



Hewlett-Packard Company: Managing Product End of Life

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Abstract. Hewlett-Packard Company, a computer manufacturer, finds that its obsolescence charges are significant and growing. This case presents a specific end-of-life task that arises when a supplier discontinues production of a part used by HP's production forcing a "life-time buy." This lifetime buy is set in the backdrop of various other issues that arise at product end of life. The case presents end-of-life issues from the perspective of various players in the organization, presenting the contradictory and conflicting objectives that arise in the management of the problem.

Keywords: lifetime buys, managing product end of life, newsvendor problem, product obsolescence.

1. Introduction

Benton Christensen swiveled away from his computer screen and sighed. An e-mail announcement had just arrived heralding yet another new product the Computing Systems group was launching. The product was the first in Hewlett-Packard's (HP) new product platform IA-64, jointly developed with Intel over the past several years. There would be a press conference, an ad campaign, a meeting with sweet rolls and coffee, and internal and external publicity for this product, all coordinated by and featuring the smiling face of Linda Vasquez, the manager of the new product development group for Unix servers. Benton and Linda had joined HP at about the same time several years ago, but Linda seemed to get all the good PR. Her star was clearly rising.

Benton's own star seemed locked on a different trajectory. In contrast to the potential energy of new product development, Benton's role was steeped in the realism and known limits of product end of life. His operations job responsibilities for product end of life included the less-than-glamorous responsibility for addressing his group's spiraling obsolescence charges. Products that had been launched with fanfare in past quarters eventually receded from view until they were no longer new products to promote but now older products to clear out in preparation for the next round of new products. Somewhere in that process, these products passed from Linda's group to the current products group until finally, they seemed to appear quietly on Benton's desk. His job was to make them disappear altogether. The fanfare that

accompanied his job was the bellyaching of the management staff when reports of inventory costs were published.

New Product Development (NPD) groups created the products that form the lifeblood of future sales, but profits and margins could evaporate in the product end of life. Over the past few quarters, Benton and his team had worked hard to take more initiative for managing product end-of-life issues at earlier and earlier times in the product life cycle. Benton had read reports that more than 50% of the costs of Medicare dollars were spent on the last two months of life; he wondered what the percentage was for computers.

2. Background

Hewlett-Packard Company was founded in 1939 by William Hewlett and David Packard. By 2001, HP was a leading global provider of computing, Internet and intranet solutions, services and communications products, all recognized for excellence in quality and support. The company's headquarters were in Palo Alto, California. Packard and Hewlett decided upon the order in which their names would appear in the company title through the flip of a coin.

Hewlett and Packard led the company well into the 1980s and remained involved at varying levels even beyond their retirements. They remained icons in the company and in Silicon Valley. Employees joined the Packard and Hewlett families in mourning the founders' deaths in 1996 and 2001.

President and Chief Executive Officer of HP, Carleton (Carly) S. Fiorina took reins of the company in July 1999 as the first outsider to lead the company. Prior to joining HP, Carly spent a total of nearly 20 years at AT&T and Lucent. She focused on leading HP to achieve improved growth in revenue and profitability; greater innovation and inventiveness; the best total customer experience; and widespread recognition of HP as the company that makes the Internet work for customers. Carly recently had reorganized the company to make it more customer oriented. Every business was expected to be #1 or #2 in its market – or HP would exit the business.

In July 2000, after spinning off its test and measurement business to form a new company (Agilent Technologies), HP had 86,000 employees worldwide. Exhibit 1 shows HP's fiscal year 1999 and 2000 financial results.

Hewlett-Packard was organized into four groups: The Consumer Business Organization (CBO) focused on solutions for consumers; this group produced desktops and laptops as well as Personal Digital Assistants (PDAs). The Business Customer Organization (BCO) focused on delivering complete solutions to business customers by combining products from the other groups as well as consulting solutions to meet the needs of HP's business customers. The Imaging & Printing Systems group (IPS) produced HP's popular laser and inkjet printers and scanners. The Computing Systems group (CS) produced

HP's most powerful computers: single and multi-user systems that ran UNIX and other operating systems, as well as the storage devices typically coupled with the systems to complete a customer order. Benton was part of CS.

3. A Life-Time Buy

The chimes of Benton's e-mail recalled him to his computer screen. E-mail from a semiconductor supplier. The supplier reminded Benton that part 2534-9437, a key component of the aging computer system product 2534A, could no longer be ordered after June 1, 2001, and he requested HP's final order. Benton checked his calendar. April 3, 2001 already? He reviewed his e-mail to find the supplier's original announcement. It was April of last year. Now, less than two months remained to finalize the analysis.

While semiconductor manufacturers typically provided a year's warning for such discontinuances, the headache lasted much longer. Requests for a lifetime buy such as this one were becoming quite commonplace at CS. Dozens of such requests had arisen in the last quarter alone for the computer chips used for their product line in addition to the hundreds of other requests for final buys of the printed circuit assemblies that were the next level up in the bill of materials. 2534A was on Benton's list of products near end of life but still on the corporate price list. Benton and his team would be forced to buy enough of part 2534-9437 to cover demand during the unpredictable ramp-down of the product as well as for a stock of inventory to cover the product's five-year support life.

Upon receiving a discontinuance notice for a part or assembly used by HP, Benton's first task was to determine what was driving the request. He made every effort to avoid or delay a "lifetime buy". Was the volume so low that setups were becoming expensive? Perhaps fewer builds per year, each with more units per build, could be run. Was the low volume making the allocated overhead too expensive? Or, did the supplier need the line for an alternate part or one with a higher margin? HP might be willing to pay a higher unit cost. Was the dedicated equipment becoming aged and costly to maintain? HP might be willing to take ownership. Could HP procure the part elsewhere? Could an engineering change obviate the need for the part? Such actions might increase the average cost of the part, but would likely be cheaper than the results of a lifetime buy.

When all alternatives were exhausted, and if the supplier mandated that a final build was in fact required, Benton had to determine the final lifetime buy quantity – after he tried to negotiate as long a delay as possible for the final buy. For part 2534-9437, the supplier had worked with Benton to demonstrate his company's case for the lifetime buy. Benton had negotiated an extra three months beyond the supplier's preferred deadline. Now, Benton had two

months to pull together his best guess for the optimal lifetime buy quantity based on the results of an arduous task of gathering cost and demand data. He had to generate a forecast for expected demands, along with possible upside and downside deviations, working with the marketing group and the Support Material Division, the division that handles demand for spare parts through the support life.

Nonetheless, Benton had no way of knowing exactly how many 2534-9437 parts would be needed to complete existing orders, support current products, and handle necessary replacements for existing customers.

On a longer-term basis, Benton hoped to improve the process for lifetime buys by working to manage demand – in effect, lowering the standard deviation of the projected demand.

Benton also realized the importance of working with suppliers to reduce the number of lifetime buys that occurred. Unfortunately, the incentives were high for a supplier to require such buys. Not only would a build-out free the supplier's lines to build other (potentially higher margin, more profitable) parts, but the supplier received through the lifetime buy a larger quantity purchase than it would otherwise receive (since the buyer had to hedge for uncertainty). Additionally, the supplier received payment earlier rather than later. Only the supplier's interest in maintaining customer goodwill prevented it from requiring even more such buys.

4. Fallout from a Life-Time Buy from Last Year

More chimes. An e-mail from Benton's boss indicated that she had heard about a shortage of a part needed to build a computer system, 7617J, that was very near its end of life. Benton recognized the part as one that was purchased as a lifetime buy in the previous year. Benton felt the knot in his stomach as he thought, "Have we already consumed our entire supply of the part? We apparently underestimated demand." Benton knew that it would be impossible to procure more of the parts needed to build the product. According to the e-mail, Marketing was burning up the phone lines insisting that CS expedite a number of orders for the product. Availability had slipped significantly in the last month as Benton's group consciously worked with suppliers to reduce supply chain inventory levels for all the material to build the product. And now, CS apparently was unable to build any units of the product due to the specific part shortage. Benton's boss wanted to know what course of action he would propose. Benton knew that none of the alternatives would be attractive to her.

Benton would deal with the recommendation later. He stood up, walked over to the soft drink machine, and decided to go see what things looked like in other parts of the HP world. Management by Walking Around (MBWA)

was a tradition formalized in the 1940s by David Packard, and it provided an excuse to release some of the tension that develops from staying too close to the phone and e-mail.

5. Management By Walking Around (MBWA)

Apart from the urgent, short-term problems resulting from lifetime buys, Benton knew that the issues of product end of life were cropping up more frequently and with greater consequences in his work. New Product Development was cranking out ideas at a rapid clip, trying to keep up with sophisticated offerings coming on-line at their primary competitors, Sun Microsystems and IBM. The sheer number of products, their ever-shrinking life cycles, and the seeming inevitability of unique parts in each product made managing product end of life extremely difficult.

Benton made the short walk to Marketing where Jackie Manuel, the Marketing manager, wanted to talk about the introduction of the ItaniumTM, the first microprocessor in the IA-64 family. He outlined the advantages to HP's customers, explaining, "As computing tasks become increasingly intensive and demand more and more power, the limitations of 32-bit architectures are becoming apparent."

While Jackie was excited about the new product, he also expressed his concerns over the management of the ramp-down of existing products. After Benton voiced his concerns about rising obsolescence charges, Jackie paused before responding, "I understand your desire to reduce our inventory exposure, but whatever you do, don't neglect our important customers. We need to be able to offer products with reasonable lead times. These older products should have even shorter lead times since we have so much experience manufacturing them. They will help to keep our revenues up until the IA-64 platform can ship in volume."

Benton nodded. He understood Jackie's point but could feel the knot in his stomach tighten as he realized the conflicting expectations he faced. He wandered over to the NPD group to visit with his long-time colleague, Linda Vasquez.

Benton's discussion with Linda echoed some of the points from Jackie. Linda elaborated on the advantages to the customer of the new product family. "The Itanium revolution will provide all the power required by applications today and in the future. The IA-64 architecture is more scalable, providing better performance for most applications including business intelligence, Internet commerce, online transaction processing, and high-end visualization applications by taking advantage of IA-64 parallel-processing optimization technology; software performance upgrades for the IA-64 system you own."

Linda continued, “As you know, the real money is to be made in getting products to the market quickly. We are sensitive to concerns about product end of life but don’t want to add constraints that might jeopardize our ability to release products in a timely way.” Benton nodded. She had a point, and he knew it would resonate with upper management.

The Finance group was much more attuned to Benton’s concerns about managing product end of life. Finance Manager Ray Felton noted with frustration, “The costs of poor management at product end of life are killing our margins. We need to get this process under control. Life-time buys alone have reduced our profit margins by a full percentage point (of revenues) over the past few years. Unloading obsolete computers at fire-sale prices should not be business as usual. We should not be buying and stocking inventory that we are not confident will be used.” Benton nodded. Ray was usually his strongest ally when he had to make tough decisions about end-of-life problems.

Jawad Williams in Operations had his own concerns: “We need better forecasts. We need to stop dragging out the life of our products – we should do more lifetime builds. Just tell us how many to build, and we can efficiently build these last units and then free up factory resources to work on more current products, especially the higher-volume ones.” Benton nodded. Jawad had a point. Jawad was looking toward the ramp-up of IA-64 products with some trepidation. He felt that a lifetime build of current products would then allow him to focus on the new products.

Benton realized that Jawad’s proposal for a lifetime build would create some of the same problems that lifetime buys were creating: significant underage and overage costs. On the other hand, perhaps freezing the schedule for the current products would ensure that the supply chain could carefully be wound down. Benton was aware that any variability in the build plan for the existing product would translate to higher variability up the supply chain (a manifestation of a phenomenon frequently referred to as the bullwhip effect). Suppliers would be hesitant to reduce inventory levels for parts supporting the aging product line if any variability remained. If the schedule were frozen, and a final build were to be performed over the next few months, all members of the supply chain could be encouraged to eliminate inventory for the product.

Such a plan that freezes the production schedule (supply) would require a greater focus on managing, or shaping, demand. Perhaps the Equipment Manufacturing and Remarketing group (EMR) would be a useful outlet for managing final demand. EMR’s business model was to buy back used computers from customers (or take back leased units) in order to remanufacture and remarket the units at prices lower than new units. EMR typically was willing to buy new units from HP divisions such as CS to distribute through its channel, if the transfer price was right. It might be possible to work closely with EMR such that if CS ended with extra units, these could be sold to EMR. On the flip side, if demand exceeded supply,

perhaps customers could be encouraged to accept remanufactured units from EMR.

Benton made a mental note to discuss Jawad's proposal issue with Marketing. Benton felt there was an overall opportunity to manage more closely with Marketing the transition to the new products. There were different models of product rollouts that had different effects on end-of-life product management. The models ranged from a "knife edge" roll out where the new product was introduced and shipped with pricing and incentives that caused the old product to die instantly, to a more phased rollout that used different regions or markets in a phased approach that created a more gradual ramp-down of the old product.

6. Managing Product End of Life Over the Entire Product Life

Benton returned to his desk to find three more e-mail messages, all requesting information and decisions related to the end-of-life buy for 2534-9437. Benton knew that this short-term end-of-life-buy problem was only part of a bigger problem; he needed to get a handle on the overall management of product end of life. Benton remembered a conversation he had with the Vice President of CS when Benton was hired. Referring to a recent inventory fiasco, the VP had commented, "When the dust settled for the Emerald product family, we had millions of dollars of worthless inventory. Your task is to avoid this in the future. I won't have a job if this happens again."

The traditional emphasis of Benton's team had focused on products shortly before they were removed from the corporate price list (CPL). Each product and product family was monitored and as the CPL removal date approached, a flurry of activities occurred. Worldwide production was consolidated to a single point. The supply chain was collapsed and simplified; suppliers of parts unique to the dying product were reduced and buffers and inventories were eliminated at both HP and suppliers. Quoted lead times were extended and marketing promotions were carefully handled. (In some cases, if significant inventory existed, a product promotion might be developed; in most cases Marketing was encouraged not to promote short lead times.)

Benton thought it would be helpful to structure the overall end of life management around the activities that should occur at each stage of the product life cycle, rather than just near the end of life. He felt that it was important to recognize triggers that would initiate activities at the appropriate times. He drew a timeline that started with pre-release activities and continued through to the end-of-support life and began to consider the issues at each stage of the product's life. Each stage of the product life cycle provided a trigger that should elicit activity from Benton's team. Prior to the release of a product, Benton would assign an end-of-life champion to push for increased use of

common parts, identify the riskiest parts, and focus on developing strategies for managing the high-risk parts throughout the product's life. Other triggers for Benton's team during product ramp and maturity were internal events (such as engineering changes) and external events (such as competitor announcements), as well as lifetime buys.

As the product approached end of life, the intensity of activity increased. The team established a process that focussed on the critical material and resources used to produce the dying product. The process included the identification of suppliers that should be the first to be called if demand was determined to be slowing down more quickly than expected. Internal partners were identified that could be called on to help manage the demand for the dying product and outlets were developed for shedding excess supply of parts or product. The team explored alternative sources for key parts that might be subject to a lifetime buy and even alternative sources for the product itself, such as with EMR, as a contingency for unexpectedly high demand.

A significant end of life issue for the supply chain was the supply of parts for the dying product. As most computers CS produced were built to order, inventory was held in component form rather than product form. An issue arose as manufacturing ramped down in that the supply chain inventories of component parts did not necessarily form entire "kits" of material that could complete a computer. Furthermore, it was difficult to manage the inventory to create such kits since the customized orders required kits that were different from each order. Complicating the issue was the challenge in identifying which parts were most vulnerable to obsolescence and thus should be most carefully monitored. It was somewhat challenging even to identify parts that were unique to the dying product family; relevant "near-unique" parts were even more challenging to identify. Near-unique parts were defined as having the greatest percentage of their demand originating from dying products, even though a small portion of demand originated from continuing products. The problem with these parts was that it was easy to assume that they were not at risk since they were used in other products. But if the demand for these parts from products other than the dying product was only nominal, they could in fact be at great risk. If the near-unique part was not closely managed, and demand for the continuing products was small, excess inventory of the part could result.

7. Design for Product End of Life?

Benton realized that the most significant end-of-life management gains would occur if they focused on the triggers earlier in the product lifecycle rather than the traditional focus that began near the end of life. The biggest opportunity was to work with NPD at the beginning of the product's life to design products

with considerations of managing product end of life. In particular, there needed to be more incentives for designers to consider utilization of common materials across products, product platforms, and time. If a part was used from one generation to the next, it avoided obsolescence and excess because demand for the part did not disappear. Similarly, the use of standard interfaces and industry standard materials facilitated end-of-life management. Demand for these materials would not disappear at the product's end of life.

Benton was excited about the work of the CS program management team. One of the supply chain analysts, David Noel, had developed a simulation based on a system's dynamic model that helped to capture the effects of tradeoffs that arise in the design process. David recently had explained the model through a current issue faced by the NPD team. The plan for the new computer platform was to offer the customers low, medium, and high-end models, and it was sometimes possible to use common parts across the models. A particular example under consideration was an IO card needed for each model. If a separate IO card were developed for each model, the low-end card might cost less than the high-end card, saving significant material expenses over the life of the platform. On the other hand, a universal card would facilitate supply chain flexibility. If the team designed and used a card that was the same for all models, a customer would never find a shipment constrained for lack of IO cards, if any were in stock. Whereas, if separate cards were used, a high-end system might be constrained for lack of an IO card even if low-end IO cards were in stock.

David's model, which made numerous assumptions about lead times and demand profiles, provided a way to demonstrate the benefits of such a universal card. David explained that the "time-to-money" response time (see Exhibit 2), or time required for a supply chain to respond to an unexpected event, could be 34 weeks or more. This was due to decision delays as well as long lead times for some of the components. Components such as semiconductors can have a 16 to 26 week lead time; power supplies can be up to a year. In addition to the component lead time, the lead time for printed circuit assemblies (PCAs) and least common denominator materials (LCD) also affected the product response time. A product could not ship until all materials were available; the longer lead-time components were frequent limiters, but occasional shortages of shorter lead-time material could also limit availability. Response time also included the time to configure to order (CTO), ship, and install for the customer. The longer the time-to-money response time, the more costly the effect on the supply chain of an inaccurate forecast.

David showed Benton an output of his model (Figure 3) that demonstrated the effect of various time-to-money response times (0, 24, or 28 weeks) on cumulative contribution margins over a product life cycle when actual demand was different than the forecast. If the time-to-money response times were 0 weeks (implying that the supply chain could respond instantly to unpredicted

demand changes), then the effect of sales on profits was linear; each additional sale contributed the same margin, even if the unit was unforecasted (i.e., the demand vs. forecast difference was not zero). On the other hand, if the response-to-money lead time was 28 weeks, weak demand (below forecast) or strong demand (above forecast) contributed less margin per unit. David pointed out the interesting phenomenon that for very strong demand under a 28 week response-to-money lead time, sales of additional units beyond 30% above forecast were actually at a loss!

David had presented his thoughts on design for supply chain management to numerous R&D organizations in an effort to work closely with them to understand the effects of design decisions on managing the supply chain. He had achieved some success and was pleased to have influenced a number of changes that benefited HP's supply chain and would not have been implemented otherwise. A continuing challenge for David was that the primary metric for the NPD team was the material cost per product at time of product introduction, a metric which failed to account for the supply chain costs and made it more difficult to encourage "design for supply chain management." Benton noted that the effects of design alternatives on the supply chain would be greatest at the end-of-product life.

Benton returned to his desk. He thought about the opportunities for his team and considered that if his team members did their jobs well, they might save HP millions of dollars per year in reduced obsolescence charges. Yet most of the current practices and processes, as well as the prevailing attitudes at HP, had been developed with a focus on new product development that emphasized time to market and had a tendency to overlook total lifetime costs. He sat down and began composing a response to his boss regarding the recommendation to be presented at the business-planning meeting for dealing with the availability problem for product 7617J.

Discussion Questions

1. What is the benefit to the supplier of a lifetime buy? Is there any benefit to the buyer?
2. What are the advantages and disadvantages of a build out (lifetime build) of the current product line in anticipation of the ramp-up of Itanium? If HP chooses to do such a lifetime build, what are the key issues?
3. Across the lifetime of a product, what are the key activities in managing product end of life? What are the key triggers?

4. What are the advantages and disadvantages of using a universal IO card for the new computer platform?
5. How should Benton respond to his boss about the availability of product 7617J?

Problems

6. From Exhibit 1, what was the current Earnings from Operations for the Computing Systems group as a percent of Net Revenue in Fiscal 2000? If lifetime buys reduce earnings by a full percentage point of revenue, by what percent would earnings increase if lifetime buys were eliminated?
7. A simplified version of the Universal IO card problem:

A new computer is being designed to sell at three performance levels: High, Medium, and Low. If separate IO cards are designed for the three levels the cards are projected to cost \$100, \$95, and \$90 per card manufactured for the high-end, mid-range, and low-end cards, respectively. Monthly demand for the three products is forecasted to be 150, 200, and 100 computers per month for the high-end, mid-range, and low-end computers, respectively (and one IO card is used in each computer). Assume that the standard deviation of monthly demand is about 33% of mean monthly demand (i.e., the coefficient of variation = .33) and HP holds safety stock at 200% of standard deviation of monthly demand.

- a) If the annual cost of inventory is 30% of the cost of the average inventory level, what is the annual inventory holding cost of the safety stock of IO cards?
- b) What are the annual material costs of manufacturing the IO cards?
- c) HP is considering a universal IO card that could be used in all three levels of computers. This card would cost \$96.50 per card manufactured, implying that HP would pay a premium for all low-end and mid-range computers, while saving a bit of money on the high-end computers. What would be the new annual material costs of manufacturing a universal IO card?
- d) Inventory holding costs would change with the universal IO card. Assuming that demand for the three levels of computers is

independent, what would be the annual inventory holding cost of the safety stock of universal IO cards?

- e) What is the net change in annual material costs plus holding costs with the introduction of a universal card?
 - f) The computer is projected to have a two-year life span. If the amount of inventory written off at the end of a product life is roughly equal to the safety stock, how much less would be written off with a universal IO card compared to separate cards?
 - g) Do you recommend using the universal IO card?
8. Lifetime buy sample problem: Using the following information, what would be the appropriate underage and overage costs to consider for the lifetime buy of 2534-9437? What is optimal purchase quantity? Clearly identify the assumptions for your solution.

Remaining demand for product 2534A (each of which requires one unit of 2534-9437) was forecast at 500 units, but that demand was uncertain, especially since it was the final six months of life. The inherent uncertainty of demand was exacerbated at end of life by the unpredictability of the ramp-up of HP's replacement products and by the activities of competitors. If HP customers were to convert their orders to the new products more quickly than expected, demand might evaporate for 2534A. On the other hand, if the schedule for HP's replacement product slipped, demand for 2534A might linger longer than expected. In addition to the remaining product demand, there was a forecasted demand for an additional 500 units of 2534-9437 from the Support Material Division over the five-year support life. These units would be available as spare parts to allow HP to service the installed base of customers. Accordingly, the combined demand forecast for 2534-9437 was 1,000 units. Benton's experience with previous forecasts was that they were rarely even close to actual demand. Although the forecast was for 1,000 units (500 for the product plus 500 for support life), actual demand was random. Benton knew from experience that the actual demand was roughly approximated with a normal distribution with the standard deviation as much as 33% of the mean. For part 2534-9437, Benton thus assumed that total demand would be normally distributed with a mean of 1,000 units and a standard deviation of 333 units.

Benton considered the following cost factors. He assumed that the annual cost of capital for HP was 30%. The overhead for carrying the part (warehousing, accounting, planning, etc.) was another 10% of the product's cost incurred each year. HP paid \$500 for each part 2534-9437 purchased from the supplier. The total profit margin on a system built using the part was approximately \$10K and if the product is not available, the sale is lost. If a support life demand was unfilled, HP could face contractual penalties of up

to \$50K. On the other hand, some of the support life demand might be met using parts cannibalized from returned units. In this case, the cost of reclaiming and retesting each part was approximately \$2K. However, there was very little predictability about the timing and quantity of returned units.

Exhibit 1: HP's Financial Statements for FY 1999 and 2000 (restated to not include Agilent)

	Fiscal 1999					Fiscal 2000				
	Q1	Q2	Q3	Q4	Year	Q1	Q2	Q3	Q4	Year
Net Revenue:										
Imaging and Printing Systems	4,460	4,715	4,194	5,181	18,550	5,048	5,138	4,805	5,485	20,476
Computing Systems	4,315	4,315	4,628	4,556	17,814	4,943	5,117	5,169	5,866	21,095
IT Services	1,521	1,547	1,551	1,636	6,255	1,678	1,758	1,818	1,875	7,129
Other	228	218	208	232	886	266	348	321	364	1,299
Total segments	10,524	10,795	10,581	11,605	43,505	11,935	12,361	12,113	13,590	49,999
Eliminations/other	(289)	(340)	(263)	(243)	(1,135)	(262)	(333)	(295)	(327)	(1,217)
Total HP consolidated	10,235	10,455	10,318	11,362	42,370	11,673	12,028	11,818	13,263	48,782
	Q1	Q2	Q3	Q4	Year	Q1	Q2	Q3	Q4	Year
Earnings From Operations:										
Imaging and Printing Systems	666	615	371	683	2,335	701	697	613	735	2,746
Computing Systems	237	124	341	148	850	179	187	379	215	960
IT Services	207	121	125	122	575	168	149	178	139	634
Other	(2)	(22)	(18)	(29)	(71)	(12)	(11)	(33)	(47)	(103)
Total segments	1,108	838	819	924	3,689	1,036	1,022	1,137	1,042	4,237
Eliminations/other	(11)	57	(32)	(15)	(1)	(84)	(132)	(45)	(87)	(348)
Total HP consolidated	1,097	895	787	909	3,688	952	890	1,092	955	3,889

Exhibit 2

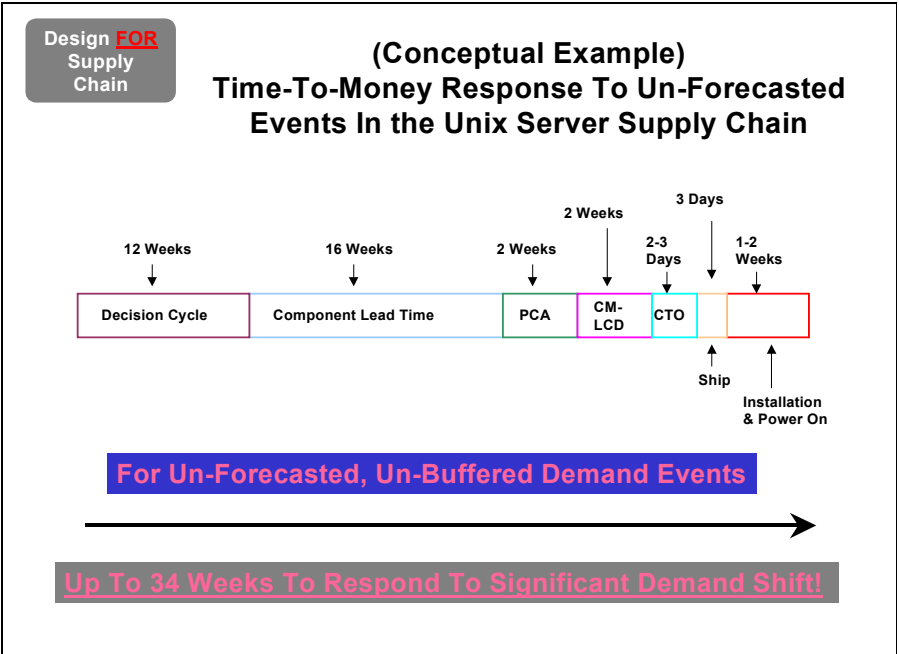
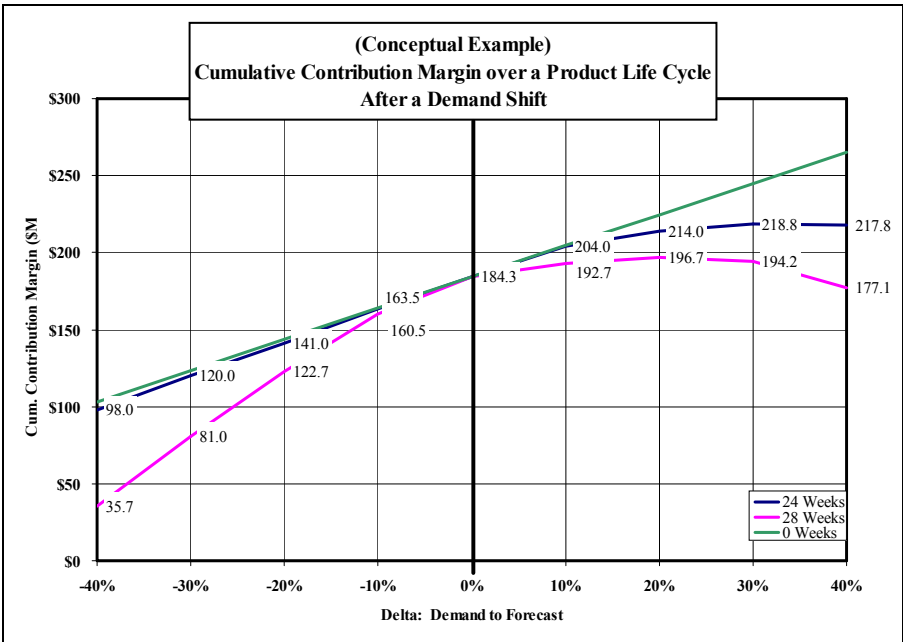


Exhibit 3



Teaching Note

Case Synopsis

Hewlett-Packard Company, a computer manufacturer, finds that its obsolescence charges are significant and growing. Our protagonist in the case is faced with the task of determining how to handle a specific end-of-life task that arises when a supplier discontinues production of a part used by HP's production forcing a "life-time buy." This lifetime buy is set in the backdrop of various other issues that arise at product end of life. The case presents end-of-life issues from the perspective of various players in the organization, presenting the contradictory and conflicting objectives that arise in the management of the problem.

Teaching Objectives

Even a quick read of this case should foster recognition of the complexity of the end-of-life problem and the order of magnitude of its effect on profitability. The case raises issues that can be used to generate class discussion: the use of commonality to manage supply chain and end-of-life risks; the possibility of a lifetime build of a dying product; and a discussion of the key activities and triggers of activities in managing end of life. For the more conscientious readers, the case presents specific problems to solve (e.g., how many parts should HP buy for a life-time-buy problem, and should a universal IO card be used?)

Analysis and Teaching Suggestions

The case was designed for a single (80 minute) session of an MBA elective in supply chain management. It has been used successfully in MBA classes, Evening MBA classes, and in Executive Education.

The class can begin with a discussion that invites students to share their experiences with managing product end of life. Sometimes there are students with experience on the topic while other times there is little direct experience. Most students will know about companies that have been hurt by large inventory write downs at the end of a product's life.

A significant portion of the class session can be used to analyze some or all of the discussion questions at the end of the case.

The final part of the class session should be used to convey principles that are important for addressing the problem of managing product end of life. Sample analysis of the problems (6-8) as well as PowerPoint slides are available electronically from the author at kyle_cattani@alumni.stanford.org.

A useful reference that discusses successful strategies for product rollovers is Billington, et al. (1998). More detail discussion of lifetime buys can be found in Cattani and Souza (2003).

Discussion Questions

Below is a possible analysis of the discussion questions raised at the end of the case.

1. *What is the benefit to the supplier of a lifetime buy? Is there any benefit to the buyer?*

Most of the benefits appear to accrue to the supplier. Some of the benefits include:

- The supplier can free up space on the manufacturing line that might then be used for more profitable products.
- The supplier is able to get a larger sale than in the absence of the buy (if the critical fractile for the customer is greater than $\frac{1}{2}$).
- The supplier gets the sales (and the cash) earlier than they would have otherwise and thus benefit from the time value of money.
- The supplier cleans up her product offering – eliminating a product that is declining in volume and perhaps becoming less profitable.

Most of the benefits to the supplier come directly at the expense of the buyer. The buyer achieves little benefit, with perhaps the exception of reduced transaction costs. However, while the buyer will subsequently not have to place additional orders, the buyer will have to monitor and manage the life-time-buy inventory, and may subsequently write off a substantial portion of the buy. In general, only the supplier's interest in maintaining customer good will cause the supplier to hesitate to require a life-time buy for a slow moving part.

- 2. What are the advantages and disadvantages of a build out (lifetime build) of the current product line in anticipation of the ramp-up of Itanium? If HP chooses to do such a lifetime build, what are the key issues?*

A lifetime build of the current product line raises many of the same issues as a lifetime buy. A lifetime build raises the possibility of significant underage and overage costs if the “wrong” quantity is produced. On the other hand, if the customer base is well defined and has few options other than HP, a lifetime build could in some ways place HP in the advantageous position that was described for HP’s suppliers that require a lifetime buy. Also, if HP could carefully manage demand, especially by working with EMR, HP could provide a clear and fixed ramp down plan to HP’s suppliers that would facilitate the careful ramp down of production in the upstream supply chain, minimizing the bullwhip effect and allowing the upstream partners to ramp down production in such a way as to reduce obsolescence costs. The success or failure of this proposition is most likely related to HP’s ability to avoid underage and overage costs; this is probably best accomplished through a close relationship with EMR.

- 3. Across the lifetime of a product, what are the key activities in managing product end of life? What are the key triggers?*

The following chart identifies some of the key activities. Triggers should include the usual product lifecycle milestones that occur during product development and life at any company. Pre-release activities are those that occur prior to customer shipments; in particular those activities that define the product and process structures. Other triggers may be externally created, such as lifetime buys or responses to competitor activity that change the relative risk of the inventory on hand.

<h2 style="text-align: center;">Managing product end of life over the entire product life</h2>				
Monitor and respond to competitor activities				
Pre-Release Activities	Product Ramp & Maturity	Approaching end of life	Off CPL -- support life	End of support life
<p>Assign EOL champion Push for common parts</p> <ul style="list-style-type: none"> •across generations •across products •across product families <p>Identify at risk parts</p> <ul style="list-style-type: none"> •expensive •long lead time •unique / near-unique <p>Focus on at-risk A parts</p> <ul style="list-style-type: none"> • identify and highlight inventory risks •avoid large stocks of these parts 	<p>Engineering Change (EC) management</p> <ul style="list-style-type: none"> •determine effect on unique parts <p>Lifetime buys</p> <ul style="list-style-type: none"> • Seek alternate suppliers 	<p>Reduce Inventory</p> <ul style="list-style-type: none"> •use conservative forecasts •reduce / eliminate SS <p>Manage Lifetime buys /builds</p> <p>Manage carefully transition to new products</p> <ul style="list-style-type: none"> •Overlap in time with existing prods (rollout new product in different regions or channels) •“knife edge” roll much more risky (out with old, in with new at same time) 	<p>Manage Lifetime Buy Inventory</p> <p>Salvage / purge excess inventory</p>	<p>Salvage / purge all inventory</p> <p>Tally results (lifetime costs)</p> <p>Debrief: lessons learned</p>

Potential triggers include:

- Formation of the NPD team
- Manufacturing Release
- Engineering Changes
- Lifetime Buys
- Corporate Price List (CPL) removal plan
- Off CPL
- End of support life

4. *What are the advantages and disadvantages of using a universal IO card for the new computer platform?*

The case provides discussion of the advantages and disadvantages. Advantages of using a universal card include supply chain management benefits that arise from pooling demand. The universal card would allow the supply chain to stock only the one card reducing the need for safety stock, creating a larger volume for the card (perhaps allowing for volume discounts), simplify the need to track the separate cards, and perhaps simplify the assembly and test of the card. At the end of product life, the supply chain management benefits are amplified as the need to manage carefully the inventory becomes more acute. With a universal card, there are fewer parts and assemblies to manage and the variability of the one assembly is lower due to the pooled demand.

The benefit of separate cards is straightforward and perhaps more easily quantified (if we know the projected demand). Each unit sold of the universal card potentially will incur a higher material cost, which should be known and easily measured. If, for example, the universal card costs \$96.50, while the high end, mid range, and low end cards cost \$100, \$95, and \$90 respectively, it is easy to project the expected cost savings for any assumed volume of demand for the mid and low range cards.

Problem 7, below, provides a specific example where the benefits of a universal design can be compared to the added costs.

5. *How should Benton respond to his boss about the availability of product 7617J?*

The Marketing group clearly is worried about specific orders and customers, and Benton would probably best be served with empathetically laying out the options, which are not likely to be what the Marketing group will want to hear. He will have to give a brief background and status on the parts, digging up the forecasts and assumptions that were used for the lifetime buy. He will have to demonstrate the options that were explored as sourcing alternatives. Assuming that it is impossible to procure additional new parts, it still may be possible to use remanufactured parts. If parts are not obtainable from any source, then the other alternative to satisfy customers may be to ship an alternative product, possibly with healthy discounts.

Separately, Benton needs to work closely with Marketing to define expectations and plans for product availability at end of life. For most products, Marketing should help customers to expect that the lead time from order to delivery will be higher than it was during product maturity. On an on-going basis, the ability to ship orders more quickly than the lead-times of

procured parts is accomplished only by holding inventory. During earlier stages of product life, inventory is purchased based on forecasts and additional inventory in the form of safety stock can be used to address demand uncertainty. Since these forecasts become much more risky at product end of life (if demand were to evaporate, inventory purchased to cover the forecast might have to be thrown away), reducing overall inventory levels and safety stocks is an appropriate strategy. However, the strategy implies that the supply chain is less equipped for meeting demand with a quick lead time. If Marketing sets expectations that customers can still receive orders under a short lead time, there is bound to be frustration throughout the supply chain.

References:

- Billington, C., Lee, H. L. and Tang, C. S. (1998) "Successful strategies for product rollovers", *Sloan Management Review*, 39 23-30.
- Cattani, K. D. and Souza, G. C. (2003) "Good buy? Delaying end-of-life purchases", *European Journal of Operational Research*, 146 (1) 216-228.