Hewlett-Packard’s Design for Supply Chain Program
By Brain Cargille, Stephen Bear, and Jason Amaral

Innovation Summary
The concept of “design for supply chain” (DfSC) is not new at Hewlett-Packard (HP). (See: HP’s “Six-Pack” for a summary of DfSC.) For more than ten years the company has evaluated the supply chain impacts of design decisions. Indeed, two early examples—DeskJet localization and LaserJet universality—are described in a well-regarded Harvard Business Review article and in widely used academic case studies.¹

What is new is the innovation that has allowed HP to deploy DfSC in a systematic, repeatable, and broad-based way to hundreds of product development teams and thousands of engineers across the company. A unified set of technologies, methods, training, and infrastructure have been implemented to enable rapid and effective DfSC decision-making.

“Over the past 3 years DfSC has been broadly adopted by all HP’s Business Groups and Regions. In addition, there have been over 50 individual projects undertaken in collaboration with engineering, marketing, supply chain and finance teams. Savings directly attributable to these programs has exceeded $200 million/year and are expected to reach the $1 billion mark in 2006.”
- Dick Conrad, Senior Vice President, HP Global Operations Supply Chain

HP’s “Six-Pack”
HP uses a portfolio of six DfSC techniques to reduce supply chain costs, enhance customer experience, and increase profits. (See page 11 for more details.)

Examples of benefits achieved.

1. **Variety Control**: The business PC organization reduced inventory by 42% while increasing product availability by moving from 107 modules and 95 options to 55 modules and 49 options.

2. **Logistics Enhancement**: Reducing the physical size of an InkJet printer by 45% saved more than $1 per unit.

3. **Commonality and Re-Use**: The server business saved $32 million in annual material costs by moving from 12 to 5 “rail kits” (for mounting servers on racks).

4. **Postponement**: A new product customization process for LaserJet printers in Europe achieves more than 98% fill rate with less than 2 weeks of supply of FGI.

5. **Tax and Duty Reduction**: The network printing capability of a printer is moved to a removable card built in a low-tax location, saving more than $10 million.

6. **Takeback Facilitation**: Design change increases the recycling of InkJet supplies by 25%.
At HP, DfSC has become a comprehensive methodology for making design decisions during product development that improve financial performance across the supply chain (SC) and throughout the product lifecycle (PLC).

In other words, DfSC allows HP to consider the impact of decisions:

- On supply chain partners, including suppliers, manufacturing and logistics service providers, resellers, retailers, and end-customers, and
- Over time, including during the pre-launch, production, and end-of-life phases of the product lifecycle.

With this methodology, HP avoids decisions that, for example, improve inventory efficiency by pushing significant risks onto suppliers, or reduce material costs but cause warranty costs to skyrocket.

Over the past several years, DfSC has allowed HP to introduce a greater variety of new products more rapidly, while simultaneously lower costs, increase revenues, and enhance the customer experience.

The cost savings alone—primarily in the form of reduced materials, inventory, packaging, and logistics costs—have contributed more than $200 million dollars in FY 2004 and $250 million in the first half of FY 2005 (HP’s fiscal year ends on October 31st).
The Beginnings of DfSC

In the late 1980s, HP formed an internal consulting team—Strategic Planning and Modeling (SPaM)—and staffed it with industrial engineers and management scientists. SPaM was chartered with supporting strategic decision-making through the application of quantitative analyses. By 1995, the team had completed many projects that helped HP dramatically reduce inventory levels while simultaneously improving order fulfillment to customers.

In some of its consulting projects, SPaM quantified the supply chain impacts of certain design decisions. Among other successes, two particularly well-know examples are DeskJet postponement and LaserJet commonality. In the first case, SPaM showed that localizing generic printers at regional DCs (i.e. adding country-specific packaging, plugs, power supplies, manuals, etc.) resulted in significant financial benefits relative to localization at one world-wide factory. In the second case, SPaM demonstrated that using a universal power supply resulted in significant inventory savings, more than compensating for an increase in material costs relative to voltage-specific power supplies.

Despite our initial successes, however, we began to believe that there were three critical limitations in how we were conducting DfSC at HP. Moreover, we feared that these limitations would prevent DfSC from delivering on its full promise.

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The first limitation was in our delivery mechanism. SPaM typically worked with HP businesses on a project-by-project basis. Although each project usually lasted between 3 and 4 months at an internal cost of $100,000 or more, we routinely identified tens of millions of dollars in savings for the company. Over time, however, we began to run out of decisions that were “strategic” enough to justify the time and cost – we had already addressed many of the key questions. Most of the remaining types of design decisions had to be made in days or weeks, not months. With ever-shortening product development lifecycles, we knew that this first limitation would only grow worse over time.

The second limitation was in our technologies. After understanding the situation, we would build a custom analytical model to explore the alternatives and enable us to make a robust recommendation. In addition to being labor intensive (as discussed above), this technical approach was data intensive. In the early phases of product design, however, there are numerous feasible options, all of which must all be evaluated against marketing, engineering, supply chain, and financial criteria. In addition, data were unavailable regarding most of the important factors, such as customer demand, competitive offerings, and supply-chain costs. After completing an analysis, we sometimes discovered that the uncertainty around inputs and assumptions often swamped the precision of our models.

The third limitation was in our client orientation. Our projects were historically sponsored by supply chain organizations directly after a particularly painful product shortage and/or inventory write-down. Although R&D owned the decisions creating the
problems, they didn’t feel the impacts (except possibly through HP’s stock price and profit sharing). In our DfSC projects, SPaM facilitated a cross-functional “negotiation” between senior managers in manufacturing, distribution, R&D, and marketing. However, most design decisions are made by R&D engineers, not managers. For every strategic decision with the cross-functional visibility to justify a consulting project, there were hundreds of other design decisions being made every day by R&D engineers across the company. Even when R&D engineers knew about DfSC, they lacked the methodologies to evaluate supply chain costs and the performance metrics to consider them important. We knew that the cumulative effects of “poor” day-to-day design decisions were costing HP millions of dollars a year.

A Fortunate Partnership
Meanwhile, HP had another internal consulting team—Product Generation Services (PGS)—that worked closely with R&D organizations to improve the efficiency and effectiveness of product generation processes across HP. In addition to having a deep understanding of the sequence and drivers of design decisions, PGS was much more involved than SPaM in building long-term capabilities within engineering organizations. Their motto was “creating change that sticks.”

In helping R&D organizations make product architecture and part design decisions, PGS used a number of methodologies, including qualitative DfSC best practices. Indeed, PGS introduced the benefits of DfSC to many people in HP’s R&D organizations. Unfortunately, however, the certainty of material costs and time-to-market impacts often
trumped potential (but poorly quantified) SC benefits. It was one thing to know that commonality was a good idea. It was quite another to know whether one common circuit board for product X was better than three unique ones.

In 2003 the need for a new approach became clear. Demand for high-tech products was increasing, but in several cases design decisions that didn’t consider supply chain impacts resulted in lost sales and excess inventory. The outsourcing of design itself was accelerating – a situation that made the need for effective DfSC even more critical. HP, not our design partners, would be responsible for downstream costs, lost revenue, and customer dissatisfaction.

In response, HP created the DfSC Program by combining key people from SPaM and PGS. SPaM possessed analytical experience and credibility with SC organizations. PGS possessed change management expertise and credibility with R&D organizations. Together the combined team created an innovation for HP that turned out to be a true competitive advantage for the company.
Program Roadmap
To successfully implement DfSC, the program established four questions as a roadmap for prioritization and development.

1. What characteristics of products affect supply chain costs? In other words, what is it about a product that makes it a good or a bad fit for a particular supply chain?

2. Which design decisions result in products with those characteristics? For example, if lack of common parts causes excess inventory and lost sales, which design decisions (collectively or alone) result in unique parts?

3. How and why are these decisions being made? More specifically, when in the product lifecycle, who is involved, which performance metrics are important, and what information is available and being used?

4. What improvements in decision-making data, techniques, and processes are necessary to augment the current product generation approach? In other words, how do we continue to deliver great products, but at higher end-to-end margins?

We used this roadmap to deploy methodologies, processes, and tools to help R&D and SC engineers make day-to-day DfSC decisions using robust qualitative frameworks and analytical methods.
Implementing the Innovation

Based on the foundation of best practices and analytical techniques that we had established, the DfSC innovation can be described through the following 11 guidelines.

1. Create a Separate Organization
2. Ensure Corporate Alignment
3. Clarify Design for Supply Chain
4. Engage the Businesses
5. Create Balanced Metrics
6. Be Unbiased
7. Understand the Process of Innovation Diffusion
8. Make Training Easily Accessible
9. Treat Consulting Projects as R&D
10. Provide Field-Tested Tools and Process Guides
11. Provide Visibility to the Successes

1. Create a Separate Organization

As mentioned above, a separate DfSC Program was created and managed by experienced people from SPaM and PGS. This overall program manager had access to experienced people from other corporate organizations and a budget for procuring external services and hiring outside contractors. This program manager was measured on his ability to drive cost reductions and asset efficiencies due to the application of DfSC.

2. Ensure Corporate Alignment

DfSC is clearly cross-functional, and requires multiple perspectives to be successful.

One of the program manager’s first activities was to align the related DfSC activities of other corporate organizations, such as SPaM, PGS, HP logistics, and HP procurement. These other organizations were doing very good work, but there was no central place to highlight the successes and aggregate the best practices. It was an opportunity to collaborate (not compete) and jointly share in the successes of projects.
3. Clarify Design for Supply Chain

Another early activity of the program manager was to clearly define what DfSC was and what it wasn’t. The goal of DfSC was to help make effective design decisions that balanced as many costs and benefits as possible. Therefore the definition of techniques included more than commonality and postponement (see “HP’s DfSC Six-Pack”) and the financial impacts considered much more than inventory and logistics costs (see “DfSC Financial Considerations”). The clarity of the framework (with examples) helped people understand exactly what types of problems the DfSC program would attack. The breadth of the financial impacts gave R&D and marketing confidence that DfSC was a holistic approach, and not a one-sided evaluation of costs important to supply chain.

HP’s DfSC Six-Pack

HP uses a portfolio of six DfSC techniques to reduce supply chain costs, enhance customer experience, and increase profits.

1. Variety Control: Trade-off supply chain costs and lost sales to determine which product variants are justified in terms of margins, brand equity, and/or channel requirements. Marketing, sales, and retailers usually want more stock-keeping units (SKUs). But design, manufacturing, and distribution usually want fewer SKUs.  

2. Logistics Enhancement: Compare distribution costs with design and material costs. For example, a smaller and lighter product may enable economical air freight, reducing inventory costs and increasing responsiveness. A more rugged product requires less packaging material and experiences fewer returns due to damage.

3. Commonality and Re-Use: Evaluate the use of unique parts versus common, reused, or industry standard parts. Unique parts often have lower material costs and enable product distinctiveness. Common parts often reduce inventory costs. Re-used and industry standard parts frequently accelerate time-to-market.

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4. **Postponement**: Determine whether it is worthwhile to design products and manufacturing processes to delay the point of differentiation/customization until end-customer demand is better known.

5. **Tax and Duty Reduction**: Decide where to source parts and assemble products. Taxes and duties for components, subassemblies, and products will be different based on the country of origin.

6. **Takeback Facilitation**: Consider product and packaging changes to reduce reverse supply chain and environmental costs. Depending on warranty terms, corporate policies, and government regulations, HP will experience costs and benefits of taking-back products.

**DfSC Financial Considerations**
The following financial costs and benefits should be considered when making DfSC decisions.

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<td>• Tooling</td>
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<td>• Freight and packaging</td>
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4. Engage the Businesses
Because the value from DfSC would be created by engineers across the company, it was critical to get business representatives as full participants of the DfSC program. A program lead was named from each of the three major hardware business segments—Personal Systems Group (PSG), Imaging and Printing Group (IPG), and Enterprise Storage and Servers (ESS). As with the HP program lead, these program leads coordinate DfSC activities across their businesses and are measured based on cost reductions and asset efficiencies due to DfSC. In addition to creating an opportunity for shared success, this partnership also allowed us to discover powerful techniques and approaches so that they could be leveraged across the entire company.

5. Create Balanced Metrics
In order to highlight successes and identify opportunity areas, the program leads created a balanced set of metrics to track DfSC progress. These metrics are applicable to the different business segments, span the DfSC techniques, and provide balanced view across the financial impacts (costs, revenues, customer experience). On a quarter by quarter basis, these metrics are calculated and reviewed with senior management.

6. Be Unbiased
We communicate clearly when certain DfSC techniques should not be pursued. For example, very early on a SC group wanted to pursue commonality on a particular product. We were able to demonstrate that, in this case, commonality would be a net cost to the company. This neutral perspective helped enhance our credibility with the R&D and marketing organizations and increase buy-in to the program.
7. Understand the Process of Innovation Diffusion
People usually implement innovations in stages, which we called awareness, self-concern, mental tryout, hands-on trial, and adoption.\(^4\) We wanted to develop resources that helped engineers and managers “stay connected” with the DfSC program (and experience value from it) while they moved through each stage of their individual implementation process. For example, we create awareness through broadcast news stories of successes and tops-down emails of valuable new resources on the DfSC website. With mental tryout, we offer compelling case studies of successful decisions and experience stories of how other people adopted DfSC. With piloting, we offer custom consulting and personal mentoring. With adoption, we help businesses customize metrics and enhance their PLC processes with appropriate DfSC checklists and guidelines.

8. Make Training Easily Accessible
In addition to an adaptation of the original DfSC course, a series of courses were created and deployed “on-demand” through the HP intranet. Some of the training is self-paced (text plus graphics and calculators), while other training narrated (slides with audio voice-over). The content includes foundational material, technique overviews and instruction, and case studies. All the material is targeted at either engineers or their managers. In fact, some managers decide to show particular courses during their staff meetings and then discuss how to best apply the lessons. We also offer in-person training as workshops – essentially “mini-consulting projects.”

9. Treat Consulting Projects as R&D
Where multi-month consulting projects were previously focused on strategic decision-making, we began to treat consulting projects as opportunities to learn about new subject areas, develop and validate tools, pilot and implement processes, and refine knowledge transfer methods. A decision and recommendation may still be a deliverable, but our focus was on leveraging the results to benefit the entire company.

10. Provide Field-Tested Tools and Process Guides
When we feel that tools, approaches, and processes have been fully improved and validated, we document them and make them generally available on the HP intranet. These are targeted at subset of engineers who will drive DfSC decisions and/or conduct analyses. We support these engineers through mentoring and coaching delivered remotely by a member of the core DfSC program team (including program managers, and internal and external consultants). Although many tools are approximate or “rough-cut” approaches, we have also developed formal decision aids in special circumstances: when the technique has been successfully applied for a period of time in at least one business, the requirements of other businesses are similar, it is cost effective to create a generally applicable tool, and the three business program leads agree that a formalized tool would be valuable (usually based on feedback from engineers).

11. Provide Visibility to the Successes
In addition to the projects and activities that we were involved with, we identified many other successful applications of DfSC. We used our position as coordinators to provide visibility to the great work being done by engineers in each of the business units. Engineers felt pleased that their work was valued by their peers across the company. We believe that others may be motivated to adopt DfSC in search of similar recognition.
HP Executive Perspectives on the Success of DfSC

“Design for Supply Chain is the next big breakthrough….”
- Mike Fawkes, Vice President of Supply Chain, HP Imaging and Printing Group

Slide used with financial analysts in December 2004:

- Gilles Bouchard, HP Chief Information Officer and Executive Vice President of Global Operations

“The design for supply chain program has been instrumental in focusing HP’s resources on the opportunities offered through DfSC. Often, knowledge of the impacts of design sits far from the designers themselves. The people who see the downstream impacts of design—the warehouse managers who handle and package the products, the transportation planners who attempt to maximize conveyance usage, and planners who manage the SKUs on the shelf—are often far from, or have never met, the product designers. The DfSC program matches the product designers (and the product design timeline/process) with the expertise from the field so that the designers can make the best tradeoffs for HP.”
- Ed Feitzinger, Vice President of Worldwide Logistics, HP
“HP’s ‘Design for Supply Chain’ program has been in place for over 8 years with a broad history of application. As the technology industry has evolved, it has been confronted with numerous global, market, customer, geopolitical and environmental dynamics that require sophisticated product and process design. Three years ago, HP modified its program to encompass new considerations that recognize the broad application of various design principles to optimize for certain outcomes. Today the program addresses and provides optimization analytics in 6 key areas: Variety Control, Logistics Enhancement, Commonality and Re-Use, Postponement, Tax and Duty Reduction, and Takeback Facilitation.

“Over the past 3 years DfSC has been broadly adopted by all HP’s Business Groups and Regions. In addition, there have been over 50 individual projects undertaken in collaboration with engineering, marketing, supply chain and finance teams. Savings directly attributable to these programs has exceeded $200 million/year and is expected to reach the $1 billion mark in 2006. The program has been endorsed as ‘best practice’ within the company and by numerous external sources.”

- Dick Conrad, Senior Vice President, HP Global Operations Supply Chain
Representative Quotes from HP Engineers and Managers

End-users (engineers across HP) regarding the DfSC tools and resources:

• “Makes my job easier. The consistent, accurate, and rapid access to data helps me estimate transportation cost and cycle time while making DfSC decisions.”

• “We now have an example of a data driven DfSC process. We can make power supply design decisions that are data driven and not driven by historical assumptions.”

• “I’m impressed with the usability of the tools; I make 10-15 commonality decisions a day – these tools help!”

• “Now we can do rough cut analyses! The approaches we learned are already being used on three product design decisions”

Managers of representative supply chain and design functions

• Customized training classes
  o “Great class, instructors, content, and presentations! Everything was very well prepared.” – Supply chain manager
  o “Great job by the facilitators! My team and I both felt that the content and instruction were excellent.” – Manager of mechanical engineering and procurement

• Logistics Enhancement: Tool for making transportation and packaging trade-offs regarding product design options (size, weight, and fragility):
  o “The tool is making a huge impact. For [new product], we are able to recommend design changes from the base plan totaling $24M over 2 years. We can do in 15 minutes what took weeks before!” – Packaging engineering manager
  o “DfSC created an effective [tool] to help optimize product, packaging, and supply chain decisions for a new logistically optimized [product]. We estimate that this will result in a $1M cost reduction, including $100K directly attributable to DfSC’s efforts. Thank you for your help!” – Procurement section manager

• Commonality: Tools for evaluating part commonality:
  o “Thanks to you and your team for all your hard work. I was very impressed with the web-based power cord knowledge base. It was well structured in terms of dealing with data now and in the future additions. Above all, it is concise and comparatively simple to use.” – Retail account manager
• “These tools save a lot of time and help the experienced as well as the neophytes.” – New product engineering manager

• Product variety: Model to quantify the impact on order cycle time and inventory:
  o “[The DfSC team] developed a tool for us with supporting documentation. We understand how to use it, and we’re getting support from the regions. I also appreciate the improvement areas we identified for improving inventory target setting and management of obsolescence. Thanks!”
    – Director of order operations

  o “The process helped us generate the right internal discussions to make trade-offs we knew were needed but had not been able to quantify. As a result, we should reduce some SKUs from our plan and emphasize simplification in our roadmap planning moving forward. Good job. Thanks.” – Vice president of regional operations

• DfSC strategy consulting projects:
  o “[We identified] potential impact from design for supply chain of $5 to $15 million per year. A special thanks to the DfSC team!”
    – Project manager

  o “[The DfSC team’s] assistance has been critical in helping us put hard data behind soft objectives so that fact-based decision making can occur. They have the experience and tool development skills to allow us to make informed business decisions.”
    – Director of marketing operations

  o “A great piece of work – very eye opening. I’m very supportive of the recommendations.” – General manager of a commercial product line