

Gerald V. Post

How Often Should A Firm Buy New PCs?

Anyone who has purchased a PC in the last 10 years knows the two basic results: the day after you buy a computer the price will drop, and as soon as you choose a computer a faster model will be released. While these factors may seem painful at the time, we are consoled by noting we will be able to buy faster, cheaper machines next year. But the real crux of the problem is how often should a you buy a new computer and what level of machine should you purchase?

Technological change and investment requirements driven by Moore's Law create the patterns we observe. Several writers [2, 3, 4, 6] have examined and attempted to measure these trends. As managers recognize, we all face the consequence of these trends when we purchase a computer [1]. Should we wait? Should we buy a faster PC? Should we buy the cheapest computer available?

The problem with answering these questions is that it is exceedingly difficult to estimate the need or demand for computers. Even on a broader scale, researchers

have found it challenging to identify the business impact of computers and IT spending. The productivity debate illustrates these problems [5].

A fundamental result of the performance and price changes is that organizations have to buy new PCs every few years. A conse-

quence of these trends is that organizations must adopt some purchasing strategy that specifies the level of machine and timeframe they will be held. Hence, the primary objective of this study is to identify which strategies are superior to others.

The goal of this study is to reduce the need issue in purchasing PCs. Of course, it is not possible to eliminate it completely. However, it is possible to narrow the choices, this making the decision process much simpler.

Buying Strategies

Even a casual knowledge of the computer industry reveals the basic patterns shown in Figure 1. The data represent prices from one company (Gateway 2000) from December 1990 through October 1998. Notice that at any point in time, there is a choice of levels of machines. At the low-end of the price scale, consumers can find a base machine with an older processor and base amounts of RAM and disk capacity. High-end machines generally boast the latest processors, substantial memory, and larger monitors.

Most vendors also offer an intermediate-level machine historically priced around \$2,500. By tracing the lifecycle of a particular computer, Figure 1 shows how a computer begins life at the high end, and moves down the ladder as new technologies are introduced.

This pattern of changing configurations and declining prices leads to an important characteristic of the PC market: the computers must be replaced at regular intervals. Which leads to the two ultimate questions: How often should

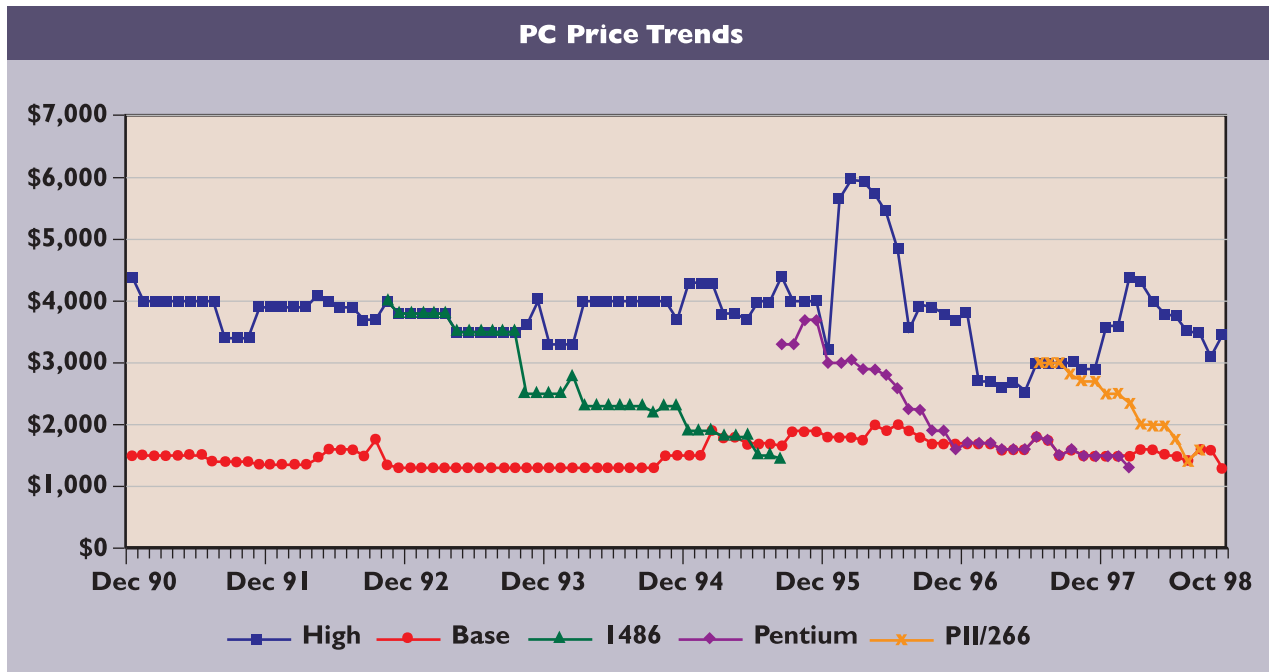


Figure 1. Note the stability of the pricing on the high-end and base systems. Over time, the configuration of the machines changes. For example, examine the falling prices portrayed by the three specific types of computers.

computers be replaced? What level of computers should be purchased?

The answers to these questions create a purchasing strategy. The key is to evaluate the cost of each strategy and the average performance of the machine. For example, a strategy of buying high-end machines every year will be expensive. However, a strategy of buying low-end machines every three years will result in employees having machines with substantially lower average performance.

Twelve basic strategies are created from hypothetical purchases of high, intermediate, and base machines and holding them for 12, 24, 36, or 48 months. When the ownership time period is completed, a new machine is purchased at the same level (but different configuration as technology changes). The objective is to

evaluate these twelve strategies to see if the options can be reduced. The technique used is to simulate purchases with the 12 strategies using the historical data.

Comparing strategies over time requires that costs be discounted to a common point in time. Hence, the purchase prices were expressed as amortized monthly costs at a 5% discount rate. For each strategy, a resale value was estimated based on the life of the processor and advertised prices from computer brokerage sites. In general, the resale values were unimportant, particularly when expressed at an amortized monthly rate.

To compensate for possible seasonal changes and random fluctuations, the strategies were started at each of the 12 months for the first year of data. The results were then averaged using the median.

The average approach also mimics firms that purchase several machines over the course of a year.

It is well known in computer science that it is difficult to compare performance characteristics of various computers. It is slightly easier in this study because all the systems use Intel processors. Consequently, the Intel iComp-2 rating is used to measure the performance of the processors. It also turns out that the iComp-2 rating is a good proxy measure for the other attributes (RAM, drive capacity, video system, and so on). A simple regression test shows that the iComp-2 rating over this data has a high correlation (0.94 R^2) with these other features.

Comparing Strategies

Consider strategy A with a cost of \$100 and a performance level

Personal Computing

of 50, versus strategy B that costs \$120 and has a performance level of 40. No one would choose strategy B.

Now consider strategy C that costs \$101 and has a performance level all of 75. Compared to strategy A, C is substantially faster, but costs more money. Would people choose strategy C over A? This answer is somewhat subjective since it depends on comparing performance to price. However, it is possible to make some general comparisons along these lines by examining the cost/performance ratio.

Ultimately, when comparing the cost/performance ratio, some subjective decisions must be reached in terms of the tradeoff. However, at some levels most would agree that one strategy is preferable to another. In the A vs. C example, strategy C results in a machine that is 50% faster than A yet costs only 1% (\$1 per month) more. Most managers would prefer strategy C. This relationship could be called "relative dominance" to indicate there is some subjectivity involved in the decision.

The question that remains is what cost/performance tradeoff levels would be acceptable to most buyers? One way to approach this issue is to identify the ratio involved with purchasing any type of system. That is, compare each strategy to the choice of no computer ($P_B = C_B = 0$) and compute the resulting cost/performance ratios. The results range from 1.15 (strategy I36) to 2.53 (strategy High-12). It is also instructive to note the least-cost approach—buying a low-end computer every 48 months—yields a ratio of 2.20.

Option	Net Cost	Slower/Cheaper			Faster/Pricier				Better	
		Ratio	Prefer	Performance	Cost	Ratio	Prefer	Performance		
High-12	239.33	12.53	H36	-12%	-59%	-1000	H24	0.1%	-42%	H36
High-24	138.38	3.59	H36	-12%	-30%					H36
High-36	97.39	1.22				3.59				H36
High-48	85.89	25.50	I36	-1%	-22%	0.48	H36	41%	13%	I36/H36
Int-12	164.74	22.30	H36	-4%	-41%	-3.14	H24	10%	-16%	H36
Int-24	95.13	3.64	I36	-12%	-29%	0.13	H36	26%	2%	H36/I36
Int-36	67.28	0.97				1.22				I36
Int-48	53.27	1.38				0.74	I36	48%	26%	I36
Low-12	103.43	7.47	L24	-13%	-44%	-3.30	I36	23%	-35%	I36
Low-24	57.77	2.47				0.56	I36	41%	16%	I36
Low-36	38.31	0.31				0.97	I36	104%	76%	I36
Low-48	34.22					0.31	L36	84%	12%	I36/L36

Table 1. Several options have better choices in terms of either saving money, or offering substantially better performance. Net cost is amortized monthly cost less the amortized salvage value.

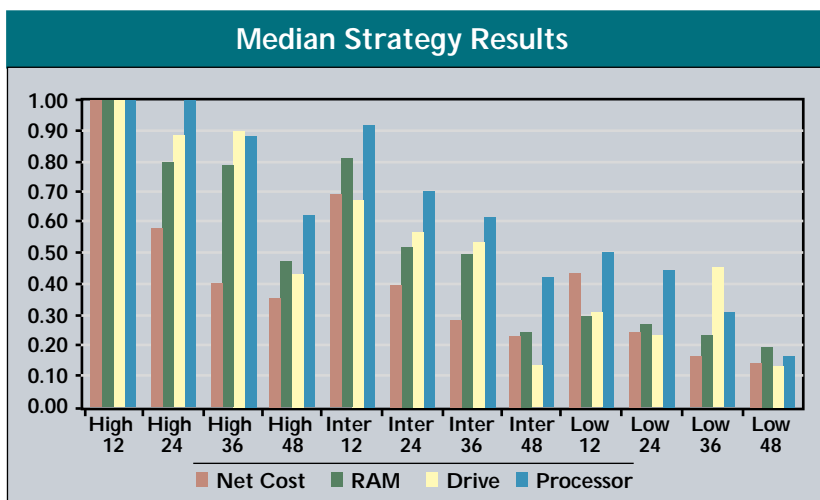


Figure 2. Each of the values (cost, RAM, drive, processor) is expressed as a percentage of the corresponding value in the most expensive strategy (H12).

By using data expressed in original (not percentage) terms, these ratios have a direct interpretation: To obtain a one-unit level of performance, buyers had to spend from \$1.15 to \$2.53 per month. And the purchase of the barest minimum computer required an average of \$2.20 per month for each unit of processing power.

This range of values identifies limits for the cost/performance tradeoff. Specifically, if strategy A results in a decrease in performance ($P_A < P_B$) then most buyers should agree that A is preferred to B if the ratio is greater than 3 (rounding up the 2.53). That is, many buyers would accept a decline in performance if it saved them at least \$3

Dominant Buying Strategies

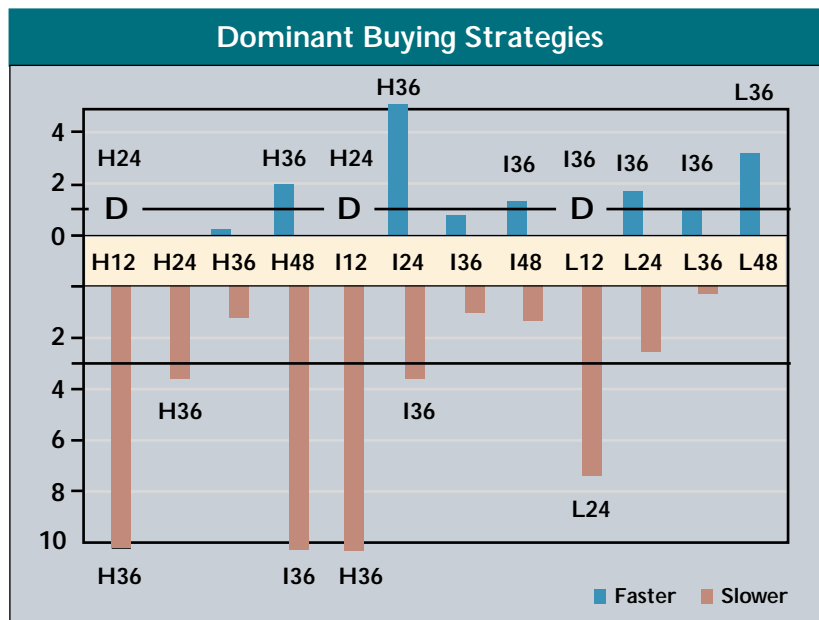


Figure 3. An x-axis strategy is dominated (less desirable) if (1) there is a D in the column (absolute dominance), (2) the bar in the top of the chart exceeds 1 (faster machine at slightly higher price), or (3) the bar in the bottom of the chart exceeds 3 (substantially cheaper option with slight decline in performance). The preferred option is displayed above or below the dominated bar. The four bars exceeding the bounds are truncated and have substantially larger values than indicated by the graph.

for each one-unit drop.

Conversely, if performance and price are higher, the more expensive strategy should be acceptable to most people if the cost ratio is less than 1 (rounding down 1.15). Since any computer costs at least \$1 per month for each unit of performance, and since people choose to buy computers, then they should be willing to accept an increased cost as long as the performance gain is higher. There are limits to extending these statements, but they will hold for comparisons of relatively similar choices (for example, small changes).

One important caveat exists: The relative comparisons do not directly include a budget constraint or a performance constraint. Some organizations may only be able to afford the absolute

lowest price machine, regardless of the performance. Similarly, some organizations could make the argument they need the absolute highest performance regardless of price. However, these two extremes are probably rare in practice. If an organization has trouble paying \$30–\$50 per month for a low-end computer, it has more serious issues to resolve. On the other end, if a company needs massive processing power, users might be better off with workstations or parallel processing machines.

Results

The basic results of the 12 strategies are shown in Figure 2, which compares the cost and performance results. Note that the median performance for High-24 is relatively high (equal to that

for High-12). The mean values (not shown) are slightly lower. In general, the H24 values should be lower than those of the H12 strategy. The current results arise because of slightly different timing in the starting purchase for the two strategies.

Both the chart and the numeric results indicate that three strategies are dominated by other options. The Low-12 option (buy base machines every 12 months) would clearly never be chosen. Comparing the L12 to the Inter-36 option generates a cost performance ratio of -3.30. That is, a \$36 decrease in costs for I36 provides an increase in performance of 11 points. In percentages, strategy I36 represents a 6% drop in costs and a 75% increase in performance. Similarly, the I12 option is dominated by the H24 strategy, with a ratio of -3.14.

Figure 3 presents the results of the dominance tests. The horizontal axis shows the strategy being examined. Strategies that dominate by providing substantially faster machines at slightly higher costs are shown in the top of the chart. For ease of comparison, these ratio values have been inverted so that a value greater than 1.0 signifies relative dominance. Strategies that are dominated absolutely are indicated with the letter “D” indicating the strategy on the x-axis would not be chosen because another strategy offers faster performance at a lower price.

Strategies that dominate by being substantially cheaper with a small decline in performance are shown in the bottom of the chart. These values are positive, and magnitudes greater than 3.0 indicate the x-axis strategy is less pre-

ferred. In all cases of dominance, the dominating strategy is listed at the top or bottom of the chart.

The numerical results are also summarized in Table 1. Note that some of the bars were truncated in the Figure 3 chart to highlight the important details around the critical values. The actual values are listed in Table 1 which shows the strategies that would typically be preferred to the base option. For example, an organization thinking about buying high-end machines every 48 months would be better off buying intermediate-level machines every 36 months, which is substantially cheaper (22%) with only a slight decline in performance (1%). Another choice is to purchase high-end machines every 36 months, which is slightly more expensive (13%), but results in a substantial increase in performance (41%).

Notice that all of the 12-month options are dominated by better strategies. In general, they are absolutely dominated. The low-end also presents an interesting situation. Clearly, there are no cheaper solutions. However, a relatively small increase in costs results in substantial performance gains. For example, it would not make sense to pursue the L48 strategy because a 12% (\$4) increase in monthly costs provides an 84% increase in median performance. The next step up is not as dramatic, but it still provides substantial gains. In general, the I36 option is better than any of the low-end machine strategies. Although it costs twice as much as the L48 strategy (\$67 v. \$34 per month), it provides almost four times the level of performance. The I36 strategy is a substantially better alternative, unless the orga-

Changing configurations and declining prices lead to an important characteristic of the PC market: the computers must be replaced at regular intervals.

nization faces severe budget constraints.

Interpretation and Conclusions

Final results indicate two strategies tend to dominate all the others: H36 and I36. Additionally, the L36 option is a viable option for organizations with extreme budget pressures, but not generally recommended. Likewise, the H12 option may be necessary for organizations requiring the absolutely highest performance levels, but it would normally be better to accept the exchange of a slight performance drop for a substantial cost savings and replace the high-end machines every 24–36 months.

The most important practical conclusion is that if companies are going to buy PCs on a regular basis, then two strategies dominate the rest: buy high-end machines every 36 months, or buy intermediate-level computers every 36 months. For organizations with severe budget constraints, buying low-end computers every 36 months is also a viable alternative. For individuals who require extreme high-end machines, purchasing these high-end machines more frequently can increase performance, albeit the costs are substantially higher.

The practical decision holds almost independently of the needs

of the organization. That is, the dominance holds because of pricing trends, and because the two alternatives represent considerably better price/performance relationships. The issue of demand does play a final role in determining which of the two strategies should be adopted. Only the needs of the organization and user can make the final determination. The high-end (H36) option costs 45% more (\$97 versus \$67 per month) and yields a 42% improvement in performance and feature attributes compared to the intermediate-level (I36) strategy. ■

References

1. Benamati, J., Lederer, A.L., M. Singh. The problems of rapid information technology change. In *Proceedings of the 1997 Conference on Computer Personnel Research*.
2. Ein-Dor, P. 1985. Grosch's law re-revisited: CPU power and the cost of computation. *Commun. ACM* 28, 2 (1985); 142–151.
3. Kang, Y.M. Computer hardware performance: Production and cost function analyses. *Commun. ACM* 32, 5 (1989), 586–593.
4. Mendelson, H. Economies of scale in computing: Grosch's Law Revisited. *Commun. ACM* 30, 12, (1987), 1066–1072.
5. Oosterbeek, H. Returns from computer use: A simple test on the productivity interpretation. *Economic Letters* 55, 2 (1997).
6. Schaller, R.R. Moore's Law: Past, present, and future. *IEEE Spect.* (June 1997), 52–59.

Gerald V. Post (JerryPost@mindspring.com) is a professor of MIS in the Eberhardt School of Business at the University of the Pacific, in Stockton, Calif.
