SECTION 17
PROJECT MANAGEMENT AND PRODUCT DEVELOPMENT

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INTRODUCTION

Development is the translation of research findings or other knowledge into a plan or design for new, modified, or improved products, processes, and services, whether intended for sale or use. It includes the conceptual formulation, design, and testing of alternatives, the construction of prototypes, and the operation of initial, scaled-down systems or pilot plants (Industrial Research Institute 1996). The focus of the present section is the process of project management applied especially to the development of new physical products.

A *project* is a task which is undertaken in a structured manner. A project organizes the task and its proposed resolution into a structure in which there is clear definition of the undertaking and the corresponding plan for its execution. Moreover, there is visibility of the progress toward completion in terms of time and resources applied versus targets previously established. The project structure also permits managerial oversight and approval at key checkpoints along the way.

The project approach has long been favored for undertakings such as product development that involve a significant expenditure of personnel, time, and resources, especially when they are considered essential to the well-being of the enterprise. More recently, the project approach has been shown effective when applied to apparently lesser problems, especially when applied serially to accomplish incremental change and even to effect breakthrough, as in quality improvement. In this instance, Juran (1988) has described a project as "a problem scheduled for solution."

What follows draws on the author's experience in developing technical products for manufacturing. The management process outlined here is specific to product development, but is applicable generally to any project undertaking, whether to product or process development, or to product development in the service sector—as for example, restoring the grandeur of Michelangelo's ceiling in the Sistine Chapel or preparing this handbook for publication. In short, with some suitable modifications and fine tuning to fit the specific task at hand, the project approach works for just about any undertaking worth the effort.

The primary attraction of the project concept as a management tool is its focus on results and the means to achieve those results. It is structured; there is a beginning, a middle and an end. When a project has been completed successfully, something happens; a new product, a new service, an improved process, comes into being where it did not exist before.

PROJECT MANAGEMENT FRAMEWORK—THREE PHASES

There are three steps or phases in every project corresponding to the beginning, the middle and the end. These are the *Project Concept* phase, the *Project Discovery* phase, and the *Project Implementation* phase. There is often also a fourth step—the *Verification* phase—which continues beyond implementation. Each phase is a multicomponent undertaking, and some of those components specifically contribute to the quality of the process itself and of the resulting product. The means to achieve improved quality must be woven into the project management process from beginning to end.

The Project Concept Phase. Some projects start out as vague ideas. It is important to eliminate vagueness quickly. In every case, moreover, vagueness surrounding key project goals must be eliminated during the concept phase. There are ways to do it, as we shall see. The Concept stage consists of those thought processes, discussions, and activities that allow us to describe precisely and concisely what it is we intend to do, and then write it down. Proper completion of the concept phase consists in writing the *Project Concept Statement,* clarifying and refining the project concept statement, writing the *Product Requirements Document,* preparing the *Project Authorization* for the *Discovery Phase,* and gaining approval to proceed to the Discovery Phase.

The Project Concept Statement. Start with the *Project Concept Statement.* Keep it simple—the complications will arise to greet us soon enough. Clear focus will help us deal with them. The Concept Statement is also an important means to eliminate vagueness. Consider two examples:

When the order for Florence's majestic Cathedral of Santa Maria del Fiore (St. Mary of the Flower) was given over to the master builder Arnolfo di Cambio in 1296, a proclamation described the citizens' requirements: "The Florentine Republic, soaring ever above the conception of the most competent judges, desires an edifice shall be constructed so magnificent in its height and beauty that it shall surpass anything of its kind produced in the times of their greatest power by the Greeks and the Romans." (McCarthy 1963).

The cathedral was required to be *higher* and *more beautiful* than anything known in the ancient world. This was a big idea—the city fathers knew it was a big idea—but it is clear and easy to understand. Higher is simply higher. More beautiful is ambiguous to our ears, but it was much less so to the Florentines of that time who, by their own remarkable insights and efforts, had begun the process of creating beauty on the model of ancient Greece and Rome. Arnolfo di Cambio, a man standing at the threshold of the Renaissance, and a sculptor as well as an architect, knew very well what was required of him. Creating beauty was the easy part.

In May 1961 the young president John Kennedy stood before a joint session of Congress and focused the country's intellect and management skill outside of earthly bounds with this challenge: "I believe the nation should commit itself, before the decade is out, to landing a man on the moon and returning him safely to earth." (Chaikin 1994.)

Note that the President was quite specific with his big idea: Land a man on the moon, then bring him back safely, and do it in 9 years. In this instance, the president introduced the schedule as a key component of the goal. There were, however, no cost limits set in either case. That is most unusual. Cost was a secondary consideration in these titanic examples where the honor, the glory, and the prestige of the state and nation were at stake. That is not likely to be the case with the more humble efforts that come our way.

The *Project Concept Statement* is always short and to the point. Sometimes one sentence will do, as these examples attest. A single page will certainly be sufficient to contain the essentials of the concept statement. Be distrustful of a concept statement that is wordy and complex. This is usually a sign of fuzzy thinking which, in turn, leads to imprecise goal setting. The conduct of a project is an iterative process. The complex details may emerge only gradually.

The essentials are: the *statement of goals,* an indication of the *time allotted* (schedule) to achieve those goals, and the *resource constraints* (people, material, and money) under which the first two must be accomplished. It is very important to write these down in their simplest form and get agreement (sign-off) on these basic elements. It is often surprising how difficult it is to reduce an idea to a simple concept statement. It is tempting to skip this "trivial step" and start the project before the concept statement has been written down, understood, agreed to, and approved by senior management. It is well to remember Theodore Levitt's (1962) pithy admonition on this point, "Unless you know where you're going, any road will lead you there." In a survey of projects that had failed to meet schedule goals (Figure 17.1), "Poor definition of product requirements" is the reason most often cited as contributing to delay in bringing the product to market (70 percent) (Product Development Consulting 1990).

The following example is from the author's product development experience in the instrumentation field during the early 1990s. The goal and focus of the project is a device we have named here—*the application controller.* It is described in the Project Concept Statement (Figure 17.2). Note that the statement specifically addresses only the three elements required of the Concept Statement: goals, schedule, and resources. The details are left to follow.

Project Concept Statement Reality Check. Before moving beyond the subject of the Project Concept Statement, we must acknowledge a real-world consideration that is well understood by experienced project managers. It is the fact that one can run into great difficulty laying out and gaining approval for a truly innovative proposal, or for one that is merely out of the ordinary for our industry, or for our company, or even for our department. We must also concede that in many of those

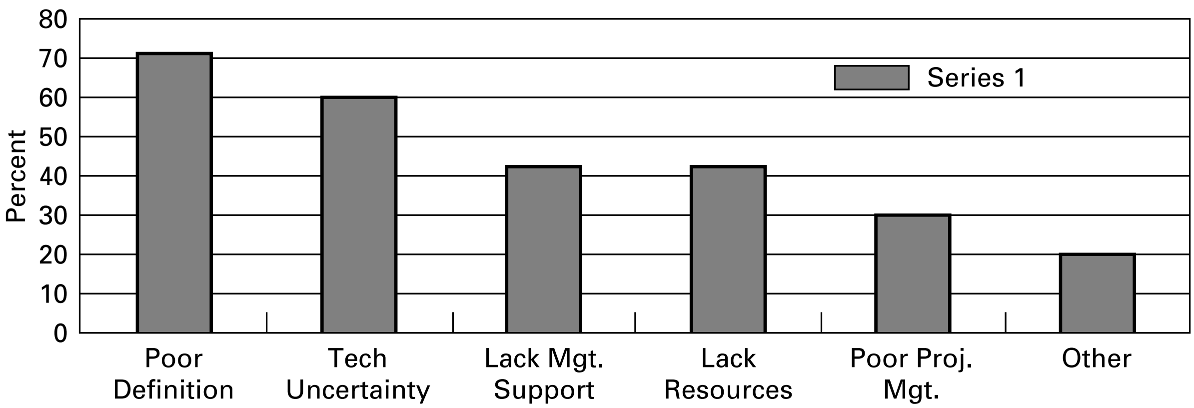

FIGURE 17.1 Reasons that products failed to meet schedule goals. (*Source: Product Development Consulting 1990.*)

Project Concept Statement
Project: Application Controller

Product goals:
1. Develop and bring to market an *application controller,* based on personal computer technology, to replace the current product line based on application-specific technology, and outpace competitors.
2. The resulting product must be fully featured, yet small and completely integrated, similar to current specialized units but with PC power and enhanced user features, including customer "turnkey" operation.
3. The cost target is $1250 for the basic configuration. At a cost of $1500 or more the product is not viable. The anticipated volume is 2000 units/year or more.

Project schedule: Complete the development and introduce the product in 2 years.

Project development expense: The development expense is not to exceed $2,000,000. Estimated payback time is 1 year, based on the expectation of cumulative gross margin to be achieved during the first full year of product shipments. Estimated product life is 5 years or more.

FIGURE 17.2 Project Concept Statement.

cases there is good reason for senior management to be wary and distrustful of ideas and proposals that depart significantly from the norm. Under these circumstances, there is a real, and often justified, motivation on the part of the project manager to avoid presenting and seeking formal approval for the project concept until the environment can be properly prepared for its acceptance.

Peters and Waterman (1983) allude to this phenomenon in their description of the "skunk works" as an out-of-sight, underfunded, often bootlegged, idea incubator where, they believe, most of the really good new products are spawned in corporate America. The very existence of the uncontrolled skunk works incubator seems to be at odds with the clear-cut outline for writing out and gaining agreement on the Concept Statement before starting the project. Yet the existence of the skunk works suggests the need to be wary of premature disclosure of offbeat ideas. As is the case with most apparent anomalies, we must contend with shades of gray.

The truth is that if management would strive to track down and ruthlessly eliminate every new or unusual idea before it has gained headway, the effect would be to drive out the best and most creative people and eventually to destroy the organization. On the other hand, if management has no mechanism in place for making decisions in an orderly way, for setting priorities and controlling events, the organization will surely founder and fall. The successful project manager must function effectively in the gray-shaded, fertile area between these pathological extremes.

Pressing Ahead—Making the Transition to the Next Phase. The transition from one project phase to the next marks a milestone. It is, therefore, appropriate to obtain management approval as we complete the Concept Phase and before we begin the Discovery Phase. To gain approval we need to prepare two very simple documents in addition to the Project Concept Statement. These are the *Product Requirements Document* and the *Project Authorization for the Discovery Phase.* We then secure management sign-off on them.

The Product Requirements Document. The purpose of this document is to establish the broad outlines of the project. The "product" is the project's focus; it is the resulting deliverable. In that sense there is universal meaning for the word "product."

The Product Requirements Document is an expansion of the Concept Statement. It is still too early to completely describe the product; the description put forth at this point will be subject to refinement and outright change. That is what the Discovery Phase is about. Nevertheless, in the Product Requirements Document, those driving the project—the project leaders and the product champions—describe their mental picture of the product or service that they intend to produce. In addition to text, the document will often include graphical forms, drawings, etc. The Product Requirements Document need not be especially lengthy or detailed—three to five pages is usually enough. For example, a suitable outline for the Product Requirements Document for the application controller would cover the topics indicated in Figure 17.3.

The Project Authorization—Discovery Phase. This is the companion to the Product Requirements Document, and it includes a concise description of the resources and an estimate of the time likely to be required to undertake and complete the Discovery Phase. It is also appropriate at this point to make a rough estimate of the total scope of the project. Note that there is overlap among the three Concept Phase documents. Overlap is to be expected, inasmuch as the documents all deal with same thing. But each document is produced from a somewhat different viewpoint. The Concept Statement is written primarily from the executive point of view; the Product Requirements Document is often written from the marketing and business management point of view; and the Project Authorization for the Discovery Phase is usually written from the viewpoint of those having responsibility for implementation.

In a corporation of medium or large size, the Project Concept Statement might come from top management, or from the head of a business unit, or it might bubble up from within the organization and be seized upon by a product champion. The Product Requirements Document might be written by the marketing department, product department, or the product champion. The Development Phase Proposal will usually come from development engineering. Whatever the case, it is advantageous to assign responsibilities ahead of time to those departments and people who will produce this project documentation.

Product Requirements Document Outline
Product: Application Controller

1. Target specifications
   a. Performance specifications
   b. Cost specifications
   c. Schedule required
   d. Those specification requirements that are vital to success
2. User interface style and hardware
3. Major software functions, i.e.:
   a. Operating system performance requirements
   b. Memory, disk space requirements
   c. Special calculations and reports
   d. Real-time data acquisition
4. Compatibility with other products and accessories
5. New technology planned—advantages versus risk
6. A block diagram or outline of the product
7. Place in product line—profit potential
8. Rough estimate of schedule and resources likely to be required
9. The list of deliverables

FIGURE 17.3 Product Requirements Document outline.

Continuing with the example of the application controller, Figure 17.4 is an example of a *Project Authorization Form.* It can be used to record management approval to proceed to the next project phase, in this case, The Discovery Phase.

With management approval of the Concept Statement, The Requirements Document, and the Project Authorization, the project activities expand. The rate of spending, although still modest at this point, will increase, and resources will be further committed to marketing fact-finding and technical studies, possibly including feasibility studies. These efforts move the project from the *Concept Phase* to the next phase—an expansive, intellectually stimulating, and dynamic period which we have labeled the *Discovery Phase.*

The Project Discovery Phase. In the Product Requirements Document in Figure 17.3, we are faced with the problem of dealing simultaneously with several interrelated issues. We need more information, and it is necessary to begin to fill in details at this point. One useful technique for making significant headway under these circumstances is to analyze the key issues related to product feasibility and viability in the marketplace.

An analysis matrix aids in balancing the twin goals of low cost and small size. It presents the percentage contribution that each of the major hardware components makes to each goal.

The elements of cost relate to the dollar value of the components involved, while the elements of size relate to the volume of space required for each component and to the footprint of the final assembly. The use of percentages generalizes the presentation and also highlights important contributors. Of course in the very beginning of the project we cannot know these cost and size contributions precisely. But even an approximate valuation yields important insights as to where the key elements are with respect to cost and size. In this example the printed circuit board, the hard disk, and the display stood out with respect to cost, while the display, the printed circuit board and the power supply were key contributors to size. These were established by the matrix analysis as the “vital few” items that must be addressed and resolved in order to establish product viability. Thus, as a result of the matrix analysis many specific questions arose, for example:

- Will there be enough room on the printed circuit board?
- Will high-density devices be required?
- How can the unit be held to a reasonable size?

Project Authorization Form

Project title: Application Controller ______________________________

Phase authorization: Discovery Phase ______________________________

Effort and expense for this phase:

Start date: ______________________ **Completion date:**______________________

Development staff

Engineering ______________________ Person-months ______________________

Electrical design ______________________ Person-months ______________________

Mechanical design ______________________ Person-months ______________________

Total staff ______________________ **Person-months** ______________________

Total cost: $ ______________________

Key goals of this phase: ______________________________

____

____

____

Appropriate signatures:

Engineering Manager ______________________________

Product Manager ______________________________

Vice President Operations ______________________________

Comptroller ______________________________

FIGURE 17.4 Project Authorization form.

The point here is that these questions flowed directly and in an orderly manner from the matrix analysis, even though the potential solutions were interactive and interdependent one with another. We knew from the matrix what was important. Thus, while the project leader and the marketing and product management members of the team continued the work of fleshing out the *Product Functional Specifications,* the technical specialist members of the team proceeded through a series of "what if" design alternatives, forcing the product configuration to evolve, to become simplified and more refined, while all the time striving to make the design process converge.

The Project Team. The project team is at the center of the approach outlined here. The team is responsible for the management and it plays an important part in the execution of the entire project from concept to introduction. The composition of the team depends on the nature of the project, the makeup of the sponsoring organization, and the time phase of the undertaking at hand. In the case of a manufactured product, for example, the team usually consists of members representing:

- Marketing (i.e., product requirements, customer communication)
- Engineering (i.e., product development)
- Manufacturing
- Quality assurance
- Sales
- Service

This core team of five or six people is responsible for guiding the project and making sure that the needs of their respective constituencies are put forward and responded to appropriately. *The team manages the project.* The team must secure the necessary resources to accomplish the tasks at hand. Many, but not necessarily all, of the team members will be assigned to work on the project full time. The team will hold regular meetings. Everyone associated with the project will remain informed as to its progress through distribution of the minutes and periodic project reviews. These reviews are usually held monthly or quarterly, depending on the project's scope and phase. A project near completion often requires more frequent reviews.

The project leader has a special position on the team as the first among equals. The project leader calls the meetings, writes and distributes minutes, and sees to it that the project team carries out its tasks. The project leader also initiates and maintains a file of documentation related to the project. In the example, this file consists of the Project Concept Statement, the Product Requirements Document, the Development Plan, Functional Specifications, meeting minutes, pertinent memos, etc. The file establishes the documentation trail for the project.

The Practiced Team. Probably nothing has more impact on the successful operation of the team (and therefore the project itself) than the effectiveness of the team leader. It is necessary to keep all the team members focused on the key objectives and the appropriate priorities as the effort progresses. This means calling the meetings, keeping them as short as possible consistent with the daily demands (try to keep regular staff meetings to an hour or less), then writing and distributing the minutes promptly. In fact, particularly in medium and large organizations, the minutes often have a much wider distribution than to the team members themselves. To that wider distribution, *the minutes are the project.* They are, accordingly, to be taken very seriously by the project leader. The meeting minutes are not something to be delegated.

Over time, this mode of operation develops a solid working relationship among team members characterized by forthright and effective communication, trust, mutual respect, and support. These bonds must be formed early and the team's working behavior must be fully in place and well exercised so that when (as inevitably will be the case) the serious, *even threatening,* problems occur, the team will be able to withstand the pressure and handle these effectively and successfully.

In fact it is of little use to call a meeting of virtual strangers when a crisis occurs. Even worse, under these circumstances, the team meeting can become associated with the stress and angst related to grappling with and trying to solve serious problems instead of the positive, sometimes even exhilarating, experience that these meetings ought to be. The *practiced team* is much better able to deal with and solve serious problems as they occur. They will do so because they will have experienced many small successes (progress) working together, thereby increasing by increments their skill and confidence so they are ready to take on the "big one" when it occurs.

Furthermore, the well-practiced team can often foresee and avoid serious or crippling problems before they burst forth, fully matured, to attack and undo their accomplishments. If undertaken properly and consistently, the cumulative effect of this methodology can be very salutary. By fostering a climate of shared purpose rather than one of adversarial relationship, the team is not only better able to deal effectively with serious problems as they arise but it will also be open to and poised to deal with change, even to the point of making the *innovative leap* when that action is required and appropriate. *Thus, the practiced team is well suited to fostering innovation.*

An Example of Team Innovation—Surface-Mount Technology. The application controller ultimately required new, higher-density circuitry. This high density is achieved by a method of packaging called "surface-mount technology." The challenge was to bring a product design which uses surface-mount integrated circuit devices into a production environment built up exclusively around older, through-hole printed circuit board assembly techniques.

Key members of the application controller team represented Manufacturing, Quality Assurance, and Service, constituencies most affected by the proposed introduction of this new technology. It helped that everyone knew that this technology had to be adopted eventually. The questions were: Why now? Why does it have to start with us? Are we ready? Is the organization ready? Nevertheless, everyone on the team gained ownership of the goal to use surface-mount devices on the main PC board. Without these devices, the board layout was not feasible in the space available. There were potential cost savings and reliability improvements to be made as well.

Everyone on the team became intimate with the facts and details of this issue, and they went to work to make the change happen. In the end it was done using a combination of in-house and, with the effective participation of the Purchasing department, external vendor resources. The in-house development support staff and the manufacturing staff were trained and primed to deal with this new technology. The first production version of the application controller had about 15 percent surface-mount devices on the main PC board. However, an enhanced version which followed 3 years later had approximately 80 percent surface-mount devices installed. By that time the use of surface-mount technology had become routine for the company.

Dealing with change often engenders anticipation, excitement, enthusiasm, and the spontaneous release of creative energy. Just as often, however, the demands of change can bring on feelings of apprehension, of inadequacy, of cynicism (they'll never do it!), even of outright fear on the part of some participants. Which of these reactions prevails is often less related to the change itself then to manner in which the team has prepared for and presented its proposal to the organization at large. The application controller team was not only confidently successful in the application of surface-mount technology within its project, but also exhilarated and proud to have made an *innovative leap* in applying a new technology to the company's process and products.

The Feasibility Study. The initiation of a project often requires a feasibility study. The objective of the feasibility study is to answer the question: Is it possible to successfully complete this project? The effort might be unprecedented: Is it possible, given the current state of technology, to land a man on the moon and bring him safely back to earth? Alternatively, the question might be more down to earth: Is the goal achievable given the skills and the resources that are available (or are likely to be available) to our organization?

Establishing Feasibility—IBM System 360, Model 50. In the early 1960s, the author was an engineering manager for the IBM Model 50, one of the System 360 computers under development at that time at the IBM facility in Poughkeepsie, NY. Everything was new: the system architecture, the technology used in the digital circuitry, the high-density packaging, the interconnect scheme, power distribution, design automation support tools, everything. Several key questions were: How will the logic circuit set perform? What will be the cycle time? Are there any nasty surprises lurking just out of sight, for example, electrical noise or cross talk?

Senior management decided to build a feasibility model to get the answers to these questions. The development team was delighted with that assignment. The design was essentially complete. The approach was simple: Count the circuit logic levels from the beginning to the end of the cycle. And, because wiring length contributes to delay and cycle time, it was necessary to make a reasonable estimate of the wiring configuration likely to be encountered in the final package. Accordingly, circuit packaging, interconnect, and layout were made to conform as closely as possible to the final configuration, as we were able to envision it at the time.

The actual number of circuits and packaging units that were used in the feasibility model were a small fraction of those that were eventually used in the final Model 50. Probably no more than 1 percent of the final circuit count turned up in the feasibility model. Moreover, some important key elements were not addressed in this study; for example, the read-only memory used for instruction sequence control was not involved in this evaluation—that was left for a later time.

Nevertheless, in spite of these shortcomings—one might say because of these shortcomings—the feasibility study was a great success. The unit was designed, laid out, built and made to run in a relatively short time—a matter of several months. Top management and the development team got the answers to their questions, and those answers generally affirmed the design assumptions. In fact, the circuitry was, for the most part, faster than the conservative predictions being made by their designers, although we were surprised by the greater-than-expected contribution that the module-to-module interconnect made to the total delay. Overall, we were very encouraged by the performance that was predicted by the feasibility model, and that predicted performance became fact a couple of years later in the production version of the Model 50 (Pugh et al. 1991).

Looking back on this experience it is quite clear that there were many more questions—some of them only partially formulated or not articulated at all—that were addressed in this feasibility study. Among these were: Does the design support and implementation system work from beginning to end? Will some key component break down (for example the design automation tools or the packaging)? Can the team overcome problems? Can it get the feasibility model to work? Can it deliver on time? Yet, despite all of these questions, there is no substitute for a working unit—even one modeling just a tiny fraction of the final version—to instill confidence in top management, and to strengthen everyone's resolve going forward.

Establishing Feasibility—Brunelleschi's Breakthrough. In the historical concept statement for the construction of the cathedral in Florence, the requirement to establish technical feasibility for the undertaking was built into the project goal itself. Di Cambio, the first architect, conceived the cathedral and the Duomo, even though the means to construct the dome itself were literally out of reach when he began construction at the beginning of the fourteenth century. In fact, over a hundred years elapsed between di Cambio's laying of the foundation for Santa Maria del Fiore and Filippo Brunelleschi's breakthrough which enabled construction of the great Duomo in the year 1420 (see Figure 17.5).

The problem was how to put a roof over the enormous expanse of the tribune, which stood unfinished and gaping while the republic cogitated. No precedent existed, for no dome of comparable size had been raised since ancient times and the methods used by the ancients were mysterious (McCarthy 1963).

To resolve the problem, the leaders of the Florentine Republic held a design competition in 1420 to which masters from every corner of Italy were invited. Filippo Brunelleschi, who had been studying architecture in Rome, and who had been specifically studying the methods used by the ancient builders, found a way of raising the dome without the use of external masonry supports, a feat everyone believed to be impossible.

Brunelleschi proposed an ingenious construction of total novelty and of unexpected benefits in economy and utility. Looking at it today, more than 500 years after its construction, it is easy to take the design's success for granted.

But the wool merchants and others of the city's leaders who funded the cathedral's construction did not leap at Brunelleschi's plan. Ever the cautious innovators, they chose instead to have Brunelleschi first try his theories and methodology for raising the dome in a much smaller church currently under construction. Only after the dome in the smaller church was shown to be feasible, was Brunelleschi given the authorization to proceed with the great cathedral.

Establishing Feasibility in the Marketplace. Establishing feasibility applies to more than the technical issues as outlined in the examples above; it also applies to establishing feasibility according to the needs of the real world in which the product must compete. The best—perhaps the only—way in which this can be done is to be there to talk to, interact with, and respond to potential customers for the planned product. Visiting and talking to customers, especially potential users, is an essential part of establishing feasibility in the marketplace. One structured technique that has proven effective is the focus group.

The Focus Group. This is a small group (rarely more than a dozen people) who are selected as representing a specific customer population and whose discussion is focused on a well-defined question. The objective of conducting a focus group is to secure customer feedback about the product. While the beta test is usually undertaken just prior to product release in order to be sure that the product as designed is functionally complete and robust in its operation, the focus group evaluation may be taken at any point in the product development cycle from the concept stage right up to the point of product release, and even afterward. Primary attention is paid here to the marketability of the product.

The focus session is usually arranged by a consultant. Potential product users are carefully selected and invited to join the focus group. The product is presented to the focus group in a scripted manner, demonstrations are made as appropriate, members of the group may actually use the proposed product, and a series of questions is asked to determine potential customer reaction. The session may be secretly witnessed by interested parties and even photographed for future analysis and for the record.

Sometimes the group will be interviewed as a whole, sometimes members will be shown the product alone, and interviewed singly as well. Questions are asked in such a way as to obtain a quantitative response to what is usually, in the focus member's mind, a qualitative impression.

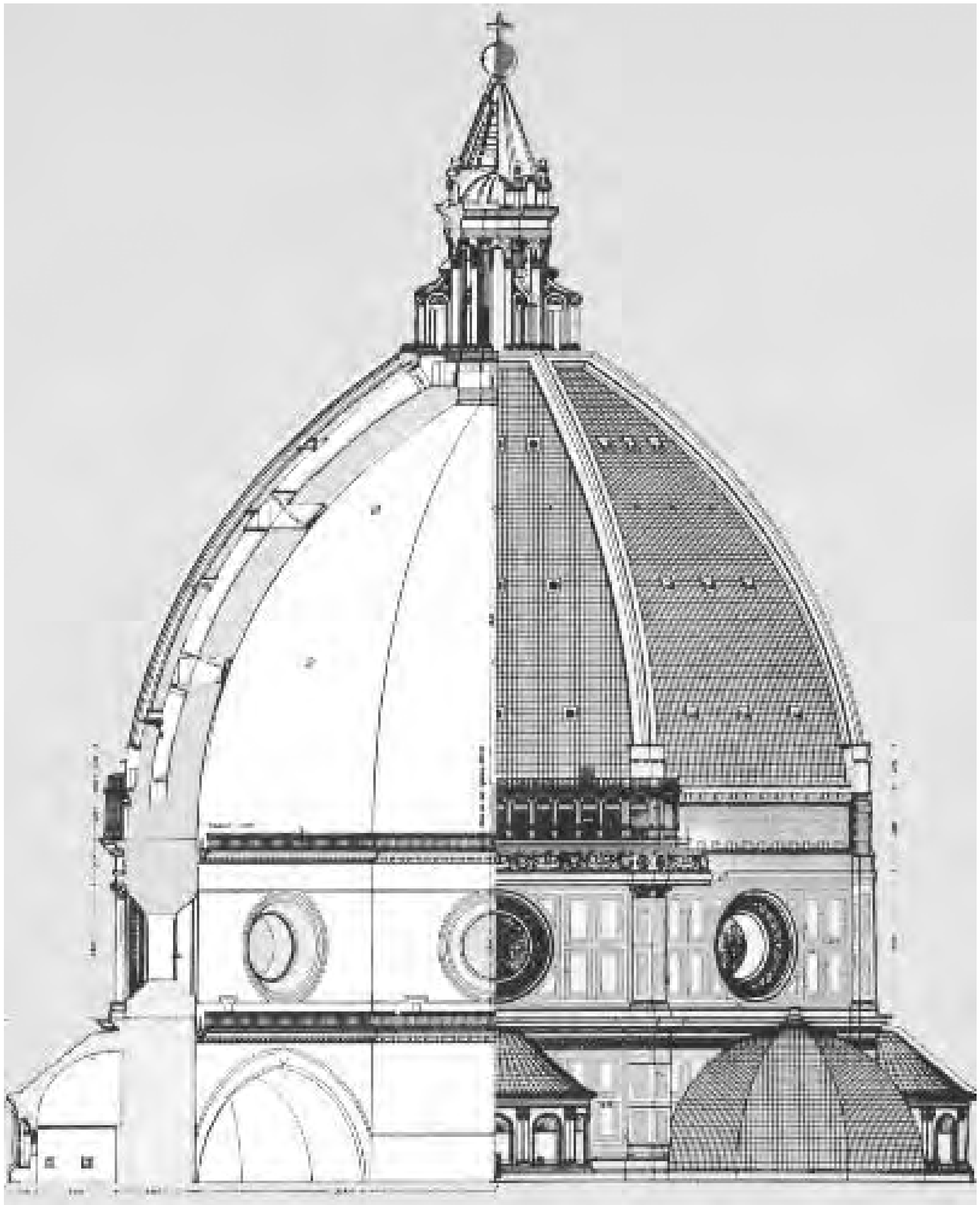

FIGURE 17.5 The cupola of the Duomo. (*Source: Used with permission of La Mandragora, Florence, Italy.*)

For example it might go something like this: (1) Do you need this product in your office, laboratory, etc.? (2) If you do need it, how badly do you want one: (*a*) Need it right now. (*b*) It is pretty important; need it soon. (*c*) Will take another look next year. (*d*) Do not need one in the foreseeable future.

How much would you be willing to pay for this box? Write down your answers and pass them to the referee. Or, would you be willing to pay $7000? How about $6000? How about $5000? How about $4000? And so forth.

What is the most important/valuable feature? Is anything important missing? What other features would you like to see in this unit? What might that feature be worth in additional cost?

There might be questions about distribution: local store, mail order, direct order, Internet, etc.? How about service, warranty, etc.?

Establish Feasibility—A Sacred Trust. In the final analysis, feasibility can address many questions: Does it work? Is it reliable? Can we afford the development and manufacturing start-up costs? Will we meet the target manufacturing cost? Is the schedule realistic? Can we make the schedule? Do we have a competitive edge? Will the potential customers buy it? These questions ought to be asked early and often during every significant project undertaking. The project manager should make every reasonable effort to get the best answers possible to the key questions related to project goals and performance.

Moving from the Discovery Phase to the Implementation Phase. To go or not to go, that is the question. But it is often not explicitly asked, let alone answered. Interestingly, at this point at the end of the Discovery Phase it is often more difficult to kill a project than to keep it going. Yet, if it ought to be stopped, now is the time to stop it.

Usually, a project will have had to pass over a multitude of hurdles in order to get through the Discovery Phase. Several project champions may have emerged in the decision-making structure; managers will have staked out positions for or against the project; careers are on the line; there may even be a working model. It is very difficult at this point to contemplate stopping the project. But now is the last time to stop the project without incurring the much greater expense and level of commitment associated with the Implementation Phase.

One generic failure mode that can trip up the project team is the emphasis on one aspect or one issue to the exclusion or de-emphasis of others. For example, a technically oriented company might have the tendency to work on establishing technical and scientific feasibility during the Discovery Phase, but not pay adequate attention to the marketing and business questions that always accompany the launch of a new product or service. Simply because the technical feasibility has been established does not mean that the product will be successful in the marketplace. Conversely, a marketing-oriented organization might get carried away with the business potential of their concept, but fail to do the technical feasibility and manufacturability work necessary to place the product or service on a solid technical footing prior to launch.

It is well, therefore, to go through a formal review at this point to make the go no-go decision and to have management formally sign off on the Implementation Phase. This review must be broadly based, taking into account all the technical, marketing, and business aspects of the proposed product or service before going forward.

The Project Proposal. The project proposal helps move a project from the Discovery Phase to the Implementation Phase. The following example, a composite from several product development projects, illustrates the document. It is about 30 pages in its full length. For each of the elements which will collectively define the move, it includes information on which to base the decision to make that move.

Product Concept, 1.5 Pages. The product concept is fleshed out beyond the few sentences suggested earlier in the development process. Still the concept is short and to the point.

Marketing Strategy, 2 Pages. Outlines the marketing approach. Is it direct or through dealers? What are the plans for marketing communication and sales? What are the customer benefits, etc.?

Target Specifications, 3 Pages. One product is small and simple to use, yet the target specifications are complex and detailed, especially details of the application and user interface specifications.

Pricing and Competition, 1 Page. Another product is unique and, at the present time at least, there is no direct competition for the unit. But there is plenty of indirect competition. Target pricing is based on a combination of competitive market factors and target manufacturing cost.

Engineering Approach, 9 Pages. This is a detailed description of the product, including several figures. In one of the products, there is a complex optical subassembly to describe, as well as the electronic PC board, user interface details, and system control logic.

Engineering Estimate of Manufacturing Cost, 1 Page. This is the initial cost estimate and it is usually made by the engineering staff on the basis of the cost of parts and an experienced estimate of what it will take to assemble and test the package for shipment. Later, during the Implementation Phase, the cost will be re-estimated and established by the manufacturing staff on the basis of detailed documentation produced by engineering.

Reliability and Installation and Estimated Warranty Cost, 1 Page. This an estimate by engineering of the reliability to be expected and the installation and warranty costs to be anticipated. Later during the Implementation Phase, the reliability figures will be established by the QA department by calculation and testing methodology. Similarly, the Service organization will establish installation and warranty costs for the product.

Schedule, 4 Pages. In this case, the schedule highlights are in the body of the report. Usually a detailed computerized schedule chart is also provided. The highlights are:

Year 1:

Begin effort in earnest	January 1
Complete Concept Document	February 1
Enter Discovery Phase (management approval)	February 15
Complete Discovery Phase	August 15
Project Proposal (this document)	September 15
Enter Implementation Phase (management approval)	October 1

Year 2:

Complete optical design	January 1
Complete mechanical design	January 1
Complete electrical design	January 1
Complete software design	February 1
Build 10 preproduction prototypes	March 1
Release drawings	April 1
Test prototypes	April 1–May 1
Evaluate prototypes internally and with potential customers—beta test	May l–July 1
Set up first production run	July 1
Begin first shipments	August 1

These days, 18 months is just a moderately fast program. In the author's experience product development projects generally take from 1 to 3 years. One year or less is very short and more than 3 years is very long. However, in the retail PC computer industry, for example, some project development times have been shortened to 6 months or less. We have been told that in this industry more than one team may be operating concurrently and out of phase by six months. Each team has a development cycle of 1 year, but a new product is announced and shipped semiannually because each development team completes its efforts 6 months apart from the other. Now that's really fast! Under those circumstances there may be a very much shortened Discovery Phase, and management approval must be forthcoming in a day or two instead of 2 weeks as shown above.

Development Cost, 1 Page. This includes an estimate of the cost of the engineering staff over the period of time outlined in the schedule. Thus, when the schedule stretches out, the costs go up as well. It includes outside consultants—for example, industrial design consultation—as well as the cost for the preproduction prototypes which, while usually assembled in the factory, are often expensed to the engineering development budget. That's one of the many reasons why very big, expensive, and complex products—for example, the modern commercial jet airplane—can be handled only by a few very large and well-established producers.

Capital Cost and Tooling, 1 Page. This will include the estimate of expenses for capital equipment that will be required to undertake the project. This equipment might be used in engineering or in manufacturing or both. Specialized tooling is also included in this estimate, for example, the tools that are required to make the plastic covers for the instrument and for making several small parts in the optical assembly. Specialized tooling is also required to make and test the PC board in production.

Risk Factors and Risk Management, 5 Pages. This is a thorough review of the risks that exist in a given development going forward. In some cases, the Discovery Phase will have eliminated many of the technical risks that exist in the undertaking. More often, however, there are still many risks that remain because there is some point at which the additional time that might be taken to resolve problems also delays that product's introduction to market. That delay can often entail more cost and risk than simply going forward in spite of the unknown factors that remain. This is always a matter of judgment, and some unknown factors simply cannot be resolved other than by going forward. At some point, therefore, management must make the conscious decision to move ahead and to take the risks involved with that decision. But first they must honestly examine those risks.

For example, the risks described in one Project Proposal report were (1) issues concerning the optics, (2) possible problems related to certification testing to specific published standards, (3) instrument temperature self-rise and possible cooling problems, (4) product testing and evaluation, and (5) production and distribution issues.

In the end, none of these became a serious problem. But they were all potentially serious, and it is better to acknowledge these before blindly plunging forward with implementation without having developed any contingency plans for dealing with them.

Summary and Change Record. Finally, there is an executive summary, up front just after the index page, and a few pages right behind the index page for keeping track of changes to the Project Proposal document itself. This document ought to be kept up to date regularly—say quarterly—and filed either electronically or in hard copy in the project history file. In one particular case, the summary required just one page and the following items were included in bold type with the text on that single page:

The product is a completely new concept.

It is expected to sell in the quantity of 3000 units per year.

The cost is expected to be $2500.

The price will be set at $6000.

The development cost is estimated to be $1,000,000.

The tooling will be about $250,000.

First shipments are expected to begin August 1.

The major risks are optics and application software.

Thus in one quick read of that single page, management or anyone else can get the complete picture very quickly. They can read on for more detail, or go to a particular section that interests them. They have the big picture, the context, and the proposal details in front of them. And, the requirements for a go no-go decision are in hand. There should be no valid reason to ask for more information.

The Product Functional Specifications. In order that everyone work to the product specifications, it is essential that the statement of requirements is agreed upon as early in the project as possible. The statement may be in the form of text—paper or electronic; it may include drawings or graphics; it may refer to existing systems or products. If there is a performance requirement, then it should be stated explicitly and quantitatively to the extent possible.

The list of *deliverables* is identified. In the case of a manufactured product this includes, for example: assembled and working prototypes for marketing, manufacturing, and quality testing and agency certification requirements; drawings and appropriate documentation for release to the factory; documentation for the methods of fabrication, assembly and test; components specifications and appropriate vendors; part numbers and bills of materials for customer deliverables, including user manuals.

Deliverables can include all that is necessary for the complete product introduction including, for example: the schedule of preproduction and early production units and their allocation to customers for evaluation; the plan and schedule for sales training and service training; provision for customer demonstration units; preparation and distribution of marketing introduction materials such as brochures, customer presentations, and advertising material.

Moreover, there must be a close linkage among the project product development staff, Manufacturing, QA, Service, and those who are responsible for introduction of the new product through initial buildup and eventual acceptance. All of the project's expenditure and the prestige of the sponsor is on the line at introduction. If there is a mistake or oversight at that point, it is most costly. So it is important that the plan carry the project right through product introduction to make sure that everything is in place for its success. When there is a handoff to be made—for example, from the product development team to the product marketing team—the transition planning should be so thorough and complete as to assure that the prospect of a slipup at this critical stage is minimized.

Project Implementation Phase. The project implementation is usually the most time-consuming and the most costly phase of a project. This need not be the case. In fact, if the proper foundation has been laid for implementation, this can be the most straightforward phase. The key is careful attention paid to producing appropriate documentation, doing the groundwork of the Concept and Discovery Phases, and proceeding to implementation on that strong foundation.

There are many tools available today to help the management team with the mechanics of project management: the ubiquitous word-processing and spread sheet programs, project management and scheduling programs, e-mail and other communication methodologies, and presentation software; the list is long. There are also many books and articles that address this subject, and more become available each day. A short list of additional readings at the end of this section points the reader to detailed treatment of these issues, which is beyond the scope of the present discussion.

As useful as these tools are, they are no substitute for a disciplined analysis such as the one advocated here. Today's modern tools help get the job done more efficiently and expeditiously. But they don't help clarify the fundamental vision of the project goals and the means for achieving them. Remember that Arnolfo di Cambio and Filippo Brunelleschi didn't have our modern technology at their service, yet their accomplishment in project management is awesome, even by the standards of the late twentieth century.

The Three Critical Periods for Customer Acceptance of a New Product. The development, manufacture, and introduction of industrial instrumentation and related computer control devices is typical of the sort of activity which requires project management. The applications for which these instruments are used are specialized, and the products themselves are quite complex. Moreover, we have found that there is a high degree of variability in the training, experience, and ability of potential customers. Often the customers are expert, or at least knowledgeable, in the target application, although they are not necessarily skilled in operating the instrument or especially adept using computer software, environments now so often used to control modern instrumentation systems.

Our further experience has been that the design team members—engineers and technical application specialists—tend to concentrate on specifications and functionality directed to the long-term use of the product, sometimes to the detriment of the potential customer's initial encounter with the product. On the other hand, sales and field specialists are very sensitive to the customer's initial reaction to a new product. However, their opinions are often not sought until the product is announced and on the verge of initial delivery. By that time it is too late to respond to criticisms that the product is "incomplete," "too complicated," "not user-friendly," etc. The reasons given for the failure to aggressively seek input from the field run generally along the following lines:

1. The new product is a secret.
2. If we start talking to field people about it before it is ready, they will stop selling the current model and orders will dry up!
3. It is difficult to talk in terms of concepts or about the future with people in the field (even our people) who are used to dealing in specifics and with the here and now.

4. Even if the field representatives don't like the new product's user interface, we don't have the time or resources now to make improvements. No product is perfect. Let them sell what they have. If these issues are opened up now we may as well throw the schedule out the window!

Of course, there is a measure of validity in each argument, especially the first one. But there is also a high price to pay if due consideration is not given to the three critical periods for product acceptance. The critical periods are

- The initial moments
- The first day
- The remainder of the product's life

The fact is that the amount of specification and development effort spent on the first two items invariably pales in comparison with the long-term considerations for product use. Yet, if the first moments with the product are not focused upon and handled correctly, we may not attract enough customers either to experience its depth and sophistication or to make the product viable. What is more, the price paid in development time and effort need not be high if these critical periods are addressed specifically and early enough.

The Initial Moments. It is during the initial moments of exposure to the product that the customer gains the critical first impressions. Exposure may be in a salesperson's demonstration; it may be in a self-directed operating session; it may come in the form of a box on the floor, from which the customer must take the contents, assemble them, and set them into operation. The initial moments may merge into the first day with the product.

Simplicity ought to be the focus when dealing with the initial moments. One useful technique is to build in operating support for the salesperson's demonstration. For example, as applied to instrumentation systems, operating methods and results can be "factory-installed." These previously stored methods and results can be used later in the field to demonstrate instrument functionality.

Furthermore, we have found that it is often much easier to run an instrument analysis than it is to set the system up and initialize an operating method. It is also quicker and easier to evolve specialized operating methods from an available suite of stored methods than to develop them from scratch. Accordingly, use of "factory-installed" methods helps the salesperson and customer during the initial encounter; these then form the basis for creating the specially tuned methods that the customer will ultimately require. This approach establishes a solid basis for the customers' understanding and acceptance of the product and for their eventual mastery of its operation.

Some products, especially computer-based products, are often set up for self-demonstration. Simply push a button or point to an icon on the screen and the "canned" demonstration takes off. This is standard practice, for example, with electronic musical keyboard instruments—and it can be very effective.

Product packaging and documentation are critically important for establishing first impressions. Opening that box on the floor can present a daunting challenge to the customer who is faced with getting the new purchase set up and running, especially for the first-time user. One useful technique is to separate installation and setup instructions from the User's Reference or Operating Guide, which is a more formidable document. It is also helpful to use lots of diagrams and other visual aids to help with the initial assembly and setup task.

An event from the author's experience exemplifies some of the first-moment issues and illustrates the means taken to deal with them. When the applications controller was first introduced to the sales force and field applications support specialists, there was genuine enthusiasm for the product concept and features. But there was also serious concern expressed about the apparent complexity of what should have been an easy-to-use product targeted to the low-priced end of the market. There was also concern about the lack of several important software features that the development staff said were to "come later." In fact, there was enough anxiety expressed by our own field sales and support staff that the decision was made to delay introduction for several months and address the deficiencies noted. We knew the effort would be worthwhile because the sales staff really liked the product. They said that it just wasn't ready yet.

A working group was formed, composed of inside development experts and several field specialists who where selected to represent their colleagues' needs and the customers' requirements. Speedy resolution of the problems was critical, and it was surprising how quickly a consensus developed about what had to be done to go successfully to market. The missing software features were agreed upon and developed more swiftly than we had imagined was possible.

Meanwhile, the working group specifically focused on the first moments and the first day with the product. They decided that two prespecified methods would be devised and stored in the unit and that the product would come out of the box ready to go. The user had only to turn on the power and a control screen would come up with the default method in place. A press of the start button would cause the unit to run the analysis, display the results on the screen, and automatically print out the analysis report.

Except for the few missing features, there was little of this "ready-to-go" functionality that did not exist already in the product. Only the streamlined start-up sequence was added. Yet, these simple adaptations, which focused specifically on the first moments with the product, completely changed the sales specialists' perception of the product's complexity. The product went from hard to use to easy to use. This was one of the most important elements of our response to the sales specialists' concerns, and it was the easiest and fastest to implement.

The product was announced and shipped on its revised schedule several months later. It was a very successful introduction, and sales of the applications controller accelerated rapidly. There is no question that we did the right thing by holding the product back and addressing the deficiencies pointed out by the field sales staff, and by focusing on the customers' first critical moments with the product.

The First Day. The approach to dealing with the first day with a new and reasonably complex product is an extension of the methodology and techniques outlined for the first moments. In this instance the focus is on a longer period of customer interaction with the product and on the deeper understanding that builds up as the product is activated and exercised. Many of us share the common experience of learning to use computer hardware and software products. Sometimes these can take months to master. In fact many features of these products are left unlearned and unused by the average person. They learn what they need to know to get the current job done. When they need to know more, they will go back to learn the additional features needed to address those new application requirements.

It is important, therefore, to give the customers the means to control the level of information and learning that they must deal with, especially at the beginning. It is also important that they quickly get the new product running in a meaningful way, in the first moments if that is possible, but certainly during the first day. Initial success with the product quickly overcomes frustration and fear, and encourages the customer to go forward with the learning process.

One technique that can be helpful in this regard is the use of a "tutorial." The tutorial usually consists of a manual or flowchart and a prearranged operating sequence that takes the customer through the product function in an orderly way. Moreover, previously stored methods and data can be used with the tutorial to support customer training. Development of an effective tutorial is an excellent way to focus on the first day with a new product. In fact, the applications controller mentioned earlier did have a tutorial feature built into it, and a specific manual was prepared to go with the tutorial.

New technology, especially new computer technology, is having an important impact in this area. In the case of one brand new computer-controlled instrument product that the author is aware of, the manuals have been replaced by a CD-ROM. Stored on that CD-ROM are the control software, the "help" files for on-line user support, the manual that shows how to assemble the complete system, and the User's Reference Manual. That CD-ROM itself is packaged in an attractive cardboard foldout that gives straightforward, step-by-step instructions on how to install the CD-ROM and get the system up and running. It can be made easy! What is more, in this particular application there is a specialized technique for preparing samples to be analyzed. The CD-ROM contains a tutorial movie video that shows, on screen and up close, how to properly prepare the sample for analysis. That kind of customer first-day support with a new product is hard to beat.

The Remainder of the Product's Life. The natural focus for a development team is the day-in, day-out use of the product. So that is where the attention is usually placed. In fact, the first moments, the first day and the rest of the customer's life with a new product form a continuum. The things done to improve the customer's first moments and first day yield benefits throughout the use of the product. For example, consider the improved product accessibility that the built-in tutorial provides when the experienced operator has to train someone new in the product operation.

We noted in the above-mentioned computer-controlled instrument product that there was extensive use of context-sensitive "help" files that, along with a good user's reference manual, form the basis of solid support for the user over the lifetime of the product.

Of course, no amount of focus on the first moments or the first-day operation can mask an inferior functionality. The product has to be logical, predictable, and solid in everyday use to properly benefit from improvements to aspects of the customer's initial encounter with the product.

Support for Multiple Languages. One additional point to be made in the area of customer acceptance is the possible requirement to translate a product or service into another language. Sometimes there is a dilemma with respect to adapting our product or service to language and usage other than our own. Is it worth the time and expense to translate the product or service in anticipation of increased sales or to fend off a possible drop in sales in foreign markets, or not? If so, in what languages and with what priority?

Sometimes the answer is clearly yes. The high-priority languages are usually those of industrialized countries. Of course, there are many special cases. Sometimes the answer is unclear until the translation is made and the potential market is tested. Sometimes it is just not worth the effort and expense. Whatever the case, to operate in global markets, it is wise to plan product and service for eventual translation into languages other than that of its original formulation.

There is more to this than meets the eye. In fact, the terminology in current use for support of additional languages is not "translation" but rather "localization," to account for this broader view of the subject. For example, word-for-word translations often don't fit into the space available. There may be alternative ways to ask a question and then deal with the response. The protocols for stating dates and addresses vary. Monetary units are different from country to country. The list of differences is long and vexing. Therefore, localization must be addressed early in the product planning process or the product may be locked out of some markets later. For example, if there are written legends on the product or service, it is worth planning ahead for changing those legends into another language. This is of special concern if expensive tooling is required. Finally—and this is very important—it is the author's experience that, while the adaptation of the product for multiple languages is an internal development responsibility, it is usually best to go to an outside, specialized, service vendor to implement the translation itself.

General Applicability of This Approach to Customer Product Acceptance. We believe that the approach outlined here—focusing on the first moments, the first day, and the remainder of product life—has general applicability. The author's experience and examples demonstrate this approach in the context of complex instrument system products. To adapt this methodology to a wide range of applications it will be necessary for project managers to pose these questions in their particular milieu. This will usually mean contacting people in the field, potential users of the product or service, describing the project—balancing somehow the need for secrecy against the need to obtain information—and considering carefully their responses.

The prudent project manager will put a line item into the Product Functional Specifications to specifically address the three critical periods for customer acceptance of a new product.

Verification Phase. Although the Verification Phase, by its nature, takes place after the preparation of the Product Proposal and the Functional specifications, the Product Test Plan ought to be prepared simultaneously with those two documents. Early consideration of the test plan can shed light on the product requirements. For example, suppose the product is not supposed to weigh more than $6^1/_2$ pounds—3 kilograms—or that it must survive a fall from a specific height, or that it is to be exposed to outdoor use. It is essential to know that at the outset and not to be surprised by test requirements after the product has been designed and the manufacturing cycle committed.

Consider the example of testing for CE Mark compliance for generation of radio-frequency interference (RFI) and for susceptibility to RFI. (The CE Mark and its test protocols originated in the

European Community.) One may think that this applies only to high-technology electronic products. It does not. Once, in an independent RFI testing lab, the author observed that the staff was testing a lawn mower for RFI emissions and susceptibility. What was a lawn mower doing here? The newly designed lawnmower ignition system was controlled by a microprocessor. To qualify for export to Europe the lawn mower was required to qualify for the CE Mark.

There is much that can be done ahead of time. For example, filters can be added to circuits that have the potential to radiate. Specialty filter components can be placed on cable connectors coming in and going out of the electronic assemblies and PC boards. There is usually plenty of time to do a design review for whatever testing will be required in advance of undertaking the design, and certainly well in advance of freezing the design and undertaking the test itself. The people who do this type of testing on a regular basis will have many suggestions for those who are new to this process. An early design conference and product review for testing and verification can save lots of money, time, and angst later on.

Product Test Plan. The product test plan must be prepared simultaneously with the Product Development Plan because it will be necessary to design in the features that will assure that the unit will satisfy the test criteria. In the author's experience, a typical test plan outline would be along the following lines:

1. CE Mark certification. This involves a safety review and test, designated IEC-1010-1, and a RFI radiation and susceptibility test, designated IEC-1010-2. When the unit has met the criteria required by this certification review and testing, the CE Mark label may be applied.
2. Additional certifications may include CSA (Canadian Standards Association) and UL (Underwriters Laboratory).
3. Test to product design requirements; for example, component analysis; fuse rating; power on-off cycling; line voltage sag, surge, dropout; drop test in shipping container; thermal profile; accelerated life test.
4. Test to application requirements; for example, product life test at 10,000 hours or more power-on operation without failure; mean time between failure analysis and prediction; performance at 35° at 80 percent relative humidity; performance at 10° at 50 percent relative humidity; operation at 50/60-Hz high line/low line; functionality with accessories and peripheral devices; lifetime predictions for critical components.
5. Maintainability/serviceability; for example, serviceability analysis; mean time to repair analysis and prediction; product performance verification; establishment of depot or on-site repair and spare parts strategy; assurance of parts interchangeability; simulation of installation procedure; and the like.
6. Documentation; for example, review all manuals and support material for completeness and accuracy; review advertising literature for claims; assess patent status prior to announcement; review factory test procedures and specifications; review product test and diagnostic procedures; etc.

The items outlined above focus primarily on the hardware component of the product. These days, however, many products are subject to highly complex and sophisticated control mechanisms that need to be tested very thoroughly as well. Many times these control systems are implemented via a personal computer that is connected to the product or by firmware embedded in a dedicated device that provides the user interface and controls the product at hand. This is often the case with today's instrumentation devices and with modern numerically controlled machine tools.

Testing software and firmware usually focuses on testing the many combinations of control inputs and product readout conditions that can occur, in contrast to physical stress testing of the software. But that is not always the case. A product—for example a database query system—might have dozens, hundreds, or even thousands of terminals connected. What will happen if the traffic on those terminals rises beyond the normal level of experience? Will the system slow down; will it become unstable; will it crash? It is sometimes advisable to set up a stress test, activate all of those terminals at once, and find out.

More typically, however, the focus will be the functionality of the complete range of product states and user inputs. To deal with this it is necessary to set up a complete check list of all the functions to be exercised and the conditions under which they must be tested. Often these test procedures can run to many tens or even hundreds of pages.

Repeating a test like this over and over again as features are added, changes are made, and bugs are fixed, can become very fatiguing for the test technician and induce errors. In the PC environment, some products are now available that remember the test sequence and repeat it again and again as required.

Still other products (e.g., Lotus Notes, from Lotus Development Corp.) help to keep track of bugs and problems as they are found. These are especially valuable as problems are turned up from multiple sources. In modern development environments, problem reporting can come from many sources: the developer in the next cubicle, the evaluator in the lab, the SQA engineer, the beta-site evaluator, the service technician, the customer. Today, a problem-reporting environment that spans several continents and many time zones is not unusual. Accordingly, it can be very difficult to report problems in a timely way, and to prioritize and deal with them in an orderly fashion. It is, therefore, important to take advantage of all the tools that are available to cope with and streamline this demanding and complex activity.

Beta Testing. In its original meaning, beta testing usually involved the exercise and evaluation of a complete product working in the operating system environment. Beta testing would ordinarily precede announcement and release. Today, the idea of beta testing has been expanded to include customer evaluation and input. Sometimes it is done in a flexible and free-form evaluation: Try it out, see how you like it. Sometimes it is done in a very structured manner: Here is the unit for one week or one month, please use it in the manner outlined, and answer the following questions about its performance and your impressions.

We certainly recommend the latter approach. The beta test is important because it causes the developers to interact directly with the customer. It must be taken seriously. In fact, the beta test—and many other elements of a project development for that matter—ought themselves to be organized into a subproject with all of the elements of project management applied to it, though on an appropriately smaller scale. A concept statement is appropriate to answer such questions as: What is the test intended to accomplish? How many customers and testers will be contacted? How many units will be required? What questions will be asked? How are the results to be interpreted?

In contrast to the focus group, which may be established quite early in the project schedule—and, we might add, the earlier the better—the beta test must come at the end of the implementation phase, and usually just before announcement and release. Therefore, there is often a severe time constraint on the information that flows from the beta test, for on it depends whether the developers should (or can) make the changes and enhancements to the product that the beta test suggests. There is little point in undertaking this verification step if there will be no provision for dealing with the results.

Beta testing is difficult but worthwhile. When well conducted, in a projectlike manner, it can yield critically valuable information on which to base midcourse correction and fine tuning prior to final rollout.

Project Management—The Augmented Product. Sometimes the focus of the team and the project manager is so intently on the product itself and its functionality that important supportive components and materials are often sadly neglected. This is particularly the case in organizations that produce technical products. We alluded to this tendency in the three critical periods for customer acceptance and their specific support needs.

There is always more to a product or service than the "product" itself. We call the larger entity the "augmented product." One classic example of augmentation is the brand name. A nationally known brand is often perceived as more valuable than a fledgling newcomer. Connecting one's product to an already accepted offering can add value and increase initial acceptance. Similarly, advertising, testimonials, and local connections can add value in this sense. Packaging of the product or service, including supporting material, is a feature of the augmented product. Official government or state acceptance [e.g., selection as a government contractor, or, in some European countries, approval to display the notice, "By Appointment to His (or Her) Majesty," etc.] are augmentation features which may aid product success.

Two examples of the effect of product augmentation on marketing goods are provided by Bose Corporation and the Saturn division of General Motors. Bose, through a direct-to-the-customer marketing approach of its Wave Radio, an approach as innovative as the patented design of the radio itself, has augmented the product, securing superior product acceptance and pricing. Saturn set out at its founding in 1985 to create a network of dealers known for superior service. Year after year, Saturn dealers have been ranked at the top in customer satisfaction. That service has augmented their product, the car itself, enabling the company to position itself strongly with first-time car buyers.

The wrapping really matters. Paying attention to it may spell the difference between success and failure for the project manager.

A FINAL ADMONITION

There is no formula or cookbook recipe that can assure success in these complex endeavors. We have suggested here a framework on which to proceed. In every case, the methodology will have to be adapted to the mechanisms, technologies, and the culture of the enterprise, which the project manager must successfully negotiate to carry out the project. While there is no guarantee of success, following the suggestions of this section will put the manager and his or her team on the right track. Having a track, recognizing what it is, and knowing where it is located is essential. There are hostile forces at work—some created by the project itself—that tend to push the team off course and threaten its well being. The known track will help the project manager and the team proceed, even in the face of those forces. Think of the outline presented here as the light on the miner's hard hat, its rays penetrating the darkness and showing the way forward. Use it wisely. Use it well.

REFERENCES

Chaikin, Andrew (1994). *A Man on the Moon—The Apollo Astronauts.* Viking, New York.

Industrial Research Institute (July, 1996). *Industrial Research and Development Facts,* Section 19, Industrial Research Institute, Washington, DC.

Juran, J. M. (1988). *Juran's Quality Control Handbook,* 4th ed. McGraw-Hill, New York, p. 22.19.

Levitt, Theodore (1962). *Innovation in Marketing.* McGraw-Hill, New York, p. 75.

McCarthy, Mary (1963). *The Stones of Florence.* Harcourt, Brace & World, New York, p. 68.

Peters, Thomas J., and Waterman, Jr., Robert H. (1983). *In Search of Excellence: Lessons from America's Best-Run Companies.* Macmillan, New York, p. 20.

Product Development Consulting (1990). Boston, MA.

Pugh, Emerson W., Johnson, Lyle R., and Palmer, John H. (1991). *IBM's 360 and Early 370 Systems.* The MIT Press, Cambridge, MA.

ADDITIONAL READING

Gouillart, Francis J., and Kelly, James N. (1995). *Transforming the Organization.* McGraw-Hill, New York.

Lewis, James P. (1995). *Fundamentals of Project Management.* American Management Association, New York.

Ludin, Ralph L., and Ludin, Irwin S. (1993). *The Noah Project: The Secrets of Practical Project Management.* Gower, Brookfield, VT.

Rummler, G. A., and Brache, A. P. (1990). *Improving Performance: How to Manage the White Space on the Organization Chart.* Jossey-Bass, San Francisco.

Shores, A. Richard (1994). *Reengineering the Factory.* Quality Press, American Society for Quality, Milwaukee.