Stanford Global Supply Chain Management Forum

Hewlett-Packard Company: Network Printer Design for Universality

Introduction

Sarah Donohoe, manufacturing engineering manager of the network laser printer division at Hewlett-Packard Company (HP), listened intently to her colleagues at the project review meeting for the development of their latest new product. With Sarah at the meeting were Jane Schushinski, marketing manager, Leo Linbeck, head of product design, and David Hooper, the controller of the division.

The main topic for this meeting was the decision of whether or not to use a universal power supply for the next generation of network laser printer, code named *Rainbow*. Previously, printers in the North American and the European market have distinct power supplies and the associated fusers in the main engine of the printer. For North American printers, a 110 volt power supply was installed. For European printers, a 220 volt power supply was added. This printer engine was built by HP's manufacturing partner in Japan. Due to the long lead time for engine manufacturing, HP had to specify the requirements of the two types of printers at least fourteen weeks ahead. The time that it takes the Japanese partner to commit the printers for shipments, the transportation times and customs clearance totals about 4 weeks. Hence, if a universal power supply is used, then HP would have the flexibility of postponing the specification of the printer engine by at least two months in planning process. Consequently, the production team believed that universal power supply can enable HP to better respond to the changing demand in the individual markets and reduce its inventory costs.

Linbeck had begun the meeting by reviewing a fax he had received from the Japanese partner. "We have been asking our partner for a universal power supply and fuser for a long time, and now, when we are about to finalize our design of the next generation network printer, they are telling us that designing the new power supply is finally feasible and can be completed within the time constraints we have set for delivering the product to market on time. However, we must make the decision within the next two weeks so our Japanese partner can line up its design engineers to work on the project." Hooper summed up finance's position as follows, "I do not know what other costs or benefits to the supply chain will be derived from this new change, but what I do know is that our Japanese partner quoted that universal power supply would increase costs by $30 per unit."

As the conversation progressed around the room, Hooper's words became more and more indicative of the group's feelings as a whole. The only hard number available for analyzing the costs and benefits of the change was the $30 increase as quoted by the Japanese partner. If the team was to implement the change, they would have to convince management that the benefits

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This case was written by Professor Hau L. Lee, based on an original case written by Steven Plous and Toni Cupal. It is intended as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The product and individuals' names have been disguised.

outweighed the costs. Unfortunately, as the meeting went on, quantifying the advantages and disadvantages appeared more and more difficult.

The Hewlett-Packard Company

Hewlett Packard (HP) was one of Silicon Valley's legends. Established by two Stanford University graduates, William Hewlett and David Packard, in 1939, the company initially prided itself on supplying superior engineering tools, designed for engineers by engineers. As the company grew and diversified, the strong belief in technological innovation as the key to competitive advantage persisted.

Innovation was the key to HP's strategy, as was expressed by Packard in 1957:

> *Improvement is accomplished by better methods, better techniques, better machinery and equipment and by people continually finding better ways to do their jobs and to work together as a team. I will never see the day when there is not yet room for improvement.*

Through time, HP's focus on innovation had brought the world products such as the hand-held calculator and the inkjet printer. In 1992, the company continued to invest heavily in technology, spending $1.6 billion or 10% of revenue on research and development. The high levels of investment have paid off: Over half of HP's orders had consistently been for products introduced within the last two years.

Changing Market Conditions

In the early 1990's, while technological innovation continued to drive the company's success, many business units were being forced to compete on other dimensions. In consumer product lines, low prices, broad availability and ease of use had become competitive requirements. Lew Platt, HP's current President and Chief Executive Officer, once acknowledged the importance of improving customer service and responsiveness,

> *We're not doing as good a job in order fulfillment as we need to. In fact, it's where we get our lowest marks from customers. We have to be a lot easier to do business with. Improvement in order fulfillment will strengthen HP's competitiveness, increase customer satisfaction and reduce expenses, so this is an area of great urgency. Along with improving profitability, it's our top priority.*

In addition, product life cycles were continually shrinking, making time to market the difference between maximizing market opportunities and missing them.

Nowhere were these demands more important than in the laser printer division. HP held a dominant 57% of the worldwide laser printer market, but several formidable competitors, including Apple, Fuji-Xerox, Kyocera, Oki, and Compaq, had recently entered the market. Product life cycles had fallen to under three years and the quality of competitive products made consumers willing to switch brands if HP's price was too far above the market average or if the product was not easily available.

To meet these challenges, HP had aggressively worked to improve its product development process. Cross-functional teams which brought specialists from all functional areas together to create a new product were becoming standard. The primary benefit of such teams was their ability to identify and eliminate potential problems early in the design cycle while the financial

and time to market costs of changing the product design was low. As intended, the different perspectives of the team members often gave rise to heated debates over design decisions.

The Network Printer Division Supply Chain

The laser products as a group constitutes a major and rapidly rising portion of HP's revenue. In 1992, the revenue of laser products was $3 billion, but was projected to reach close to $8 billion by 1998. The network printer is a high end laser printer that has networking capabilities and special functionalities. Rainbow, the network printer under development, is a product with much more configurable options and features for the printer, such as memory, stapling ability, firmware, system software, fax modems, paper handling, linkage to print server, scanner, and printer stand. It will be priced between $5,000 to $6,000. The product is shown in Exhibit 1.

The network printer division at HP currently outsources the procurement and assembly of the product's main engine to a Japanese partner. The components, including the power supply and fuser unit, were fully integrated with a printed circuit board from HP's Boise factory into the printer engine at the partner's factory. Monopoly control of one of the key components allowed this partner to require a 14 week lead time from HP.

The design team of Rainbow recognized that the multiple thousands of configurable options for the new product would be a nightmare for forecasting and production planning. Consequently, special efforts were spent in the design of the products so that most of the customization of the products, like the installation of paper input units, cabinet stands, fax modems, paper output units, stapler upgrade package, memory, and print server linkage can all be carried out at the distribution centers (DCs). Hence, all these options can be installed as accessories at the DCs. In addition, the localization of the product through the inclusion of driver software disks, manuals, power cords and front panels (with the correct mix of languages) are also done at the DCs.

Hence, the supply chain process involves the transportation of the base printer, almost exclusively by boat, from the partner's facility to HP's DCs in either North America or Europe. The shipment process lasted one month. The demand for network printer in Asia and Latin America was still minimal compared with those of North America or Europe. Similarly, all necessary accessories and localization materials are also shipped to the DCs from the respective suppliers. Both the printers and other materials are stocked at the DCs.

When customer orders from resellers arrive, the printers are customized and localized, followed by appropriate labeling and packaging. Final transportation time, typically via truck, to the resellers in each region, US or Europe, ranges from a few days to approximately a week.

The Universal Power Supply Decision

The Marketing Perspective

Jane Schushinski, Marketing Manager,

> *I think changing to a universal power supply is a fantastic idea if it does not add cost to the product. Customers will not pay for features that they don't need, and universal power supply is irrelevant to them - the network printer is not like a portable hair dryer that they would carry with them to travel around the world.*
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> *The biggest difficulty we have in marketing is not will there be demand for our product, but how*

much and where. HP makes great printers. We have always been the leader in innovation, reliability and service. Rainbow is just the first of our series of new network printer line, and we expect to sell 25,000 per month of the product worldwide, with N. America having about 60% of the market.

What hurts us is our inability to accurately forecast the mix of demands in geographical regions. We may think that Europe will need ten thousand units and North America two thousand when the numbers may turn out to be fifteen and fifteen thousands respectively. The problem lies in market conditions where increased competition and constantly changing technical innovations can drastically change the demand for a product in a few weeks. In addition, there are a lot of firms trying to compete on price. This too changes demand.

Finally, the long lead time from Japan causes my marketing staff to pull their hair out. We have to specify the market for the printer four and a half months ahead of delivery. We estimate that the entire life cycle of the product is at most 18 months. Four and a half months lead time in an 18 months market - it's ridiculous! The last thing that we want is a repeat of the VIPER debacle. That episode has my hair turning prematurely gray. We had so much of that product laying around we started calling our factory the 'snake pit!'

It is easy to see why we love the universal power supply. With the universal power supply, we only need to estimate worldwide product demand four months ahead of time instead of numbers for each market. We can make the determination of individual market demands much later, and this postponement will help us create more accurate forecasts and help prevent expensive localization errors.

The VIPER was an earlier generation HP laser printer. While the printer itself was very successful, the VIPER's story illustrates the difficulties with demand uncertainties. The VIPER was developed in the same manner as the new printer being considered. The main components of the VIPER were sourced from Japan and resulted in the same three and a half month lead time to the factories. The product requires dedicated power supply and fuser, 110V or 220V, which cannot be interchangeable. Specification of the dedicated power supply, at the beginning of the three and a half months, committed the product either to North American or European market.

HP had not forecasted the correct mix of European and North American VIPER demand. The printer was sold out in Europe while demand in the United States was less than anticipated. HP filled a warehouse with unwanted North American printers that cannot be used to satisfy demands for the European market without incurring heavy costs of disassembling the printer and reconfiguring the power supply and fuser in the engine. Eventually, heavy discounting, or "fire sales," was needed to rid the excess inventory, incurring very high cost. Buyers in the North American market now expected HP to reduce printer prices over time. Inadvertently, HP had undercut its ability to command premium prices in the market.

The Product Development Perspective

The product life cycle of printers can be divided into three stages; ramp-up, maturity and end-of-life. The ramp-up period is the time from the initial introduction of the product until HP's production volume levels off. During this stage the product is usually the only printer on the market providing its distinctive features. The maturity stage reflects a period of increasing competition. Comparable printers will be introduced and price will become a more influential aspect of the product market. In the last stage, end-of-life, there is fierce competition on all fronts. Retail profits at this stage reach their lowest point as margins are squeezed. It is here that HP aims to introduce its next generation product.

When there is an imbalance of demand in North America and Europe, the division can live with the consequence of having excess inventory in one continent and shortages in another, or ship the excess from one continent to another (an operation known as "transshipment"), where the printer is reconfigured and sold.

In the end-of-life stage, in addition to transshipping the products across the continent to correct for some of the imbalances, the division can also discount the product to create demand, dismantle the product and sell the parts to HP's service division in Roseville, or just write the product off.

Leo Linbeck's office was stacked high with what must have represented every available trade journal related to printing technology. From behind his HP workstation he explained his point of view regarding the universal power supply.

> *While Jane gains 'responsiveness,' I'm staring at a $30 per unit cost increase. With the pressure to lower material costs, the design team would find it hard to justify this seemingly unnecessary increase in material cost. Although the printer engine costs about $1,000 each so that $30 may not seem that much, but every single dollar increase in material cost is a decrease of a dollar in our profit. That is why our design group is getting so much heat to get the material cost down. My concern is that we have no way to reliably predict how much value the so-called benefits of universal power supply truly represent.*
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> *Now, I'm the first to admit that I'm no marketing expert, but it's pretty clear to me that if we could just learn to forecast demand better, this universal supply would literally be a worthless idea. Maybe pumping $30 per unit into improving the forecasting process makes more sense than sending it out the door in a cardboard box. At least in the first case we have some hope of recovering it again.*
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> *I do agree with Jane's point regarding the benefits late in the product life cycle. Currently, reconfiguring the product with a different power supply is a real pain. We have to purchase new power supplies rated at the correct voltage, ship the printers across the Atlantic from the undersold region, swap the power supply, change the fuser electronic circuit and the fuser bulb, and, finally, distribute the product to retailers. The old power supplies have to be disposed of. To make matters worse, there are all kinds of regulatory issues which surface. A universal power supply eliminates all the rework which is now required, but whether the gains it provides outweigh the increase in materials cost remains unclear.*
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> *Whichever way we end up going, one thing is certain: We cannot delay our development schedule in order to make this decision. We need to decide on a strategy quickly and GO!*

As early as 1991, in order to improve their cost position and speed up time to market, the printer divisions in Boise had implemented two new product development metrics. First, they had instituted cost reduction goals for each new generation of printer. The costs captured in this measure included labor, material, and manufacturing overhead. The second metric, called Break Even Time (BET), had been mandated by upper management. It measured the time from project initiation to break even defined as the point where total discounted cash outflow equaled total discounted cash inflow.

The Finance Perspective

Neatly arranged on David Hooper's desk were the latest sets of pro-forma income statements and

balance sheets for the new project. Pointing out the effect of the universal power supply on income he noted,

> *If we incorporate the universal power supply and sell 450,000 units of Rainbow, it will cost us approximately $13.5 million in additional material costs. If we are not able to pass this increase along to the customer, or at least our retailers, that comes straight out of our bottom line.*
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> *I sure agree that there will be benefits from universal power supply. Maybe we should take a hard look at the costs of stockouts and inventory.*
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> *Demand fluctuates during each of the three life-cycle periods and so do the costs of making or missing a sale. We typically estimate that for each lost sale we actually forego multiple times our profit margin. The reason for this is that if a customer buys a competitive brand due to our inability to keep the resellers on stock, there is a chance that he will stay with that brand when he purchases a printer in the future. This effect might cover three or four generations of printers. Moreover, we may lose the profits from the sales of consumables like toner cartridges and perhaps even other HP peripheral products. The cost of stockouts when the product is first introduced into the market is even higher, as the potential word-of-mouth and publicity effects can damage the future sales and ultimate success of the product. On the other hand, the cost of stockouts at the end-of-life stage is probably considerably lower, as there is less fear of adverse effect on future sales, and the resellers might in some cases steer the customer to wait for the new, incoming, replacement product.*
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> *Although the cost of stockouts in the ramp-up stage is the highest, it is also this stage when we know the least about the market response to our new product, and our forecast errors are usually much greater. I understand that Sara's material planning people had done some homework and found that the standard deviation of our monthly forecast error (a new measure of forecast accuracy that the group has started to measure), was close to 40% of the average monthly demand in both markets in the mature and end-of-life stage. Their perception is that the corresponding percentage is 80-90% in the ramp up stage.*
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> *The other major cost that I have to monitor is inventory. My financial analysts have estimated that our annual holding cost rate is approximately 30%, which covers warehousing, insurance, cost of capital, and shrinkage.*

The Manufacturing Perspective

Sara Donohoe, manufacturing engineering manager, commented,

> *I think the universal power supply is a great idea. This innovation will improve our flexibility to respond to orders in two key ways. The first is the obvious gain of delaying the regional allocation decision by two and a half months. I'm sure marketing has expounded on this ad infinitum. The second gain is more subtle. You see, while transshipment has always been possible in theory, we have avoided it whenever possible. Let me explain.*
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> *At the ramp-up stage, we always try to stockpile our DCs with loads of printers so that we don't ever run out of stock, and, given the high cost of shortage at this stage, this seems reasonable. There is not much of a need for transshipment. In the mature phase, if we keep doing what everyone at HP does and keep enough safety stock to meet the standard service target of around 98%, then again, the chance of our needing transshipment is still small. However, I am not sure if we want to keep having 98% service goals at the end-of-life stage, and indeed that is when transshipments will be most needed.*

The whole idea behind transshipment is to adjust inventories in response to market demand. To do this effectively, you need to move the product quickly. Unfortunately, to send a printer by air across the Atlantic costs us $75. Sea shipment reduces costs significantly to approximately $15/unit, but a month out on the ocean does not do much for responsiveness which is exactly what you're trying to achieve! In addition to the transportation cost, we know how tedious and complex it is to reconfigure the power supply and fuser. I would put my conservative estimate of the activity-based cost for reconfiguration to be at least $250 per printer.

As you might imagine, the quality people go nuts when they find out we're doing this. How can you establish a controlled process if you only do something once a year? Even worse, since the rework involves electrical components, safety standards require the reconfiguration process to be certified by Underwriter's Laboratory. If you've ever dealt with UL, you'll realize how much trouble you'd have getting a process like this approved.

The universal power supply would allow us to avoid this mess, making transshipment a distinct possibility. The cost of reconfiguration is almost zero. It is at least a possibility, although I'm not sure who would coordinate it or decide when to ship... our friends in distribution, I guess.

My only real concern with developing the universal supply is the potential power play which could emerge at the time of allocation of the production build to the two regions. Again, I'm not sure who will decide how to allocate the units, but I certainly don't want to be caught in the middle of that battle. At the same time, I would like some visibility and control over how many units I can count on receiving.

The Distribution Perspective

Rob Seigel runs the North America distribution center. Rob worked in a variety of positions before he moved to management and his present position.

Given a universal product, transshipment won't present a big problem for the DC; its just another shipment to us and we can easily "localize" the product by adding manuals and plug adapters at the DC. Personally, however, I feel like it's a great way to chew up company profits. I can just see us sending 1000 units to Germany in February only to have them ship another 1000 back to me in March. Both actions may seem to make sense at the time the decision was made, but in the end the company's out hundreds of thousand dollars!

Who is going to make the decision to shift inventory from DC to DC? I can see a real firefight if one DC want more but the other is unwilling to give up its excess. We all have pressures for high customer service and even if I have some excesses now, that does not mean that I may not need it next month. Sending the product to Europe helps their performance, but what about mine? I hope I do not have to do it! One thing I don't have time for is spending half of my day on the phone to Germany trying to negotiate a transfer.

I guess, though, if we can avoid what happened with the VIPER we have got to be better off. That was an interesting time. See that warehouse, pretty big. It was so full we stopped leaving the aisles clear and just stacked printers solid, from floor to ceiling, all the way from front to back. I would pay money to prevent that from happening again. All other work grinds to a halt when a crisis like that emerges.

The Decision

The team had decision making authority, but they would have to defend their decision to upper management. From past experience, they knew that if they decided to adopt the universal power supply, management would want to ensure they had performed adequate analyses of all the costs and benefits of such a decision, as well as some estimate of the risks involved. In addition, some consideration of how the decision would impact future generations of products will have to be made.

Assignment

If you have ½ an hour:

Read the case, and summarize the pros and cons of each alternative from a functional perspective.

If you have 1 hour:

Do the ½ hour work, and list the costs and benefits that you would consider in switching to a UPS. Outline how the costs might change over the product lifecycle.

Think about how you would quantify some of these costs.

Based on your qualitative assessment, which power supply would you recommend?

If you have 1 ½ hours:

Do the 1 hour work, and prepare to defend your recommendation. Do rough-cut analyses where possible.

Exhibit 1: The product