Don't Just Tell Me!
Build A Model To Show Me.

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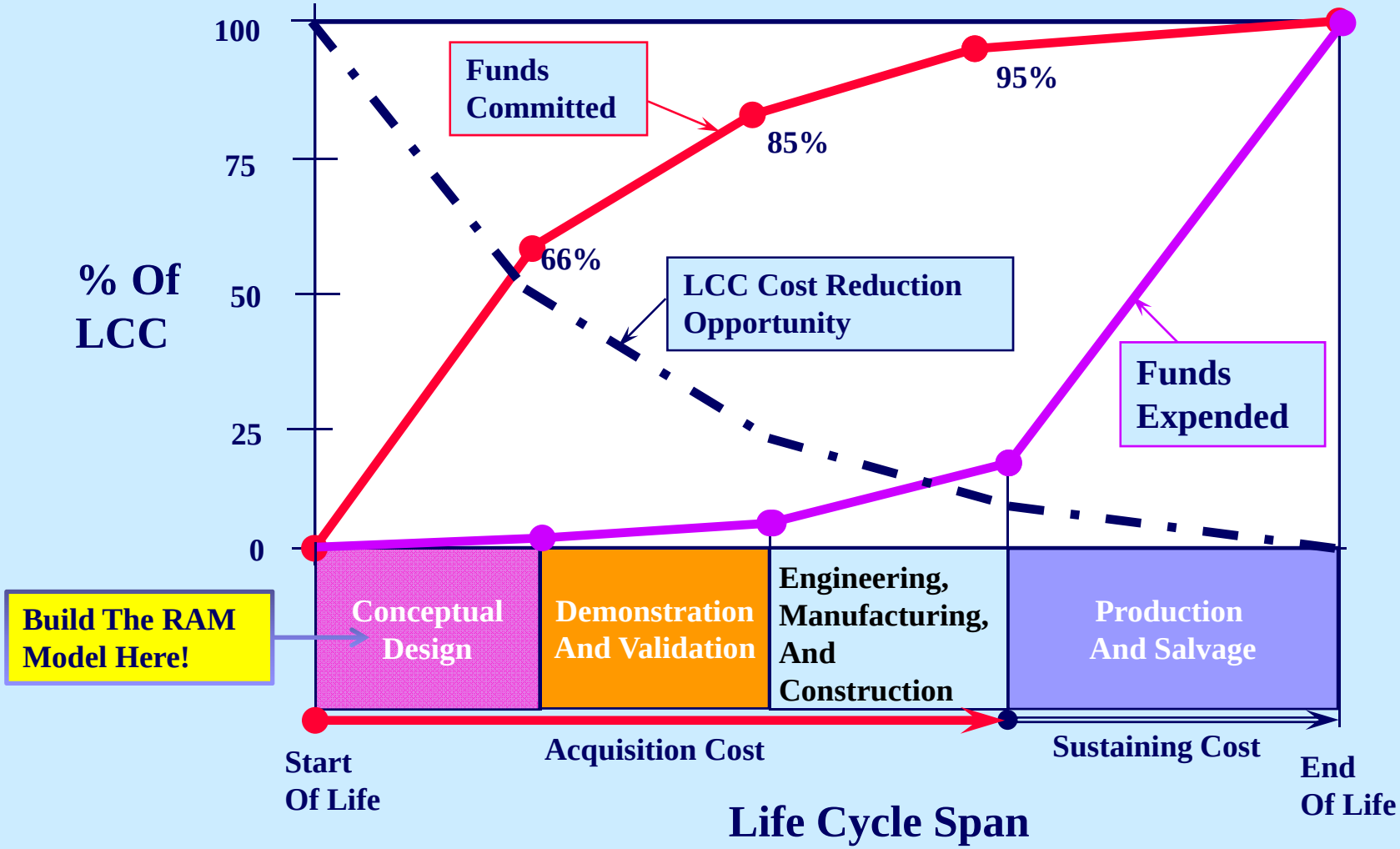
Find Hidden Costs From RAM Models

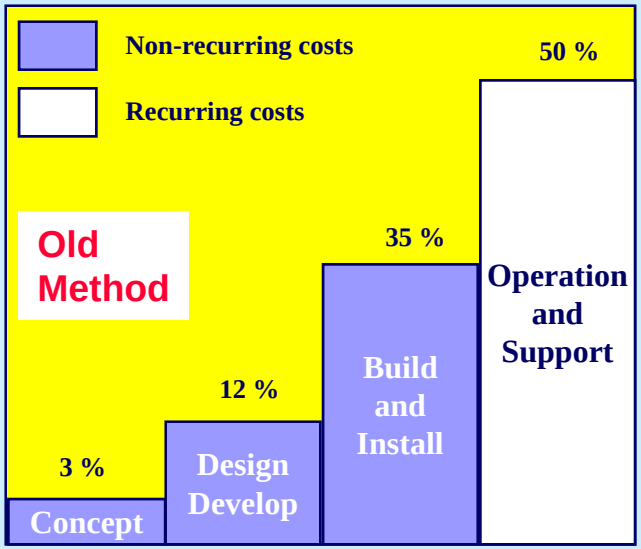
- Often sustaining costs (including hidden costs) are 2-20 times acquisition costs (obvious costs)
- About 65%+ of total life cycle costs are fixed by the time equipment is specified (but only a few percent of funds have been expended at this point in time)
- Minimizing life cycle cost pushes up net present value and builds stockholder wealth—it's not about cheapest first cost
- Finding the lowest long term life cycle cost requires details for both acquisition costs and sustaining costs hence the need for building RAM models to make tradeoffs

Commitments And Expenditures

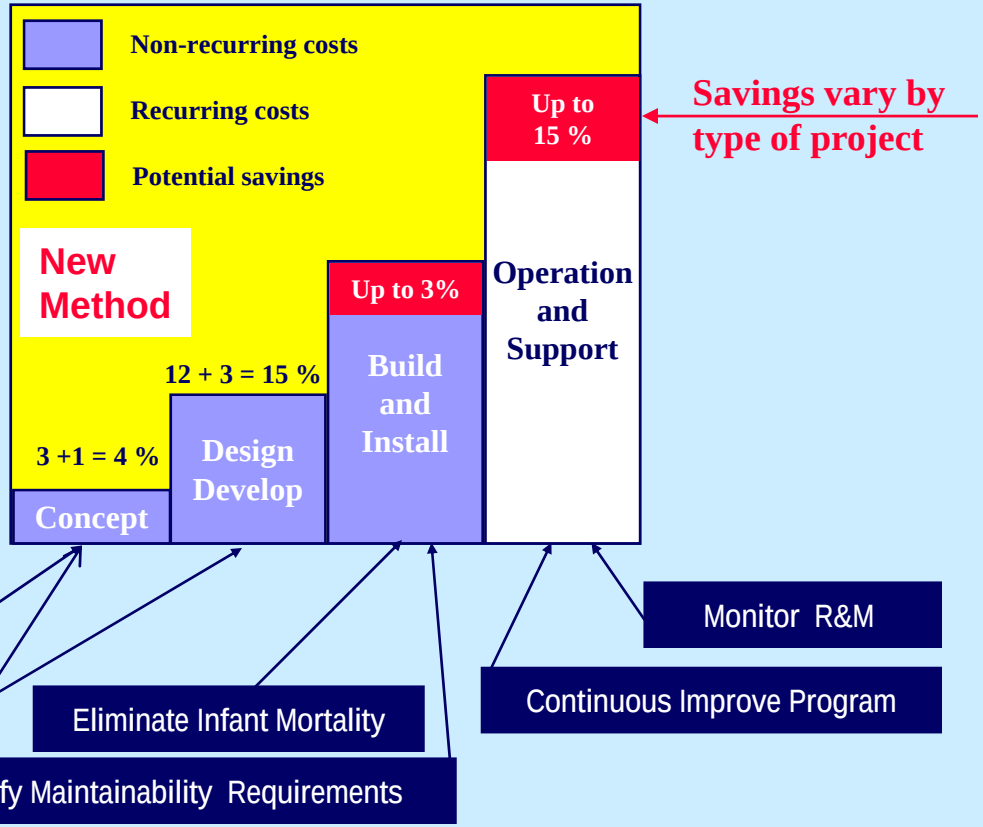


A New View Of RAM Influence On Life Cycle Cost

Save up front and defer costs until later by holding down engineering costs



Use strong RAM engineering tools to reduce the largest cost components and reduce cost



Source:
SAE Reliability and Maintainability Guideline for Manufacturing Machinery and Equipment, 2nd edition, M-110.2

The Big Picture For Each Phase

Short List Of Reliability & Maintainability Activities Over The Life Cycle Phases

The Big PictureTasks	Concept & Proposal Phase	Design & Development Phase	Build & Install Phase	Operation & Support Phase	Conversion Or Decomm. Phase
Set Availability Requirements	X				`
Set Reliability Requirements	X				
Set Maintainability Requirements	X				
Define Functional Failures	X				
Define Environment/Usage	X				
Define Capital Budgets and Make TradeOff Decisions	X	X			
Set Design Margins		X			
Design For Maintainability		X			
Make Reliability Predictions		X			
Do FMEA & Fault Tree Analysis		X			
Do Preliminary Cost Of Unreliability		X			
Conduct Design Reviews		X			
Make Machinery Parts Selections		X			
Do Tolerance/Process Studies		X			
Do Critical Parts Stress Analysis		X			
Do Reliability Qualification Testing			X		
Do Reliability Acceptance Testing			X		
Do Reliability/Maintainability Growth Improvement		X	X	X	
Collect Failure Reports & Analize			X	X	
Provide Data Feedback	X	X	X	X	X

RAM Model

Tailor the matrix to avoid too little or too much emphasis on R&M but meet the needs of the business to make the effort cost effective

Which Equipment To Buy?

A vendor offers three grades of equipment for solving our plant problem. Disregarding depreciation and other accounting details, which grade of equipment should we select for the lowest long term cost of ownership (assume plant life ends after 20 years = 175,200 hours).

	Good	Better	Best
Cost of the new equipment	$50,000	$75,000	$150,000

Which equipment will you buy?--Why

Which equipment do you want to buy?—Why

Which equipment is in the best interest of the stockholder assuming each can perform the designated task?

You need details to make the correct decision—what do you need?

An Arithmetic Model

Watch out for changes in decisions when discount rates are used by accounting.

Reliability Models & Costs--Life Time Costs

A vendor offers three grades of equipment for solving our plant problem. Disregarding depreciation and other accounting details, which grade of equipment should we select for the lowest long term cost of ownership (assume plant life ends after 20 years = 175,200 hours). What are the savings?

Answer Sheet

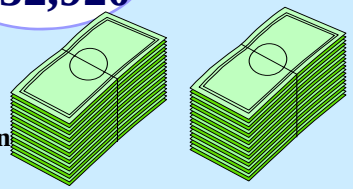
	Good	Better	Best
Cost of the new equipment	$ 50,000	$ 75,000	$ 150,000
Failure rate (failures/hour)	0.0005	0.0001	0.00001
Reliability for a 1 year mission?	1.25%	41.64%	91.61%
Number of failures in 20 years?	# 87.6	# 17.52	# 1.752
20 year failure costs @$5,000/failure?	$ 438,000	$ 87,600	$ 8,760
Equipment overhaul required every	5 yr	10	10
Each overhaul cost is	$10,000	$20,000	$45,000
20 year number of overhauls & costs?	# 3 $ 30,000	# 1 $ 20,000	# 1 $ 45,000
Operating/routine maintenance costs	$1.00/hr	$0.90/hr	$0.90/hr
20 year operating/routine maintenance costs	$ 175,200	$ 157,680	$ 157,680
Disposal cost at retirement	$ 5,000	$ 5,000	$ 5,000
Total long term costs (ex depreciation, etc)	$ 698,200	$ 345,280	$ 366,440

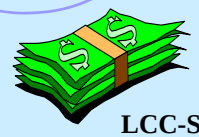
Chance Failures

Wear-out Failures

Save $352,920

Save $21,160





Long term cost of ownership = Initial cost
+ maintenance cost (include spares & outside services)
+ operating costs + disposal costs.

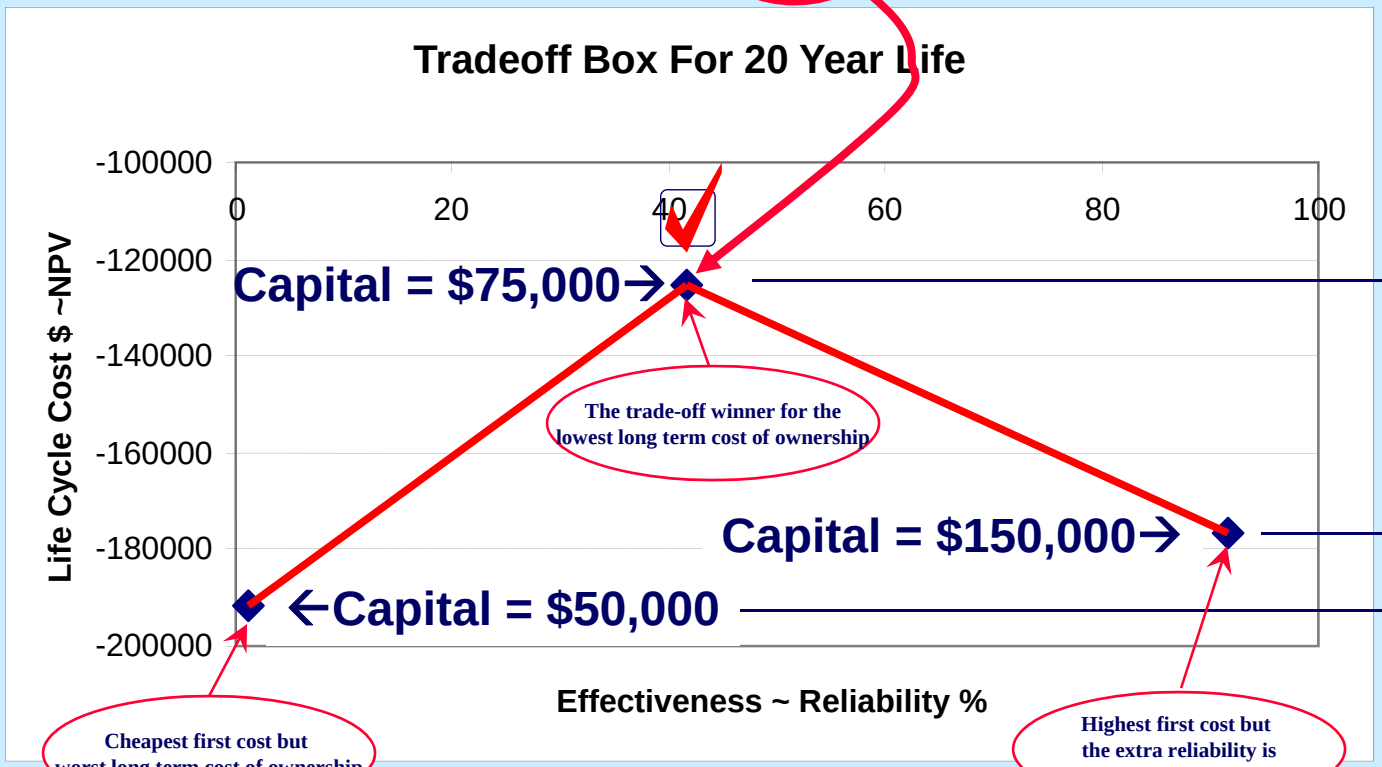
NPV For Simple LCC Models--Cont'd

Answer Sheet

	Alternative 1	Alternative 2	Alternative 3
Grade	**Good**	**Better**	**Best**
NPV	-$191,861	**-$125,465**	-$176,556
Reliability	1.25%	41.64%	91.61%

+66,396

+51,091



The Final Exam Question

Use:
12% discount rate
38% tax rate
20 year project life

Device Reliability = 0.95 for 1 year mission,
Failure Consequence = $20,000,000/yr,
Device Costs = $10,000/each—assume a 20 year life & 20 year project
How Many Devices Should We Install?

Number of Instruments	Reliability (%)	$Risk/yr	Capital Cost	NPV
1				
2				
3				
4				
5				
6				
7				
8				
9				

Final Exam Answers-

$Risk/yr = POF/yr * $Consequence/yr

Answer Sheet

Device Reliability = 0.95 for 1 year mission,
Failure Consequence = $20,000,000/yr,
Device Costs = $10,000/each—assume a 20 year life & 20 year project
How Many Devices Should We Install?

Number of Instruments	Reliability (%)	$Risk/yr	Capital Cost	NPV
1	0.95	$1,000,000	$10,000	-$4,639,636
2	0.9975	$50,000	$20,000	-$248,714
3	0.999875	$2,500	$30,000	-$37,320
4	**0.99999375**	**$125**	**$40,000**	**-$34,902**
5	0.999999688	$6.25	$50,000	-$42,932
6	0.999999984	$0.31250	$60,000	-$51,486
7	0.999999999219	$0.01562	$70,000	-$60,066
8	0.999999999961	$0.00078	$80,000	-$68,646
9	0.999999999998	$0.00004	$90,000	-$77,227

Risk Too High & Capital Too Low

*

Risk To Low & Capital To HIgh

Advantage = $4,639,636 - $34,902 = $4,604,734

Remember---

- Old pilots have a saying: "You can't make a good landing from a poor approach." And….
- You can't make a good life cycle cost analysis from poor data—RAM models require a team approach using many different sources of information and no one ever becomes a true LCC expert
- Better LCC decisions driven by RAM models result in better operating plants that are truly cost effective rather than just cost effective on paper
- Build a RAM model plus do your life cycle cost tradeoffs!