Research Report

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Keeping Notebooks Past Their Prime: A Study of Failures and Costs

A J.Gold Associates Research Report

"The purpose of this research report is to analyze the failure rates and associated costs for enterprise-class notebook computers deployed in businesses. The resultant data provides companies with an ability to choose the most cost effective and optimum lifespan for their devices based on empirical cost models. We determine the yearly cost per device associated with three deployment lifecycle scenarios; a three year life cycle with an extended three year warranty on each device; a three year life cycle with a standard one year warranty on each device; and an analysis of year 4 and 5 costs for companies choosing an extended 5 year lifecycle for their devices."

Contents

Introduction

Most businesses currently have a substantial investment in notebook computers. Indeed, as the need for a more mobile workforce has grown over the years, so has the deployment of mobile computing devices. Many organizations' use of notebooks already exceed 50% of their installed base of personal computers, with some achieving a penetration rate as high as 80%-90%. Further, notebooks currently outsell desktops in businesses by a substantial margin. We expect the rate of notebook deployments to continue to exceed the deployment of fixed desktop PCs, and in fact accelerate as the cost differential continues to decline while the benefits to the mobile workforce continues to expand. Our research indicates that companies can achieve end user productivity improvements of 5%-15% by deploying mobile computers instead of desktops. For knowledge workers, this can add to substantial bottom line returns to the business and can easily pay for the cost premium of a notebook over a desktop, with an ROI often achieved in a matter of months.

There are a wide variety of notebook devices available in the market. Many are targeted at consumers, and may seem attractive to businesses due to their low cost. However, our research indicates that failure rates of consumer-class notebooks when used in a business environment are substantially higher than for machines designed as enterprise-class devices. Failure rates may be 50%-100% greater per year, thus negating any potential benefits obtained from the lower purchase cost.

The majority of businesses acquire enterprise-class notebooks as standard practice despite the somewhat higher cost, as they represent a better value overall. They exhibit reduced failure rates, better manageability, increased standardization of components, and longer model life. However, even within the ranks of enterprise-class notebooks, there is a substantial variation in failures rates, not only from vendor to vendor, but even between the various models of a particular vendor. As a result, for purposes of this study, we have used what we consider to be the maximum acceptable first year failure rate to be expected of a quality enterprise-class notebook.

Most companies understand the need to purchase high quality devices for their workforce. However, many organizations are challenged with determining what the optimum lifetime of a notebook should be. A range of advice is available, with most indicating an optimum 3-4 year lifecycle. Our research indicates most organizations fit into this general timeframe for replacement of their notebook computers, with most leaning towards the lower end (3 years). However, with the current climate of budget and manpower reductions, keeping a notebook for 5 years seems like an attractive cost saving proposition to some businesses. But does a longer notebook lifecycle make economic sense?

The purpose of this research report is to analyze the failure rates and associated costs for enterprise-class notebook computers deployed in businesses. The resultant data provides companies with the ability to choose the most cost effective and optimum lifespan for their

devices based on empirical cost models. We will determine the yearly cost per device associated with three deployment lifecycle scenarios; a three year life cycle with an extended three year warranty for each device; a three year life cycle with a standard one year warranty for each device; and an analysis of year 4 and 5 costs for companies choosing an extended 5 year lifecycle for their devices. We will then make recommendations based on the lifecycle total cost of ownership to determine the optimum notebook deployment duration.

This research does not take into account the costs associated with the software, manageability and security of the machine lifecycle, as this is beyond the current scope of the project. While we believe that extended machine life also has a significantly negative affect on these parameters of a notebook deployment, they are left for a future study.

Modeling the Cost of Failure

J.Gold Associates has built a model that realistically analyzes the costs associated with notebook computer failures. The model takes into account both under warranty and out of warranty repairs, and then allocates a per-device-deployed cost to each notebook. While it may be impossible to determine each unique cost for each failure across a variety of machines and organizations, we have calculated reasonable average costs which reflect typical costs associates with various failures and repairs. Also included in the model are typical IT organizational costs which are necessary to maintain the computing environment for the end user community, and end user costs associated with failure-related activates.

Some of the major assumptions in this model are based on industry averages or what our research indicates is either best practice or within the normative industry practice. We have chosen a user base of 5000 notebook computers for our model, which in our opinion represents a medium size enterprise. This number can easily be modified within the model to reflect other organizational sizes. We have also chosen a year one failure rate for our enterprise-class notebook of 12%. While this is an average figure, it represents what we consider to be the maximum machine failure rate for any organization purchasing business notebooks. We have also assumed that approximately 35% of machine failures are due to a problem with hard drives, and 65% are other functional failures. These numbers will vary widely by device, but we believe this is a representative failure rate. A breakout of our assumptions regarding cost/labor rates and other assumptions is listed in Appendix 1.

Cost of Failure for Three Scenarios of Deployment

Our model has been segmented to calculate failure costs associated with the three most typical scenarios in deployments of business-class notebook computers. They are:

Cost of Failure for 3 Years of Warranty

Many organizations have elected to purchase new machines with a 3 year manufacturers' extended warranty, whether through choice or through offers from the vendor. We have

modeled the costs associated with this scenario to determine the cost per failure, the distributed costs allocated to each notebook deployed, and the total cost of failures over the lifecycle of each machine.

Cost of Failure for 1 Year of Warranty and Years 2-3 Without Warranty
Many vendors of notebooks continue to offer standard one year warrantees with their machines, and some organizations choose to purchase machines with this option as a cost saving measure. We have modeled a typical three year lifecycle based on a first year covered by the manufacturer's warranty, but year 2 and 3 not covered under warranty.

Cost of Failure Years 4 and 5 Without Warranty
In an effort to maximize return and minimize capital costs, some organizations have chosen to extend the typical notebook lifecycle beyond the recommended three years. This scenario evaluates the costs associated with keeping a notebook in years 4 and 5 of the lifecycle. These costs can easily be added to the costs associated with either of the previous two scenarios to reflect a true total lifecycle cost for the machine if kept for 5 years.

Warranty vs Non-Warranty Cost of Failures

We begin our analysis by determining the costs associated with failures for machines both under warranty and not under warranty. The costs are:

Cost of Failure per Machine Under Warranty

We modeled the cost per failure based on the fact that the machine was still under warranty and that the component replacement and repair costs would be borne by the manufacturer. This cost is the same for each year the machine is under warranty, whether in scenario one or two above. Figure 1 shows the calculations employed to determine this amount.

- ***The cost of an in-warranty repair for a failed machine is $970.40***

Figure 1: The Failure Cost per Machine for an In-Warranty Repair

		Time-End User	Time-Service Tech	Expense	Total
End User Failure Diagnosis		1			72
Average 2 calls to help desk				100	100
					0
Pack and Ship machine if remote	40%	1	0.25	50	56.8
Send tech to pick up if local	60%		0.75		36
					0
Technician failure diagnosis			0.5		40
If not the HD, pull drive and place in new machine	65%		0.5		26
If HD failure, re-image new machine	35%		2		56
attempt to recover any lost data (recovery ser	35%			500	175
					0
Return machine to end user if remote	40%	0.25	0.5	50	43.2
Tech return if local	60%		0.75		36
					0
End user set up if disk was re-imaged	35%	4			100.8
Set up if HD saved	65%	0.5			23.4
Return machine to Mfg for warranty repair			0.5	50	90
Loss of end user productivity - 10% for 2 days without machine		1.6			115.2
TOTAL COST OF FAILURE PER MACHINE					$ 970.40

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Cost of Failure per Machine Not Under Warranty

We modeled the cost per failure based on the fact that the machine was no longer in warranty, and as such all parts replacement and repair costs would be borne by the organization owning the machines. This cost is true for any failures regardless of which year the failure occurred. Figure 2 shows the calculations employed to determine this amount.

- ***The costs of out of warranty repair for a failed machine is $1425.40.***

Figure 2: The Failure Cost per Machine for an Out of Warranty Repair

		Time-End User	Time-Service Tech	Expense	Total
End User Failure Diagnosis		1			72
Average 2 calls to help desk				100	100
					0
Pack and Ship machine if remote	40%	1	0.25	50	56.8
Send tech to pick up if local	60%		0.75		36
					0
Technician failure diagnosis			0.5		40
If not the HD, pull drive and place in new machine	65%		0.5		26
If HD failure, re-image new machine	35%		2		56
attempt to recover any lost data (recovery ser	35%			500	175
Repair Costs					
Avg cost if HD failure	35%			350	122.5
Avg cost if mother board failure	35%			550	192.5
Avg cost if LCD failure	15%			600	90
Avg cost if keyboard failure	10%			350	35
Avg cost if misc. failure	5%			300	15
Return machine to end user if remote	40%	0.25	0.5	50	43.2
Tech return if local	60%		0.75		36
End user set up if disk was re-imaged	35%	4			100.8
Set up if HD saved	65%	0.5			23.4
Return machine to Mfg for warranty repair			0.5	50	90
Loss of end user productivity - 10% for 2 days without machine		1.6			115.2
TOTAL COST OF FAILURE PER MACHINE					$ 1,425.40

Failure Rate

Total cost to the organization is directly related to the rate of failure of the devices. This has both a design and environmental component. The design has an overall effect on the rate of first year (and later) failures, with models that come from the same manufacturer often having significantly different rates of failure. Failure rates can also vary substantially between vendors. We have observed some first year machine models with failure rates below 10% while others are near 20%. We have chosen a first year failure rate of 12% as the maximum that should be acceptable in enterprise-class notebooks, and have used this number for our model. This number can easily be adjusted for different machine models and brands to provide organizations with a result reflective of their own failure history.

However, the first year failure rate is only a starting point in determining lifetime failures. Various industry data and discussions with vendors show that failure rates grow over time due to "wear and tear" on the devices. Our research indicates they grow by 50% of the initial failure rate by year 3, 100% by year 4 and 170% by year 5 of the machine's life. Table 1 indicates the failure rates used to by the model to calculate the various lifecycle failures.

Table 1: Failure Rates by Year in Service

Year 1	*12%*
Year 2	*15%*
Year 3	*18%*
Year 4	*24%*
Year 5	*32%*

Spare Devices

Most organizations require that spare devices be inventoried so that users can get back up and running very quickly in case of a failure. Indeed, in the case of a failure that does not involve the hard drive, swapping out the hard drive into an equivalent machine can restore the user to full capability in a very short time. We estimate that most enterprises will be required to keep a one month's supply of inventory, based on the failure rates for the machine and the worst case turn around time on machine repairs. The inventory will change for each year of service, rising with the failure rate of the devices. Spares represent a significant cost to the organization, and the number of necessary spare units can nearly double by year 5 of an extended machine lifecycle.

Battery Replacement

Most users will need to replace their batteries on a regular cycle. The normal life of a battery is approximately 300 charge and discharge cycles. We estimate that, starting in the second year of life, 50% of batteries will need to be replaced each year of service. Since batteries are not generally covered under extended warranty, we have included the cost of battery replacement even in the extended warranty period of years 2 and 3 in scenario one.

Lifecycle Costs

Once the cost of failure for machines covered under warranty and not under warranty was determined, as well as the failure rates and spares costs, we calculated the failure contributed cost per machine over its intended lifecycle.

Calculating the Cost of Failure per Machine by Year of Service

In the following sections, we have used the model to calculate the total cost to repair machines, as well as the total costs distributed across all of the organization's machines.

Cost of Failure per Machine for Year 1

Figure 3 shows the calculated total cost to repair machines in year 1 distributed over all of the machines within the organization and allocated on a per-machine basis.

- ***The per -machine cost to repair machines in Year 1 distributed over all machines is $126.45***

Figure 3: Distributed Cost per Machine Year 1

Total machines	5000			
Average Cost per machine	$ 1,000			
Failure Rate =	12%			
Cost to repair machines per year				$ 582,240
One month supply of spare machines at above failure rate			purchase cost of spares	
	50 machines		$ 50,000	
Total cost to repair 12% machine failures per year				$ 632,240
Cost per machine year 1			$ 126.45	

Cost of Failure per Machine for Years 2 and 3 Under Warranty

Figure 4 shows the calculated total cost to repair machines under warranty in years 2 and 3 distributed over all machines within the organization and allocated on a per-machine basis.

- ***The per-machine cost to repair machines in Year 2 and 3 respectively distributed over all machines is $223.16 and $252.07.***

Figure 4: Distributed Cost per Machine Years 2 and 3 Under Warranty

Total machines	5000			
Average Cost per machine	$ 1,000			
Failure Rate =	15%			
Cost to repair machines per year				$ 727,800
One month supply of spare machines at above failure rate - additional machines			purchase cost of spares	
	13 machines		$ 13,000	
Total cost to repair 15% machine failure per year				$ 740,800
Battery Replacement	50%	150	75	
Cost per machine year 2			$ 223.16	

Total machines	5000			
Average Cost per machine	$ 1,000			
Failure Rate =	18%			
Cost to repair machines per year				$ 873,360
One month supply of spare machines at above failure rate - additonal machines			purchase cost of spares	
	12 machines		$ 12,000	
Total cost to repair 18% machine failure per year				$ 885,360
Battery Replacement	50%	150	75	
Cost per machine year 3			$ 252.07	

Cost of Failure per Machine for Years 2 and 3 Not Under Warranty

Figure 5 shows the calculated total cost to repair machines not under warranty in year 2 and 3 distributed over all machines within the organization and allocated on a per-machine basis.

- ***The per-machine cost to repair machines in Year 2 and 3 respectively distributed over all machines is $291.41 and $333.97.***

Figure 5: Distributed Failure Cost per Machine Years 2 and 3 Not in Warranty

Total machines	5000				
Average Cost per machine	$ 1,000				
Failure Rate =	15%				
Cost to repair machines per year					$ 1,069,050
One month supply of spare machines at above failure rate - additional machines	13 machines		purchase cost of spares	$ 13,000	
Total cost to repair 15% machine failure per year					$ 1,082,050
Battery Replacement	50%	150		75	
Cost per machine year 2			**$**	**291.41**	

Total machines	5000				
Average Cost per machine	$ 1,000				
Failure Rate =	18%				
Cost to repair machines per year					$ 1,282,860
One month supply of spare machines at above failure rate - additional machines	12 machines		purchase cost of spares	$ 12,000	
Total cost to repair 18% machine failure per year					$ 1,294,860
Battery Replacement	50%	150		75	
Cost per machine year 3			**$**	**333.97**	

Failure Cost Comparison for 3 Year Lifecycle: 1 Year vs 3 year Warranty

Using the model, we have determined the total 3 year per-device lifecycle cost for both the 1 year standard warranty and 3 year extended warranty scenarios.

- ***Total Cost of Failures Over 3 Years Allocated per Machine for 1 Year Warranty is $751.83***

- ***Total Cost of Failures Over 3 Years Allocated per Machine for 3 Year Extended Warranty is $601.68***

The results show that companies can save approximately $150 per notebook by obtaining a three year extended warranty on each device. Consequently, if an organization when purchasing new machines can obtain this extended warranty either as a negotiation component or for a cost that is less than $150, it will be a worthwhile investment.

Failure Cost Comparison for Years 4 and 5

Figure 6 shows the calculated total cost to repair machines in years 4 and 5 distributed over all of the machines within the organization and allocated on a per-machine basis.

- ***The per-machine cost to repair machines in Year 4 and 5 respectively distributed over all machines is $422.10 and $537.93.***

Figure 6: Distributed Failure Cost per Machine for Years 4 and 5

Total machines	5000			
Average Cost per machine	$ 1,000			
Failure Rate =	24%			
Cost to repair machines per year				$ 1,710,480
One month supply of spare machines at above failure rate - additional machines			purchase cost of spares	
	25 machines		$ 25,000	
Total cost to repair 24% machine failure per year				$ 1,735,480
Batttery replacement	50%	150	75	
Cost per machine year 4			$ 422.10	

Total machines	5000			
Average Cost per machine	$ 1,000			
Failure Rate =	32%			
Cost to repair machines per year				$ 2,280,640
One month supply of spare machines at above failure rate - additional machines			purchase cost of spares	
	34 machines		$ 34,000	
Total cost to repair 32% machine failure per year				$ 2,314,640
Battery Replacement	50%	150	75	
Cost per machine year 5			$ 537.93	

From the model, we can determine that the cost to keep a notebook for a 5 year lifecycle adds a cost per device of $960.03 to the 3 year lifecycle costs of the device. Since we assume an average cost of $1,000 per new notebook purchased, the costs associated with the increased failures of aging machines is approximately equivalent to the cost of a new device.

Lost End User Productivity in Years 4 and 5 of a Notebook Lifecycle

Figure 7 indicates the cost of lost productivity associated with having older, slower and less reliable machines in service. We assumed a fully burdened rate of $120,000 per employee per year. We further assumed that a 4 year old laptop, being at least 2 technology generations behind current devices, has a negative 3% productivity impact, and a 5 year old machine has a negative 5% productivity impact. Keeping a notebook for 5 years has a negative productivity impact on each user of $9,600 for years 4 and 5. This is far in excess of the cost of a new machine and should be a consideration in any organization's analysis of whether it makes sense to maintain a 5 year lifecycle for its installed base of notebooks.

Figure 7: Lost Productivity Cost

Productivity loss in year 4 and 5 due to outdated HW and SW				
		Burdened rate		
Year 4	3%	120000	$	3,600
Year 5	5%	120000	$	6,000
Total Cost of Lost Productivity Years 4 and 5			**$**	**9,600**

Recommendations

Based upon the model and the results indicated above, we recommend that organizations take the following actions:

- Companies should acquire only notebooks they deem to be of highest quality with low failure rates. Obtaining lower quality devices will add substantially to the lifecycle cost of the device. Paying a little more up front can offer substantial savings over the lifetime of the device.

- Organizations should obtain an extended (3 year) warranty on notebooks if the total cost of purchasing such an option does not exceed $150 in addition to the base price of the machine. This is the breakeven point for extended (3 year) vs. standard (1 year) warranties.

- Businesses should not keep machines past the optimum three year lifecycle of the device. The failure costs associated with years 4 and 5 will be equivalent to the cost of a new machine. Further, the end user productivity loss as a result of keeping slower and less reliable technology in service will far offset any potential capital cost savings to the organization.

- Notebooks have a normal lifecycle. Keeping them past their prime is not a good investment and may actually result in a substantial loss for the organization.

Many organizations have unique requirements and/or different assumptions than represented here. This model is easily modified to reflect the unique characteristics of individual companies, devices, and failure rates. We encourage any organization that wishes to have a more customized model reflecting its own costs and rates to contact us.

Appendix 1: Study Assumptions

The model and calculations within this study are based on some assumptions. The major assumptions are indicated below. We encourage those who would like to understand the model in greater detail to contact us.

Major Assumptions**:**

- One month supply of replacement machines
- Disk failures rate = 35% of failed machines
- Non-disk failures (e.g., LCD, keyboard, NIC) = 65% of failed machines
- Average end user knowledge worker rate (burdened) = $150K per year ($72 per hour)
- Average technician rate = $80 per hour
- Average call to help desk = $50
- Average notebook shipping cost = $50
- Assume all broken machines returned to manufacturer for in-warranty repair (3 year warranty)
- Battery replaced every 2 years - not covered under warranty beyond year one. 50% of machines per year replace battery after year one.

Repair Costs When Not Under Warranty (Estimated Average)

- Average cost if HD failure $350
- Average cost if mother board failure $550
- Average cost if LCD failure $600
- Average cost if keyboard failure $350
- Average cost if misc. failure $300
- Battery Replacement $150

About J.Gold Associates, LLC.

J.Gold Associates provides insightful, meaningful and actionable analysis of trends and opportunities in the computer and technology industries. We offer a broad based knowledge of the technology landscape, and bring that expertise to bear in our work. J.Gold Associates provides strategic consulting, syndicated research and advisory services, and in-context analysis to help its clients make important technology choices and to enable improved product deployment decisions and go to market strategies.

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