Managing Risk as Product Development Schedules Shrink

Be proactive in identifying and resolving project risks—and don't limit your view to the technical operation.

Preston G. Smith

OVERVIEW: *As product development cycles shrink, and as the products themselves grow more complex, managing risk in a product development project becomes increasingly critical. Effective risk management follows two principles: 1) Start on it at the very beginning of the project, and 2) Go well beyond technical areas to capture anything that could impact success of the project. Thus, risk management starts at the same time the project schedule, budget and specification are created, and—just as these items are managed throughout the project—the identified risks receive active, cross-functional management throughout the project. Because each risk item has its own character, each receives a customized risk management plan. Guidelines for generating these plans include addressing the toughest issues first and providing a productive role for failure.*

Although innovation has always involved considerable risk, managing project risk is even tougher on today's tight schedules and when limited resources cause us to question any risk-control activity that does not add value directly. However, effective project risk management can help us to do more with less while providing comfort that we can achieve tight schedules reliably.

I focus on cycle time for two reasons. One is that time-to-market is crucial for many projects, and risk management is more difficult in rapid projects, simply because there is less time available to react to anything that goes wrong. Methods that worked before may no longer be adequate as schedules accelerate. The other reason is that delay is usually the outcome of any risk item, such as cost or quality, that becomes apparent before product launch. Thus, if we concentrate on anything that can delay the project, a comprehensive risk management program will follow naturally.

Preston Smith is a Certified Management Consultant with New Product Dynamics, a Portland, Oregon consultancy specializing in rapid product development. For 15 years, he has advised managers in mechanical, electronic, software, and materials industries in North America, Europe and Asia on faster product development. This article is drawn from Chapter 12 of *Developing Products in Half the Time* (John Wiley, 1998), which he co-authored with Donald Reinertsen. Smith holds a Ph.D. in engineering from Stanford University and has worked as an engineer and manager at IBM, Bell Laboratories, and several other firms.
preston@NewProductDynamics.com;
www.NewProductDynamics.com

This article has two themes. One is that risk management is not just an R&D issue. Although others may think of risk as solely a technical issue and attribute it to the R&D department, most risk issues have much broader roots than this. If you treat development risk as R&D-centric, you simply miss many risks that are likely to materialize later. If others try to place responsibility for product-development risk on R&D, they unwittingly mismanage the problem.

The other theme is that effective risk management is very much proactive. Even when resources are tight, waiting to see where risks may materialize wastes time and effort. The most effective tools identify risks, while freedom of action allows us a choice of solutions.

By identifying and resolving risks proactively, we can minimize their impact on the schedule and budget. And by viewing project risk more broadly than as simply technical risk, we open ourselves to the majority of risks that are not limited to R&D. This article, illustrated with examples from several companies, shows how to accelerate projects and improve success rates by managing risk proactively while taking the sole spotlight off of R&D.

Technical vs. Market Risk

To broaden our view of product-development risk, it is useful to draw a dividing line at the product's specification. If the developers are unable to develop a product that satisfies the specification, we have a *technical risk* issue. On the other hand, if the specification is satisfied but we are still unable to achieve commercial success, then we have misjudged the customer; that is, we have a *market risk* issue.

When we view risk as an R&D issue, we naturally concentrate on technical risk. Unfortunately, this guides us into the most unfruitful areas of risk management, because most products fail to be commercially successful due to market risks, not technical risks. Robert Cooper has spent almost 25 years investigating the causes of success and failure in new products. His findings, based on research into nearly 2,000 products in

0895-6308/99/$5.00 1999 © Industrial Research Institute, Inc.

many industries and countries, are that success depends primarily on six factors *(1).*

- Differentiated, superior products.
- Sharp, early product definition.
- Solid up-front homework (competitive, market, technical, and financial studies, for instance).
- Marketing actions executed well.
- Technology actions executed well.
- True cross-functional teams.

As you can see, only the fifth item—"technology actions executed well"—resides solely in R&D. The others are either dominated by marketing or are cross-functional in nature. For example, nearly everyone who uses a Macintosh computer praises it for being a better technical solution than a Windows computer (more user-friendly, more stable, faster for a given clock speed, and less greedy of memory), but Apple lags greatly in market share to Windows machines.

This means that we must look beyond R&D to manage risk, and we must go beyond the familiar R&D risk-management tools, such as design reviews and engineering prototype testing. For example, SENCO Products, Inc., a producer of commercial fastening systems, decided to enter an emerging market of non-professional users. The technology existed, but success depended on low-cost manufacturing, new channels of distribution, reframed "retail type" merchandising, and extending their brand image.

Through a similarly broad view of project risk, Tellabs, when developing the latest release of its TITAN 532L,® which transports voice and data through the telephone network, found the key to its success to be in the assumptions regarding product requirements. Tellabs teamed marketing and engineering with the customer to probe certain market assumptions. According to Guy Merritt, lead engineer at Tellabs, "Some assumptions proved to be inaccurate, which translated into simpler functionality, thus enabling us to deliver the product months earlier."

Even though these companies looked at risk broadly in these examples, in general, engineers will tend to revert to thinking more narrowly of just technical risk. It is management's job to keep the perspective broad.

The Arithmetic of Risk

The level of risk, or exposure, is the product of two factors: 1) its impact, which is the severity of the risk should it occur, and 2) the likelihood of occurrence. It is useful to keep these two components separate, however, as portrayed in Figure 1, because one of them is under our control more than the other. The impact is the

We must look beyond R&D to manage risk, and we must go beyond the familiar R&D risk-management tools.

left-hand graph of Figure 1, which is the same in parts A and B. This impact often depends on what we have invested to get to this point—in labor or money—and there is little we can do about this investment. If we attempt to scale back our investment, we are actually deferring progress, which is not the route to rapid product development.

The key to managing risk is usually to control the likelihood of its occurrence, constantly driving it down as we progress. The risk is still there, but we manage it by reducing the chance that it will hurt us or slow us down. This is the difference in Figures 1A and 1B.

What this figure means to us is that our opportunity to manage risk is usually to methodically work on driving down the likelihood of occurrence throughout the project—what I have previously called proactive risk management. We manage risk effectively by starting early in the project and working throughout to keep the level of risk under control by managing the likelihood that the risk item will actually occur. Note that this is truly a probabilistic situation. We will never eliminate risks, but we can keep them under control on average. Furthermore, proactively managed risk will be far less disruptive than if we work in a reactive mode, ignoring the likelihood of occurrence and dealing with the damage when it occurs.

For example, Invetech, a contract product development firm in Australia, created a risk management plan early in the development of a biomedical instrument for Vision Instruments Ltd. Because Invetech had uncovered a new reagent probe technology as being a critical risk, its plan highlighted this risk. Consequently, the schedule was adjusted to give priority to reagent probe design and verification, allowing time for redesign cycles if performance specifications were not met initially. The new technology remained just as risky, but Invetech reduced the chance that it would disrupt the schedule.

A Risk Management Process

Once we appreciate that risk should be managed proactively from a broad cross-functional perspective, many approaches can be used. I shall outline a simple one that many companies have found useful; it involves identifying the risks critical to the project's schedule, then mapping them in a manner that makes them easy to track.

You can identify risks by using any creativity tool you like that brings a group's ideas to the surface, such as brainstorming. Most organizations, through their total quality training, have made such tools familiar. In a clever move, Hill-Rom, a manufacturer of hospital beds, recognized that it already had a well-honed process to identify product safety risks, so it parlayed it into a process for identifying project risks. This provided Hill-Rom with the comfort of using a familiar tool from its design-for-safety work as the company ventured into the new area of project risk management.

Keep two thoughts in mind as you identify risks. One is that many critical risks will be cross-functional, so a cross-functional group is more likely to find them. If only the engineers look for risks, for example, they are likely to miss many market risks. Also, a cross-functional group can fertilize each other's thoughts, discovering risks that no single mindset would have spotted.

The other thought is to focus on those risks that are likely to disrupt the schedule. If time-to-market is driving this project, then speed is a natural objective. If it is not, then schedule delay is still a comprehensive measure of overall project performance, as mentioned earlier.

The key to managing risk is usually to control the likelihood of its occurrence, constantly driving it down as we progress.

You should identify these risks early in the project—at the same time that you create the budget, schedule and product specification—for two reasons: 1) Good risk management is proactive; 2) The risk level is a basic criterion for deciding whether to undertake the project, just as is the schedule or budget. Of course, the risk assessment may be imprecise before you have done any of the development. But it can be improved later as you conduct ongoing risk management, just as you may have to adjust the schedule and budget as you gain more information.

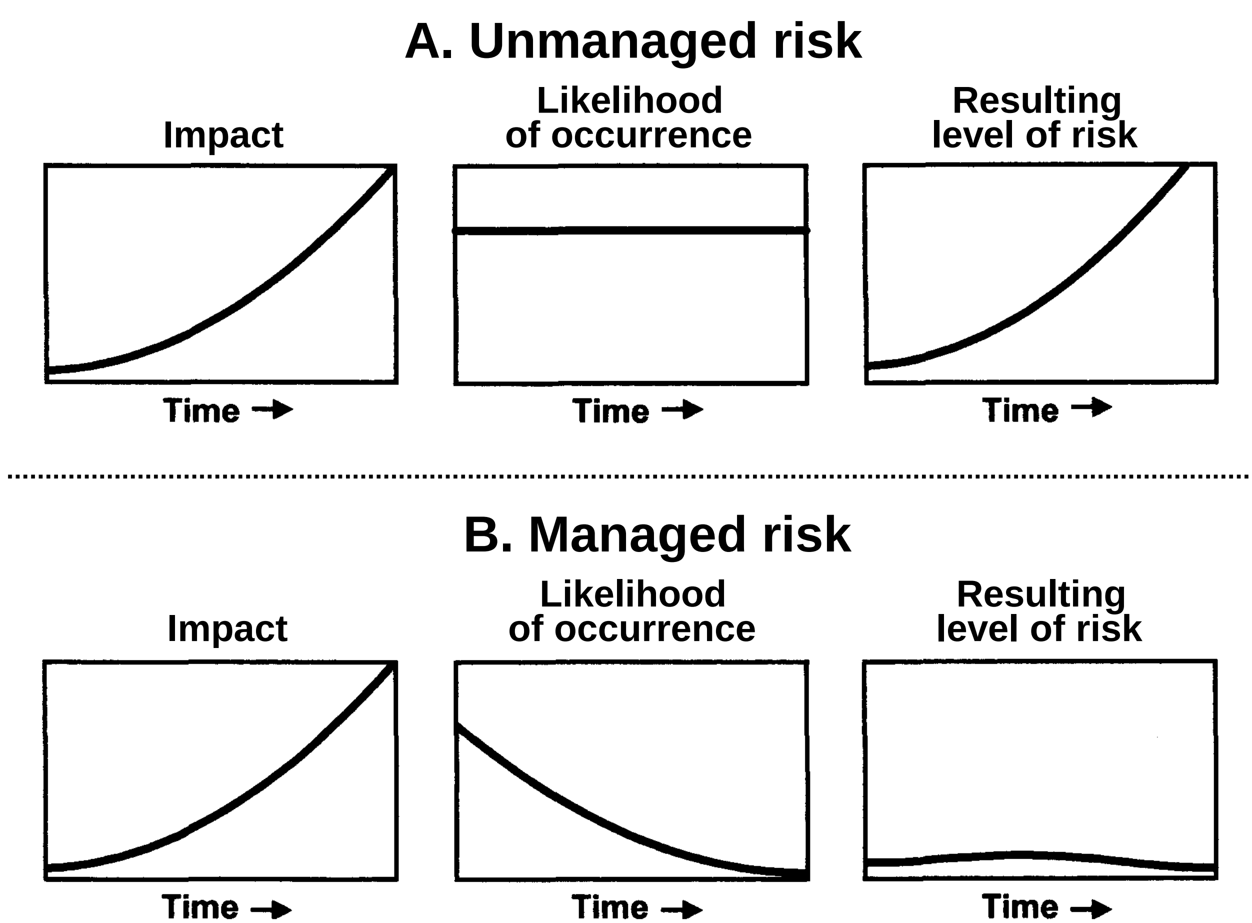

Figure l.—The best way to control the level of risk is to manage its likelihood of occurrence, as illustrated in B.

The risks you identify will be very specific to your project. For example, Tellabs discovered that the length of test cables carrying data between subsystems was critical to an in-house testing project and surmised that certain conditions could corrupt data due to test cable length. Since this risk was identified *before* the expensive test cables were constructed, mitigation action was taken to prevent it from becoming an issue later. Similarly, Hill-Rom identified at the beginning of a current project that delay in gaining access to shared testing lab services was likely to disrupt its schedule.

Notice that this approach is much like a process called failure modes and effects analysis (FMEA) often used by design engineers. However, what I am suggesting here is broader than FMEA in important ways. Because FMEA is design-oriented, it is based on a specific design, so you cannot start using it until you have a design to analyze—much later than we need our initial risk assessment. Also, because it concentrates on the design, it is unlikely to uncover management or marketing issues that may be crucial to the project but not the design. Would Tellabs have unearthed the testability issue by analyzing the design of the subsystem?

Mapping Risks

Once you have identified your risks, you need a way to prioritize and track them. A chart such as the one in Figure 2 is useful in this regard. Following from the discussion on the arithmetic of risk, the two axes represent the likelihood of occurrence and the impact. These axes can be quantified to the degree possible (notice that in this example, I have assigned numbers to one axis but not the other one to illustrate this point).

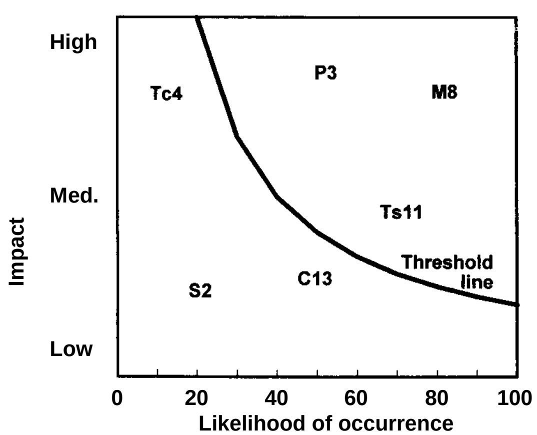

Figure 2.—By plotting identified risks on a map such as this, we can decide which of them warrant active management and then track our progress in mitigating these risks.

Because many critical risks will be cross-functional, a cross-functional group is more likely to find them.

To demonstrate the technique, I have mapped six risks in Figure 2. These have been culled from a longer list of identified project risks. The illustrative risks are:

- P3: Product performance (requirement uncertain).
- M8: Management (project's godfather to retire).
- Ts 11: Testing (Will test replicate field conditions?).
- Tc4: Technology (Works at required temperature?).
- C13: Competitor (claims better signal/noise ratio).
- S2: Supplier (lacks compatible computer-aided design system).

One last element appears in Figure 2: the curved line of constant level of risk (or exposure, if you prefer), which follows from the arithmetic-of-risk discussion. This line forms a threshold; any risk above it is deemed important, so it comes under active risk management (described below). Risks below the threshold line are not actively managed.

You set the threshold line according to your tolerance for risk. If you move it lower, you will be bringing more risks under active risk management, thus reducing your overall level of risk. However, you will also be paying more to manage this larger group of risks. In other words, you obtain more protection by buying more insurance.

There is nothing immutable about this particular risk map, and companies modify it to their needs. For instance, Invetech Australia lists and then sorts the risks in priority order, first by impact and second by likelihood. Tellabs managers adjust their identified risks relative to the project's "threshold of pain." Then they rank them and manage their Top Ten list.

Risk Monitoring and Mitigation

Any risk above the threshold line receives active risk management, which means that we devise an appropriate plan to manage that risk. Managing it usually means driving its likelihood of occurrence down (driving it leftward on Figure 2).

Note that the six risks illustrated here are quite diverse, as will normally be the case. Consequently, a "standard" risk management plan will not do. Each risk above the line gets a customized plan that will address it most effectively. The plan specifies actions, responsible parties, due dates, and metrics, just as any action plan would. Tellabs documents these plans using a Web-based tracking tool (see Figure 3).

Earlier, I mentioned that Hill-Rom found that delay in accessing shared test labs was a risk to the project. Thus, its management plan included coordination activities with other teams and putting a shared-services manager on its own team. Bill Riley, a senior design engineer at Hill-Rom, explains, “We defined milestones and tasks and put them into our project schedule, and we planned resources and time requirements for these tasks. These tasks thus became subject to our normal project controls.”

SENCO discovered that one particular part of its new commercial pneumatic stapler was at risk because of a new high-performance reinforced plastic material it wished to use. This part was also on the project’s critical path. Consequently, explains Scott Allspaw, operating manager at SENCO, “The team’s plan was to acquire

RiskID: **Testproj-079**	State: **CLOSED**	Date Originated: **1999/03/05**	Originator: **Guy Merritt**

Owner:	Joan Hoigard	**Owner e-mail:**	hoigard@tellabs.com
Impact Severity:	30 Work Days	**Risk Exposure:**	4.50
Impact Type:	Schedule Impact	**Risk Factor:**	0.92

Risk Event

Prototype build for ABC module on the Surface Mount Technology (SMT) line will not be completed by April 20, 1999.

Risk Impact

Firmware unit testing for the ABC module will delayed by six weeks.

Event Drivers

1. SMT line is scheduled for replacement during the prototype build for the ABC module. Time required for replacement is six weeks.

Impact Drivers

1. Firmware unit testing activity for ABC module is on the critical path.
2. Firmware unit testing requires ABC module.

Probability of Event *(Pe):* 0.3

Probability of Impact *(Pi):* 0.5

<u>Prevention Plan 1</u>

Due Date: March 9 1999
Date Completed: March 29 1999
Owner: Joan Hoigard

Plan the replacement for the SMT line to occur four weeks earlier to allow the ABC module to be built on time. We need to contact the vendor.

<u>Status 1</u>

March 29, 1999: SMT line vendor is not able to install earlier due to other customer commitments.

<u>Contingency Plan 1</u>

Due Date: April 10 1999
Date Completed: April 14 1999
Owner: Bob Maher

Develop a hardware emulator to allow unit testing to continue without the ABC module.

<u>Status 1</u>

April 6, 1999: A simple emulator has been developed. It appears that 85% of the firmware functions can be tested without the ABC module.

Notes:

April 10, 1999: Risk Event occurred and firmware unit testing has been completed using the hardware emulator. Resultant schedule slip will only be 4 work days.
May 10, 1999: Prototypes have been built and the last 15% of testing has been completed.

Closure Data

Actual Closed Date: May 10 1999

Actual Impact: 4 Work Days

Disposition of Risk Event: Occurred

Disposition of Risk Impact: Mitigated

Last Modified: **1999/03/05**

Figure 3.—Tellabs uses such Web-based charts to manage each of its project risks.

tooling for both the new material and for our traditional aluminum to ensure that time to market would not be compromised."

Now that we have a risk map and a group of plans for the risks currently above the threshold line, managing risk involves ongoing work on each of the plans, as well as keeping the map up-to-date. Management regularly reviews progress on the plans and updates the map. Updating has five components:

• Replotting the risks under active management (usually they will be moving to the left).

• Replotting the risks below the threshold line (they can move in any direction).

• Identifying any new risks that have arisen and locating them on the map.

• Generating action plans for any risks now appearing above the threshold line.

• Terminating the action plans of those risks that have moved below the line.

The SENCO material selection risk, above, provides an example of this ongoing management. This team managed the reinforced plastic risk issue until they had mitigated it. Then they canceled the aluminum tooling procurement, paying for the work performed to date.

This risk-updating process is a powerful tool for management to use in monitoring a fast-moving development project. Most commonly, management monitors a project by assessing progress on tasks relative to schedule, checking expenditures relative to the budget, and assuring that deliverables are acceptable. An accelerated project, however, is more likely to get into difficulty due to unforeseen risks, so monitoring it via its risk map and action plans is more vital than tracking the normal schedule, budget and deliverables. Thus, I am suggesting an approach to monitoring a project that is quite different from common management practice.

By monitoring risk in this ongoing way, Tellabs detected a decreasing capacity for prototype manufacturing in relation to a recent project. Merritt notes that without risk monitoring, this probably would not have been noticed until the project's prototype production request was made, thus resulting in production delays.

At a monthly risk review meeting, SENCO identified an emerging risk on a pneumatic nailer used for construction in areas prone to earthquakes or hurricanes. It detected that this special market would need more comprehensive communication and training than the company's traditional markets. "It was the monitoring that made the difference," Allspaw observed.

Starting with the easier tasks is exactly the wrong way to approach product development

Risk Management Techniques

Our focus so far has been on an overall risk management approach in which there is a plan for each identified risk. Now, I shall suggest some useful tactics for building and executing those plans, although in many cases the means of managing the risk most effectively will be apparent once the risk has been identified.

Avoid Risk Whenever Possible

Although it seems trivial, many developers overlook major opportunities to simply avoid risk. One way of doing this is to reuse proven components and designs. For instance, Hewlett-Packard encourages its engineers to reuse software, because this reduces risk while saving labor (see Figure 4). Using standard parts is a variation on this theme. Curiously, however, management will have to encourage the use of standard parts if it is to occur, because many engineers consider standard parts to be inelegant solutions!

Cummins Engine Company has divided its product—diesel engines—into a continuum of value-adding categories, starting with standard parts and ending with those few portions of the engine where its creativity and expertise truly makes a better engine. Some parts, while not contributing much value, must be redesigned for each engine, for instance, the flywheel. Consequently, Cummins has automated flywheel design, which virtually eliminates both labor and risk from flywheel design.

Stay Flexible on Unresolved Issues

If you can narrow a market risk issue down to just two options, you can sometimes keep both options open. For example, Black & Decker conducted focus groups on handle size and shape for a battery-powered screwdriver. It knew this was a critical issue, but it was unable to decide between two options: a slim one—more comfortable for smaller hands but holding only two cells—and a somewhat fatter handle holding three cells for greater power. Unsure about the handle, Black & Decker decided to design both sets of handle tooling while doing more market research.

After several years of offering various mouse alternatives, such as trackballs, on notebook computers, manufacturers seem to be coming down to either a pointing stick or a touch-pad. WinBook® computers, rather than taking on the risk of a poor choice, simply offers both devices on its

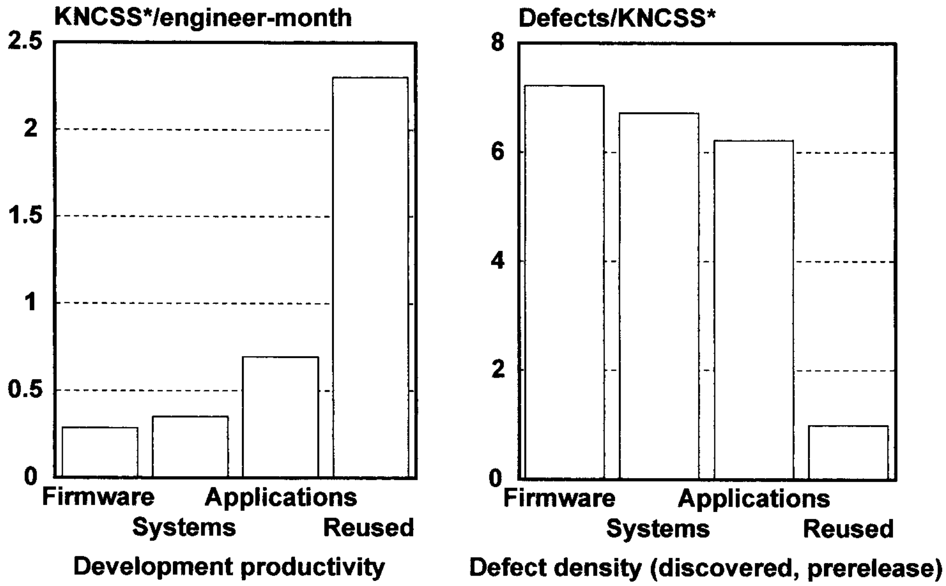

Figure 4.—Reusing software improves engineering productivity while simultaneously reducing risk. (KNCSS = 1000 lines of Non-Comment Source Statements.) From Grady/Caswell, Software Metrics: Establishing a Company-Wide Program, *© 1987, pp. 111–112. Reprinted by permission of Prentice Hall, Upper Saddle River, New Jersey.*

notebooks. Clearly, you cannot afford to use this rather expensive tool on too many uncertainties.

Maintain Contact with Customers

Perhaps the best general-purpose means of reducing market risk is to put your design engineers into direct contact with customers and users. Software engineers at Invetech Australia obtain early input to user interface designs for their laboratory instruments by reviewing prototypes with mixed groups (range of skill levels) of laboratory staff users and human factors experts. Boeing, when developing its 777 airliner, asked its customer, United Airlines, to send several United operations experts to join the development team at Boeing, and gave these customers unrestricted freedom to review documents and attend meetings as they mingled with the developers. Engineers from Sentrol, Inc, which makes building security sensors, learned that miniaturized sensors, which they had assumed were desirable to the customer, actually created problems in mounting and wiring on the ceiling of a room. Engineers at Hewlett-Packard had to be in direct contact with the difficulties that typical customers experienced with their DeskJet printers before they could find ways of overcoming these problems.

To gain the greatest value from customer contact, make sure that customers are directly in contact with design engineers—not through intermediaries, such as marketing. And arrange this contact to occur before design decisions are made. All too often, engineers visit customers to fix problems during field trials, after the problems have been designed into the product!

Address the Tough Issues First

When faced with an assortment of work, as a development project offers, the natural human tendency is to begin with the easier tasks. This gives us a sense of confidence that fortifies us to tackle the tougher parts. Although there may be a great deal of wisdom to this in general, it is exactly the wrong way to approach product development. If we cannot handle the difficult, high-risk issues, we might as well kill the project before we waste our effort on the easy items. Even when we are ultimately successful, it is the difficult, high-risk tasks that are likely to have the greatest impact on the schedule; consequently, these should be undertaken first.

Addressing the tough issues first is one way of being proactive about risk management. This is the way to drive down the likelihood-of-occurrence curve in Figure 1.

Apportion Risk Carefully

Along with getting a jump start on high-risk areas, be careful how you apportion risk in the product. It is best to concentrate risk in a few known areas where you can watch it especially carefully, as discussed by Smith and

Reinertsen *(2).* Then you can put some of your best developers on these areas and give them extra management attention.

An excellent way to provide this management attention is through "management by walking around." MBWA is especially beneficial in high-risk areas of fast-moving projects because it gives management unfiltered, real-time information on progress and problems. It also allows dialog and problem solving right on the spot, rather than misjudging or waiting until the problems get out of hand.

Test at a Low Level

We often resolve technical risk through some kind of testing, and testing can be useful for mitigating market risk too. To move quickly with testing, try to test at the lowest level possible. This gives you quick answers to specific questions. For example, Invetech Australia, on a washing machine development project, initially identified a risk of not achieving balanced spinning. Consequently, they concentrated on just this issue until they understood it. According to Fred Davis, product development manager at Invetech, "We identified potential causes and decided to start early on vacuum-cast prototyping of fluid passages to verify effective fluid balancing."

This concept of testing at a low level is precisely what allowed the Wright brothers to beat their competition to market with the first flyable aircraft in 1903. Whereas the competition tried to make progress most logically, by designing, building and flying a complete aircraft to test their theories, the Wright brothers instead saw that there were several areas of risk that had to be resolved first. These included techniques of lift, propulsion and control. So they tested simple subsystems to overcome the risks at this level first. For example, they tested sections of propellers in a wind tunnel before they even bothered to build a complete propeller. They could build and test propeller sections faster than complete propellers, and far faster than complete airplanes.

The shortcoming of resolving risk at a subsystem or component level is that the complete system still may not work when it is assembled. Consequently, you must anticipate and plan for such integration risks. Integration risk is becoming increasingly prevalent as systems become more complex, and testing at a low level will delay its discovery.

Put Failure in Perspective

Much of risk management has to do with avoiding failure. Interestingly, however, failure provides valuable information that helps us to develop products faster, and is thus not always to be avoided.

To accelerate learning, design experiments so that the expectation beforehand is midway between passing and failing.

Product development is really a process of learning, and we learn the most from an experiment or test when we have no idea beforehand how it will turn out. Ironically, if we design an experiment so that we expect it to be successful and it turns out to be successful, then we have not learned anything. To accelerate learning, we should design our experiments so that the expectation beforehand is just midway between passing and failing. Then the outcome gives us the greatest information and allows us to make progress fastest.

For example, a firm that makes door locks, which must pass a severe and expensive fire test, designed its locks conservatively, so that they would always pass the test. However, this company found that it could move faster by designing the locks quickly, with only partial confidence that they would pass the test. Then it used the test results to learn where the lock needed more strength.

There is an exception to designing tests and experiments for learning, however. Some tests are not intended for learning but instead for verification that we have a commercially acceptable design. Such tests often come at the end of development, where they can involve lengthy cycles. Should the product fail such a test, we have a big surprise and an enormous schedule disruption.

Thus, consider the purpose of each test or experiment before undertaking it. If it is intended for learning, as many will be (especially if you are operating in a proactive mode), design it so that the outcome is as uncertain as possible to maximize the rate of learning. However, if you want it to verify that your design meets specifications, arrange your prior learning to make passing the final test as certain as possible. In fact, if it is a lengthy test and you have high confidence of passing, you may be able to take the test off of your critical path. For example, you could start production while you complete the final life test, accumulating some inventory to accelerate market launch.

References

1. Cooper, Robert G. *Product Leadership.* (Reading, Massachusetts: Perseus Books, 1998).
2. Smith, Preston G. and Reinertsen, Donald G. *Developing Products in Half the Time: New Rules, New Tools,* Chapter 6 (New York: John Wiley & Sons, 1998).