Estimating Project Risk Reserves

Richard D. Stutzke
Science Applications International Corp.
6725 Odyssey Drive
Huntsville, AL 35806-3301
(256) 971-6224 (office)
(256) 971-6550 (facsimile)
(256) 971-7330 (asst)

Richard.D.Stutzke@saic.com

Presented at the 17th International Forum on COCOMO and Software Cost Modeling, 22-25 October 2003 Los Angeles, CA.

Topics

- Basic Concepts and Notation
- The Spreadsheet
- Deciding to Accept or Mitigate
- Deciding to Prevent or Track

Definitions

- Definitions

  Risk = an uncertain condition or event that, if it occurs, could have a negative effect on the project, the product, or the process

  Mitigation = actions taken to reduce the impact of a risk

- Example of mitigation
  - Redesign so hardware won't fail
  - Multi-version programming
  - Contract Terms and Conditions ("Not my fault!")
  - Purchase insurance

Goals

- Choose an "optimal" reserve amount (money)
  - Too large ⇒ overpriced
  - Too small ⇒ inadequate resources
- Provide justification for the amount
  - Hard reserve versus soft reserve
  - Documented calculations
- Advice on planning
  - Preventative versus contingent
  - Schedule impacts

Notation

- Basic Quantities

  P_B = Probability of occurrence before mitigation
  C_B = Cost of occurrence before mitigation
  P_A = Probability of occurrence after mitigation
  C_A = Cost of occurrence after mitigation
  C_M = Cost of mitigation

- Useful Quantities

  I_i = Impact = Pi*Ci

  RRL = Risk Reduction Leverage = $\frac{I_B - I_A}{C_M}$

Handling Insurance

- Definitions:

  C_F = Face Value

  C_D = Deductible amount

  C_I = Cost of policy

- Calculations

  $I_B = P_B * C_B$

  $I_A = P_B * [C_B - (C_F - C_D)]$

  $RRL = P_B * (C_F - C_D)/C_I$

Risk Analysis Spreadsheet*

Project:													
Date Prepared:													
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Description			*Before Mitigation*			*Mitigation*		*After Mitigation*			*Analysis*		
ID	Owner	Title	Prob.	Cost	Impact	Action	Cost	Prob.	Cost	Impact	Impact Red.	RRL	Notes
				($K)	($K)		($K)		($K)	($K)	($K)		
1		A	0.4	45.0	18.0	A-1	10.0	0.05	10.0	0.5	17.5	1.75	
2		B	0.5	75.0	37.5	B-1	75.0	0.00	0.0	0.0	37.5	0.50	
3		C	0.3	25.0	7.5	C-1	2.0	0.00	0.0	0.0	7.5	3.75	
4		D	0.2	100.0	15.0	D-1	15.0	0.00	0.0	0.0	15.0	1.00	
5		E	1.0	150.0	150.0	E-1	5.0	0.00	0.0	0.0	150.0	30.00	
6		F	0.3	375.0	112.5	F-1	100.0	0.15	200.0	30.0	82.5	0.83	
7		G	0.1	1000.0	100.0	G-1	150.0	0.01	900.0	9.0	91.0	0.61	
8		H	0.2	1125.0	225.0	H-1	90.0	0.05	100.0	5.0	220.0	2.44	
9		I2	0.4	500.0	200	I-1	30.0	0.10	500.0	50	150	5.00	
10		J	0.4	1500.0	600	J-1	100.0	0.15	500.0	75	525	5.25	

*Based on concepts in [Hwang, 1973] and [Army, 1979].

Regions of the Spreadsheet

Purpose	Columns
1. Description	A-C
2. Before Mitigation	D-F
3. Mitigation Action	G-H
4. After Mitigation	I-K
5. Analysis	L-M
6. Notes	N

Overlapping Risks

- Coupling
  - Mitigating one risk increases the impact of another risk
  - "Buy instead of build" reduces new development risk, but increases COTS volatility risk
- Compounding
  - One occurrence affects several components or tasks
  - The new ICASE tool lacks needed features, and is "buggy"
  - Reference Section 2.5.2 in [Boehm, 1989]

Overlapping Mitigation Actions

- One mitigation action affects multiple risks
  - Example: A high maturity process mitigates risks associated with multiple process areas
  - The concern: allocating C_M to the risks so RRL_i is realistic
- Alternatives
  - Allocate C_M equally to the risks
  - Allocate C_M in proportion to $(I_B - I_A)$

Computing the Appropriate Reserve

- Approach
  - Mitigate only risks with RRL > 1
  - Rank order risks by decreasing RRL
- Definitions:

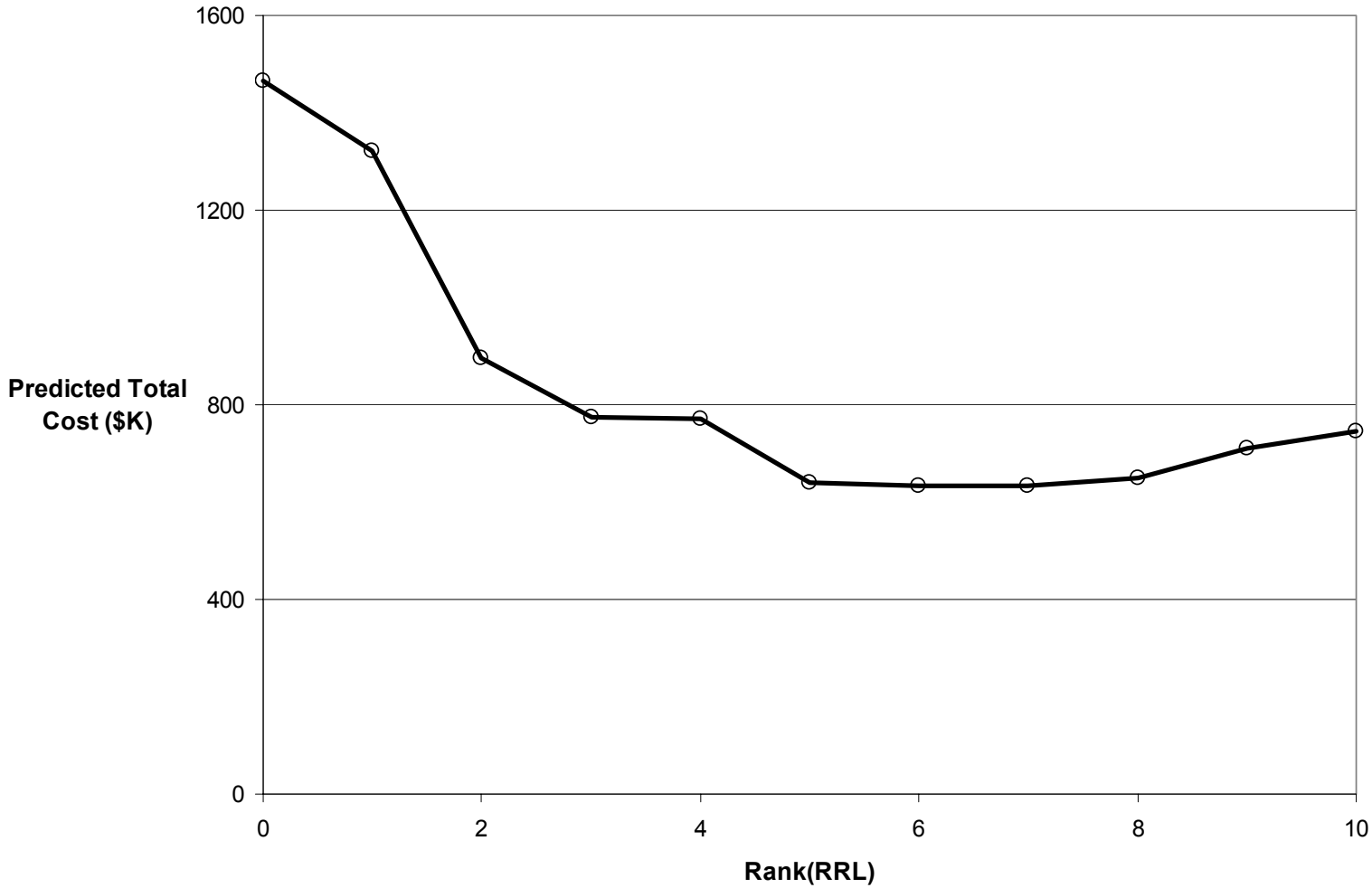
$$\text{CMC} = \text{Cumulative Mitigation Cost} = \sum_{\text{RRL}>1} C_M$$

$$\text{PTC} = \text{Predicted Total Cost} = \sum_{\text{RRL}>1} I_A + \sum_{\text{RRL}<1} I_B + \sum_{\text{RRL}>1} C_M$$

Sample Risk Analysis

Project:																
Date Prepared:																
A	B	C	D	E	F	G	H	I	J	K	L	M	N			
Description			*Before Mitigation*			*Mitigation*		*After Mitigation*			*Analysis*		*Rank*	Cumul	Impact	Predicted
ID	Owner	Title	Prob.	Cost	Impact	Action	Cost	Prob.	Cost	Impact	Impact Red.	RRL	(RRL)	Mitig	Remaining	Total Cost
				($K)	($K)		($K)		($K)	($K)	($K)		0	0.00	1465.50	1465.50
5		E	1.0	150.0	150.0	E-1	5.0	0.00	0.0	0.0	150.0	30.00	1	5.00	1315.5	1320.50
10		J	0.4	1500.0	600	J-1	100.0	0.15	500.0	75	525	5.25	2	105.00	790.5	895.50
9		I2	0.4	500.0	200	I-1	30.0	0.10	500.0	50	150	5.00	3	135.00	640.5	775.50
3		C	0.3	25.0	7.5	C-1	2.0	0.00	0.0	0.0	7.5	3.75	4	137.00	633.0	770.00
8		H	0.2	1125.0	225.0	H-1	90.0	0.05	100.0	5.0	220.0	2.44	5	227.00	413.0	640.00
1		A	0.4	45.0	18.0	A-1	10.0	0.05	10.0	0.5	17.5	1.75	6	237.00	395.5	632.50
4		D	0.2	100.0	15.0	D-1	15.0	0.00	0.0	0.0	15.0	1.00	7	252.00	380.5	632.50
6		F	0.3	375.0	112.5	F-1	100.0	0.15	200.0	30.0	82.5	0.83	8	352.00	298.0	650.00
7		G	0.1	1000.0	100.0	G-1	150.0	0.01	900.0	9.0	91.0	0.61	9	502.00	207.0	709.00
2		B	0.5	75.0	37.5	B-1	75.0	0.00	0.0	0.0	37.5	0.50	10	577.00	169.5	746.50

Predicted Total Cost vs Rank(RRL)



Deferring Mitigation Actions

- Some risks may never occur. (They expire)
- Some risks are almost certain to occur.
- Strategy to expend the risk reserve:
  - Preventative: Do something immediately
  - Contingent: Track the risk. Take action if threshold exceeded.

Choosing the Preventative Mitigation Actions

Mitigate a Task If:

1. $I_B > 0.05*(\text{Total Project Cost})$

or 2. $RRL_i \geq 2$

Applying the Two Criteria

Project:																		Total	
Date Prepared:																		Budget	
																		227	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
Description			*Before Mitigation*			*Mitigation*		*After Mitigation*			*Analysis*					Sum		Prevent	
ID	Owner	Title	Prob.	Cost	Impact	Action	Cost	Prob.	Cost	Impact	Impact Red.	RRL	Notes	1	2	CP	Disp.	Cost	
				($K)	($K)		($K)		($K)	($K)	($K)								
5		E	1.0	150.0	150.0	E-1	5.0	0.00	0.0	0.0	150.0	30.00			P	1	P	5	
10		J	0.4	1500.0	600	J-1	100.0	0.15	500.0	75	525	5.25		P	P	2	P	100	
9		I	0.4	500.0	200	I-1	30.0	0.10	500.0	50	150	5.00			P	1	P	30	
3		C	0.3	25.0	7.5	C-1	2.0	0.00	0.0	0.0	7.5	3.75			P	1	P	2	
8		H	0.2	1125.0	225.0	H-1	90.0	0.05	100.0	5.0	220.0	2.44			P	1	P	90	
1		A	0.4	45.0	18.0	A-1	10.0	0.05	10.0	0.5	17.5	1.75				0	C	0	*
4		D	0.2	100.0	15.0	D-1	15.0	0.00	0.0	0.0	15.0	1.00				0	C	0	*
6		F	0.3	375.0	112.5	F-1	100.0	0.15	200.0	30.0	82.5	0.83				0	A	0	
7		G	0.1	1000.0	100.0	G-1	150.0	0.01	900.0	9.0	91.0	0.61				0	A	0	
2		B	0.5	75.0	37.5	B-1	75.0	0.00	0.0	0.0	37.5	0.50				0	A	0	

Summary of Example

Type	Amount	Category	Meaning
R	$250.0K	Accepted	Sum of IA for all non-mitigated tasks
P	$227.0K	Preventative	Sum of mitigation tasks to be executed
R	$ 25.0K	Contingent	Sum of mitigation costs for deferred tasks
R	$130.5K	Remaining Impact	Sum of IB for all mitigated tasks

Total Reserve = $405.5K

Planned Tasks = $227.0K

Addressing Schedule Risk

- Delays may occur due to:
  - Repair or rework
  - Dependence on predecessor tasks
    ($\Rightarrow$ all tasks not affected)
- Possible approaches
  - Use a Resource Loaded Network
  - Add a column to spreadsheet for schedule slip (if identifiable)*
- Advice
  - Reduce coupling between tasks
  - Include slack in the branches of the network
  - Include tasks for “large” contingent actions in the network

*Reference Chapter 5 in [McConnell, 1996]

References

[Army, 1979] "Total Risk Assessing Cost Estimate (TRACE) Guide", technical report dated 1 September 1979 from Department of the Army Contract DAAK40-79-C-0034.

[Boehm, 1989] "Software Risk Management", Barry Boehm, IEEE Press, 1989.

[Hwang, 1973] "An Impact Assessment Algorithm for R&D Project Risk Analysis", J.D. Hwang and H.M. Kodani, U.S. Army Air Mobility R&D Laboratory, Ames Research Center, Moffet Field, CA, October 1973.

[McConnell, 1996] "Rapid Application Development: Taming Wild Software Schedules", Steve McConnell, Microsoft Press, 1996, ISBN 1-55615-900-5.

[Stutzke, 2003?] "Software and System Estimation: Projects, Products, and Processes", Richard D. Stutzke, Addison-Wesley, 2003?