

Quantifying the Impact of Proposed Risk Mitigation Strategies:

Does the Cost of the Mitigation Exceed the Cost of the Impact?

SCEA, Washington Chapter

Phil Beenhouwer
The MITRE Corporation
pbeenhou@mitre.org

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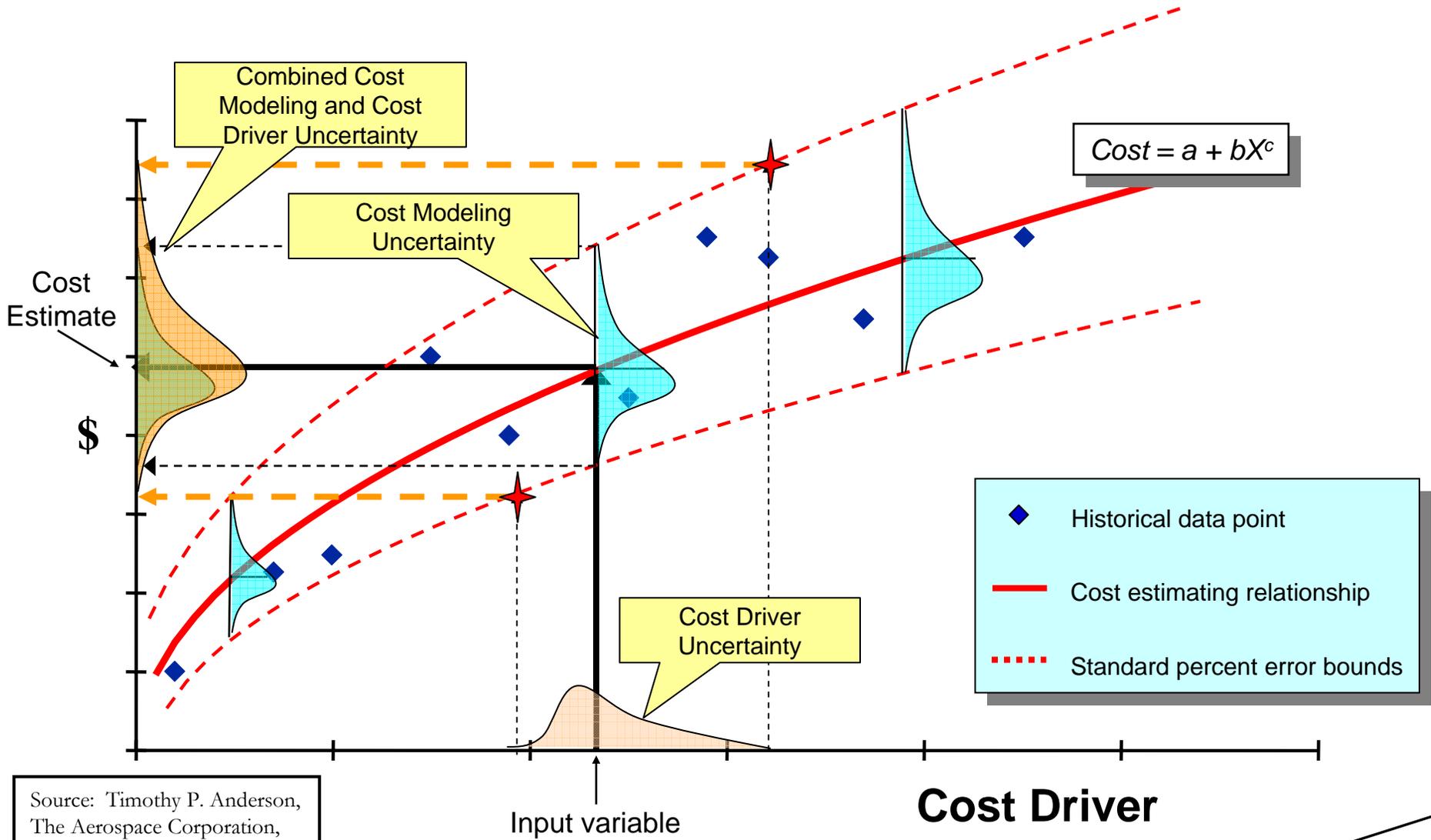


Agenda

- **The Problem**
- **Objective**
- **Federal Government Requirements**
- **Risk Management**
- **A Quantitative Example**
- **'Risk Assumption' vs. 'Risk Control / Mitigation'**



The Problem



Source: Timothy P. Anderson,
The Aerospace Corporation,
2005 DoDCAS Symposium



Objective

This presentation presents an economic analysis approach to quantifying the cost of a risk's mitigation strategy, and demonstrates the value of quantifying and comparing the cost of a risk's impact against the cost of its mitigation so that a Program can determine whether to 'assume' or 'control / mitigate' the risk.



Federal Government Requirements

Office of Management and Budget (OMB)

- Refer to Federal regulations (e.g., OMB) and best practices
 - *Circular A-11: Preparation, Submission, and Execution of the Budget*
 - Circular A-25: User Charges
 - Circular A-76: Performance of Commercial Activities
 - *Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*
- OMB A-11, Part 7 (Planning, Budgeting, Acquisition, and Management of Capital Assets), Section E-300 requirement to:
 - “*Briefly describe how investment risks are reflected in the life cycle cost estimate and investment schedule.*”
 - “*Identify and prioritize the top risks of [the] investment along with their probability and impact.*”

Send to OMB	Alternative Analyzed	Description of Alternative	Risk Adjusted Lifecycle Costs estimate	Risk Adjusted Lifecycle Benefits estimate
True				

OMB E-300: Section II.A: “Alternatives Analysis Results” table



Federal Government Requirements (cont'd)



UNDER SECRETARY OF THE AIR FORCE
WASHINGTON

SEP 20 2004

04A-003

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Revitalizing the Software Aspects of Systems Engineering

REFERENCE: Air Force Software-Intensive Systems Strategic Improvement Program (AFSSIP) memo dated 13 Jan 2004.

In multiple programs across our acquisition communities, we have recognized systems engineering challenges over the past few years, and have taken steps to improve the implementation and effectiveness of our systems engineering processes.

This policy memorandum is intended to improve the efficiency and effectiveness of our acquisition processes and software management. These processes are applied as an integral part of our systems engineering and capability acquisition processes. To support our overall agile acquisition objectives, we expect you to address, as a minimum, the following software focus areas throughout the life cycle of your acquisition programs beginning with pre-Milestone/Key Decision Point A activities:

1. **High Confidence Estimates:** Estimate the software development and integration effort (staff hours), cost, and schedule at high (80-90%) confidence.

- **Line of Code Growth for Satellite Ground Station from Award to Delivery: 100%–232%¹**
- **Cost Growth for Air Force Space Programs as high as 400%²**

¹ Universal Risk Issues in Source Selection, Stephen A. Book, MCR, LLC; 38th Annual DoD Cost Analysis Symposium, Williamsburg VA; February 2005

² Naval Center for Cost Analysis, "Software Development Estimating Handbook, Phase One," 1998. (<http://www.ncca.navy.mil/software/handbook/software.htm>)



OMB Guidance on Good Practice in Regulatory Analysis

- “A good analysis is transparent. It should be possible for a qualified third party reading the report to see clearly how you arrived at your estimates and conclusions.”
- “For major rules involving annual economic effects of \$1 billion or more, you should present a formal quantitative analysis of the relevant uncertainties about benefits and costs.”
- “... expert solicitation is a useful way... to quantify the probability distributions of key parameters and relationships. These solicitations... can be combined in Monte Carlo simulations to derive a probability distribution of benefits and costs.”
- “Use a numerical sensitivity analysis to examine how the results of your analysis vary with plausible changes in assumptions, choices of input data, and alternative analytical approaches.”

(Emphasis added)

OMB Circular A-4, John Graham, PhD, OIRA Administrator, 17 Sep 2003
www.whitehouse.gov/omb/circulars/a004/a-4.html

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National Academy of Sciences Guidance on Good Practice to the Environmental Protection Agency (EPA)

- “EPA should... move the assessment of uncertainties... to its primary analyses. This shift will require the specification of a probability distribution for each uncertainty source.”
- “Expert judgment, as well as data, will be required to specify these distributions.”
- “EPA should consider conducting analyses to determine which uncertainty sources have the greatest influence on the mean and spread of the probability distribution.”

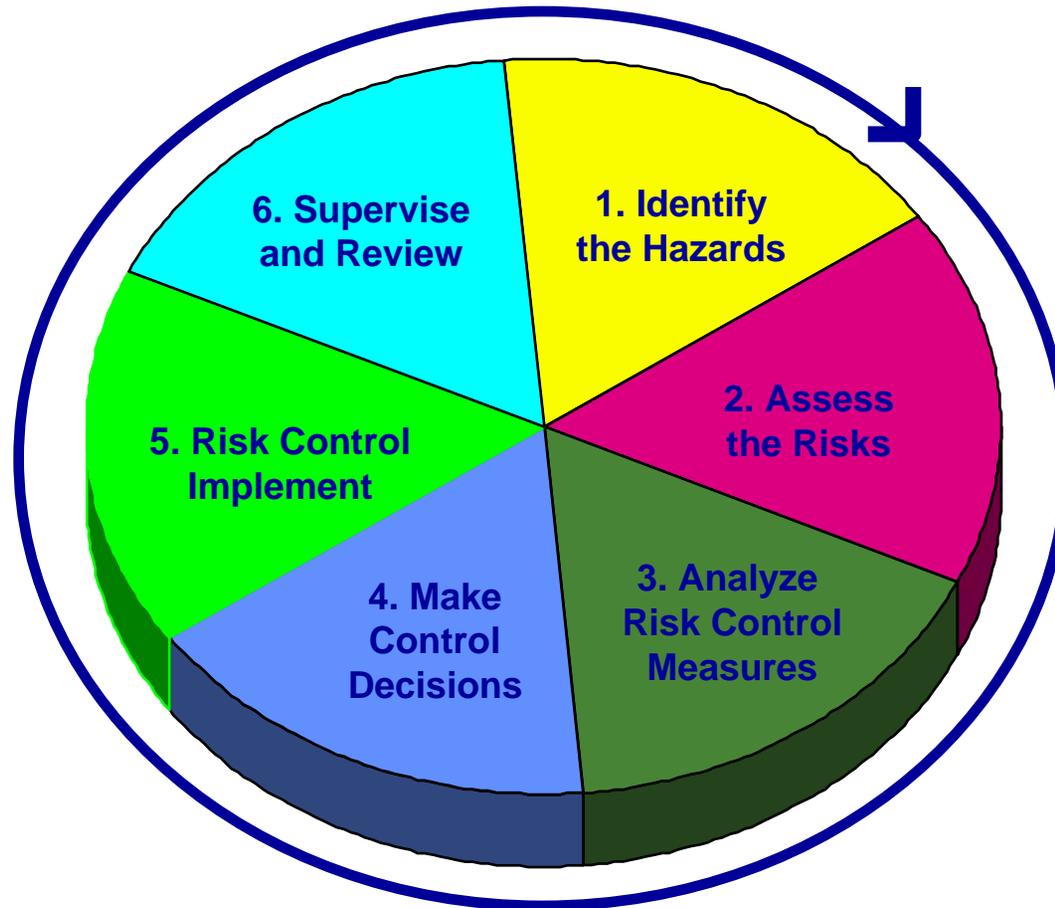
(Emphasis added)

From Estimating the Public Health Benefits of Proposed Air Pollution Regulations
National Academy of Sciences, 2002.

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Risk Management Process



Risk Management Consolidated Training, January 2003, MITRE Corporation.



Risk Management in Government Programs

- **“Currently, a typical approach to cost risk analysis includes performing the risk analysis as part of the cost estimating function for the program. While some programs can afford to staff a risk management office, others do not have the funds for a full blown risk management program. Often the risks are identified and scored by some member of the program management team so that the cost risk analysis can be performed but then, inevitably, no further action occurs in managing the risks by program management.”**
 - ***“True Risk Cost: Including Mitigation Reduction in Upfront Cost Risk Analysis”*, R. Kim Clark, Booz Allen Hamilton**
- **One “further action” would be quantifying (1) the cost of the risk and (2) the cost of the “handling option” (i.e., risk control / mitigation, risk avoidance, risk assumption, risk transference)**
- **Whereas ‘risk transference’ and ‘risk avoidance’ are preferred, this presentation focuses on the inevitable**



Qualitative Risk

- A typical risk matrix.....

Probability	Very High				2, 4	1
	High					
	Moderate					
	Low		3			
	Very Low					
		Very Low	Low	Moderate	High	Very High
		Impact				

-but aside from visualizing the risks, there is little basis for making control decisions.



A Quantitative Example...

<u>Cost Estimate</u> <u>(Before Risk)</u>	
Hardware	\$10.0M
Software	\$0.5M
Integration	\$7.9M
Testing	\$1.2M
Training	\$3.9M
Maintenance	\$3.7M
Helpdesk	\$1.8M
Total	\$29.0M



Risk Management Database

<u>Risk Description</u>	<u>Probability</u>	<u>Cost of Risk</u>	<u>Expected Value</u>	<u>Mitigation</u>	<u>Cost of Mitigation</u>
If the 5,000 field laptops are not replaced next year, the cost to maintain them will increase.					
If Increment 1 testing is not completed on time, the environment will not be available for Increment 2 design, causing a three-month slip.					
The incorporation of Microsoft Vista across the workforce will produce new problems for the Tier 1 HelpDesk to resolve, causing more trouble-tickets and decreasing productivity.					
The increased use of user laptops in the field will result in increased hard drive failures, which will cause a spike in repair costs and user downtime.					

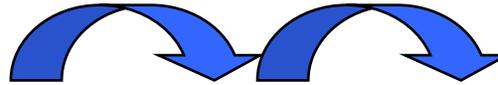


Risk Management Database

<u>Risk Description</u>	<u>Probability</u>	<u>Cost of Risk</u>	<u>Expected Value</u>	<u>Mitigation</u>	<u>Cost of Mitigation</u>
If the 5,000 field laptops are not replaced next year, the cost to maintain them will increase.	50%				
If Increment 1 testing is not completed on time, the environment will not be available for Increment 2 design, causing a three-month slip.	90%				
The incorporation of Microsoft Vista across the workforce will produce new problems for the Tier 1 HelpDesk to resolve, causing more trouble-tickets and decreasing productivity.	75%				
The increased use of user laptops in the field will result in increased hard drive failures, which will cause a spike in repair costs and user downtime.	100%				



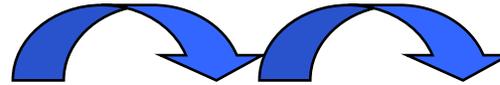
Risk Management Database



<u>Risk Description</u>	<u>Probability</u>	<u>Cost of Risk</u>	<u>Expected Value</u>	<u>Mitigation</u>	<u>Cost of Mitigation</u>
If the 5,000 field laptops are not replaced next year, the cost to maintain them will increase.	50%	\$1.25M			
If Increment 1 testing is not completed on time, the environment will not be available for Increment 2 design, causing a three-month slip.	90%	\$3M			
The incorporation of Microsoft Vista across the workforce will produce new problems for the Tier 1 HelpDesk to resolve, causing more trouble-tickets and decreasing productivity.	75%	\$7.5M			
The increased use of user laptops in the field will result in increased hard drive failures, which will cause a spike in repair costs and user downtime.	100%	\$0.6M			



Risk Management Database



<u>Risk Description</u>	<u>Probability</u> ×	<u>Cost of Risk</u> =	<u>Expected Value</u>	<u>Mitigation</u>	<u>Cost of Mitigation</u>
If the 5,000 field laptops are not replaced next year, the cost to maintain them will increase.	50%	\$1.25M	\$0.625M		
If Increment 1 testing is not completed on time, the environment will not be available for Increment 2 design, causing a three-month slip.	90%	\$3M	\$2.7M		
The incorporation of Microsoft Vista across the workforce will produce new problems for the Tier 1 HelpDesk to resolve, causing more trouble-tickets and decreasing productivity.	75%	\$7.5M	\$5.625M		
The increased use of user laptops in the field will result in increased hard drive failures, which will cause a spike in repair costs and user downtime.	100%	\$0.6M	\$0.6M		



Risk Management Database

<u>Risk Description</u>	<u>Probability</u>	<u>Cost of Risk</u>	<u>Expected Value</u>	<u>Mitigation</u>	<u>Cost of Mitigation</u>
If the 5,000 field laptops are not replaced next year, the cost to maintain them will increase.	50%	\$1.25M	\$0.625M	Replace broken laptops with available spares.	
If Increment 1 testing is not completed on time, the environment will not be available for Increment 2 design, causing a three-month slip.	90%	\$3M	\$2.7M	Purchase another environment for concurrent use.	
The incorporation of Microsoft Vista across the workforce will produce new problems for the Tier 1 HelpDesk to resolve, causing more trouble-tickets and decreasing productivity.	75%	\$7.5M	\$5.625M	Prepare a program to train all HelpDesk personnel.	
The increased use of user laptops in the field will result in increased hard drive failures, which will cause a spike in repair costs and user downtime.	100%	\$0.6M	\$0.6M	Purchase new laptops equipped with solid-state hard drives.	



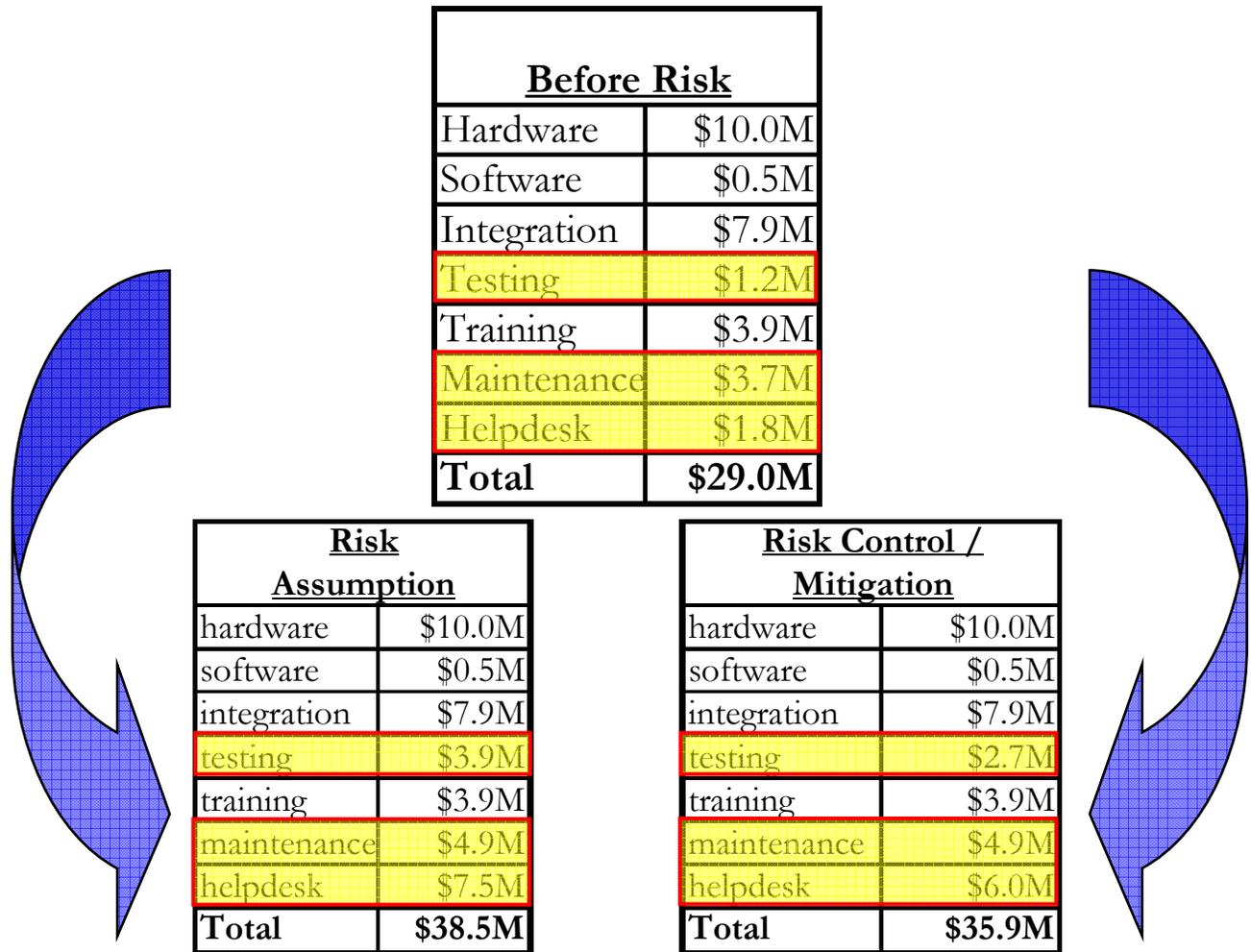
Risk Management Database

<u>Risk Description</u>	<u>Probability</u>	<u>Cost of Risk</u>	<u>Expected Value</u>	<u>Mitigation</u>	<u>Cost of Mitigation</u>
If the 5,000 field laptops are not replaced next year, the cost to maintain them will increase.	50%	\$1.25M	\$0.625M	Replace broken laptops with available spares.	\$0.75M
If Increment 1 testing is not completed on time, the environment will not be available for Increment 2 design, causing a three-month slip.	90%	\$3M	\$2.7M	Purchase another environment for concurrent use.	\$1.5M
The incorporation of Microsoft Vista across the workforce will produce new problems for the Tier 1 HelpDesk to resolve, causing more trouble-tickets and decreasing productivity.	75%	\$7.5M	\$5.625M	Prepare a program to train all HelpDesk personnel.	\$4.2M
The increased use of user laptops in the field will result in increased hard drive failures, which will cause a spike in repair costs and user downtime.	100%	\$0.6M	\$0.6M	Purchase new laptops equipped with solid-state hard drives.	\$1.0M



'Risk Assumption' vs. 'Risk Control / Mitigation'

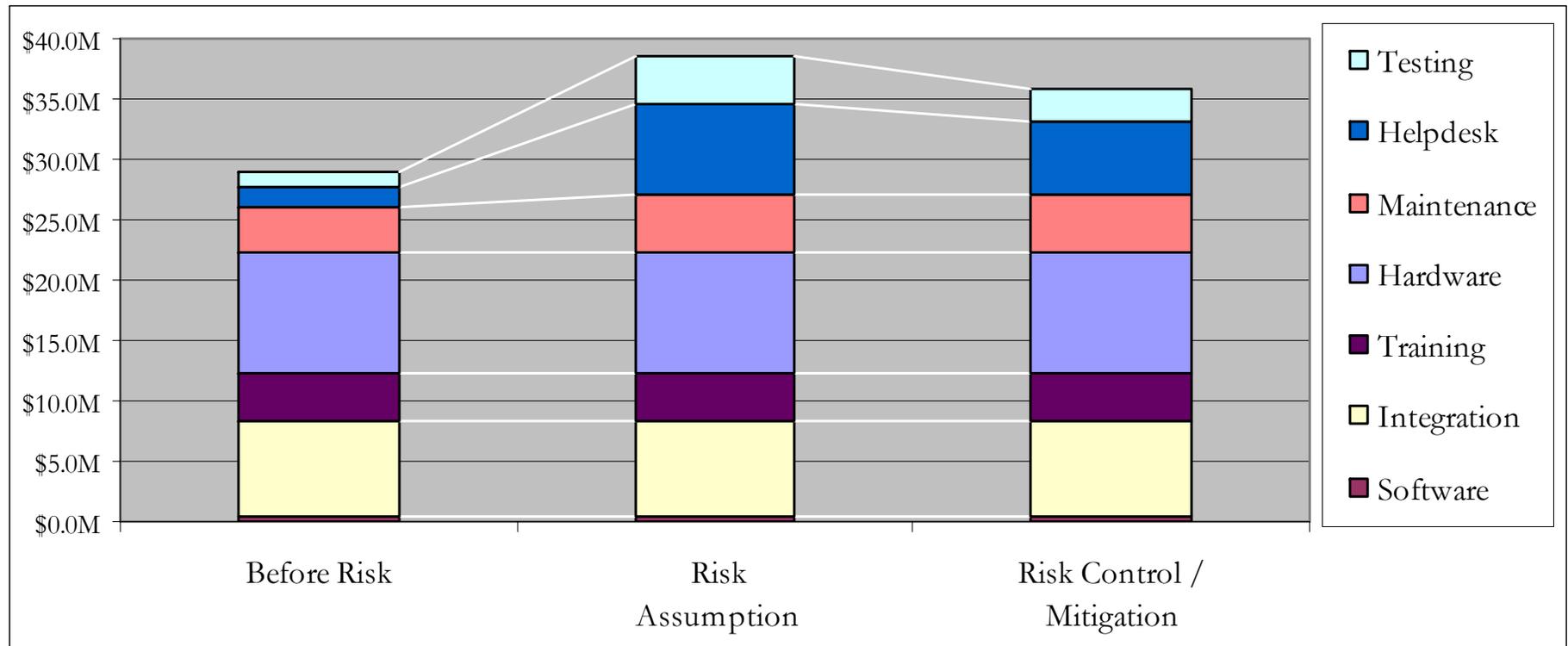
A Point Estimate





'Risk Assumption' vs. 'Risk Control / Mitigation'

A Point Estimate (Cont'd)



Choosing 'Before Risk' is not an option;
therefore, controlling / mitigating the risk
is preferred over assuming it.



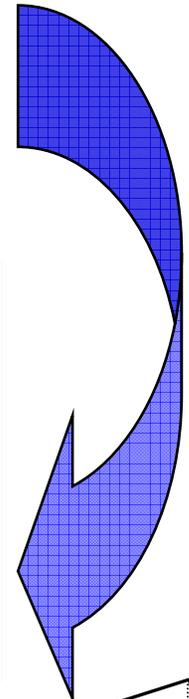
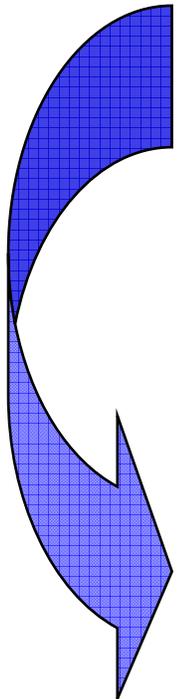
'Risk Assumption' vs. 'Risk Control / Mitigation'

A Stochastic Model (-10% / +25%)

Before Risk				
	<u>L</u>	<u>ML</u>	<u>H</u>	
Hardware	\$9.0M	\$10.0M	\$12.5M	\$10.5M
Software	\$0.5M	\$0.5M	\$0.6M	\$0.5M
Integration	\$7.1M	\$7.9M	\$9.8M	\$8.3M
Testing	\$1.1M	\$1.2M	\$1.5M	\$1.2M
Training	\$3.5M	\$3.9M	\$4.9M	\$4.1M
Maintenance	\$3.3M	\$3.7M	\$4.6M	\$3.9M
Helpdesk	\$1.7M	\$1.8M	\$2.3M	\$1.9M
Total				\$30.4M

Risk Assumption				
	<u>L</u>	<u>ML</u>	<u>H</u>	
hardware	\$9.0M	\$10.0M	\$12.5M	\$10.5M
software	\$0.5M	\$0.5M	\$0.6M	\$0.5M
integration	\$7.1M	\$7.9M	\$9.8M	\$8.3M
testing	\$3.5M	\$3.9M	\$4.9M	\$4.1M
training	\$3.5M	\$3.9M	\$4.9M	\$4.1M
maintenance	\$4.4M	\$4.9M	\$6.1M	\$5.1M
helpdesk	\$6.7M	\$7.5M	\$9.3M	\$7.8M
Total				\$40.4M

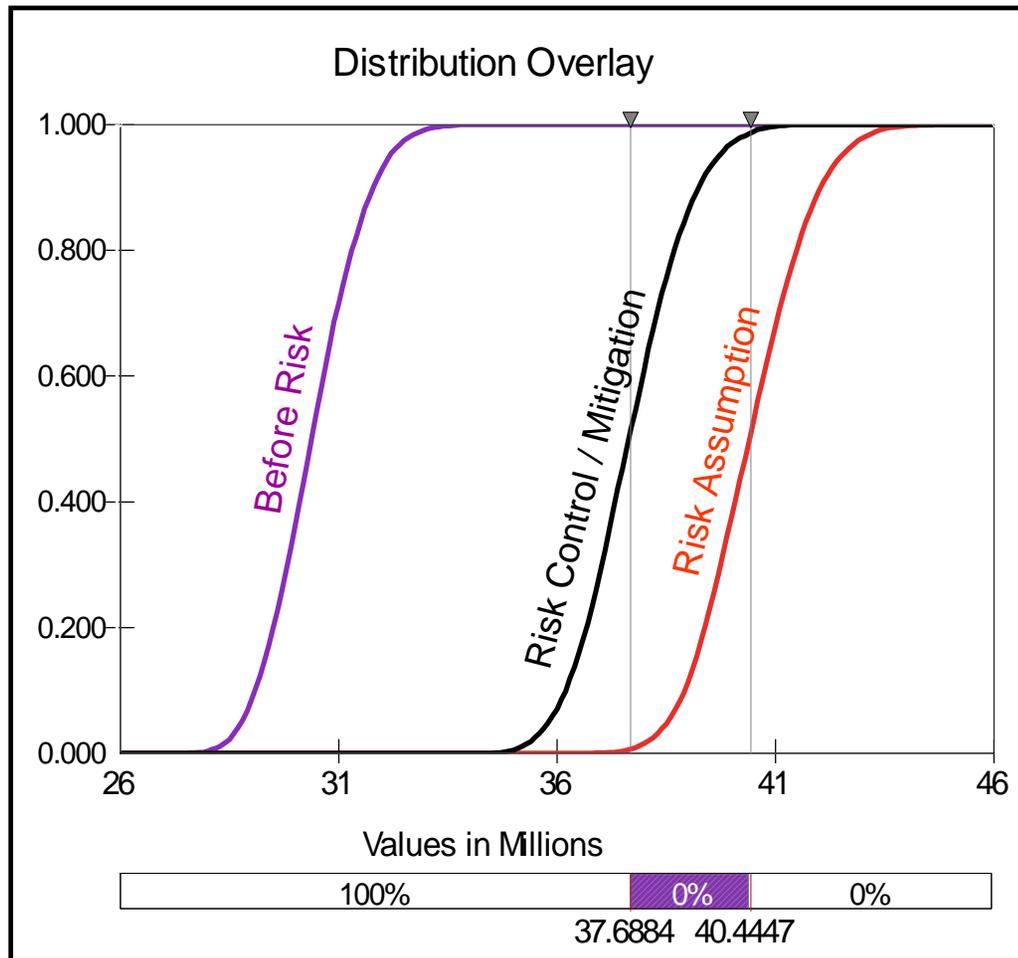
Risk Control / Mitigation				
	<u>L</u>	<u>ML</u>	<u>H</u>	
hardware	\$9.0M	\$10.0M	\$12.5M	\$10.5M
software	\$0.5M	\$0.5M	\$0.6M	\$0.5M
integration	\$7.1M	\$7.9M	\$9.8M	\$8.3M
testing	\$2.4M	\$2.7M	\$3.4M	\$2.8M
training	\$3.5M	\$3.9M	\$4.9M	\$4.1M
maintenance	\$4.4M	\$4.9M	\$6.1M	\$5.1M
helpdesk	\$5.4M	\$6.0M	\$7.5M	\$6.3M
Total				\$37.7M





'Risk Assumption' vs. 'Risk Control / Mitigation'

A Stochastic Model (-10% / +25%) (Cont'd)



- The three approaches create three different cumulative distribution functions (CDFs)
- Although they have the identical shape, the difference is in cost (x-axis)

Choosing 'Before Risk' is not an option; therefore, controlling / mitigating the risk is preferred over assuming it.

Quantifying the Impact of Proposed Risk Mitigation Strategies:

Does the Cost of the Mitigation Exceed the Cost of the Impact?

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