Modeling Equipment Costs

UNC CHARLOTTE

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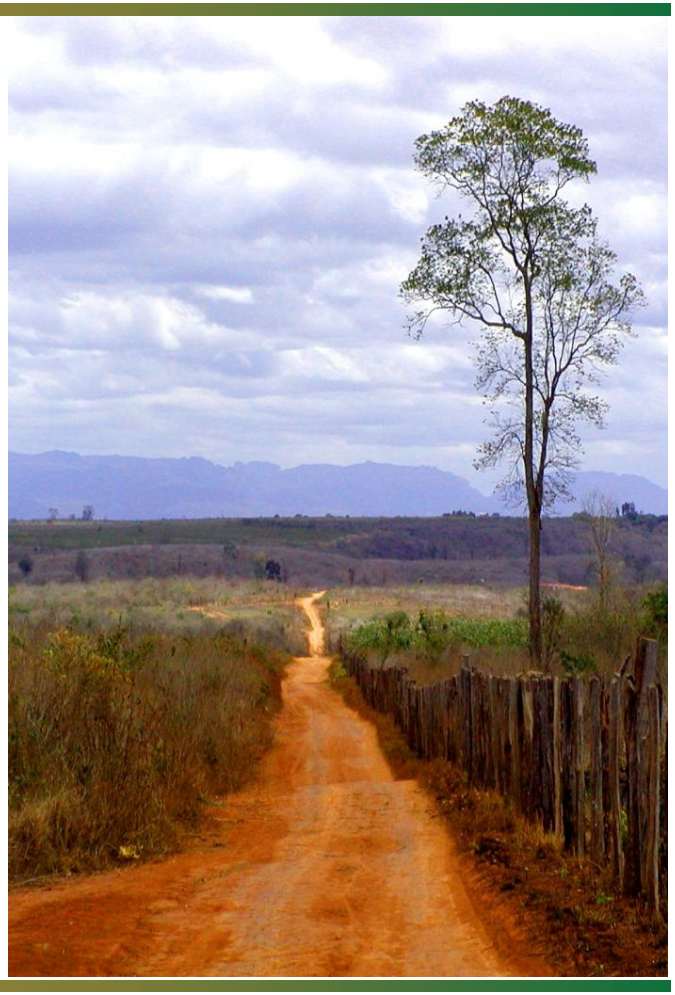
Agenda

1. Equipment Cost Types
2. Owning Costs
3. Operating Costs
4. Economic Life

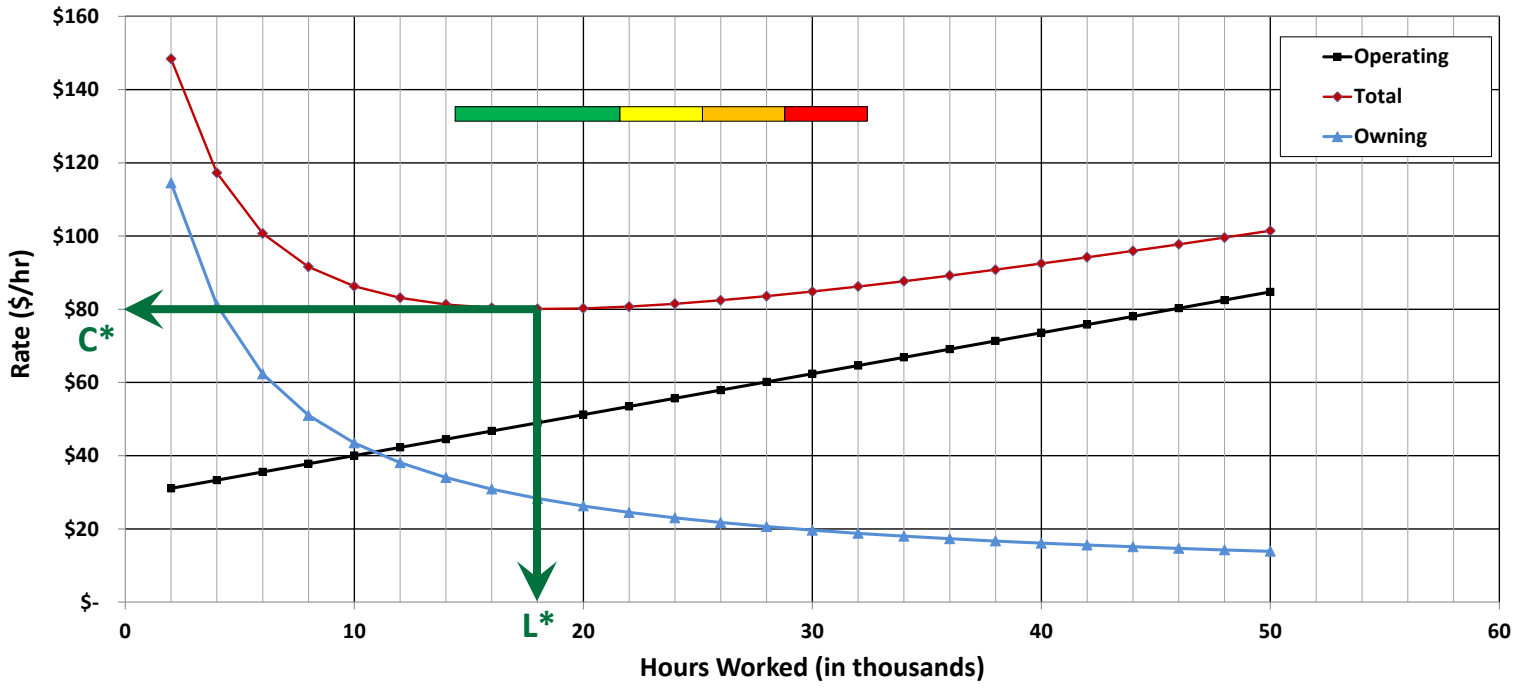


1. Equipment Cost Types

Total O&O cost is made up of

- Owning costs
- Operating costs

Rate ($/hr) of each varies with machine age



1. Equipment Cost Types

Owning Costs – owning a machine and keeping it in the fleet

- Hourly rate *decreases* with age as hours are collected over which to spread the depreciation

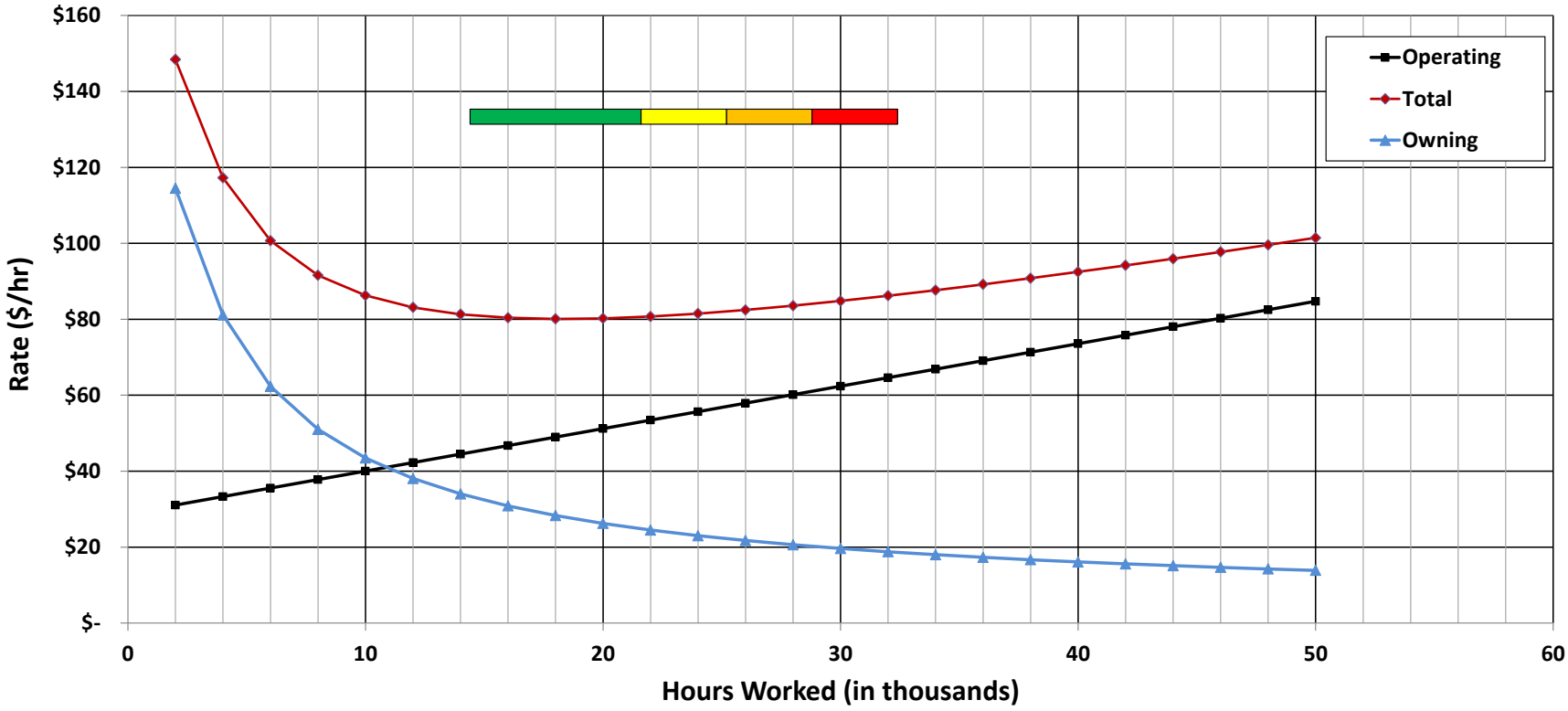
Operating Costs – when the machine fires up

- Hourly rate *increases* with age as ever increasing costs for repair parts and labor accumulate

Average O&O Rate – total machine cost divided by total machine hours

1. Equipment Cost Types

Model owning and operating costs separately, then add them together for a total O&O model



2. Owning Costs

Costs associated with owning a machine and keeping it in the fleet

2. Owning Costs

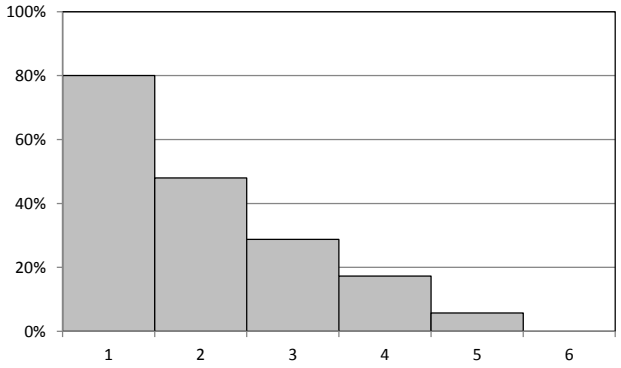
Ownership Cost Model must account for:

1. Depreciation – value of the machine decreases as the machine ages, charged annually to recover this lost value
2. Interest – equipment is a capital investment and should provide a return, charged annually based on the value of the machine
3. Other – cost of licenses, insurances, etc. associated with keeping the machine in the fleet

2. Depreciation Costs

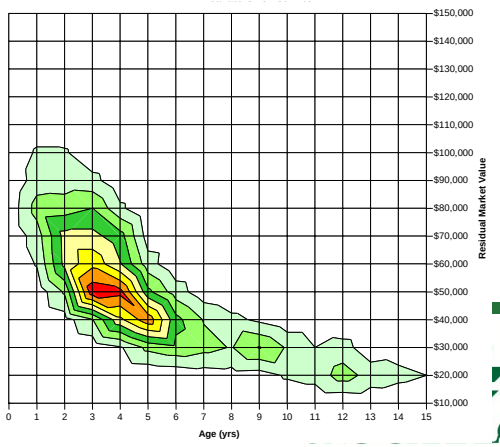
1. A series of predetermined annual charges

- There are many ways to do it, but all are based on percentages of purchase price



2. True loss in machine value

- Purchase price less residual market value (RMV)



2. Residual Market Value

At any point in time, there is potential to sell a machine and a positive, cash-in transaction

Magnitude of that transaction depends on:

- Market preference for the make and model
- Market conditions
- Machine age
- Machine condition

2. Modeling RMV

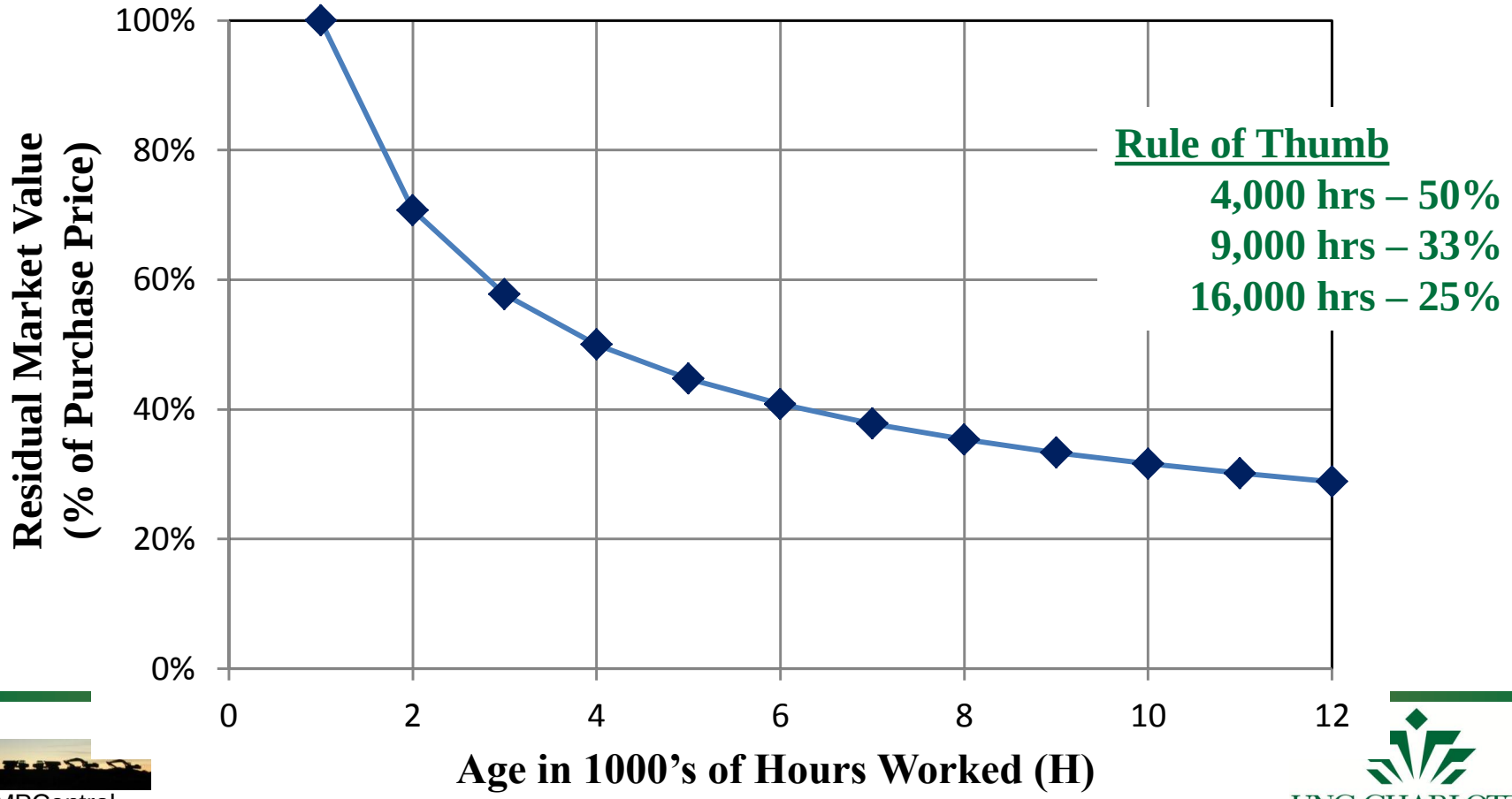
To estimate the relationship between RMV and age, you can use:

- Rules of thumb
- Auction results
- Your data

RMV is expressed as a percentage of the purchase price

2. RMV Rule of Thumb

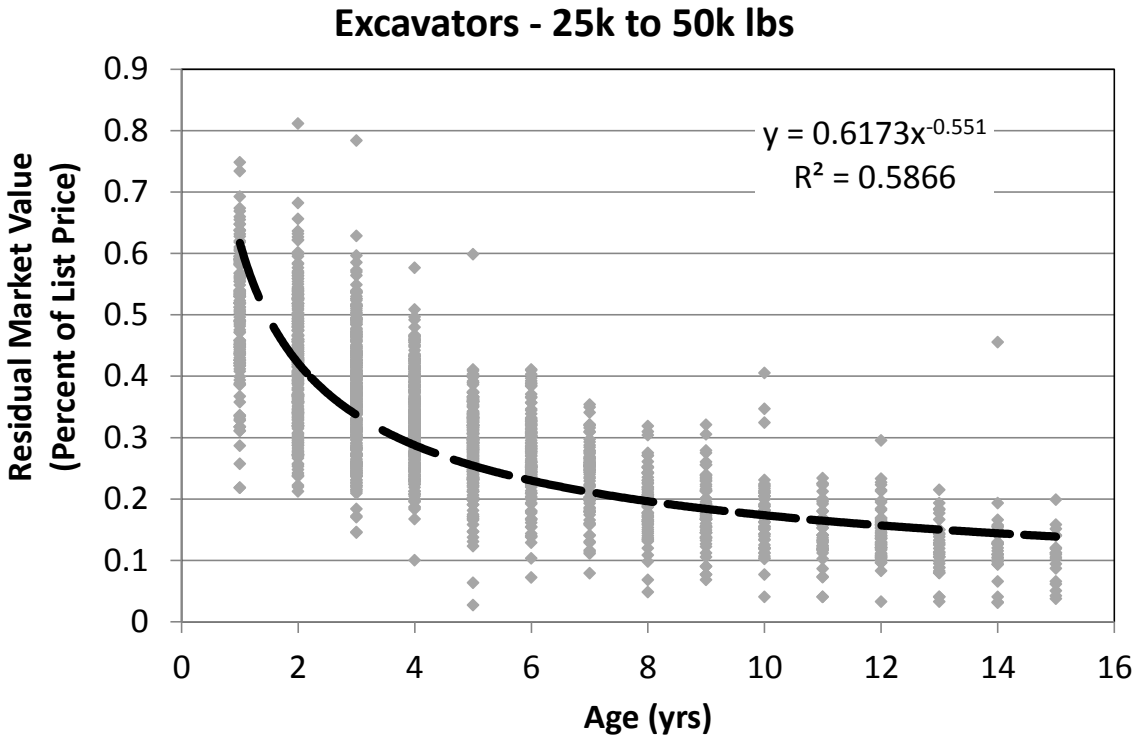
$$RMV = \frac{1}{\sqrt{H}}$$



2. RMV from Auction Data

Wealth of data available from the auction sale prices of similar machines

- Collect the data and use Excel to find the model



Or an interesting way to look at it is…

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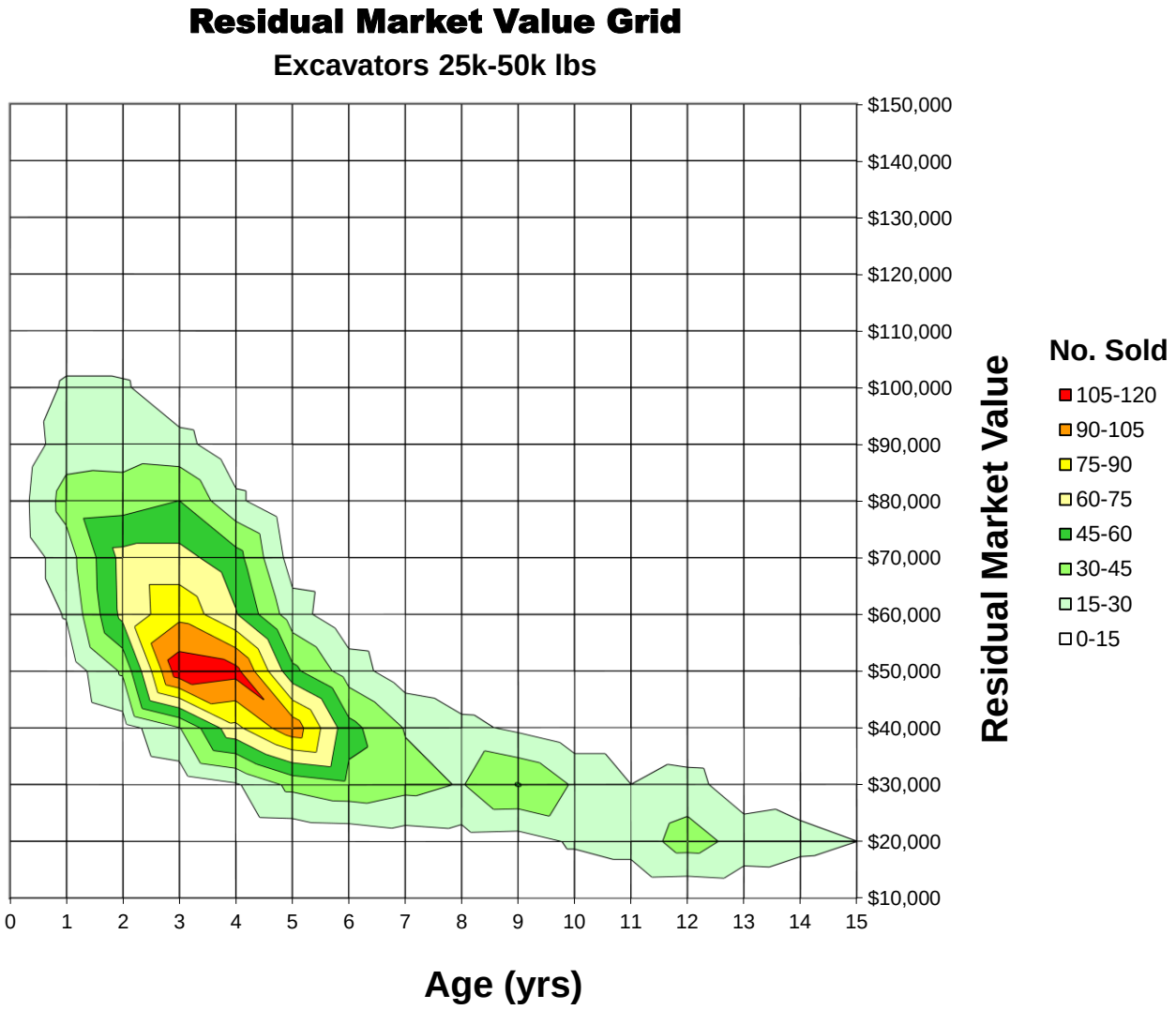
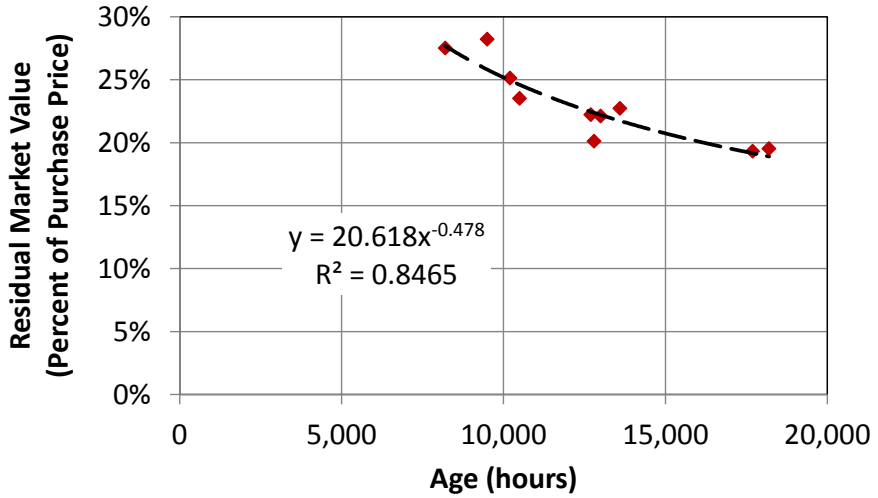
2. RMV from Auction Data

1,888 auction transactions



2. RMV from Your Data

1. Collect recent sale prices
2. Divide price by purchase price to normalize the data
3. Fit a Power Curve trend line using Excel
4. Use the equation to calculate RMV at any machine age



2. Interest

Cost of interest is certainly in the rates paid to lease or rent equipment

Should the cost of money (*i*) be included in the owning rate when *public monies* are used?

Yes – the state has invested capital in the asset that could be used elsewhere & should get a return on investment

No – the state is a non-profit organization & the goal is to provide a safe, functional fleet

2. Interest

But…

The cost of money is a true cost, including it in the owning costs is an appropriate means to recover the cost

But then…

What happens to the money recovered?

2. Interest

So you can…

Include it – collect it and pass it along to the capital provider

Exclude it – let the capital provider worry with it

But you must:

- Know and abide by the rules and regulations of your organization
- Be consistent

2. Interest

If you include interest, you must decide on:

1. The interest rate used in the calculations
   - What capital costs you (plus something for risk?)
   - The expected return on assets
   - The time value of money
2. The amount invested in the machine as it ages
   - Average value of the machine over its life
   - Book value of the machine in each year

2. Other Owning Costs

Any other costs of keeping the machine in the fleet in any year

- Licenses
- Insurances
- Taxes
- Shop overhead

2. Owning Cost Summary

1. Owning rate ($/hr) decreases as hours are collected over which to spread the depreciation
2. Accuracy results from the quality of your estimates, not the complexity of the calculations
   - Residual market value
   - Interest rate
   - Other owning costs
   - Hours worked per year
3. Make the best estimates you can and perform the calculations so everyone understands

3. Operating Costs

Costs incurred when you fire the engine

3. Operating Costs

Mostly proportional to hours worked

Operating cost categories:

1. Fuel
2. Traction system
3. Ground engaging tools (wear parts)
4. Preventive Maintenance
5. Repairs

Key unknowns:

- Interval between repairs
- Cost of repair

3. Constant Operating Rates

Hourly rate for many are relatively constant throughout the life of the machine

$$\text{Fuel} = \text{Cost} * \text{Dispensing Factor} * \text{Consumption Rate}$$

$$\text{Tires/Tracks} = \frac{\text{Cost} * \text{Installation Factor}}{\text{Life}}$$

$$\text{GET} = \frac{\text{Cost} * \text{Installation Factor}}{\text{Life}}$$

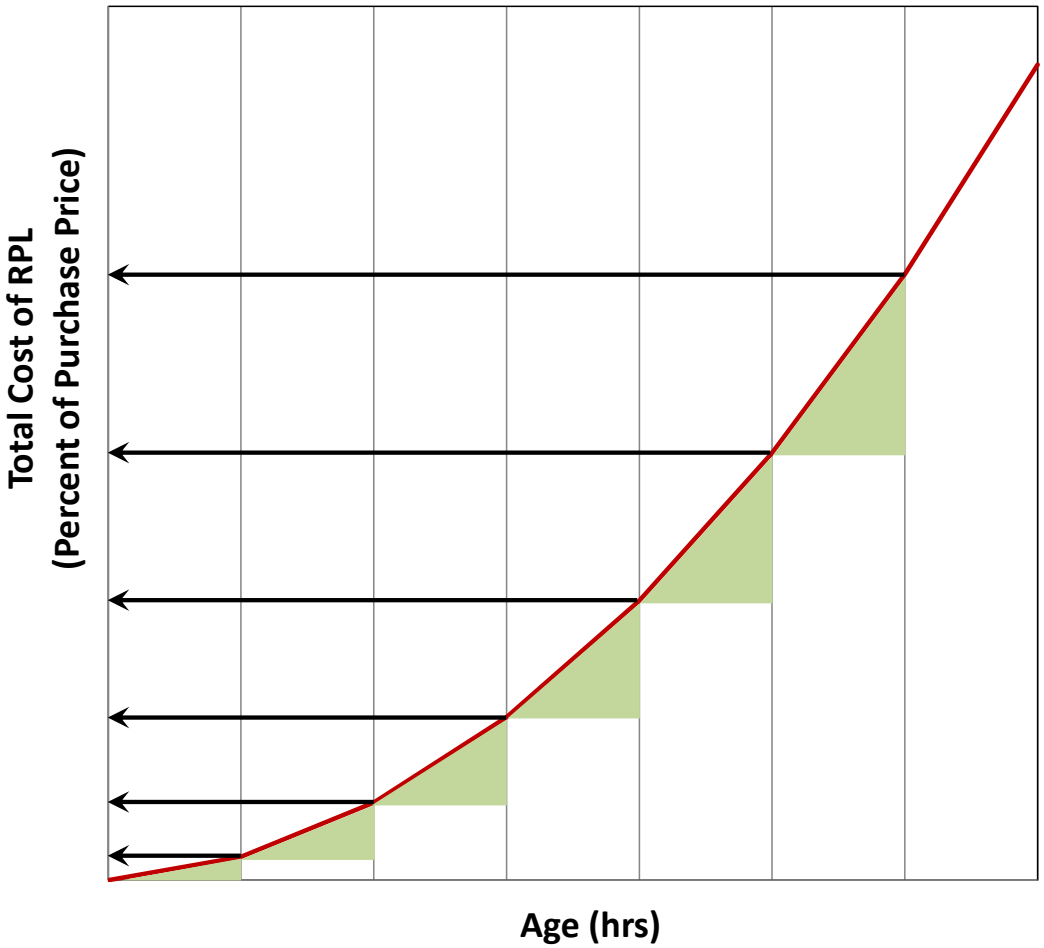
$$\text{PM} = \frac{\text{Cost} * \text{Labor Factor}}{\text{Interval}}$$

3. Variable Operating Rate

For Repair Parts and Labor:

- It's lots of money
- Expenditure increases with age
- Increasing expenditure likely determines how long to keep the machine
- Expenditures come in large chunks
- Depends on operating conditions

3. Modeling Repair Parts & Labor



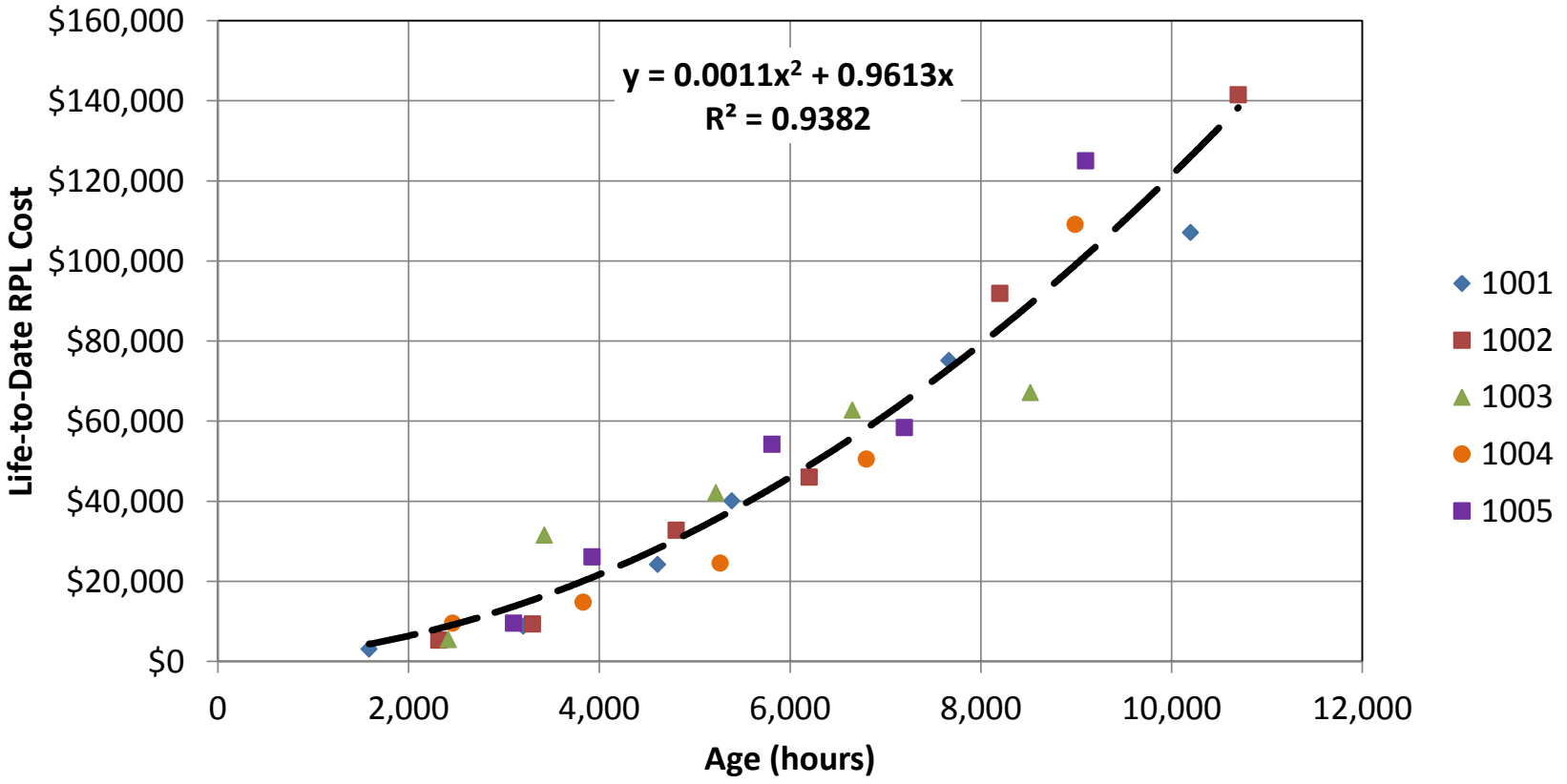
RPL costs increase with age due to:

1. Increasing frequency in repair actions
2. Increasing magnitude in the cost of repair actions

Defining this curve will help us understand our operating costs

3. Mitchell Curve

Field measurements of life-to-date RPL costs used to find the best fit equation for the curve



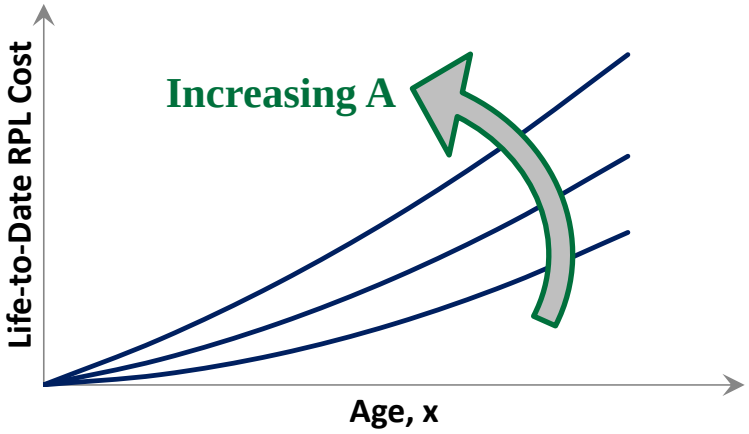
3. Mitchell Curve

Final resulting model is:

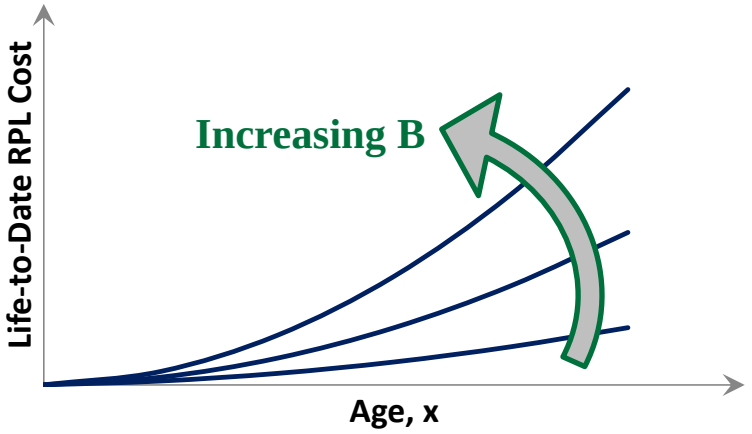
Cumulative Cost of Repair Parts and Labor

$$= A * age + B * age^{2}$$

A – Linear Component
Direct expenditure with age



B – Exponential Component
Increasing expenditure with age



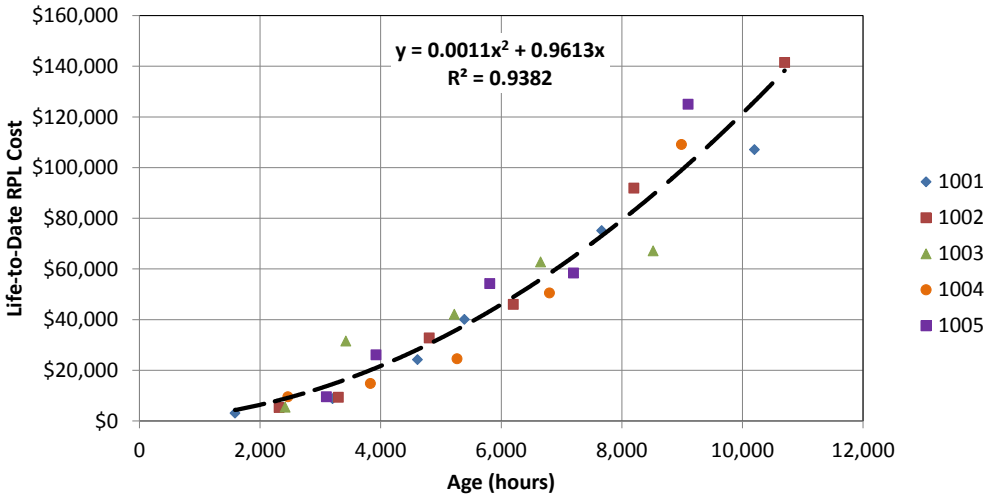
3. Mitchell Curve

What you should take home from Zane's work:

1. The RPL model is not complex and cumbersome
2. There is an "A" component
   - $/hr remains the same as the machine ages
3. The "B" component must be managed
   - $/hr increases as the machine ages
4. "B" determines the economic life
   - Low B – slow cost increase, long economic life
   - High B – rapid cost increase, short economic life

3. Defining the Mitchell Curve

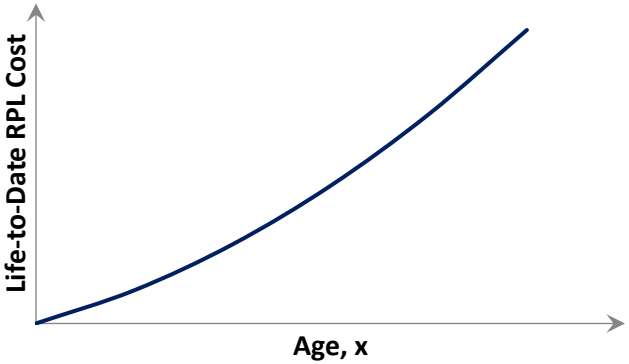
1. Define the study group
   - Similar machines, location, and operation
2. Collect the data
   - Life-to-date cost of RPL and machine age
3. Fit a 2nd order polynomial trendline in Excel

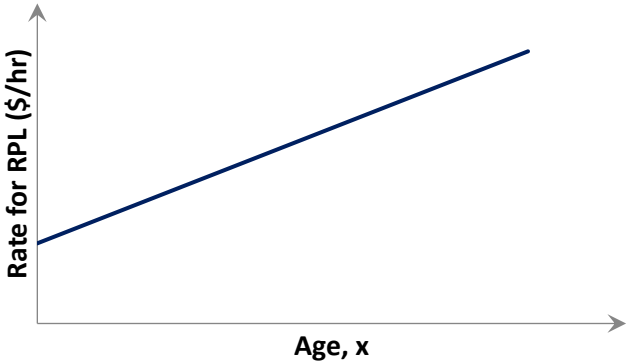


3. Period Cost Analysis

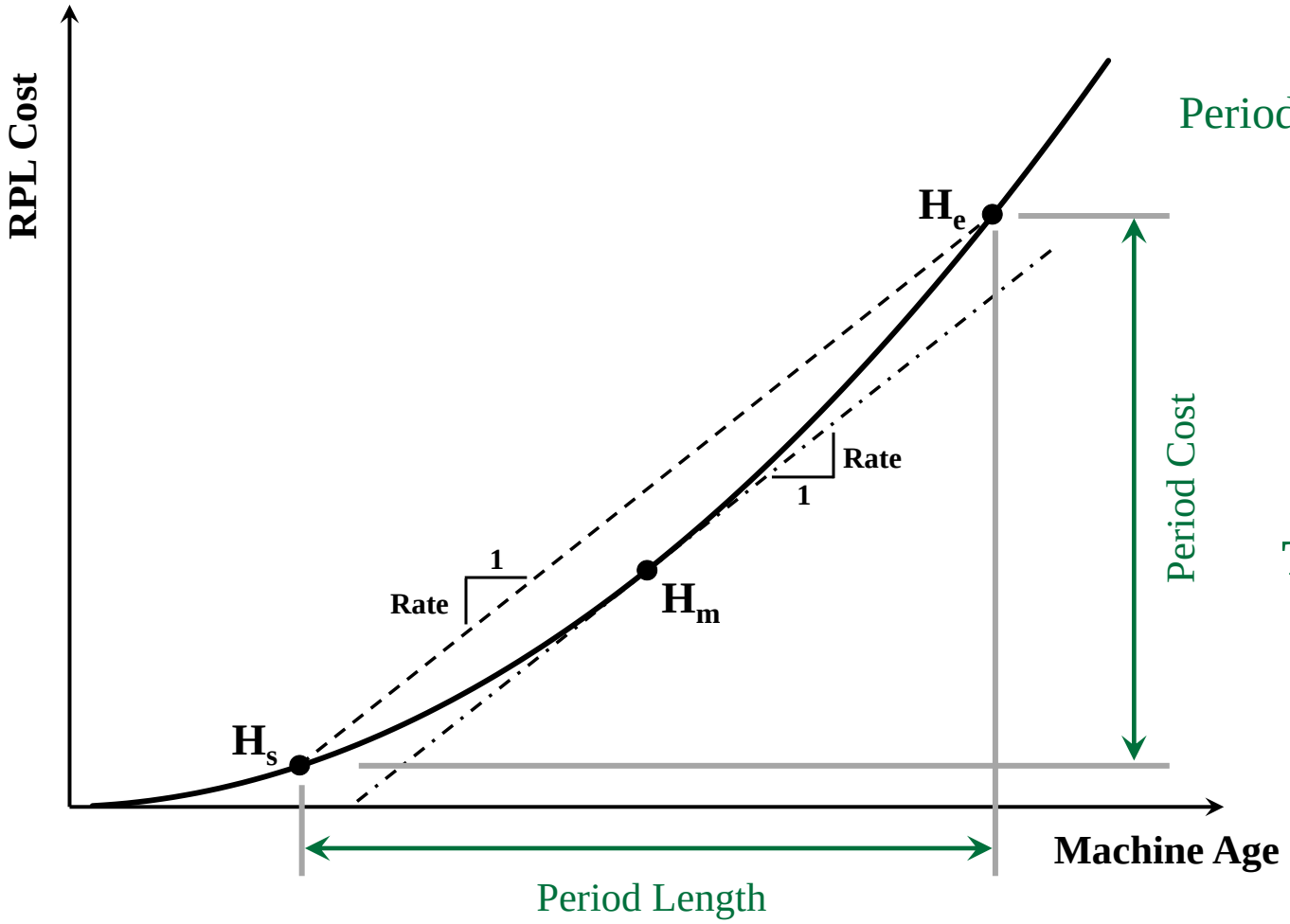
Alternative method of obtaining A and B

- LTD cost data is the gold standard, but not always available
- The Mitchell Curve model ($y=Ax + Bx^2$) means the derivative ($y'=A + 2Bx$) also relies on A and B
- The derivative (y') is the rate ($/hr), which increases linearly as the machine ages





3. Period Cost Analysis

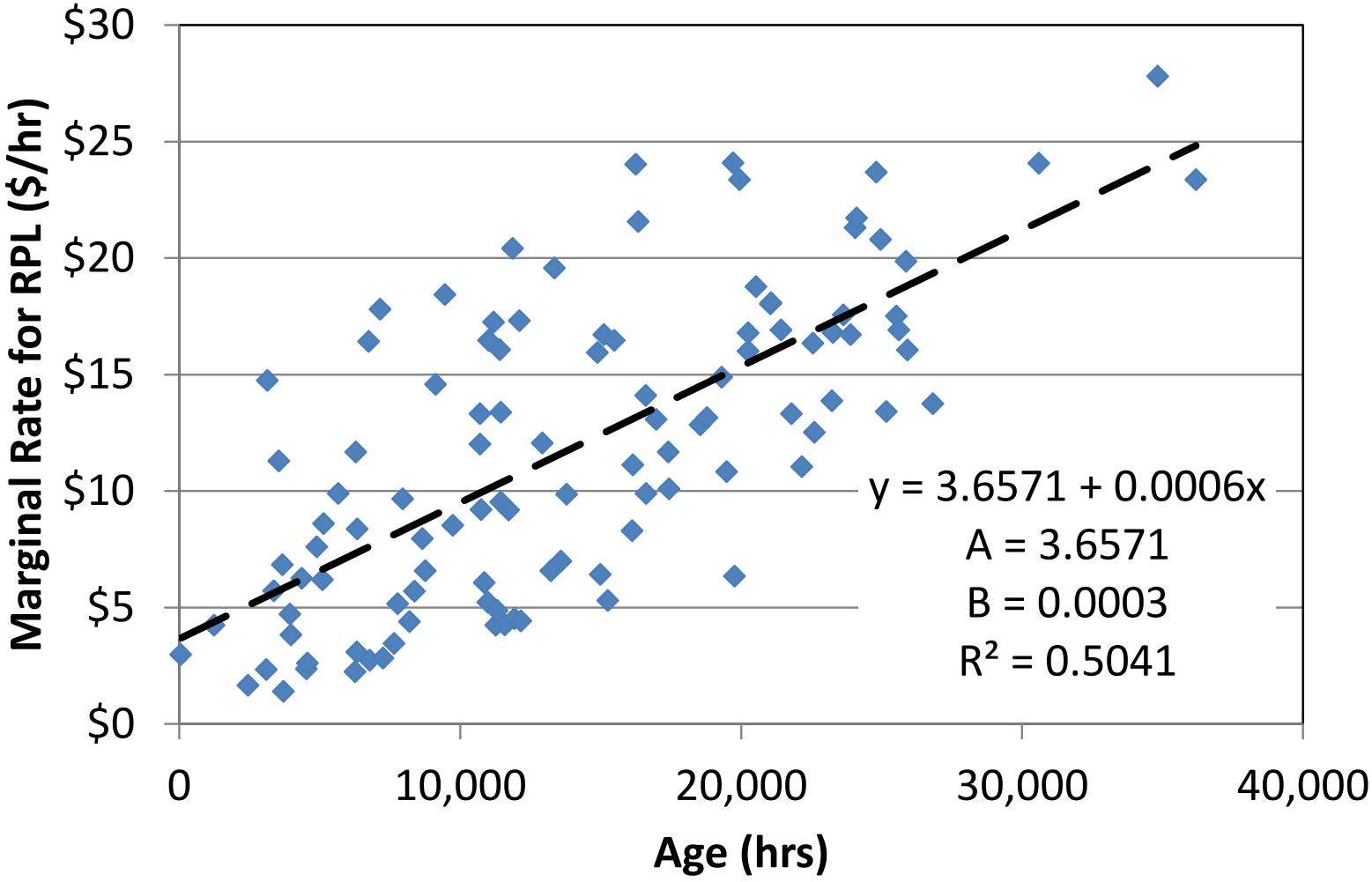


$$\text{Period Rate} = \frac{\text{Period Cost}}{\text{Period Length}}$$

$$H_m = \frac{H_s + H_e}{2}$$

The rate experienced is applied at the period midpoint

3. Period Cost Analysis



3. Operating Costs Summary

1. Operating rate ($/hr) increases with age due to the increasing costs of repair parts and labor
2. Estimate the constant operating costs
3. Use your data and the Mitchell curve to model RPL
   - Period cost analysis method can be used in the absence of life-to-date RPL data
4. Recognize the importance of “B” and manage it

Agenda

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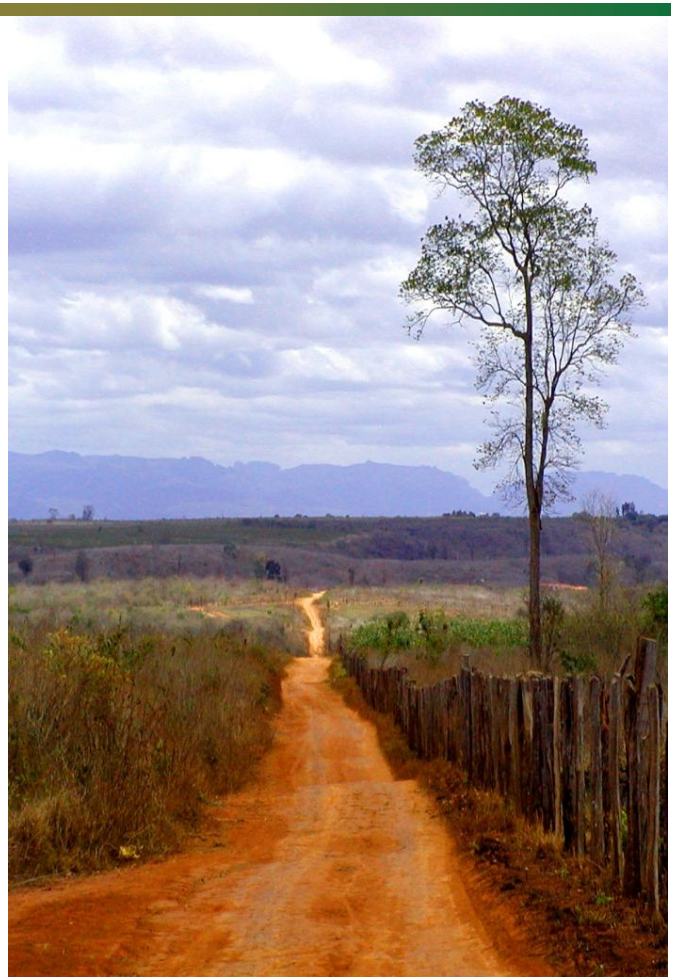
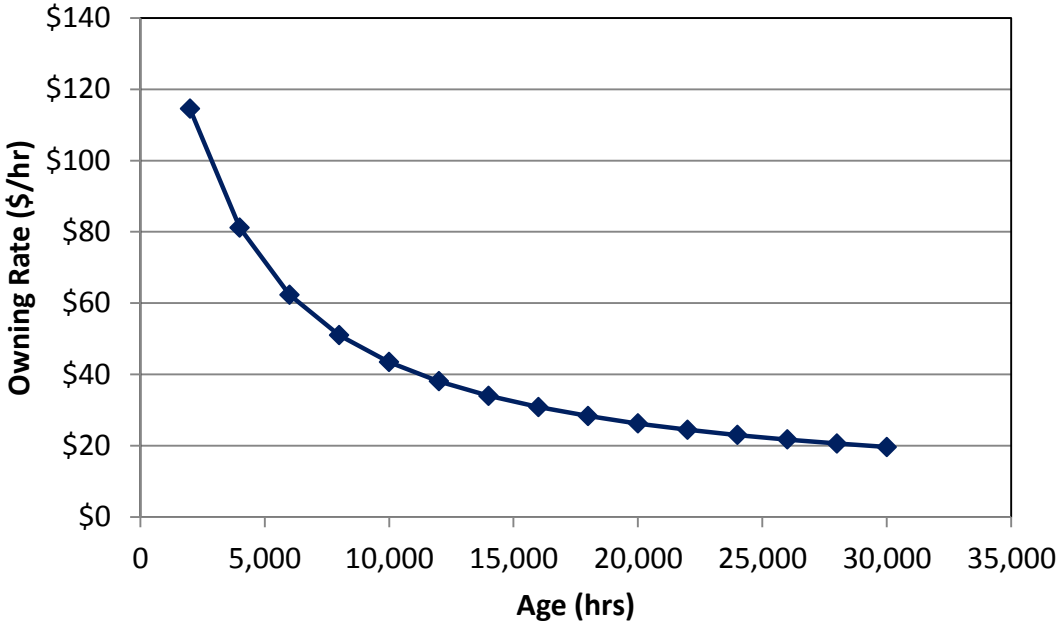
2. Owning Costs
3. Operating Costs
4. Economic Life



4. Recap

Owning Costs

- *Costs associated with owning a machine and keeping it in the fleet*
- *Hourly owning costs decreases with age*
- *It depends on the rate at which the residual market value decreases and the number of hours worked per year*



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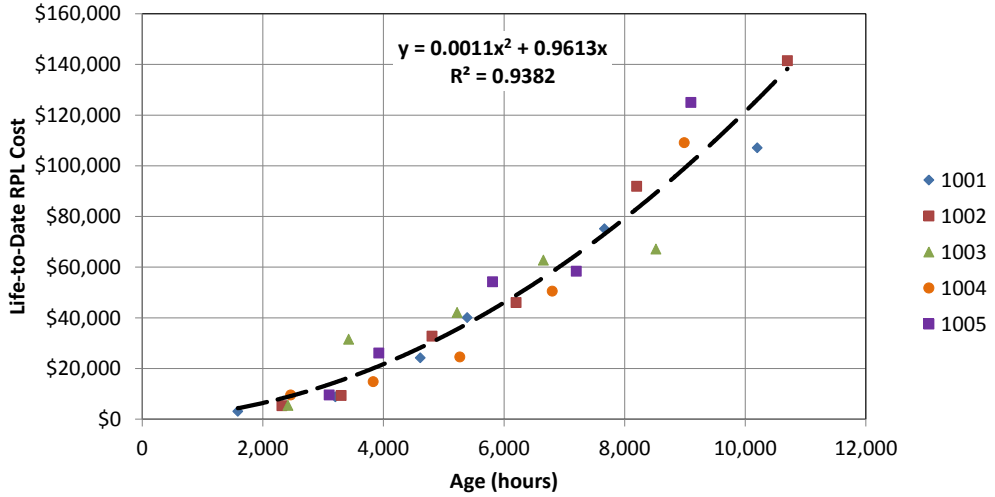
4. Recap

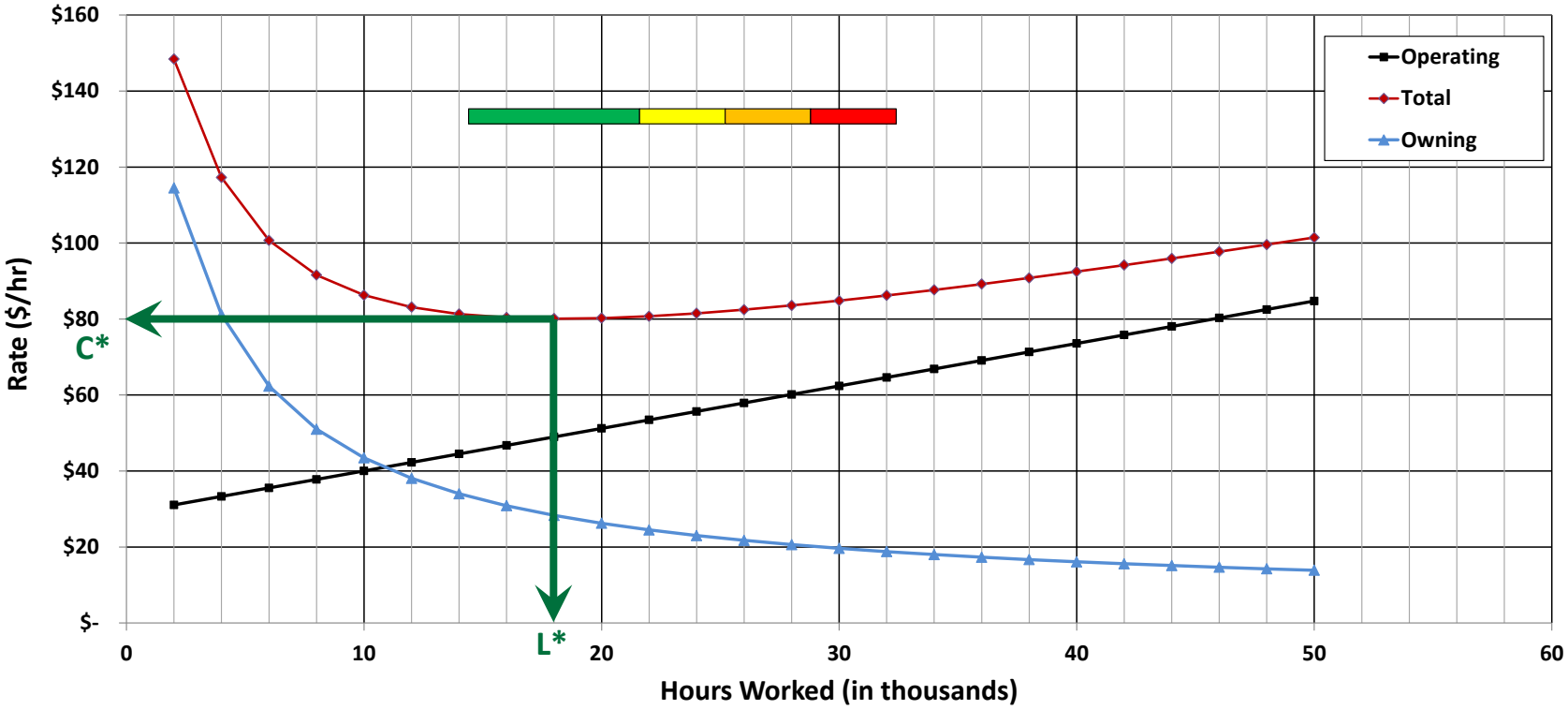
Operating Costs

- *Costs incurred when you fire the machine*
- *Hourly operating costs increase with age*
- *It depends on the rate at which the costs of repair parts and labor increase with machine age*



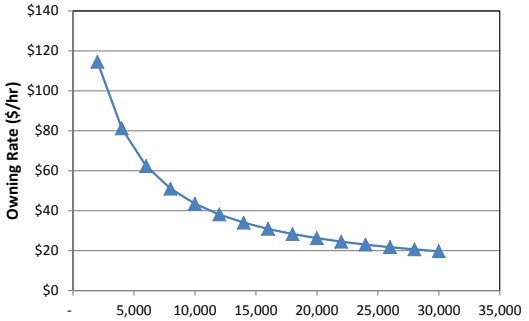
4. Economic Life

Economic life is the period that ends when the average owning and operating costs to date reach a minimum



4. Economic Life Modeling

1. Calculate the costs of keeping the machine in the fleet for a number of years (*Owning*)
2. Calculate the costs of working the machine for a number of years (*Operating*)
3. Add the Owning and Operating costs and "stumble across" both the magnitude and timing of the sweet spot



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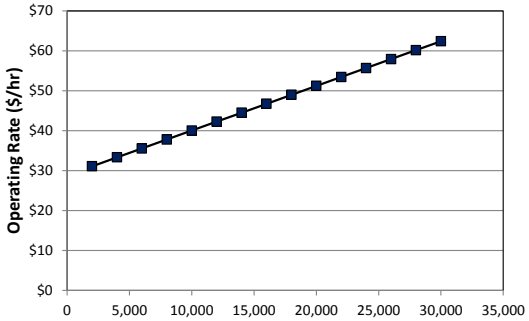

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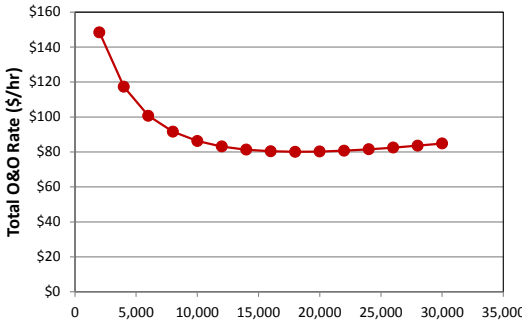


4. Owning Rate Calculations

Owning Costs			
Purchase Price	$	450,000	
Expected Utilization		2,000	hrs/yr
Annual Decline		0	hrs/yr
Interest Rate		6%	per year
Other Owning Costs	$	5,600	per year
Overhead Charge	$	5,600	per year

Basis for Depreciation and Book Value	RMV Estimate
Constant (k)	0.78
Exponent (t)	-0.50

1. Owning Cost Parameters

2. Basis for Depreciation

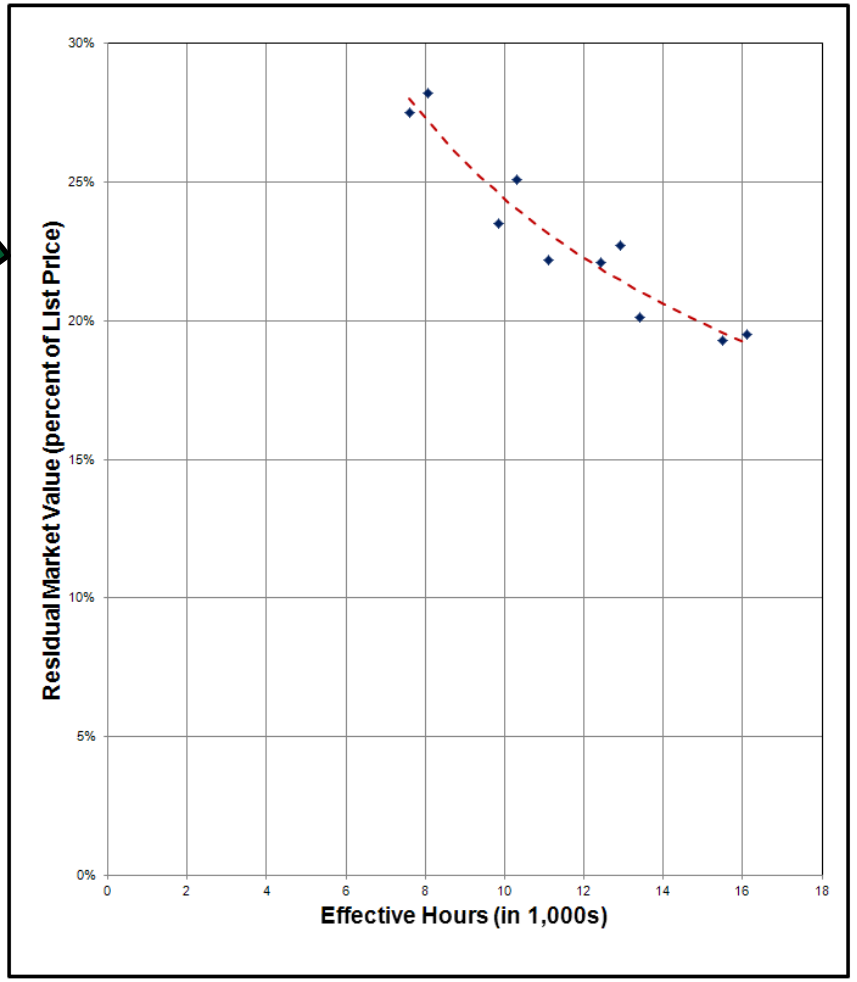
Year	Hours Worked	Loss in Value for the Year	Estimated Market Value at Year End	Annual Interest Charge	Life to Date Rates			
					Depreciation ($/hr)	Interest ($/hr)	Other ($/hr)	Total Owning ($/hr)
0	0	$ -	$ 450,000	$ -				
1	2,000	$ 196,435	$ 253,565	$ 27,000	$ 98.22	$ 13.50	$ 2.80	**$ 114.52**
2	4,000	$ 74,745	$ 178,820	$ 15,214	$ 67.80	$ 10.55	$ 2.80	**$ 81.15**
3	6,000	$ 33,042	$ 145,778	$ 10,729	$ 50.70	$ 8.82	$ 2.80	**$ 62.33**
4	8,000	$ 19,670	$ 126,108	$ 8,747	$ 40.49	$ 7.71	$ 2.80	**$ 51.00**
5	10,000	$ 13,410	$ 112,698	$ 7,566	$ 33.73	$ 6.93	$ 2.80	**$ 43.46**
6	12,000	$ 9,891	$ 102,806	$ 6,762	$ 28.93	$ 6.33	$ 2.80	**$ 38.07**
7	14,000	$ 7,683	$ 95,124	$ 6,168	$ 25.35	$ 5.87	$ 2.80	**$ 34.02**
8	16,000	$ 6,189	$ 88,934	$ 5,707	$ 22.57	$ 5.49	$ 2.80	**$ 30.86**
9	18,000	$ 5,124	$ 83,810	$ 5,336	$ 20.34	$ 5.18	$ 2.80	**$ 28.32**
10	20,000	$ 4,333	$ 79,477	$ 5,029	$ 18.53	$ 4.91	$ 2.80	**$ 26.24**
11	22,000	$ 3,726	$ 75,751	$ 4,769	$ 17.01	$ 4.68	$ 2.80	**$ 24.49**
12	24,000	$ 3,249	$ 72,501	$ 4,545	$ 15.73	$ 4.48	$ 2.80	**$ 23.01**
13	26,000	$ 2,866	$ 69,636	$ 4,350	$ 14.63	$ 4.30	$ 2.80	**$ 21.73**
14	28,000	$ 2,552	$ 67,083	$ 4,178	$ 13.68	$ 4.15	$ 2.80	**$ 20.62**
15	30,000	$ 2,292	$ 64,792	$ 4,025	$ 12.84	$ 4.00	$ 2.80	**$ 19.64**
16	32,000	$ 2,073	$ 62,719	$ 3,887	$ 12.10	$ 3.88	$ 2.80	**$ 18.78**
17	34,000	$ 1,887	$ 60,832	$ 3,763	$ 11.45	$ 3.76	$ 2.80	**$ 18.00**
18	36,000	$ 1,727	$ 59,105	$ 3,650	$ 10.86	$ 3.65	$ 2.80	**$ 17.31**
19	38,000	$ 1,588	$ 57,517	$ 3,546	$ 10.33	$ 3.55	$ 2.80	**$ 16.68**
20	40,000	$ 1,467	$ 56,049	$ 3,451	$ 9.85	$ 3.46	$ 2.80	**$ 16.11**
21	42,000	$ 1,361	$ 54,688	$ 3,363	$ 9.41	$ 3.38	$ 2.80	**$ 15.59**
22	44,000	$ 1,267	$ 53,421	$ 3,281	$ 9.01	$ 3.30	$ 2.80	**$ 15.11**
23	46,000	$ 1,183	$ 52,238	$ 3,205	$ 8.65	$ 3.22	$ 2.80	**$ 14.67**
24	48,000	$ 1,108	$ 51,130	$ 3,134	$ 8.31	$ 3.15	$ 2.80	**$ 14.26**
25	50,000	$ 1,041	$ 50,089	$ 3,068	$ 8.00	$ 3.09	$ 2.80	**$ 13.89**

4. Residual Market Value

Machine Parameters	
Category	CEE
Class	Ch 4 and 7

Hours/Age Parameters		
w	0.5	weighting on W_A
Std Hrs	1,800	hrs/yr

Age (hrs)	Age (yrs)	Residual Value	List Price	Standard Hours	Effective Hours	Residual Market Value
8,200	3.9	$ 26,125	$ 95,000	7,020	7,610	28%
9,500	3.7	$ 26,818	$ 95,100	6,660	8,080	28%
10,500	5.1	$ 20,680	$ 88,000	9,180	9,840	24%
10,200	5.8	$ 21,134	$ 84,200	10,440	10,320	25%
12,700	5.3	$ 19,314	$ 87,000	9,540	11,120	22%
13,000	6.6	$ 18,785	$ 85,000	11,880	12,440	22%
13,600	6.8	$ 18,886	$ 83,200	12,240	12,920	23%
12,800	7.8	$ 16,422	$ 81,700	14,040	13,420	20%
17,700	7.4	$ 14,803	$ 76,700	13,320	15,510	19%
18,200	7.8	$ 16,322	$ 83,700	14,040	16,120	20%



Best Fit Line: RMV = 0.78 x H_e ^ -0.50

Where: RMV is Residual Market Value in percent of list price

H_e is effective machine hours in thousands

R^2 = 0.92

Basis for Depreciation and Book Value		RMV Estimate
Constant (k)	0.78	
Exponent (t)	-0.50	

4. Operating Rate Calculations

Constant Operating Costs							
Fuel				**Implement**			
Direct cost	$	2.95	per gal	Direct cost	$	2,600	per set
Dispensing cost	$	1.18	per gal	Installation factor		1.2	
Consumption rate		3.6	gal per hr	Expected life		500	hrs
Fuel Rate	$	14.87	per hr	Implement Rate	$	6.24	per hr
Traction System				**PM Service**			
Direct cost	$	9,500	per set	Direct cost	$	800	each
Installation factor		1.1		Travel factor		1.3	
Expected life		4,000	hrs	PM Interval		250	hrs
Traction System Rate	$	2.61	per hr	PM Rate	$	4.16	per hr

Repair Costs	
A - Coef of X	0.9613
B - Coef of X^2	0.0011

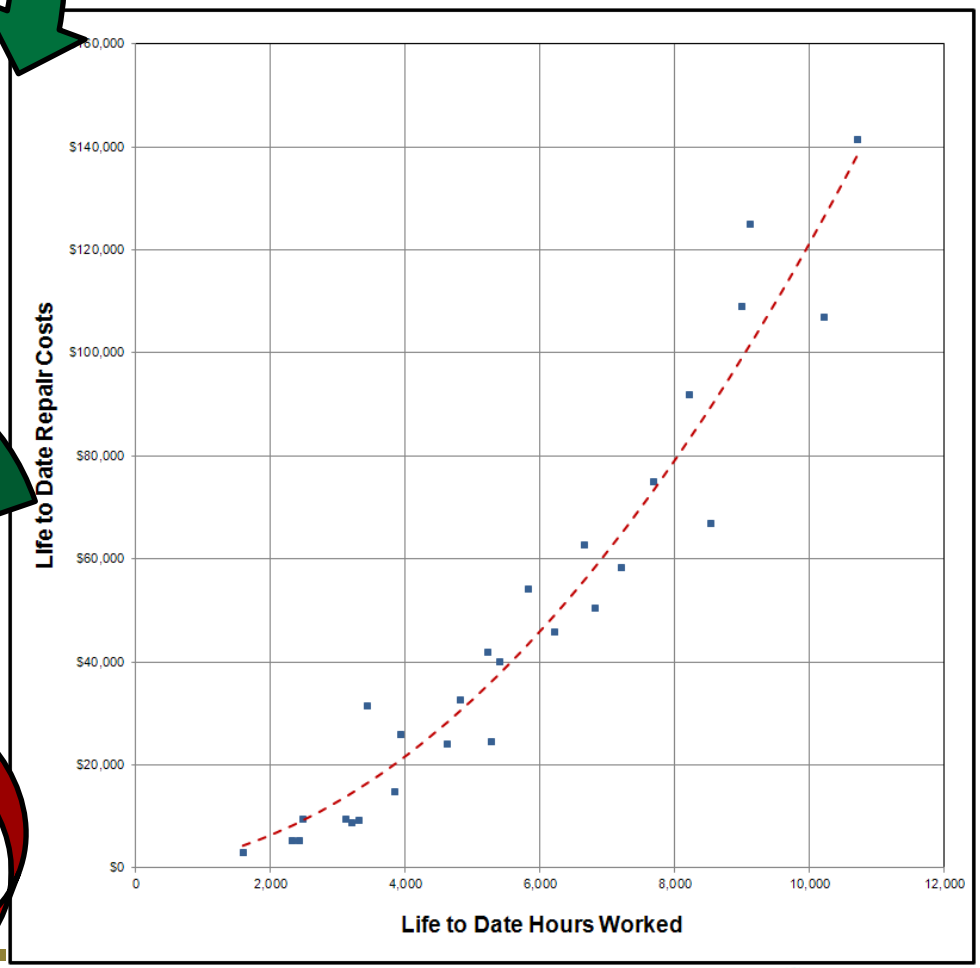
1. Constant Operating Costs

2. Repair Parts and Labor Model

Year	Hours Worked	Annual Cost of RP&L	Annual Constant Operating Cost	Life to Date Rates		
				RP&L ($/hr)	Constant Operating ($/hr)	Total Operating ($/hr)
0	0					
1	2,000	$ 6,395	$ 55,761	$ 3.20	$ 27.88	$ 31.08
2	4,000	$ 15,339	$ 55,761	$ 5.43	$ 27.88	$ 33.31
3	6,000	$ 24,284	$ 55,761	$ 7.67	$ 27.88	$ 35.55
4	8,000	$ 33,228	$ 55,761	$ 9.91	$ 27.88	$ 37.79
5	10,000	$ 42,172	$ 55,761	$ 12.14	$ 27.88	$ 40.02
6	12,000	$ 51,117	$ 55,761	$ 14.38	$ 27.88	$ 42.26
7	14,000	$ 60,061	$ 55,761	$ 16.61	$ 27.88	$ 44.49
8	16,000	$ 69,006	$ 55,761	$ 18.85	$ 27.88	$ 46.73
9	18,000	$ 77,950	$ 55,761	$ 21.09	$ 27.88	$ 48.97
10	20,000	$ 86,894	$ 55,761	$ 23.32	$ 27.88	$ 51.20
11	22,000	$ 95,839	$ 55,761	$ 25.56	$ 27.88	$ 53.44
12	24,000	$ 104,783	$ 55,761	$ 27.79	$ 27.88	$ 55.67
13	26,000	$ 113,728	$ 55,761	$ 30.03	$ 27.88	$ 57.91
14	28,000	$ 122,672	$ 55,761	$ 32.27	$ 27.88	$ 60.15
15	30,000	$ 131,616	$ 55,761	$ 34.50	$ 27.88	$ 62.38
16	32,000	$ 140,561	$ 55,761	$ 36.74	$ 27.88	$ 64.62
17	34,000	$ 149,505	$ 55,761	$ 38.97	$ 27.88	$ 66.86
18	36,000	$ 158,450	$ 55,761	$ 41.21	$ 27.88	$ 69.09
19	38,000	$ 167,394	$ 55,761	$ 43.45	$ 27.88	$ 71.33
20	40,000	$ 176,338	$ 55,761	$ 45.68	$ 27.88	$ 73.56
21	42,000	$ 185,283	$ 55,761	$ 47.92	$ 27.88	$ 75.80
22	44,000	$ 194,227	$ 55,761	$ 50.16	$ 27.88	$ 78.04
23	46,000	$ 203,172	$ 55,761	$ 52.39	$ 27.88	$ 80.27
24	48,000	$ 212,116	$ 55,761	$ 54.63	$ 27.88	$ 82.51
25	50,000	$ 221,060	$ 55,761	$ 56.86	$ 27.88	$ 84.74

4. Mitchell Curve

Life-to-Date	
Hours Worked	Repair Costs
1,586	$3,093.00
3,202	$8,826.00
4,612	$24,222.00
5,390	$40,070.00
7,666	$75,117.00
10,200	$107,100.00
2,317	$5,305.00
3,300	$9,308.00
4,805	$32,730.00
6,200	$46,000.00
8,200	$91,900.00
10,700	$141,450.00
2,416	$5,462.00
3,422	$31,526.00
5,221	$42,100.00
6,652	$62,754.00
8,520	$67,100.00
2,463	$9,562.00
3,832	$14,821.00
5,266	$24,555.00
6,800	$50,500.00
8,990	$109,100.00
3,100	$9,509.00
3,924	$26,112.00
5,810	$54,200.00
7,200	$58,400.00
9,100	$125,009.00



Best Fit Curve: RCL_D = 0.9613 x W_D + 0.0011 x W_D^2

Where: RCL_D is the life to date repair cost at machine age W_D

W_D is the life to date hours worked by the machine

R^2 = 0.94

Repair Costs	
A - Coef of X	0.9613
B - Coef of X^2	0.0011

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Machine Parameters	
Category	CEE
Class	Ch 4 and 7
Unit	Fig 4.4 and 7.1

Owning Costs		
Purchase Price	$ 450,000	
Expected Utilization	2,000	hrs/yr
Annual Decline	0	hrs/yr
Interest Rate	6%	per year
Other Owning Costs	$ 5,600	per year
Overhead Charge	$ 5,600	per year

Basis for Depreciation and Book Value	RMV Estimate
Constant (k)	0.78
Exponent (t)	-0.50

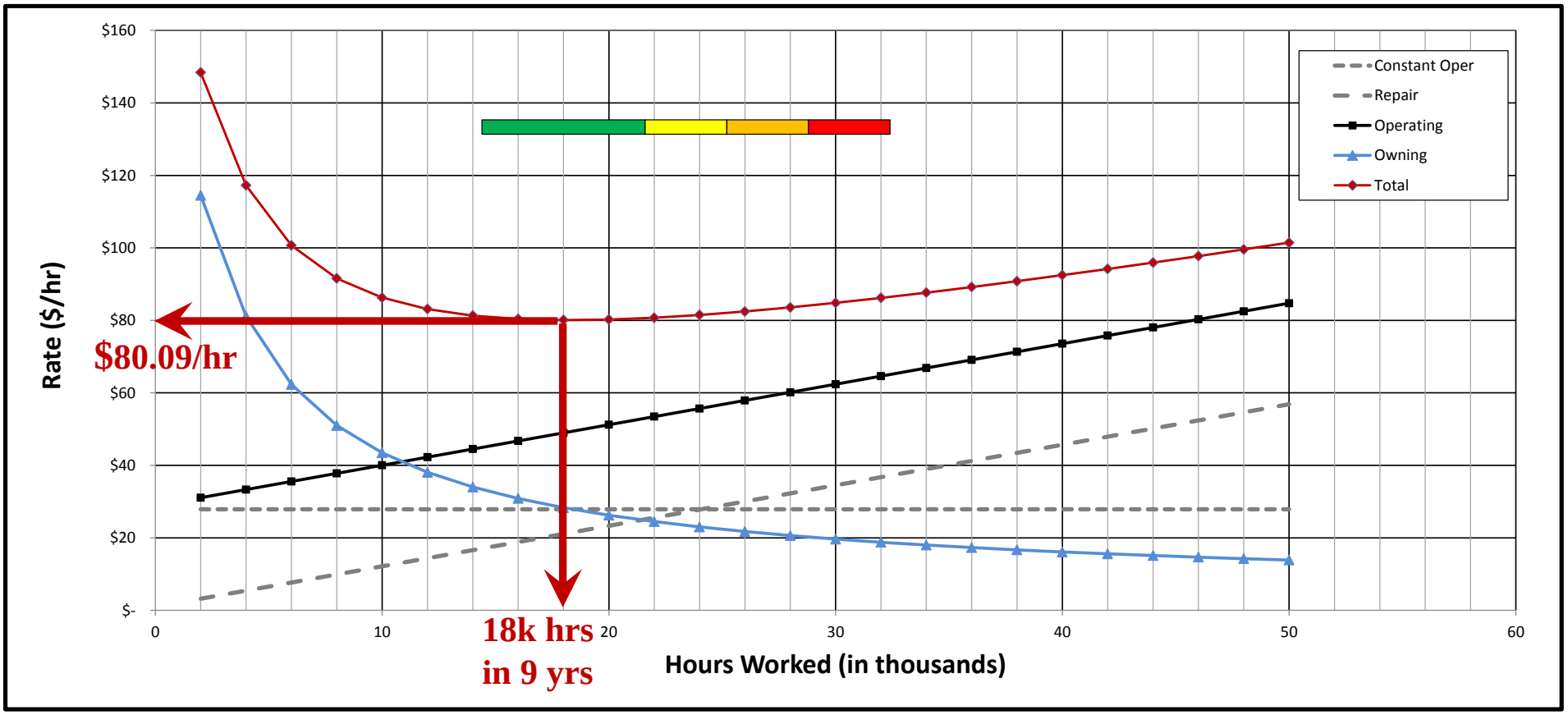
Sweet Spot Size	20%	of optimum hrs

Constant Operating Costs				Implement			
Fuel				Direct cost	$ 2,600	per set	
Direct cost	$ 2.95	per gal		Installation factor	1.2		
Dispensing cost	$ 1.18	per gal		Expected life	500	hrs	
Consumption rate	3.6	gal per hr		Implement Rate	$ 6.24	per hr	
Fuel Rate	$ 14.87	per hr					
Traction System				**PM Service**			
Direct cost	$ 9,500	per set		Direct cost	$ 800	each	
Installation factor	1.1			Travel factor	1.3		
Expected life	4,000	hrs		PM Interval	250	hrs	
Traction System Rate	$ 2.61	per hr		PM Rate	$ 4.16	per hr	

Repair Costs	
A - Coef of X	0.9613
B - Coef of X^2	0.0011

Year	Hours Worked	Loss in Value for the Year	Estimated Market Value at Year End	Annual Interest Charge	Life to Date Rates				Annual Cost of RP&L	Annual Constant Operating Cost	Life to Date Rates			Life to Date Overhead Rate ($/hr)	Total Life to Date Rate ($/hr)
					Depreciation ($/hr)	Interest ($/hr)	Other ($/hr)	Total Owning ($/hr)			RP&L ($/hr)	Constant Operating ($/hr)	Total Operating ($/hr)		
0	0	$ -	$ 450,000	$ -											
1	2,000	$ 196,435	$ 253,565	$ 27,000	$ 98.22	$ 13.50	$ 2.80	$ 114.52	$ 6,395	$ 55,761	$ 3.20	$ 27.88	$ 31.08	$ 2.80	$ 148.40
2	4,000	$ 74,745	$ 178,820	$ 15,214	$ 67.80	$ 10.55	$ 2.80	$ 81.15	$ 15,339	$ 55,761	$ 5.43	$ 27.88	$ 33.31	$ 2.80	$ 117.26
3	6,000	$ 33,042	$ 145,778	$ 10,729	$ 50.70	$ 8.82	$ 2.80	$ 62.33	$ 24,284	$ 55,761	$ 7.67	$ 27.88	$ 35.55	$ 2.80	$ 100.68
4	8,000	$ 19,670	$ 126,108	$ 8,747	$ 40.49	$ 7.71	$ 2.80	$ 51.00	$ 33,228	$ 55,761	$ 9.91	$ 27.88	$ 37.79	$ 2.80	$ 91.58
5	10,000	$ 13,410	$ 112,698	$ 7,566	$ 33.73	$ 6.93	$ 2.80	$ 43.46	$ 42,172	$ 55,761	$ 12.14	$ 27.88	$ 40.02	$ 2.80	$ 86.28
6	12,000	$ 9,891	$ 102,806	$ 6,762	$ 28.93	$ 6.33	$ 2.80	$ 38.07	$ 51,117	$ 55,761	$ 14.38	$ 27.88	$ 42.26	$ 2.80	$ 83.13
7	14,000	$ 7,683	$ 95,124	$ 6,168	$ 25.35	$ 5.87	$ 2.80	$ 34.02	$ 60,061	$ 55,761	$ 16.61	$ 27.88	$ 44.49	$ 2.80	$ 81.31
8	16,000	$ 6,189	$ 88,934	$ 5,707	$ 22.57	$ 5.49	$ 2.80	$ 30.86	$ 69,006	$ 55,761	$ 18.85	$ 27.88	$ 46.73	$ 2.80	$ 80.39
9	18,000	$ 5,124	$ 83,810	$ 5,336	$ 20.34	$ 5.18	$ 2.80	$ 28.32	$ 77,950	$ 55,761	$ 21.09	$ 27.88	$ 48.97	$ 2.80	$ 80.09
10	20,000	$ 4,333	$ 79,477	$ 5,029	$ 18.53	$ 4.91	$ 2.80	$ 26.24	$ 86,894	$ 55,761	$ 23.32	$ 27.88	$ 51.20	$ 2.80	$ 80.24
11	22,000	$ 3,726	$ 75,751	$ 4,769	$ 17.01	$ 4.68	$ 2.80	$ 24.49	$ 95,839	$ 55,761	$ 25.56	$ 27.88	$ 53.44	$ 2.80	$ 80.73
12	24,000	$ 3,249	$ 72,501	$ 4,545	$ 15.73	$ 4.48	$ 2.80	$ 23.01	$ 104,783	$ 55,761	$ 27.79	$ 27.88	$ 55.67	$ 2.80	$ 81.49
13	26,000	$ 2,866	$ 69,636	$ 4,350	$ 14.63	$ 4.30	$ 2.80	$ 21.73	$ 113,728	$ 55,761	$ 30.03	$ 27.88	$ 57.91	$ 2.80	$ 82.45
14	28,000	$ 2,552	$ 67,083	$ 4,178	$ 13.68	$ 4.15	$ 2.80	$ 20.62	$ 122,672	$ 55,761	$ 32.27	$ 27.88	$ 60.15	$ 2.80	$ 83.57
15	30,000	$ 2,292	$ 64,792	$ 4,025	$ 12.84	$ 4.00	$ 2.80	$ 19.64	$ 131,616	$ 55,761	$ 34.50	$ 27.88	$ 62.38	$ 2.80	$ 84.83
16	32,000	$ 2,073	$ 62,719	$ 3,887	$ 12.10	$ 3.88	$ 2.80	$ 18.78	$ 140,561	$ 55,761	$ 36.74	$ 27.88	$ 64.62	$ 2.80	$ 86.20
17	34,000	$ 1,887	$ 60,832	$ 3,763	$ 11.45	$ 3.76	$ 2.80	$ 18.00	$ 149,505	$ 55,761	$ 38.97	$ 27.88	$ 66.86	$ 2.80	$ 87.66
18	36,000	$ 1,727	$ 59,105	$ 3,650	$ 10.86	$ 3.65	$ 2.80	$ 17.31	$ 158,450	$ 55,761	$ 41.21	$ 27.88	$ 69.09	$ 2.80	$ 89.20
19	38,000	$ 1,588	$ 57,517	$ 3,546	$ 10.33	$ 3.55	$ 2.80	$ 16.68	$ 167,394	$ 55,761	$ 43.45	$ 27.88	$ 71.33	$ 2.80	$ 90.81
20	40,000	$ 1,467	$ 56,049	$ 3,451	$ 9.85	$ 3.46	$ 2.80	$ 16.11	$ 176,338	$ 55,761	$ 45.68	$ 27.88	$ 73.56	$ 2.80	$ 92.47
21	42,000	$ 1,361	$ 54,688	$ 3,363	$ 9.41	$ 3.38	$ 2.80	$ 15.59	$ 185,283	$ 55,761	$ 47.92	$ 27.88	$ 75.80	$ 2.80	$ 94.19
22	44,000	$ 1,267	$ 53,421	$ 3,281	$ 9.01	$ 3.30	$ 2.80	$ 15.11	$ 194,227	$ 55,761	$ 50.16	$ 27.88	$ 78.04	$ 2.80	$ 95.95
23	46,000	$ 1,183	$ 52,238	$ 3,205	$ 8.65	$ 3.22	$ 2.80	$ 14.67	$ 203,172	$ 55,761	$ 52.39	$ 27.88	$ 80.27	$ 2.80	$ 97.74
24	48,000	$ 1,108	$ 51,130	$ 3,134	$ 8.31	$ 3.15	$ 2.80	$ 14.26	$ 212,116	$ 55,761	$ 54.63	$ 27.88	$ 82.51	$ 2.80	$ 99.57
25	50,000	$ 1,041	$ 50,089	$ 3,068	$ 8.00	$ 3.09	$ 2.80	$ 13.89	$ 221,060	$ 55,761	$ 56.86	$ 27.88	$ 84.74	$ 2.80	$ 101.43

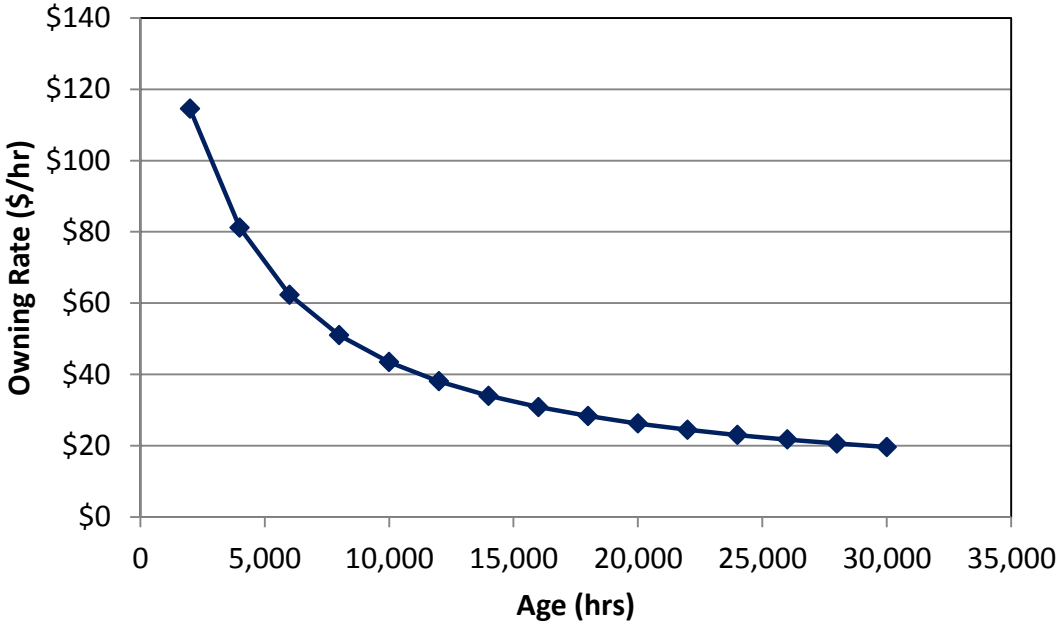
4. Economic Life



Equipment Cost Modeling

Owning Costs

- *Costs associated with owning a machine and keeping it in the fleet*
- *Hourly owning costs decreases with age*
- *It depends on the rate at which the residual market value decreases and the number of hours worked per year*



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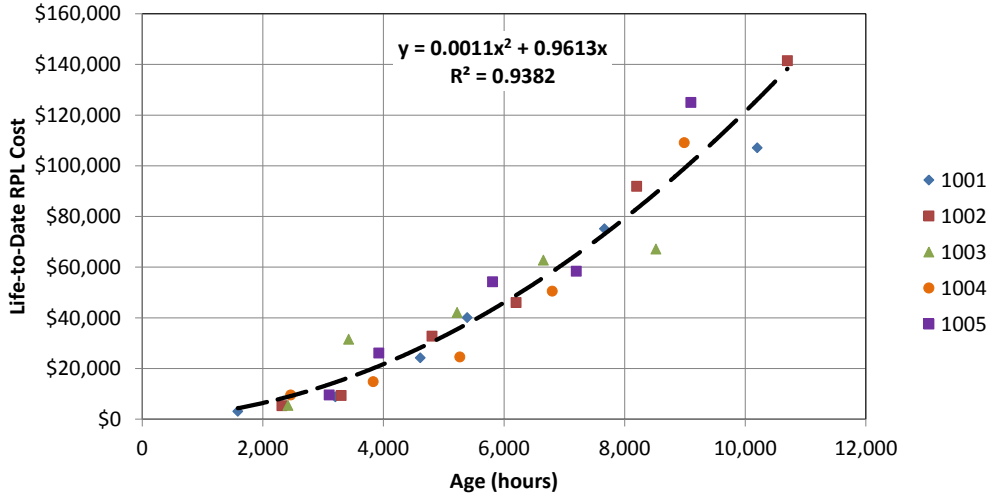
Equipment Cost Modeling

Operating Costs

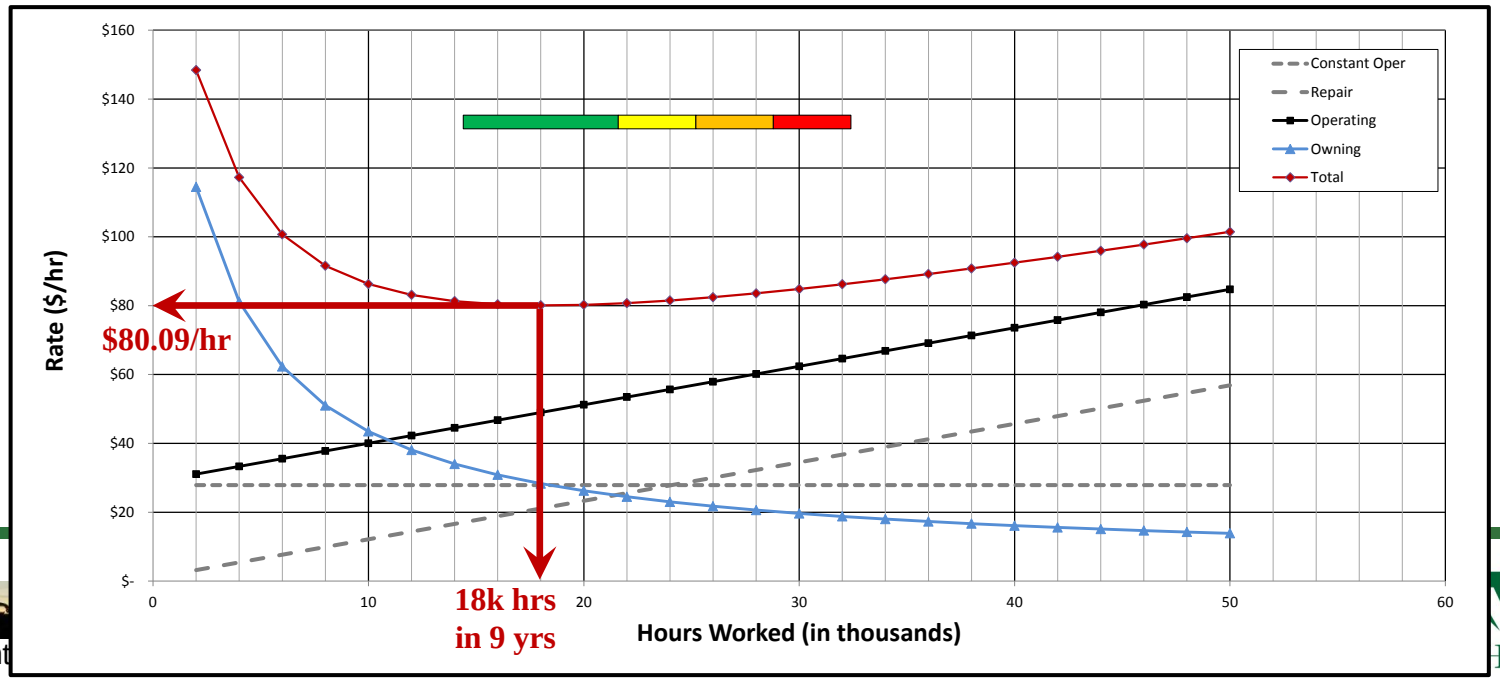
- *Costs incurred when you fire the machine*
- *Hourly operating costs increase with age*
- *It depends on the rate at which the costs of repair parts and labor increase with machine age*



Equipment Cost Modeling

Economic Life

- *The period that ends when the average owning and operating cost reaches a minimum*
- *Add the Owning and Operating costs and "stumble across" both the magnitude and timing of the sweet spot*



Equipment Cost Modeling

How long should it be kept in the fleet?
How much will it cost?

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Thank you

John.Hildreth@UNCC.edu

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