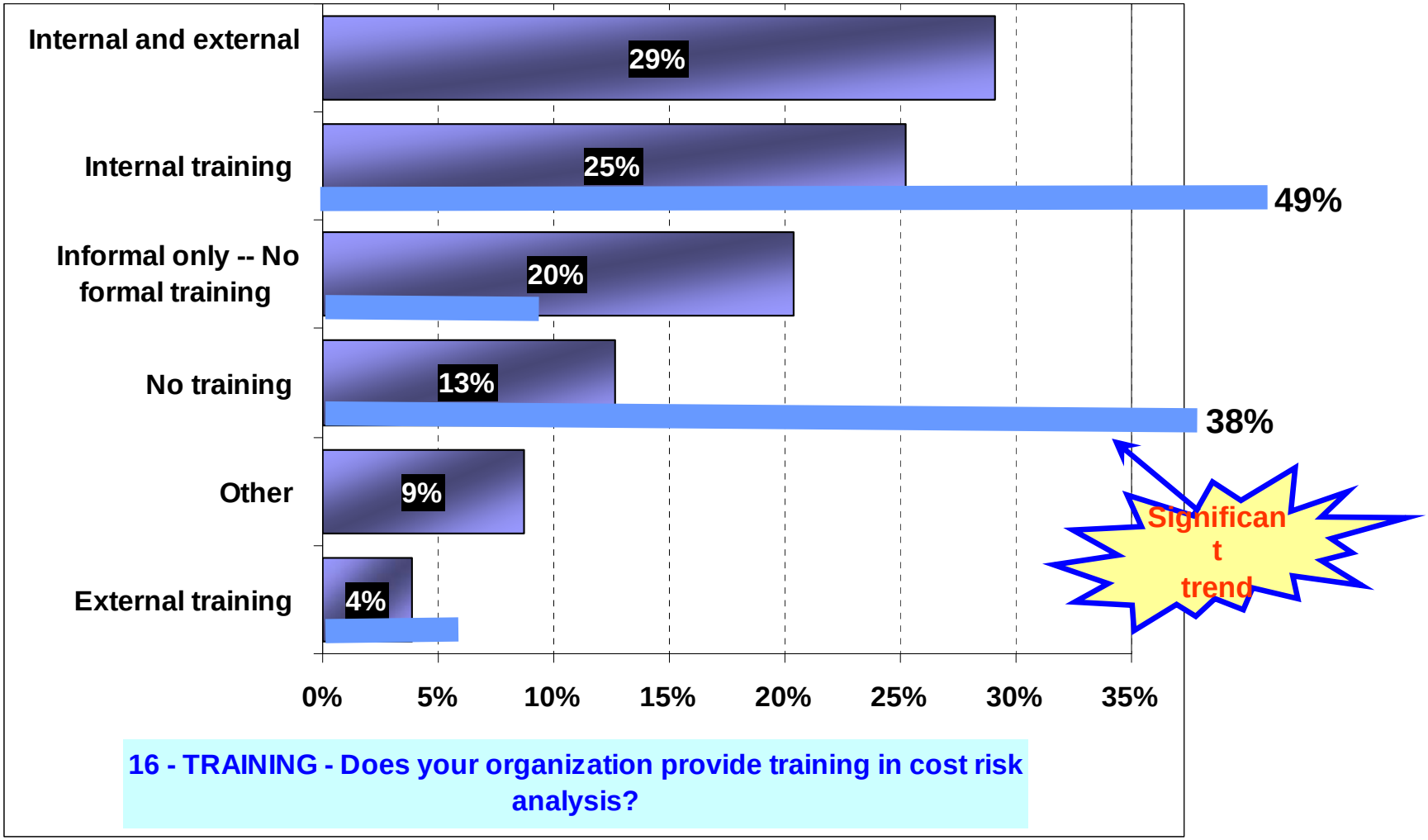


15 - DIFFICULTY - Is cost risk analysis difficult? *(Total 100%)*

1998 survey observations …

- Critical skills is the ability to interview capably
- Not many understand what's really happening
- Requires exceptional communication skills, statistics, analytical ability, and knowledge of eng and mfg processes
- Adequate training in probability is a necessity

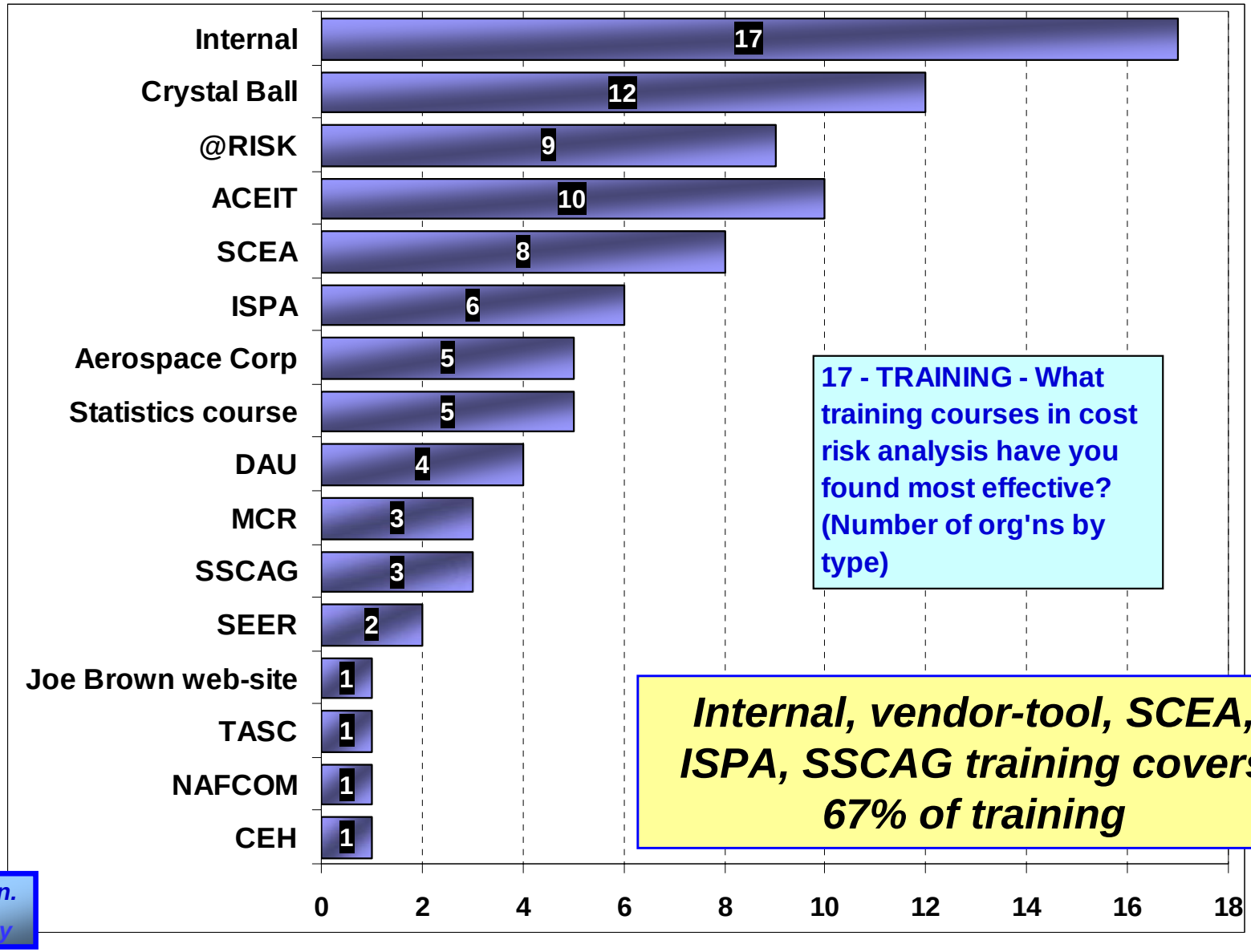
16 – Training Provided



1998 survey

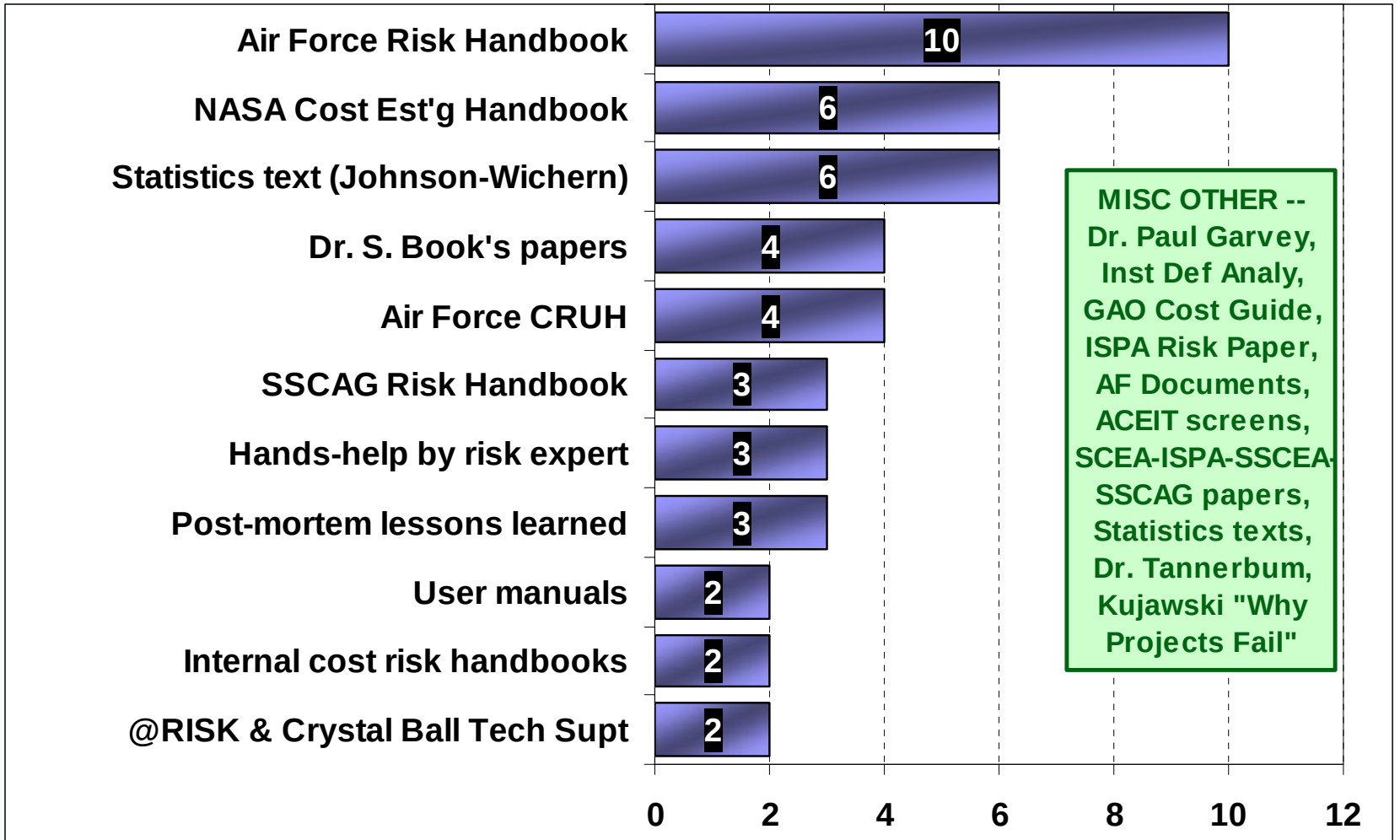
Training way up! Today 13% of surveyed organ's have no formal training … vs. 38% in 1998

17 – Training Source



New 2008 question.
Not in 1998 survey

18 – Useful Cost Risk References



18 - REFERENCES - What reference documents do you find most helpful in conducting cost risk analysis? *(Number of org'ns by type)*

New 2008 question.
Not in 1998 survey

19 – Mitigation Strategies

1- Re-scope req't, develop mitigation plan.

2- Improve design, higher cost

3- Press on. Hope support tech'y will mature

4- Customer controls mitigation

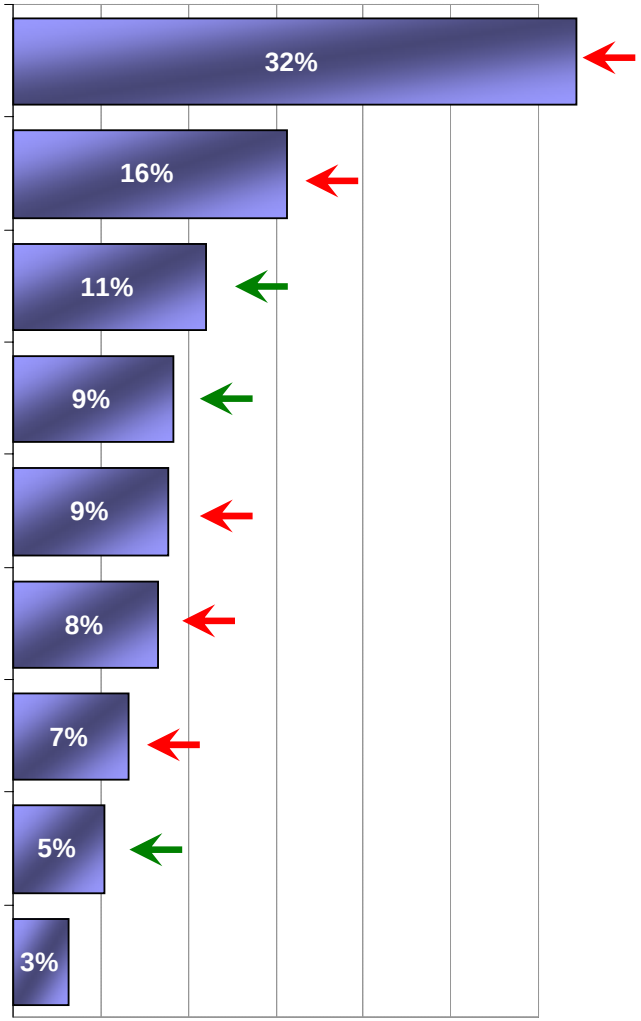
5- Increase IR&D for technical hurdles (TRLs)

6- Improved design/fab processes

7- Further test developing technologies

8- Slow project. Wait affordable technology

Combination of above



Proactive solutions used 75% of the time to reduce cost risk (was 90%)

Re-scoping, mitigation plan, improved design, IR&D, and test.

Stand-off used 25% of the time (was 10%)

(hopefulness, waiting, and "not-my-job").

1998 survey

19 - MITIGATION - How does your organization mitigate unacceptably high program risks (technical, performance, schedule, etc.)? *(Percent of time each used, mixed average)*

Important survey question

20 –Maturity of Cost & Risk Mgmt

5 = Most Mature, Integrated, Tracked-Managed, EVMS-EAC

RISK MANAGEMENT MATURITY …

To what extent does your organization integrate cost risk analysis into the overall Risk Mgmt process?

(Percent of time each used, mixed average, do not total 100%)

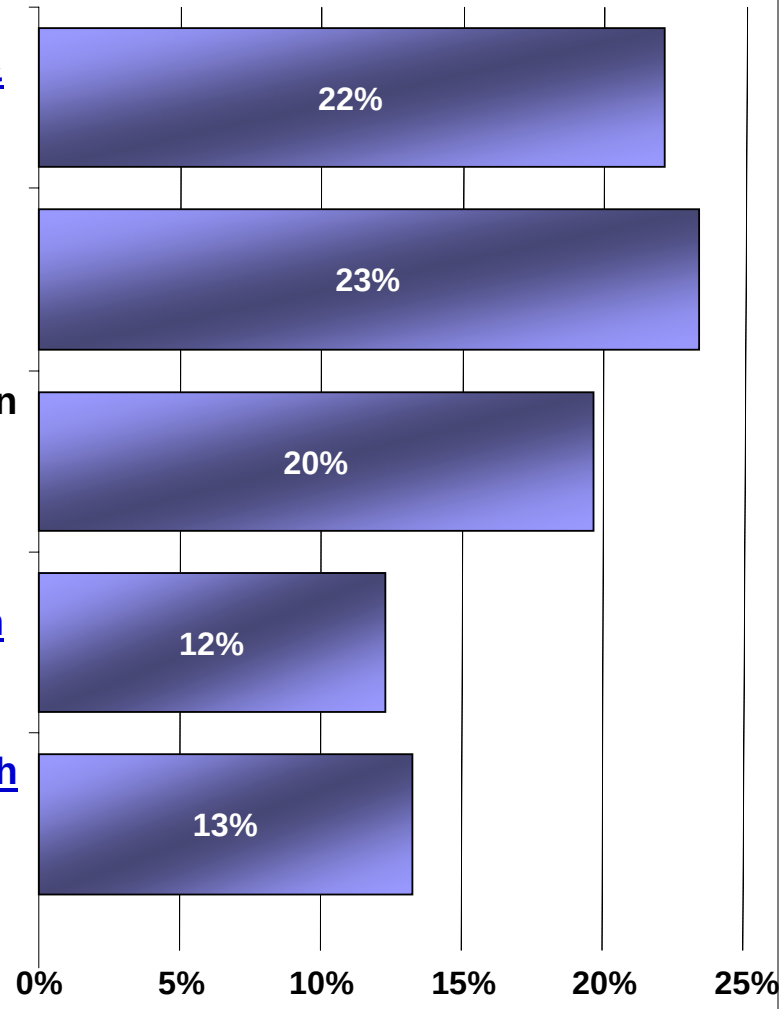
1 - Cost risks sometimes assessed & quantified in the estimating process.

2 - Cost risk ranges occasionally provided (low-likely-high)

3 - High probability risks quantified in cost estimates; or tracked in a risk mitigation plan that effectively reduces risk to moderate/low.

4 - Cost Risk Analysis integrated with Risk Mgmt Plans; tracked-managed.

5 - Cost Risk Analysis integrated with Risk Mgmt Plans, tracked-managed, and evident in proposals and EVMS-EACs to support decision making.

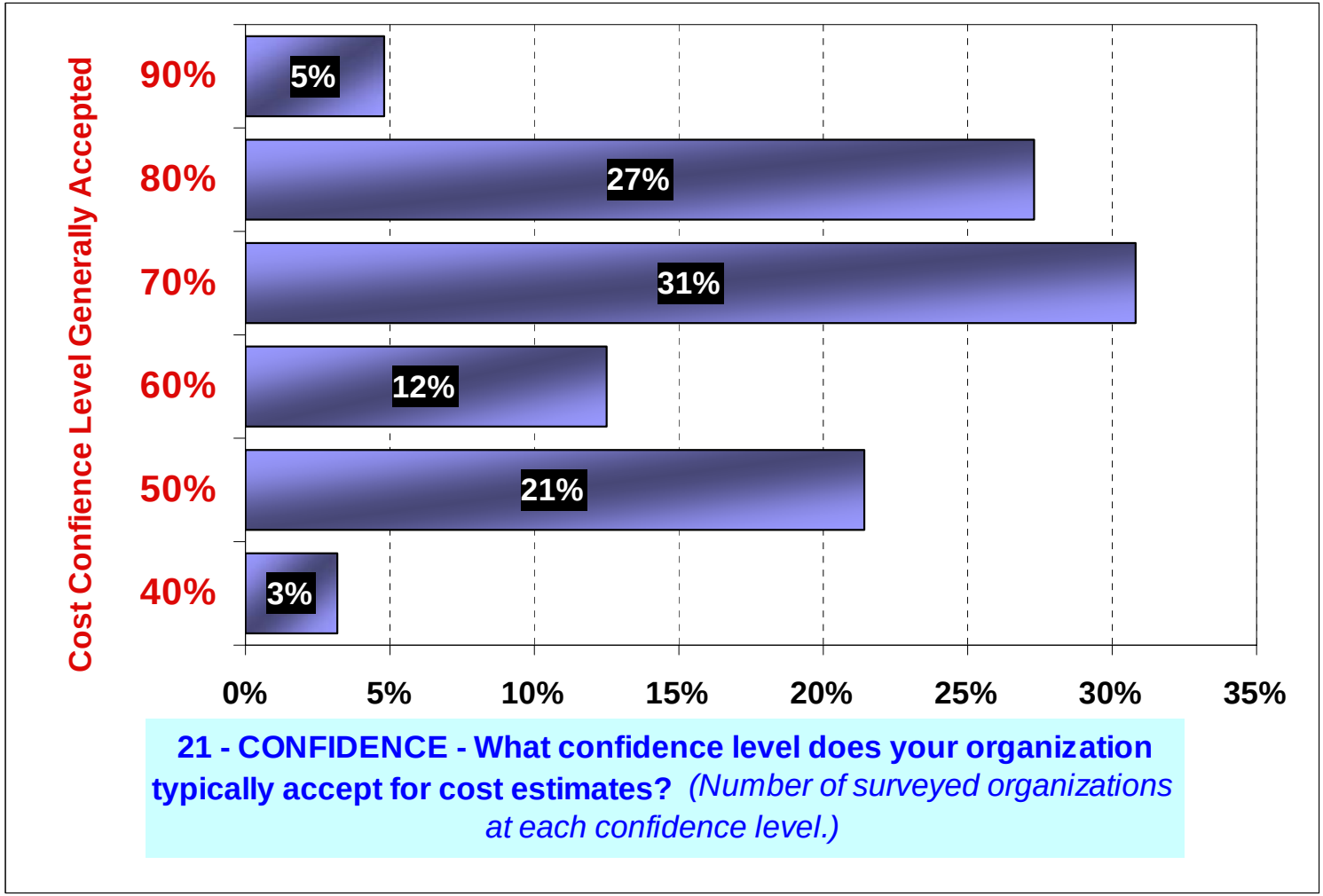


New 2008 question. Not in 1998 survey

Only 25% of organizations are at level 4-5 maturity

21 – Acceptable Confidence Level

Totals for Government and Industry



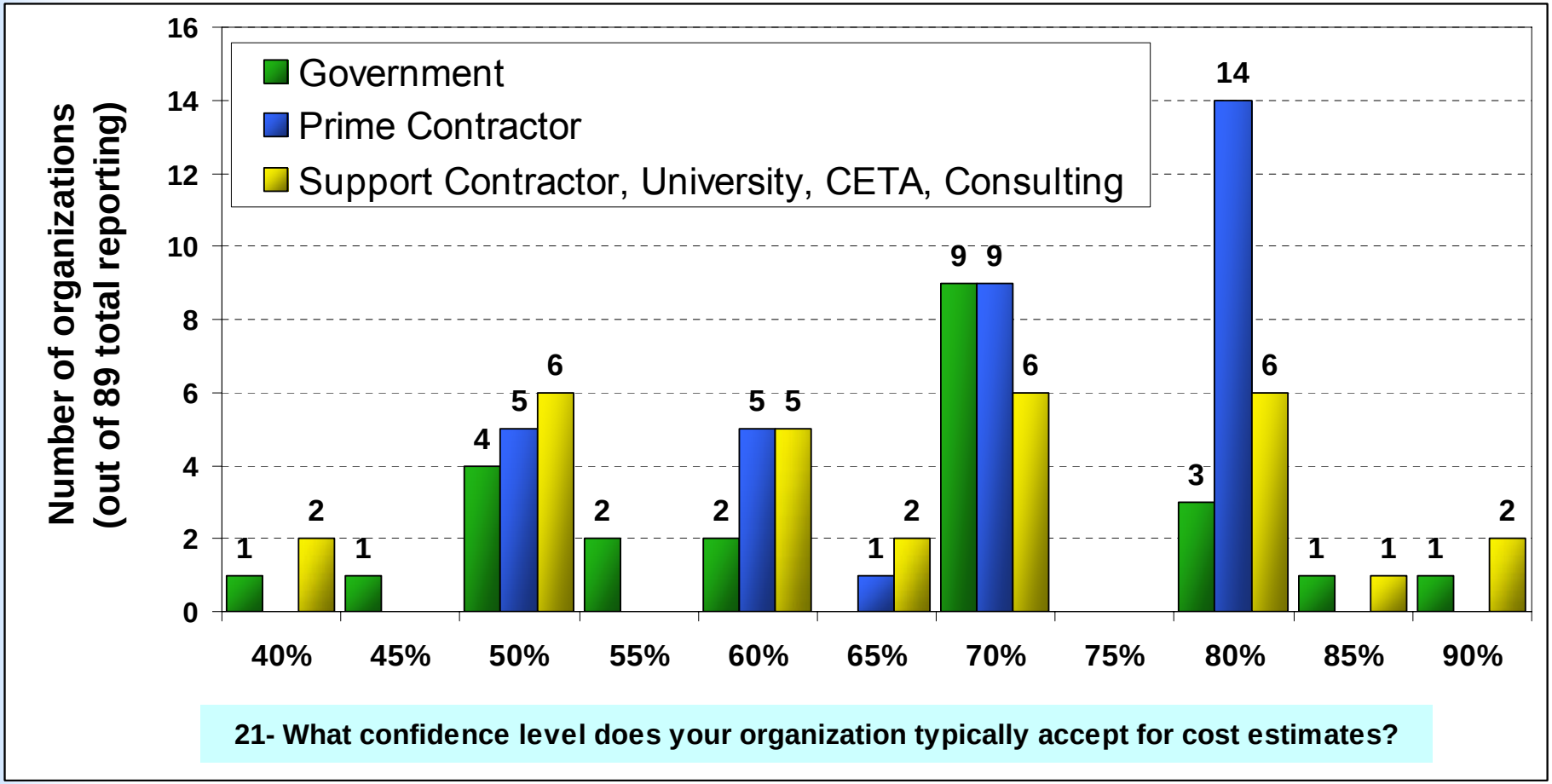
21 - CONFIDENCE - What confidence level does your organization typically accept for cost estimates? *(Number of surveyed organizations at each confidence level.)*

New 2008 question.
Not in 1998 survey

Two thirds of organ's desire >70% cost confidence. Weighted average = 67%.

21 – Acceptable Confidence Level

Totals for 89 Government and Industry Responses

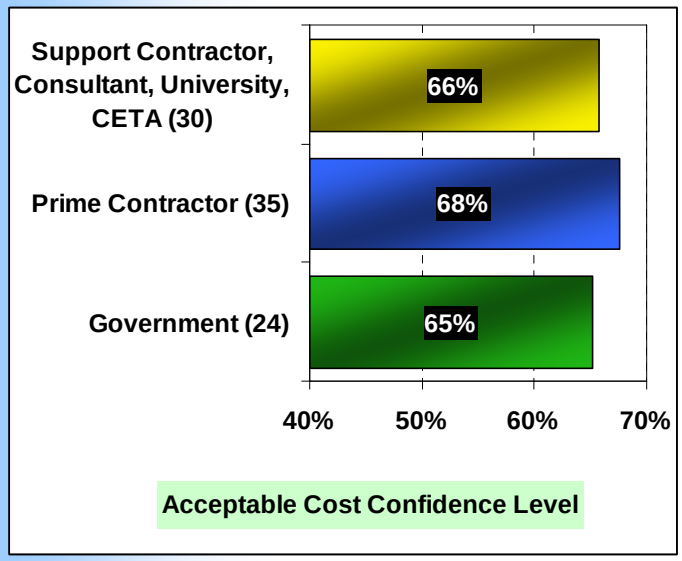


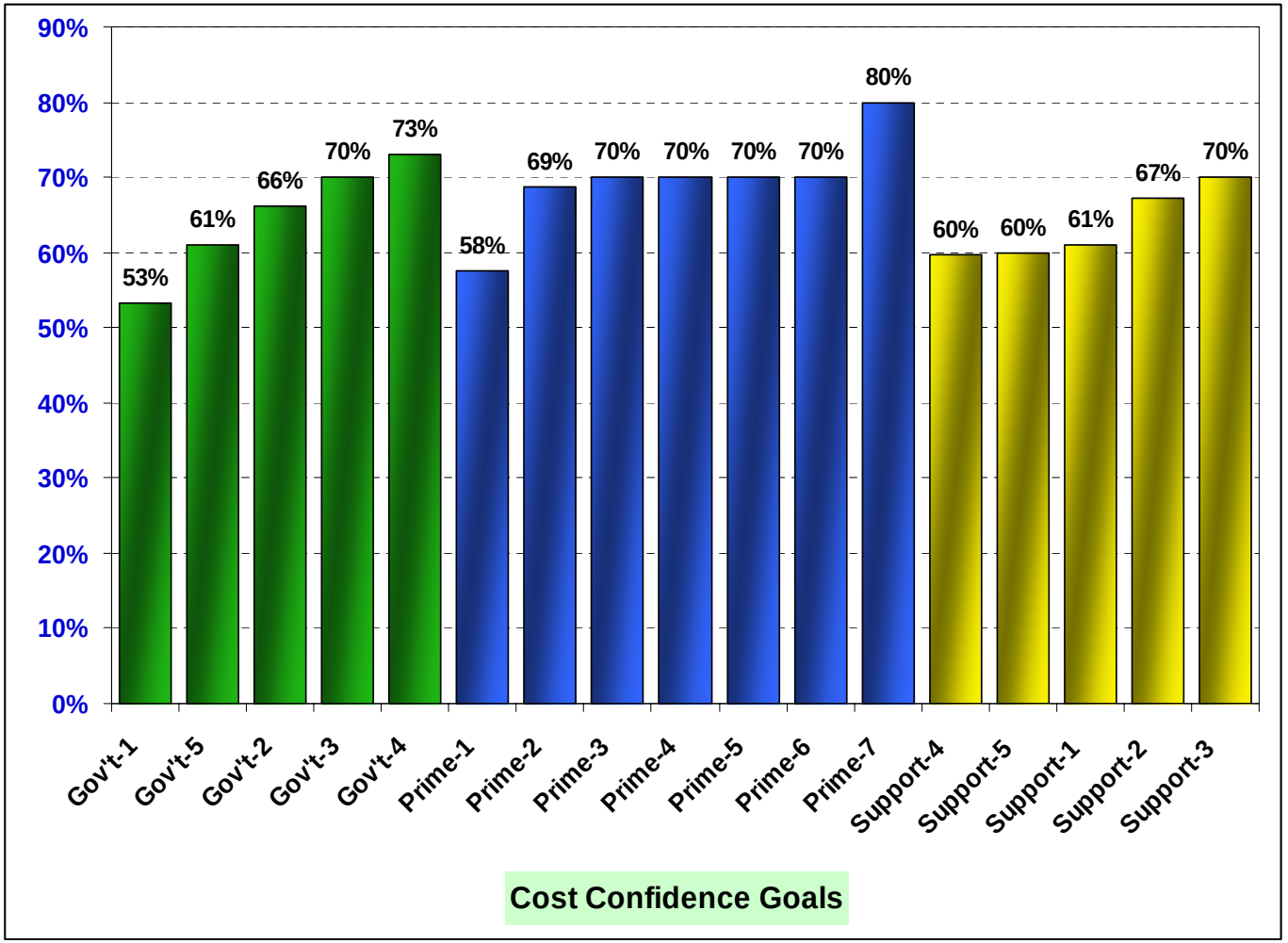
Gov't has little consensus .. 70% is most common goal. Prime contractors want 50-80%, heavy on high end. Support contractors very diverse. No consensus.

New 2008 question.
Not in 1998 survey

21 – Acceptable Confidence Level

Totals for 89 Government and Industry Responses

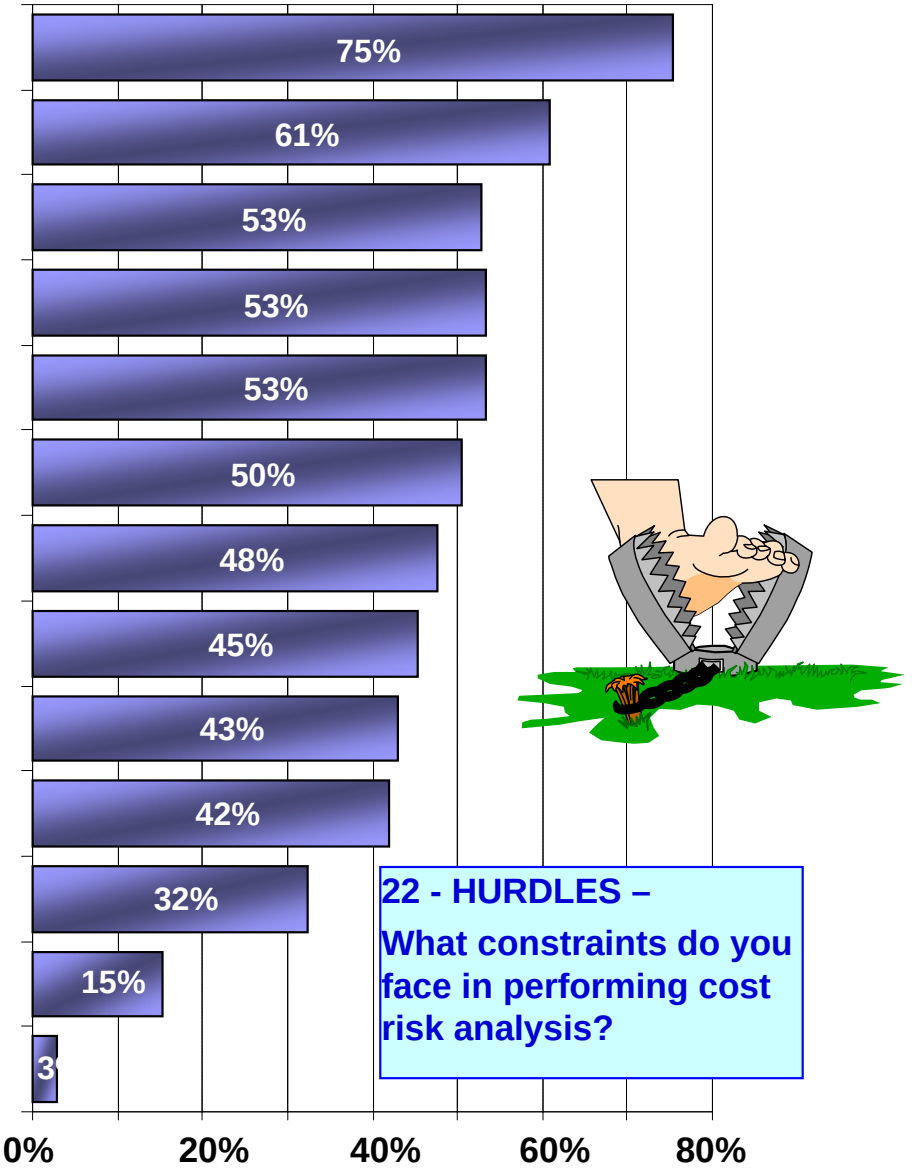




New 2008 question.
Not in 1998 survey

Gov't, Prime, and Support Organizations vary somewhat, but average around 67% in desired confidence levels

22 - Hurdles to Cost Risk Analysis

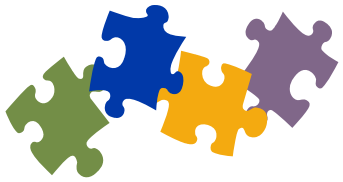


New 2008 question.
Not in 1998 survey

Ten-year Trends Since 1998 Survey

Positive Trends … 1998-2008

- **Historical actuals, as the basis of cost uncertainty, used twice as often (38%);** *team consensus is now half as much (15%).*
- **Training way up! Today ~30% of surveyed organ's have no formal training** *(vs. ~60% in 1998).* ***Internal, vendor-tool, SCEA, ISPA, SSCAG training covers 67% of training***
- **Finance estimating more responsible (53%) for cost risk analysis (CRA).** *Engineering and mgmt are now less responsible (35%).*
- **Cost risk analysis is seen as less specialized (48%)**
  vs. 65% ten years ago.



Negative ▼ & Neutral ❑ Trends

- ▼ **Programs (responding to survey) appear to be less pro-active (more stand-off) in mitigating risk (75% *vs. 90%*).** *Proactive strategies include re-scoping, mitigation plan, improved design, IR&D, and test.*
- ▼ **CRA is seen as somewhat difficult to do well and to explain. Training, experience, and good data are major shortcomings.**

- ❑ **ACE-IT, SEER, & FRISK handle more analyses.** *Crystal Ball, @RISK, ProAct, Risk+, PRICE, in-house tools handle fewer.*
- ❑ **Tornado charts, std dev, and other methods are increasingly used in risk presentations;** *S-curve somewhat reduced (48%).*

Summary & Recommendations

Significant Findings *(page 1 of 3)*

- **Top 4 benefits to business decisions …**
  - **Evaluate program strategies (e.g., bid/no-bid, make/buy, trades)**
  - **Avoid cost overruns and resist unwarranted cost reductions**
  - **Evaluate sufficiency of management reserve**
  - **Manage and mitigate program risks**

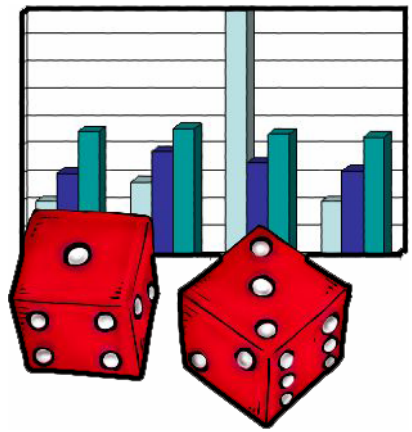
- **Top 3 motivations to assess cost risk … Project size, obvious risks, and customer direction (40% of the time)**

Significant Findings *(page 2 of 3)*

- **Top 2 situations for cost risk analysis**
  - **Independent Cost Estimates**
  - **DDT&E proposals (40-50% of the time)**
- **Cost uncertainty is based on data-driven historical methods … 70% of the time**
- **Affordability (reduction) initiatives included … 50% of the time**
- **Cost to mitigate risk and cost to absorb risk are quantified 46% and 36% of the time, respectively**
- **Excel-based tools handle 60% of cost risk analyses (vs. commercial models)**

Significant Findings *(page 3 of 3)*

- **One fourth of organizations appear to operate at the highest level (4-5) of risk management maturity, where cost risk analysis is integrated to program risk mgmt, tracked-managed, and evident in proposals & EVMS**
- **Two thirds of organizations desire >70% cost confidence**
- **Most significant obstacles to cost risk analysis …**
  - **Sparse historical data**
  - **Weak mgmt and functional support**
  - **Overly optimistic targets**
  - **Lack of cost analyst experience and training**



Summary

- Steady progress has been made since 1998, due to initiatives by government agencies, contractors, & tool/model providers
- Training has dramatically improved
- Cost risk analysis is more broadly applied by both government and industry
- This survey serves as a type of industry metric to assess progress toward important goals.

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