

FAST-CYCLE PRODUCT DEVELOPMENT

by Preston G. Smith, New Product Dynamics

ABSTRACT

In today's highly competitive industrial environment, those who are slow in bringing new products to market often lose out to those with a more agile development process. Developing products quickly while maintaining cost and quality demands a distinctive management approach that integrates marketing, engineering, manufacturing, and other activities. This article discusses the importance of development speed relative to the product's cost, performance, and development expense, and it suggests ways in which a company can cut development time. Topics covered include top management involvement; product objectives and complexity; team composition and leadership; communication vehicles, including the product specification; prototyping and testing; and control systems, such as design reviews.

Introduction

Today, new products do not remain new for long. The technologies going into our products change more quickly than they have in the past. Relentless pressure exists to differentiate products and gain market share, which fuels the process of change. Gone is the era when all telephones were black and you had your choice of one desk model or one wall model.

These faster shifts in the marketplace and in the technologies we use are accelerating the way we run our businesses. Companies that are poised to adapt to change quickly will be in a stronger position to survive and prosper. Much has appeared in the press lately about time-based competition and the competitive value of speed (Dumaine, 1989; Peters, 1987; Stalk and Hout, 1990). New product development, due to external market and technology pressures and internal organizational weaknesses, can benefit greatly from faster management techniques. More and more companies recognize this and have shortened their product development cycles by 50% and more, as illustrated in Exhibit 1.

The pressure is on to accelerate product development partly because product life cycles are shrinking. If a product becomes obsolete sooner, it must be developed faster or it will become stale by the time it reaches the market. By exploiting management techniques that allow activities to start sooner and run concurrently with formerly sequential activities, a company can build a strategic advantage based on speed. This advantage pays off in product development because early product introduction can dramatically enhance market share and product margins while building the company's image as an innovation leader.

Product Development Trade-offs

Although a strong case exists for rapid product development, some concerns about the side effects of rushing the development process are valid. Speedy development can increase R&D expense and inflate product cost. It can also degrade product performance or quality. Managers make trade-off decisions among these variables daily, but often their decisions are made without good rules of thumb or a true appreciation of what is being given up in the trade. Time, the least tangible of these variables, is often undervalued. Until we know the value of time, we cannot make wise trade-off decisions.

The value of development time can be calculated by building a financial model for a specific product. The model can be constructed easily on a personal computer by using a spreadsheet program. Using a cash-flow approach, we first model the revenue generated by the product each year over its life by projecting selling price and unit sales. Then the product's costs are projected each year. These costs include relatively heavy development expenses over the development period and smaller maintenance engineering expenses later. They also include manufacturing costs and sales and marketing expenses annually. The output of the model is cumulative before-tax profit over the life of the product. (Pretax values are more useful because most items we will be comparing against profit, such as overtime labor to speed up development, are also pretax.)

Simple models are usually quite adequate. In particular, unless the sales life is long, net present value modeling is unnecessary. The precision of the data we are working with does not justify a sophisticated model. Furthermore, complex models require additional assumptions that can lead to arguments, and complicated models obscure inner financial mechanisms

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This management tool article was accepted April 1990.

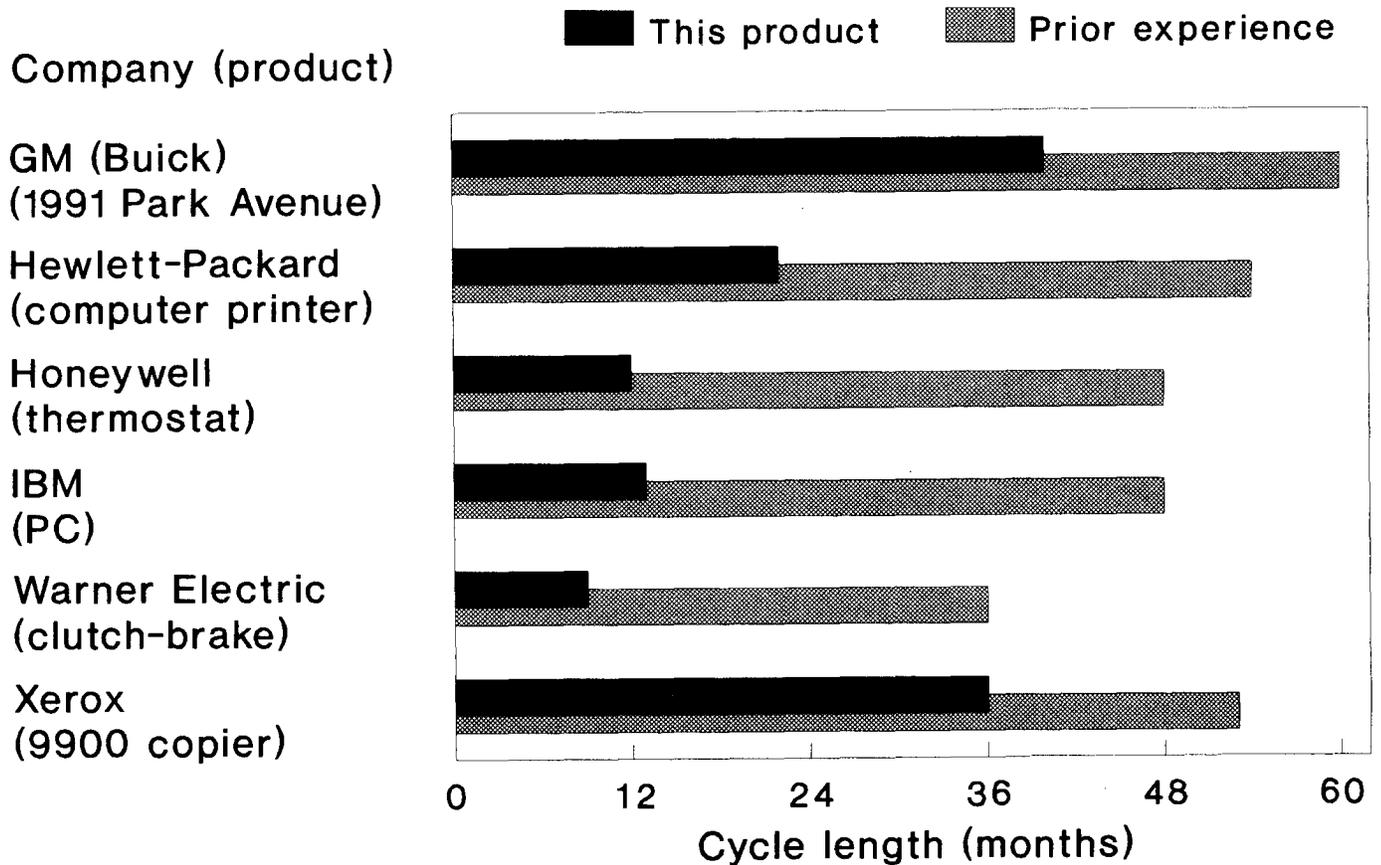


Exhibit 1. Manufacturers in many industries are cutting their development cycles by roughly 50%.

and increase the likelihood of rejection by non-financial people.

Once this baseline model is ready, the next step is to develop other models as variations from the baseline. Each variation models a change in one development objective. Usually, four variations are appropriate: development delay, product cost, product performance, and development expense. Product cost and development expense are simplest to model; a percentage increase in baseline values is adequate. Performance shortcomings in a product are usually reflected financially in either unit sales or price. For example, if we are designing electrical wiring devices, the performance of a device is related to its ability to fit into a wide variety of installations, so a higher-performing device will enjoy larger unit sales. By

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contrast, computer printers are often categorized by printing speed, and if a printer fails to reach its speed target, it will have to be discounted to sell against cheaper, slower printers.

Similarly, development delays can be modeled in different ways, depending on the circumstances. The simplest situation is that only the early sales, those due to the delay, are lost (although they are usually the sales with the highest margins). More often, delay means that customers will switch to other products, so market share is lost as well.

Results from each variation are compared with the baseline results to calculate trade-off rules. For example, one such rule is the cumulative profit lost due to a 1-month delay; another is the profit impact of a 1% increase in product cost.

Such analysis provides two types of useful information: guidance as to which product development objectives (cost, time, performance, expense) warrant the greatest emphasis, and trade-off rules between these objectives. The rules help managers to make well-founded decisions on issues that arise daily in bringing a new product to market. A byproduct of having this firm foundation is that the trade-off decision itself can be made and supported faster.

Exhibit 2 provides a set of representative trade-off rules. The values in an actual case may vary greatly from this example depending on sales volume, opportunity costs, development risk, and the state of the underlying technology. Consequently, a financial model must be built specifically for each business, but the diagram indicates the kinds of useful information the model provides.

Exhibit 2 presents six trade-off rules among the four development objectives. To illustrate how trade-off rules are used, consider the value shown on the left edge of Exhibit 2, \$100,000 of development expense per month of delay. This value indicates that it would be advantageous to cut 1 month from the development cycle by spending up to \$100,000 extra on developing the product, for example, on items such as:

- Travel to customers, suppliers, or trade shows to get or confirm product ideas
- Extra laboratory or CAD/CAM/CAE equipment
- Laboratory supplies
- More models or prototypes
- Additional testing
- Contract services

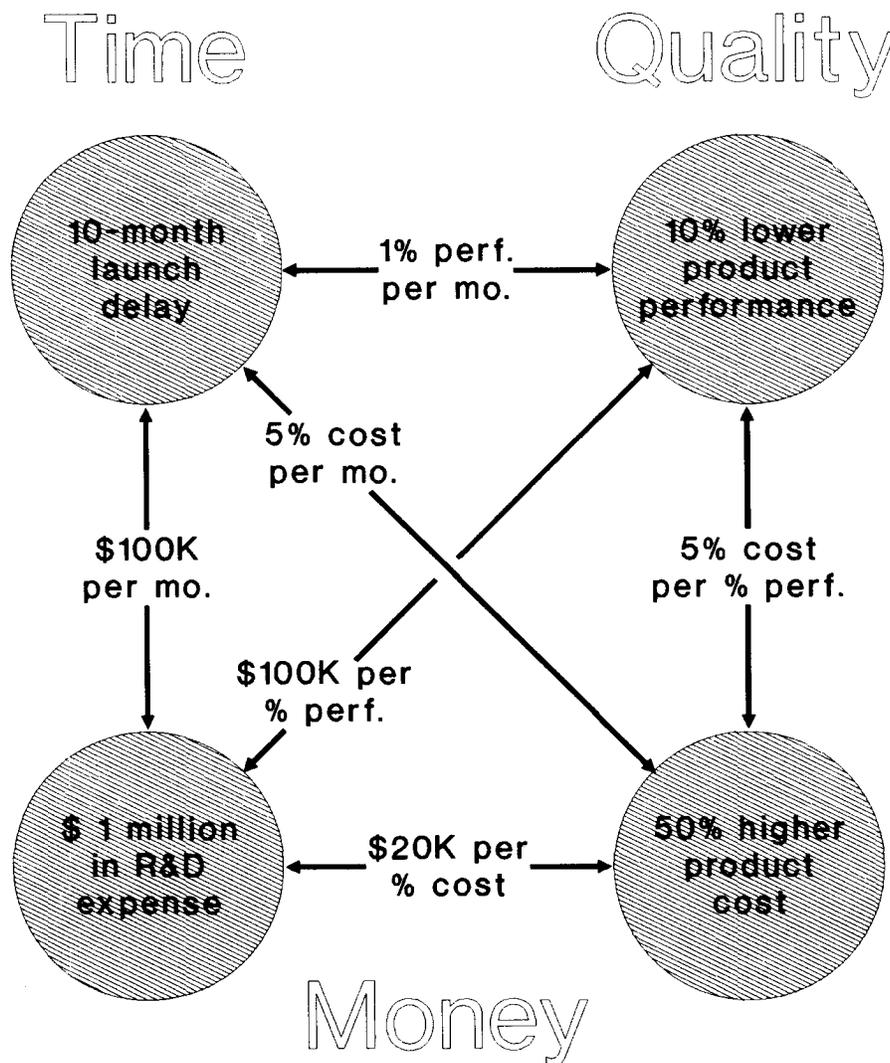
Incentives

Speculative or temporary tooling.

Factors Affecting Development Speed

The time required to bring a given product to market depends on countless factors, some relating to the product itself, some having to do with the effectiveness and commitment of the development team, and some depending on the management system and the degree of support and urgency initiated by top management. Exhibit 3 outlines these factors broadly, and the following discussion covers particular topics in more detail.

Top Management Involvement. Company image, goals, atmosphere, and tolerance for failure all start with top management. While a new product projects the company's image into



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Exhibit 2. Because each circle represents a value equivalent to a \$1-million loss in pretax product profit, the trade-off rules are apparent (representative values). *Quality* and *performance* are effectively synonymous here because, in contemporary usage, quality is conformance to customer expectations, which is essentially how product performance is interpreted in this diagram.

The Elements of Rapid Product Development*

- Sensitivity to Time's Value
 - Calculate and use the value of time to make daily tradeoff decisions
 - Be sure that everyone, from the CEO to the shipping clerk, knows just why time-to-market is crucial and what one month of delay costs
 - Particularly watch for those large periods of time that slip away, as in the fuzzy front end of a project (before a team is formed)
- A Product Structured for Rapid Development
 - Strive to introduce a rapid sequence of incrementally better products rather than the “ultimate product”
 - Write product specifications jointly to expose the key design tradeoffs early
 - Design the product's architecture for clean interfaces and independent modules rather than a global optimum laced with interactions
- A Team Designed for Rapid Decision Making
 - Select a team leader who can make business *and* design decisions, and have him/her report directly to general management
 - Recruit a small, dedicated (full-time), multi-functional team of volunteers
 - Co-locate the team to enhance communication and commitment
- Techniques to Compress Time
 - Religiously prune your project list so that new products don't sit in queue waiting for resources
 - Develop the process concurrently with the product by getting full-time manufacturing involvement from day one
 - Seek opportunities to overlap activities by using partial information rather than waiting for a task to be completed before starting its successor
- Streamlined Management Techniques
 - Expect the team to make all design decisions, reserving for management only change of scope, resource allocation, and project termination issues
 - Stress very frequent, informal peer reviews to monitor and control progress
 - Manage both technical risk and market risk concurrently and actively, and continually remember that delay automatically raises market risk
- A Well-Supported Transition to the New Mode
 - Start with a relatively small pilot project and provide it with everything needed to ensure the crucial initial success
 - Encourage and support positive changes in behavior, even if they are somewhat uncomfortable
 - Resist the temptation to rush every project, and develop a system to identify the projects that must be rushed and to treat them differently

* This list, which is essentially an outline of *Developing Products in Half the Time* (Smith and Reinertsen), mentions some topics beyond those covered in the present article.

Exhibit 3. The elements of rapid product development.

the future, the CEO is the one who normally holds the vision of what the company is to become. The CEO, therefore, has a central role in aligning the vision of the product with the company's desired image. If this alignment does not occur at the outset of a development project, much time is likely to be wasted later in “review,” justification, and rework, and the project is more likely to get sidetracked.

Getting senior management involved at the conceptual stage is often difficult because senior managers are busy, and they may feel uncomfortable discussing technology and communicating an intangible vision to lower-level product creators.

Often, the designers are obliged to create the product and pass it up to management for after-the-fact ratification, which essentially amounts to roulette.

Later on, the situation reverses itself. Top management can get overly involved, especially when project problems occur; this expands the decision-making loop and slows the project. It can also affect team morale by undermining the authority and commitment that should reside in the project team. The team's willingness to accept responsibility for the project hinges on the subtle difference between top management directing the project versus supporting and coaching it.

A Strong Team. Product development is complicated by its dependence on many different types of expertise, which in most organizations reside in different departments, both inside and outside of engineering. We often try to skirt this issue by convening a team or using matrix management. In reality, so-called teams and matrix organizations span a broad range depending on the authority of the team leader. For the group to move quickly, the team leader's authority over the project must exceed the authority of the functional heads (Hayes et al., 1988; Larson and Gobeli, 1988). Otherwise, the structure is really design-by-committee, which is simply too slow.

In working with numerous companies to implement rapid development programs, we have found that a competent, strong team leader is *the most important element* in getting a new product to market quickly. Technical competence is needed because the leader's ability to make wise decisions on the product must be respected in order to build support for the position. Strong, creative leadership is required because fast innovation occurs through a series of clever workarounds and not by checking off completed steps in a guidebook.

Clearly, good team leaders are a scarce and vital resource, and this is why upper management so often becomes the *de facto* team leader. A strong leader can overcome the difficult obstacles that arise in any development project, while a weak leader will stumble over small hurdles. A political controversy continues as to whether the team leader should come from engineering, manufacturing, marketing, or some other function. These debates obscure the fact that good team leaders are so crucial to success that they should be taken from wherever they can be obtained.

Because this role is so vital, the leader should be assigned to it full time with no other responsibilities. Similarly, core members of the team should be assigned to the project full time to strengthen commitment and accountability. Depending on the nature of the product and the company, core members of the team can include engineering design, testing, industrial design, marketing, quality, purchasing, and manufacturing.

Continual Communication. A major management challenge in accelerated product development is to revamp communication mechanisms to facilitate fast decision making. The development of a new product requires a huge amount of detailed communication among team members. To facilitate this, keep the team as small as possible (through the use of full-time members) and physically locate team members within talking distance. Strive for informal face-to-face conversation. Fast-paced new products communication involves a great deal of partial information as activities are overlapped to cut time (Smith and Reinertsen, 1990; Takeuchi and Nonaka, 1986), and the only way to transmit partial information quickly and reliably is through direct conversation.

The standard communication media such as plans, specifications, reports, and reviews have questionable value because they require time to prepare. They also enlarge and slow the decision-making process and tend to be out of date immediately if the team is moving quickly.

Limited Product Objectives. If new features are added to a product, we tend to believe that project complexity will rise in proportion. Project complexity, however, actually rises

much faster than a proportional relationship would suggest (Hagel, 1988). In fact, just adding one new feature to a product more than doubles the potential for complexity (Smith and Reinertsen, 1990). Development complexity often manifests itself in development time because, as mentioned earlier, this is the least tangible development variable.

Getting trapped by product complexity is easy because it seems so beneficial. Individually, product advances may be worthwhile, but their combined effect on development effort is multiplicative, not additive. Engineers love new product features and improved performance because they represent a technical challenge, and the greater the challenge, the better. Marketing people desire product advances of any type because they translate into advertising claims. Often specifying a feature is easier than doing the market research necessary to determine its value. Those outside of engineering and marketing often do not appreciate the amount of risk that is buried in an ambitious product specification.

Product complexity must be managed carefully to develop products rapidly. An advantageous strategy is to limit or freeze the advances in one product and defer other advances

“. . . Just adding one new feature to a product more than doubles the potential for complexity.”

to the next generation product, which follows the first product quickly. Fast-paced incremental innovation has been used very successfully by some Japanese companies (Stalk and Hout, 1990).

Joint Product Specifications. Product features, performance, cost, and development schedule are specified in a document often known as the product specification. This key document should indicate the areas of product risk and flexibility and establish a basis of communication, negotiation, and understanding among the various functions involved in the product's development, manufacture, and sale.

It is impossible for one party to write a good specification because effective product definition requires the involvement of many different disciplines. And involvement is more than just input or review. Specifications created Ping-Pong style yield weak products developed by uncommitted people. A new product concept is loaded with trade-offs that may not be apparent in the specification document. These need to be considered from different viewpoints to obtain a cost-effective blend.

Because product development is a process of trade-offs, writing the specification jointly is good initial training for those who will be negotiating countless trade-offs on the same product over the months to come. Those who write the specification in effect “sign up” for the project. You are wasting a valuable opportunity, both for a good product and for fast team execution, if you let any one function write the specification, even if others review and approve it.

Model Building. Innovation is a cut-and-try business. Those who get products out quickly do it by building and testing

models relentlessly and not by careful planning and analyzing. They use models to identify and learn about soft spots in the design and to reduce technical and market risks.

The models may be made of toothpicks, software, or parts from existing or competitors' products. The first model of the mouse used with Apple's Macintosh computer, for instance, was fashioned from a plastic butter dish (Smith and Reinertsen, 1990)! The key is to avoid building elaborate models that look and function like the expected product. Instead, build several functional models to test basic concepts, and make a nonfunctional dummy if you want to see how the product looks. Clearly, fast product development is a hands-on activity, and the team needs continual access to a workshop and test equipment. Building a model is one activity where you can spend some extra money to save time, as suggested by Exhibit 2.

You learn what works from models, and just as importantly, you find out what does not work. How management reacts to these "failures" has a major effect on the team's willingness to move ahead quickly. Is failure avoidance more valued than fast progress? The development team will be sensitive to management's mixed signals on this.

Procedures and Controls. One reason that small companies beat big ones to market is that product developers in many big companies have to contend with a thicket of procedures, reviews, checklists, signoffs, and reports. Admittedly, big companies often have a more valuable reputation to protect, but the effectiveness of volumes of procedures is questionable in protecting a company's reputation. Many procedures protect against events that are unlikely to recur or have limited consequences if they do occur. However, the cumulative burden of these procedures can slow the development pace to a crawl. Many of these controls are cost-oriented to protect the company's financial resources. When considered in light of time-based thinking (Exhibit 2), they may no longer seem appropriate.

The development team must not only build models relentlessly, it must also relentlessly challenge the value of corporate control systems that stretch development time. One team accelerated progress effectively by informing management that they would proceed with development presuming management approval unless they heard otherwise. Although this tended to put management, as well as the team, on the hot seat, it highlighted an area in which management indecision was delaying projects and undermining team commitment to the schedule, and it eventually led to reform of the system.

Project Overload. It is a fact of corporate life that everyone has more to do than they can handle. Development cycles are long largely because a project typically spends most of its time in someone's in-basket. If time has financial value (see Exhibit 2), then these queues are a financial drain that can be calculated. We have shown clients through financial analysis similar to that illustrated in Exhibit 2 that their long project list was actually reducing their profitability.

The reward system encourages this glut: Product planners are rated on how many new product concepts they can pump into a constricted pipeline. Given these realities, management must select carefully the product concepts to enter development and exercise great discipline in setting, maintaining, and communicating product priorities. If one project is at the top of the list,

another must be at the bottom. Not to admit this is to give workers license to set their own priorities.

Ultimately, these issues are rooted in corporate strategy, or lack of strategy. Is the firm's strategy to be an innovation leader or to match what competitors are offering, feature by feature? It is very difficult to do both.

Beyond Engineering. Product development is often equated with engineering. Although the product may take form and actually start to function in engineering, many of the time-saving opportunities often lie outside engineering. A product that spends 2 years in engineering development may spend a decade before that as a product concept for consideration and another 18 months in transition to manufacturing after engineering releases the drawings. If time counts, then it counts from the day a company first becomes aware of the product idea until it is shipping the product to market. Particularly watch the cross-functional interfaces, which are notorious black holes in the schedule. Cross-functional teams and jointly written specifications are the means of overcoming these interfaces.

Putting It All Together

Several factors contributing to product development speed have been discussed here. If you want to reduce development time significantly, remember that these factors interact. You cannot choose to upgrade a couple of them and expect to observe significantly improved results.

As indicated at the outset, making dramatic cuts in time to market really requires a distinctive management viewpoint and style in which every action is taken as though time matters dearly. This approach, which ultimately has to be communicated from the top of the organization to the bottom, affects how products are planned and defined; how people are selected, trained, and motivated; how resources are allocated; and where management spends its time (Smith and Reinertsen, 1990). This is the challenge we face if we are to be leaders in new product development.

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