DESIGN FOR SUPPLY CHAIN

Spreading the Word Across HP

For several years, Hewlett-Packard (HP) has run a design for supply chain (DfSC) program aimed at bringing supply chain cost considerations to bear on product design decisions. The program has been an unqualified success. To date, DfSC efforts have resulted in aggregate cost savings that exceed $100 million. Here's a look at how design for supply chain best practices are diffused throughout HP.

By Brian Cargille and Chris Fry

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These days, there is growing acceptance of designing products with the supply chain in mind. We see more articles and success stories touting the importance and impact of the "design for supply chain" (DfSC) concept. Further, the DfSC approaches themselves—such as variety management, logistics enhancement, commonality and reuse, postponement, tax and duty reduction, and takeback facilitation—are fast becoming staples of today's business vocabulary.[1] As multinational corporations adapt to increasingly global supply chains, product design decisions are affecting their supply chain costs and efficiency to an unprecedented degree.

Despite the growing attention, however, many large manufacturers are still a long way from making DfSC an integral part of their product-development and product-management missions and processes. There are many circumstances where managers may see some value in practicing DfSC. But other constraints—limited time, scarce personnel resources, or lack of familiarity with the benefits of DfSC, for instance—stand in the way. The challenge lies in the diffusion of responsibility. Supply chain cost savings are rarely reflected in the performance scorecard of a design engineer or marketing manager. New product introduction teams are already overwhelmed with directives to "design for X," and they prioritize their scarce resources to meet increasingly stringent cost and performance objectives. It is crucial to find ways to ensure that professionals across functional areas understand and act on the DfSC principles.

Our experiences at Hewlett-Packard (HP) have shown that there are effective ways to spread DfSC best practices. HP's design for supply chain efforts began in the early 1990s with a few visionaries making innovative decisions for their product lines. Project-by-project DfSC efforts have reduced material, inventory, and logistics costs as well as in improved service to customers. In 2001, we began asking, "How can we harness and

diffuse this knowledge across the company?" With more than 30 different product lines, facilities in more than 70 countries, and upwards of 120,000 employees, it was far from easy. Yet we have successfully developed a formal process that has helped us spread best practices across all our businesses.

The Story of the All-In-One Printer

The power of drawing together design-for-supply-chain best practices that were developed across the company can be seen in HP's efforts to design a new all-in-one printer. In 2002, HP wanted to launch an all-in-one printer at a price comparable to that of its existing low-end printers. Until then, all-in-ones had sold well, but they were relatively large, complex products. Soon, they would no longer be competitive as inkjet printer prices dropped lower and lower. HP management set aggressive targets for material cost, assembly cost/complexity, and shipping expense; there was no slack added to the launch schedule.[2]

Faced with these constraints, our R&D, supply chain, and packaging groups knew they needed an even stronger partnership to reach their new goals. So they looked closely at the DfSC techniques that had been proven elsewhere at HP—in development of DeskJet and LaserJet printers, for instance. They improved the all-in-one's structural robustness so that it could handle rougher handling with less padding. They kept the unit small and cube-shaped to make better use of container space. They stuffed the cables and pens inside the printer access door to further reduce final packaging size and thus fit more units on a pallet.

Other enhancements enabled the generic printer to be to be sold in all of HP's markets but configured for any language, managing variety while keeping assembly costs low. The team employed old tricks such as using a 110/220V universal power supply. And it came up with some novel ideas. One example: shipping the all-in-one with a barcode label that is scanned by the user during startup. The scan activates the unit's own software to configure the language that will appear on its display, among other region-specific character-

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istics. With those and a few other developments, the team met its goals, and the product has been very successful.

The outcome of this partnership is an example of the best that DfSC has to offer at HP. Instead of relying on a single-minded, across-the-board push for one type of improvement such as commonality or postponement, different departmental functions work together using multiple techniques in concert so they can meet aggressive cost and schedule goals. These techniques have spread across all of HP's businesses, including printing, personal computing, and servers.

HP follows a well-defined, four-step process to develop and diffuse design for supply chain practices. It begins by proving the concept with early wins.

A Four-Step Process

At HP, we follow a defined process (see Exhibit 1) to develop and diffuse design for supply chain practices.[3] We believe the four-step process is generally applicable to other businesses and other types of best practices. While each step is important to DfSC's diffusion, we will focus the second half of this article on an interesting and valuable process that is central to the fourth step: what we call our "opportunity assessment" process. First, however, we review the overall diffusion process that we have used at HP.

Step 1: Prove the concept with early wins. This step involves demonstrating the viability of the concept using early success stories and developing collateral that summarizes the successes. At HP, we perform this education through the work done by our internal consultants—members of HP's Strategic Planning and Modeling (SPaM) team—in partnership with product-line managers. Successes are publicized internally to build excitement about the approaches. By recognizing and rewarding early wins, we build a positive reinforcement mechanism to generate further interest, granting more responsibility, additional resources, and a wider range of leadership opportunities to those who generate the wins.

One story we tell is about the mounting racks for HP's mid-range servers. When HP and Compaq Computer merged some years ago, HP's supply chain managers found that the racks on HP's servers had round holes while those for Compaq used square holes. That might not seem to be a big issue, but it meant that the merged company had to order, stock, and distribute 12 different rail kits for mounting servers to cabinet racks—an unnecessary cost since the rack mounting did not matter to HP's customers. The eventual decision was to create five common rail kits for both families of servers. The expected savings in materials and inventory over the lifecycle of the products: $32 million.

Step 2: Formalize the concept. Formalizing the concept involves making it easy to understand so it resonates with others. At HP, we came up with the "DfSC Six Pack" as a graphical representation of the concept as a whole. (See Exhibit 2) Over the life of our program, we have redesigned the Six Pack several times. Although we don't believe it is perfect, the Six Pack diagram presents a clear and understandable message—something that has been marketable to a broad audience.

Formalizing the concept also includes developing educational materials such as live courses, online training classes, short case studies that we call "experience stories," and published articles as a way to establish credibility and facilitate knowledge sharing. Once the concept is clear (not perfect, just clear), formalizing the program can begin. For example, for DfSC, we have produced more than 20 online and instructor-led training modules as well as calculators and process guides that are available on HP's internal Web site. These were invaluable in standardizing the approaches, sharing the ideas, and creating buy-in across our broad and complex organization.

Step 3: Formalize the program. This step calls for chartering a team that is responsible for diffusing and implementing the DfSC best practices across the organization. At HP, this team included internal supply chain and product design consultants along with managers from

EXHIBIT 1

Key Steps for Diffusing Best Practices

Develop Collateral	Formalize		Diffuse
(1) Prove the concept with early wins	(2) Formalize the concept	(3) Formalize the program	(4) Accelerate adoption
• Use a combination of business experts and internal consultants • Recognize and reward early successes • Create brief, positive messages that appeal to the needs of the adopters	• Crystallize definitions • Develop educational materials that identify adopter concerns, provide relevant examples, and give reliable information • Promote discussion with satisfied peer adopters • Develop not only live courses but also online training, experience stories, articles, etc.	• Assign business owners and create incentives for success • Establish metrics and use them to measure the company's performance • Set up a process for nonexperts to learn skills, adopt the practices, and connect with a network of experts for support	• Use metrics to identify gaps in performance • Conduct opportunity assessments to help management prioritize future applications

each of HP's business groups. By assigning specific project management and technical support resources and establishing appropriate metrics and incentives (for example, cost reductions per product line or number of units shipped per pallet), the rate of adoption increases.

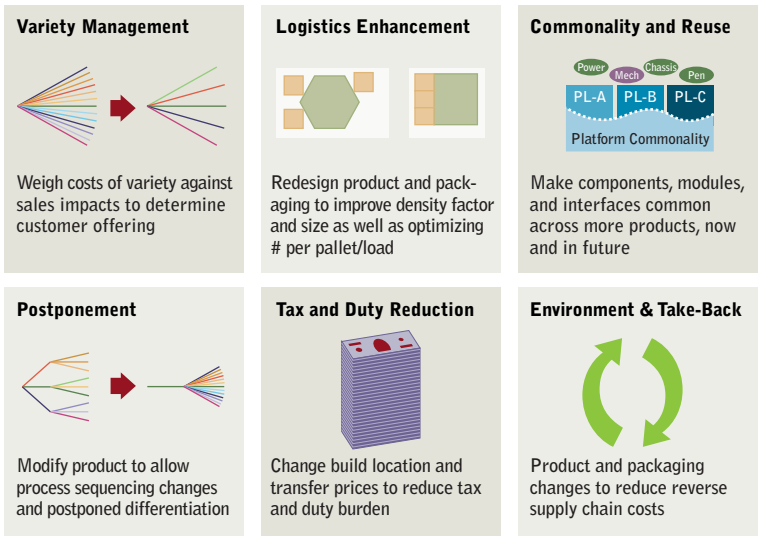
Step 4: Accelerate adoption. Adoption occurs once sufficient attention is being given to applying the techniques across a wide range of products. At this stage, management must prioritize and focus resources to capture the most value. In other words, having discovered applications for DfSC, we must now focus attention on those of greatest value to the company as a whole. This can be challenging in corporations as broad and fast-moving as HP, where the "big value" opportunities may not be concentrated in one place. In fact, they may be spread across multiple product lines that are managed from many sites around the world. That's what makes adoption of DfSC difficult.

To identify these opportunities, we have developed an approach that we call the DfSC opportunity assessment. The assessment process makes the best use of business managers' limited time by introducing them to the benefits of using DfSC techniques and helping them understand where to focus their teams.

EXHIBIT 2

HP's "Six-Pack" View of DfSC

The following graphic illustrates HP's view of what DfSC "is." HP has used these techniques successfully for more than a decade.



The Opportunity Assessment Approach

The DfSC opportunity assessment is an easy and relatively quick way to help businesses identify specific opportunities for applying DfSC in their product lines. It also helps prioritize opportunities according to their potential impacts on operations and the bottom line. The assessment scans each of the DfSC Six-Pack techniques to pinpoint opportunities and attempts to estimate the potential of each one. Each assessment comprises a six-week investigation during which the assessment team collects data and performs analysis, wrapping up with a week-long, face-to-face working session. Here are its main elements:

The design-for-supply-chain opportunity assessmnt is an easy and relatively quick way to help businesses identify specific opportunities for applying DfSC in their product lines.

Project Objectives

- Identify opportunities for the business team to implement any or all of the six DfSC techniques.
- Estimate the potential value to HP of acting on the identified opportunities.

Project Timeline

- *Kickoff* (one week): Team meetings to review the assessment process, roles, and responsibilities. Includes training for the team members on how to complete their tasks during the assessment.
- *Phase 1* (four weeks): Data collection/preparation of initial findings—data collection and phone interviews, followed by offsite analysis by SPaM team.
- *Phase 2* (one week): On-site working session—joint working session for five days to develop final opportunity list.

Expected Outcome and Results

- A list of potential DfSC improvement opportunities for the business team.
- For each identified opportunity, a rough estimation of its impact for HP.

Project Team

- Two SPaM consultants (30 percent of their time each).
- Project manager (20 percent).
- Data collection coordinator (20 percent).
- Finance representative (15 percent), marketing repre-

sentative (15 percent), operations representative (15 percent).
- Executive sponsor (5-10 percent), general manager (less than 5 percent).

The effort culminates in a presentation to management highlighting the identified opportunities and potential value to the business. One point to note: Although the assessment is easy and fairly fast, it is no small commitment. If you calculate the aggregate person-hours required from the business team, it calls for about one full-time equivalent staff for six weeks. But as we will discuss later, the results make it well worth while.

An assessment might start when an R&D manager calls in our SPaM team to resolve design-for-supply-chain challenges on a planned inkjet printer. In the first week, a formal kickoff is held to make sure that the participants are in sync with the objectives and scope of the assessment. All relevant stakeholders agree to the plan and resource commitments.

To conduct the assessment itself—which usually takes place during weeks two through five—we form a cross-functional team that comprises two of our in-house SPaM consultants along with participants from finance, marketing, and operations groups that are already serving the product line being evaluated for DfSC. All those deployed are part-time on the project. The assessment is led by the SPaM consultants working alongside a project manager from the business. Early in this phase, the data collection templates are completed and a series of phone interviews takes place with key stakeholders—managers from R&D, marketing, and operations, for instance. By the end of the phase, an initial "opportunity list" has been developed (see Exhibit 3).

The project team works together to collect data, conduct interviews, and perform an analysis to identify and measure the potential impact of opportunities for implementing DfSC approaches in that business. The team reviews the entire product line, using simple metrics to assess opportunities across the six techniques along with any additional opportunities identified by our in-house experts. Exhibit 4 shows examples of basic estimation approaches used to size the identified opportunities. Of course, each case is different, so the approaches are adjusted as appropriate to the business situation.

Example of the Opportunity Analysis

Here's an example of the results from one section of an assessment for evaluating a postponement opportunity.[4] The typical postponement choice in high-tech products is between shipping finished-goods inventory (FGI) from a worldwide factory directly to demand regions or shipping a generic unfinished product from the factory that will undergo final assembly and test in each region.

For the first alternative, our example assumes a six-week lead time for full assembly through to finished goods at the factory in Asia, followed by four weeks in transit to the regional distribution center (DC) in the United States. In the second situation, lead time for partial assembly is just four weeks; transit time is the same, but another two weeks are spent later (at the DC) to complete the product. Delaying differentiation of products often enables dramatic inventory reductions while maintaining high service levels, but it also carries increased manufacturing costs.[5] Our opportunity assessment teams compare the major cost elements under each alternative to assess whether or not a savings opportunity exists.

The finished-goods inventory direct-ship scenario may require slightly larger boxes in ocean shipment, which will increase freight cost per unit. However, the freight cost increase may be offset somewhat by a reduction in manufacturing overhead at the destination region. By measuring and combining these cost changes with the expected changes in inventory-driven costs for both stock and transit inventory, we can obtain a rough approximation of the cost difference between the two alternatives. (See Exhibit 5.)

EXHIBIT 3

Example of an Initial Opportunity List

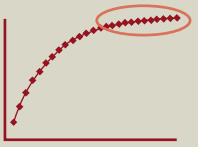
Variety Management	Logistics Enhancement	Commonality and Reuse
• Reduce packaging variety • Manage SKUs • Decrease feature set	• Reduce product size • Change packing orientation • Eliminate in-box materials	• Leverage key components • Improve supplier management
Postponement	**Tax and Duty Reduction**	**Take-Back Facilitation**
• Add multi-language capability • Decrease touches • Manage increased lead time	Existing programs already in place	Existing programs already in place

EXHIBIT 4

Illustration of Simple Estimation Method

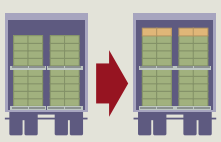
Variety Management

Net complexity cost reduction from eliminating products contributing last 5% of margin



Logistics Enhancement

Freight savings from adding 1 layer to each pallet



Tax and Duty Reduction

Savings if switch 100% of production to lowest tax region

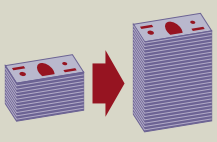
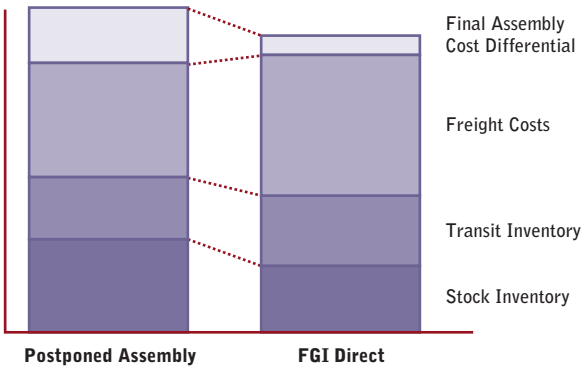


EXHIBIT 5

Example of Costs Comparison for a Postponement Opportunity



In our example, there were actually higher inventory costs under the postponement scenario (contrary to the popular wisdom about postponement) because each base unit was linked only to one single finished product. When one base unit is used in many end products, inventory pooling benefits generally outweigh the added cost of additional stockpiling, changing the economics of the decision. This is a good example of how a rigorous opportunity assessment exercise can turn up findings that managers may not be expecting.

A variety of techniques exist for creating rough, yet realistic, assessments of opportunity size. For examples of other techniques we use at HP, see the September 2001 and September 2005 issues of *Supply Chain Management Review*.[6]

In the last week of the opportunity assessment project, the business leadership decides how to proceed with the opportunities identified. The initial opportunity list is reviewed by the whole project team. Final working sessions allow for revisions to the list and refinement of the impact estimates. The team then presents the opportunities to the managers. The Six Pack framework now acts as a color-coded "opportunity map" that provides an at-a-glance idea of the potential impact for each initiative identified. (See Exhibit 6.)

Senior managers may decide not to take action on some opportunities if priorities clash or if the potential for savings seems small. They may also choose to pursue opportunities independently without further support, or they may request additional help from HP's DfSC experts.

The Opportunity Assessment Toolkit

In order to deliver the opportunity assessment repeatedly across HP, it was important to develop a structured process and a reusable set of tools to facilitate deployment. The challenge was to balance the need for a standard approach for all of HP's businesses with the need for some level of customization to address the diversity of the company's business activities. We created a suite of tools and templates to aid the DfSC experts in delivering fast, reliable, and consistent assessments. These include:

- A project memorandum of understanding (MOU) template describing the problem statement, project objectives, and project approach.
- A customizable kickoff-presentation template, which gives a week-by-week timetable for the project with a breakdown of who is doing what.
- A project data-collection template, which clearly defines the financial and operational data required and provides a format that team members can use to input their information into.
- Analysis tools that automate a portion of the analyses, so as to expedite the workflow for our consultants.
- A template for the presentation of results, usually featuring a waterfall diagram that categorizes the impact across each of the six components of the Six Pack.
- A process guide that describes how to deliver the assessment.

Together, this framework and the accompanying tools get the team about halfway to a complete high-quality assessment, making the process quick and repeatable. The other 50 percent of the journey calls for domain knowledge, business judgment, and project management skills—traits that each SPaM consultant must bring to the table.

Results of the Opportunity Assessment

So is it worth going to such lengths to perform such an assessment? Do the results merit this kind of staff involvement for as long as six weeks? The questions are not inappropriate, particularly for managers more accustomed to making quick decisions and taking action than to deliberating over inputs to those decisions.

At HP, we have no doubts about the value of the opportunity assessment approach. We not only see measurable benefits but also find that the effort has a powerful proselytizing

EXHIBIT 6

DfSC Assessment Results

Variety Management $X-Y	Logistics Enhancement $X-Y	Commonality and Reuse $X-Y
• Reduce packaging variety • Manage SKUs	• Reduce product size • Increase pallet-loading efficiency	• Leverage key components • Improve supplier management
Postponement $X-Y	**Tax and Duty Reduction**	**Take-Back Facilitation**
• Decrease touches • Manage increased lead time	Existing programs already in place	Existing programs already in place

Significant opportunity Moderate opportunity

effect. Throughout the assessment exercise, team members gain a much greater understanding of DfSC principles and practices overall—to the point where they can implement and sustain those practices themselves.

In the example described, the opportunity assessment pointed to significant benefits from a simple packaging change for an inkjet printer model that would reduce variety from 100 to less than 40 options without affecting the range of products themselves. A similar exercise on a personal computer product yielded comparable benefits. Together, the two DfSC opportunity assessments identified more than $16 million in cost-saving and revenue-enhancement opportunities.

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$100 Million and Counting

We've seen an explosion in DfSC activity in Hewlett-Packard's businesses over the last few years, with aggregate cost-savings results exceeding $100 million to date. The use of opportunity assessments to prioritize resources, followed by focused improvement efforts with consultative support, has helped to speed both the diffusion of methods and the amount of value captured across HP.

We firmly believe that these experiences are transferable to a wide range of industries—particularly those with frequent new product launches, worldwide markets, and a broad footprint spanning multiple product lines, manufacturing sites, and regions. While we believe that the opportunity assessment approach and the DfSC principles are relatively simple and easy to apply, they do require work, commitment, and a formalized process. For HP, the impacts on our supply chain have far outweighed the costs of the investment, generating significant benefits for our shareholders. We wish you luck in the application and diffusion of these techniques in your business.

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Endnotes

1 See for example: David Simchi-Levi, Philip Kaminsky, and Edith Simchi-Levi, "Coordinated Product and Supply Chain Design," *Designing and Managing the Supply Chain*, McGraw-Hill, 2000. Bradley Keup, "DFA Transforms Computer Chassis," *Assembly Magazine*, June 2003. Mark Gottfredson and Keith Aspinall, "Innovation Versus Complexity: What is Too Much of a Good Thing?" *Harvard Business Review*, November 2005. Laurent Dumarest, Gillis Jonk, and Bart van Dijk, "Learning a New Complexity Language," *Executive Agenda*, First Quarter 2004.

2 "HP's Design Measure Reorientation," case study for Operations Management Roundtable (now Supply Chain Executive Board), 2002: www.sceb.executiveboard.com

3 Developed based on principles from Diane Dormant "The ABCDs of Managing Change," *Introduction to Performance Technology*, ed. Martin Smith, International Society for Performance Improvement, 1986: pp 238-256, and Everett M. Rogers, *Diffusion of Innovations* 4th edition, The Free Press, 1995.

4 All data presented are for illustrative purposes only and do not reflect actual material, freight, manufacturing overhead, or inventory-driven costs for HP products.

5 Hau L. Lee, Corey Billington, and Brent Carter, "HP Gains Control of Inventory and Service through Design for Localization" *Interfaces* vol. 23, issue 4 (July-August 1993): pp 1-11.

6 See Brian Cargille and Robert Bliss, "How Supply Chain Analysis Enhances Product Design," *Supply Chain Management Review*, September/October 2001: pp 64-74. Jason Amaral and Brian Cargille, "How 'Rough Cut' Analysis Smooths HP's Supply Chain," *Supply Chain Management Review*, September 2005: pp 38-45