

1. Illustrate the role of resource allocations in product development and plan timing.

It is likely that the firm cannot afford to invest in every product development opportunity in its desired balanced portfolio of projects. As timing and resource allocation are determined for the most promising projects, too many projects will invariably compete for too few resources. As a result, the attempt to assign resources and plan timing almost always results in a return to the prior evaluation and prioritization step to prune the set of projects to be pursued.

Resource Allocation:

Many organizations take on too many projects without regard for the limited availability of development resources. As a result, skilled engineers and managers are assigned to more and more projects, productivity drops off dramatically, projects take longer to complete, products become late to the market, and profits are lower. Aggregate planning helps an organization make efficient use of its resources by pursuing only those projects that can reasonably be completed with the budgeted resources.

Estimating the resources required for each of the projects in the plan by month, quarter, or year forces the organization to face the realities of finite resources. In most cases, the primary resource to be managed is the effort of the development staff, usually expressed in person-hours or person-months. Other critical resources may also require careful planning, such as model shop facilities, rapid prototyping equipment, pilot production lines, testing facilities, and so on. Estimates of required resources in each period can be compared with available resources to compute an overall capacity utilization ratio (demand/capacity) as well as utilizations by resource types.

Project Timing:

Determining the timing and sequence of projects, sometimes called pipeline management, must consider a number of factors, including:

- Timing of product introductions: Generally the sooner a product is brought to market the better. However, launching a product before it is of adequate quality can damage the reputation of the firm.

- **Technology readiness:** The robustness of the underlying technologies plays a critical role in the planning process. A proven, robust technology can be integrated into products much more quickly and reliably.
- **Market readiness:** The sequence of product introductions determines whether early adopters buy the low-end product and may trade up or whether they buy the high-end product offered at a high initial price. Releasing improvements too quickly can frustrate customers who want to keep up; on the other hand, releasing new products too slowly risks lagging behind competitors.
- **Competition:** The anticipated release of competing products may accelerate the timing of development projects.

2. Summarize the different methods of gathering raw data from customers to identify the needs.

Consistent with our basic philosophy of creating a high-quality information channel directly from the customer, gathering data involves contact with customers and experience with the use environment of the product. Three methods are commonly used:

- **Interviews:** One or more development team members discusses needs with a single customer. Interviews are usually conducted in the customer's environment and typically last one to two hours.
- **Focus groups:** A moderator facilitates a two-hour discussion with a group of 8 to 12 customers. Focus groups are typically conducted in a special room equipped with a two-way mirror allowing several members of the development team to observe the group. In most cases, the moderator is a professional market researcher, but a member of the development team sometimes moderates. The proceedings are usually video recorded. Participants are usually paid a modest fee (\$50 to \$100 each) for their attendance. The total cost of a focus group, including rental of the room, participant fees, video recording, and refreshments, is about \$5,000. In most U.S. cities, firms that recruit participants, moderate focus groups, and/or rent facilities are listed in directories under "Market Research".
- **Observing the product in use:** Watching customers use an existing product or perform a task for which a new product is intended can reveal important

details about customer needs. For example, a customer painting a house may use a screwdriver to open paint cans in addition to driving screws. Observation may be completely passive, without any direct interaction with the customer, or may involve working side by side with a customer, allowing members of the development team to develop firsthand experience using the product.

3. Demonstrate the different steps involved in the process of establishing target specifications.

The process of establishing the target specifications contains four steps:

Step 1: Prepare the List of Metrics

The most useful metrics are those that reflect as directly as possible the degree to which the product satisfies the customer needs. The relationship between needs and metrics is central to the entire concept of specifications. The working assumption is that a translation from customer needs to a set of precise, measurable specifications is possible and that meeting specifications will therefore lead to satisfaction of the associated customer needs. A good way to generate the list of metrics is to contemplate each need in turn and to consider what precise, measurable characteristic of the product will reflect the degree to which the product satisfies that need. In the ideal case, there is one and only one metric for each need. In practice, this is frequently not possible.

Step 2: Collect Competitive Benchmarking Information

Unless the team expects to enjoy a total monopoly, the relationship of the new product to competitive products is paramount in determining commercial success. While the team will have entered the product development process with some idea of how it wishes to compete in the marketplace, the target specifications are the language the team uses to discuss and agree on the detailed positioning of its product relative to existing products, both its own and competitors'. Information on competing products must be gathered to support these positioning decisions. The benchmarking chart is conceptually very simple. For each competitive product, the values of the metrics are simply

entered down a column. Gathering these data can be very time consuming, involving (at the least) purchasing, testing, disassembling, and estimating the production costs of the most important competitive products. However, this investment of time is essential, as no product development team can expect to succeed without having this type of information.

Step 3: Set Ideal and Marginally Acceptable Target Values

In this step, the team synthesizes the available information in order to actually set the target values for the metrics. Two types of target value are useful: an ideal value and a marginally acceptable value. The ideal value is the best result the team could hope for. The marginally acceptable value is the value of the metric that would just barely make the product commercially viable. Both of these targets are useful in guiding the subsequent stages of concept generation and concept selection, and for refining the specifications after the product concept has been selected.

Step 4: Reflect on the Results and the Process

The team may require some iteration to agree on the targets. Reflection after each iteration helps to ensure that the results are consistent with the goals of the project. Questions to consider include:

- Are members of the team “gaming”? For example, is the key marketing representative insisting that an aggressive value is required for a particular metric in the hopes that by setting a high goal, the team will actually achieve more than if his or her true, and more lenient, beliefs were expressed?
- Should the team consider offering multiple products or at least multiple options for the product in order to best match the particular needs of more than one market segment, or will one “average” product suffice?
- Are any specifications missing? Do the specifications reflect the characteristics that will dictate commercial success?

4. Discuss how to develop technical models of the product.

A technical model of the product is a tool for predicting the values of the metrics for a particular set of design decisions. We intend the term models to refer to both analytical and physical approximations of the product.

At this point, the team had chosen an oil-damped coil spring concept for the suspension fork. The design decisions facing the team included details such as the materials for the structural components, the orifice diameter and oil viscosity for the damper, and the spring constant. Such models can be used to predict the product's performance along a number of dimensions. The inputs to these models are the independent design variables associated with the product concept, such as oil viscosity, orifice diameter, spring constant, and geometry. The outputs of the model are the values of the metrics, such as attenuation, stiffness, and fatigue life.

Ideally, the team will be able to accurately model the product analytically, perhaps by implementing the model equations in a spreadsheet or computer simulation. Such a model allows the team to predict rapidly what type of performance can be expected from a particular choice of design variables, without costly physical experimentation. In most cases, such analytical models will be available for only a small subset of the metrics. For example, the team was able to model attenuation analytically, based on the engineers' knowledge of dynamic systems.

Several independent models, each corresponding to a subset of the metrics, may be more manageable than one large integrated model. For example, the team developed a separate analytical model for the brake mounting stiffness that was completely independent of the dynamic model used to predict vibration attenuation. In some cases, no analytical models will be available at all. For example, the team was not able to model analytically the fatigue performance of the suspension, so physical models were built and tested. It is generally necessary to actually build a variety of different physical mock-ups or prototypes in order to explore the implications of several combinations of design variables. To reduce the number of models that must be constructed, it is useful to employ design-of-experiments (DOE) techniques, which can minimize the number of experiments required to explore the design space.

Armed with these technical models, the team can predict whether any particular set of specifications (such as the ideal target values) is technically feasible by exploring different combinations of design variables. This type of modeling and analysis prevents the team from setting a combination of specifications that cannot be achieved using the available latitude in the product concept.

5. What is product planning? Illustrate the product planning process with flow chart.

Product planning is an activity that considers the portfolio of projects that an organization might pursue and determines what subset of these projects will be pursued over what time period.

The planning process considers product development opportunities identified by many sources, including suggestions from marketing, research, customers, current product development teams, and benchmarking of competitors. From among these opportunities, a portfolio of projects is chosen, timing of projects is outlined, and resources are allocated.

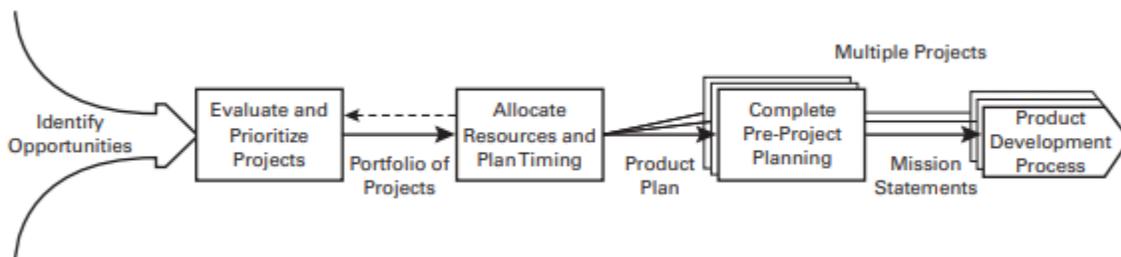


Fig: Product planning process flow chart

A five-step process to develop a product plan are:

Step 1: Identify Opportunities: The planning process begins with the identification of product development opportunities. Such opportunities may involve any of the four types of projects defined above. This step can be thought of as the opportunity funnel because it brings together inputs from across the enterprise. Opportunities may be collected passively, but we also recommend that the firm explicitly attempt to generate opportunities.

Step 2: Evaluate and Prioritize Projects: If managed actively, the opportunity funnel can collect hundreds or even thousands of opportunities during a year. Some of these opportunities do not make sense in the context of the firm's other activities, and in most cases, there are simply too many opportunities for the firm to pursue at once. The second step in the product planning process is therefore to select the most promising projects to pursue. Four basic perspectives are useful in evaluating and prioritizing opportunities for new products in existing product categories: competitive strategy, market segmentation, technological trajectories, and product platforms. After discussing these four perspectives, we then discuss evaluating opportunities for fundamentally new products, and how to balance the portfolio of projects.

Step 3: Allocate Resources and Plan Timing: It is likely that the firm cannot afford to invest in every product development opportunity in its desired balanced portfolio of projects. As timing and resource allocation are determined for the most promising projects, too many projects will invariably compete for too few resources. As a result, the attempt to assign resources and plan timing almost always results in a return to the prior evaluation and prioritization step to prune the set of projects to be pursued.

Step 4: Complete Pre-Project Planning: Once the project has been approved, but before substantial resources are applied, a pre-project planning activity takes place. This activity involves a small, cross-functional team of people, often known as the core team. The Lakes core team consisted of approximately 30 people representing a wide range of technical expertise, marketing, manufacturing, and service functions.

Step 5: Reflect on the Results and the Process: In this final step of the planning and strategy process, the team should ask several questions to assess the quality of both the process and the results. Some suggested questions are:

- Is the opportunity funnel collecting an exciting and diverse set of product opportunities?
- Does the product plan support the competitive strategy of the firm?

- Does the product plan address the most important current opportunities facing the firm?
- Are the total resources allocated to product development sufficient to pursue the firm's competitive strategy?
- Does the core team accept the challenges of the resulting mission statement?
- Are the elements of the mission statement consistent?
- How can the product planning process be improved?

6. Identify and discuss different methods commonly used for documenting interactions with customers.

Four methods are commonly used for documenting interactions with customers:

- 1. Audio recording:** Making an audio recording of the interview is very easy. Unfortunately, transcribing the recording into text is very time consuming, and hiring someone to do it can be expensive. Also, audio recording has the disadvantage of being intimidating to some customers.
- 2. Notes:** Handwritten notes are the most common method of documenting an interview. Designating one person as the primary notetaker allows the other person to concentrate on effective questioning. The notetaker should strive to capture some of the wording of every customer statement verbatim. These notes, if transcribed immediately after the interview, can be used to create a description of the interview that is very close to an actual transcript. This debriefing immediately after the interview also facilitates sharing of insights between the interviewers.
- 3. Video recording:** Video recording is almost always used to document a focus group session. It is also very useful for documenting observations of the customer in the use environment and/or using existing products. The video recording is useful for bringing new team members "up to speed" and is also useful as raw material for presentations to upper management. Multiple viewings of video recordings of customers in action often facilitate the identification of latent

customer needs. Video recording is also useful for capturing many aspects of the end user's environment.

4. Still photography: Taking photographs provides many of the benefits of video recording, but is usually less intrusive and therefore easier to do while observing customers in the field. Additional advantages of still photography are ease of display of the photos, excellent image quality, and readily available equipment. The primary disadvantage is the relative inability to record dynamic information.

7. Construct the product platform planning with sketch.

The product platform is the set of assets shared across a set of products. Components and subassemblies are often the most important of these assets. An effective platform can allow a variety of derivative products to be created more rapidly and easily, with each product providing the features and functions desired by a particular market segment.

Since platform development projects can take from 2 to 10 times as much time and money as derivative product development projects, a firm cannot afford to make every project a new platform. The critical strategic decision at this stage is whether a project will develop a derivative product from an existing platform or develop an entirely new platform. Decisions about product platforms are very closely related to the technology development efforts of the firm and to decisions about which technologies to employ in new products.

One technique for coordinating technology development with product planning is the technology roadmap. A technology roadmap is a way to represent the expected availability and future use of various technologies relevant to the product being considered. This method has been used by Motorola, Philips, Xerox, and other leaders in fast-moving high-technology industries. The method is particularly useful for planning products in which the critical functional elements are well known in advance.

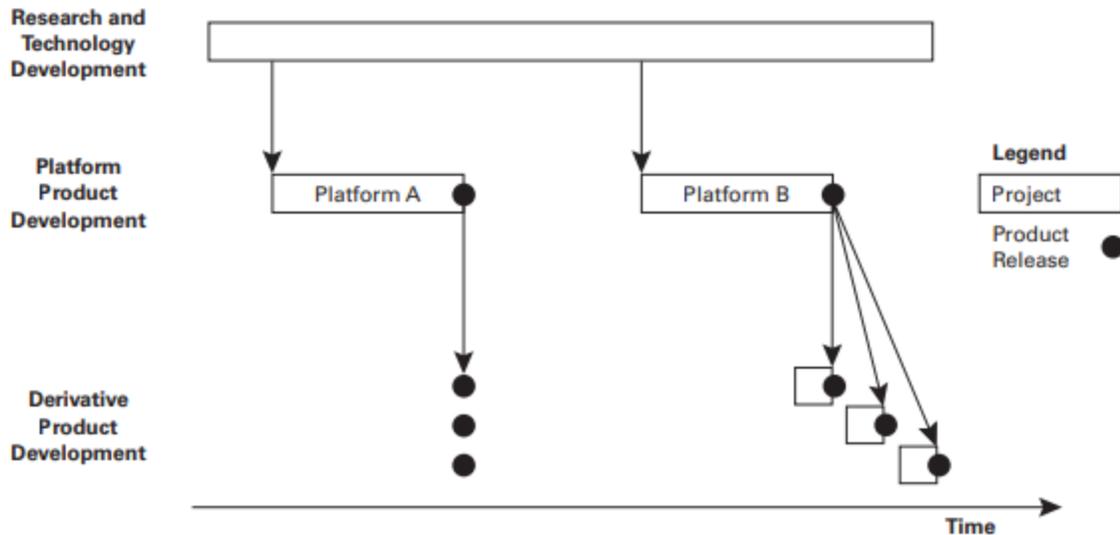


Fig: Product platform planning sketch

8. What are the guidelines should be considered when constructing list of metrics? Conclude in brief.

A few guidelines should be considered when constructing the list of metrics:

- **Metrics should be complete.** Ideally each customer need would correspond to a single metric, and the value of that metric would correlate perfectly with satisfaction of that need. In practice, several metrics may be necessary to completely reflect a single customer need.
- **Metrics should be dependent, not independent, variables.** As do customer needs, specifications also indicate what the product must do, but not how the specifications will be achieved. Designers use many types of variables in product development; some are dependent, such as the mass of the fork, and some are independent, such as the material used for the fork. In other words, designers cannot control mass directly because it arises from other independent decisions the designers will make, such as dimensions and materials choices.
- **Metrics should be practical.** It does not serve the team to devise a metric for a bicycle suspension that can only be measured by a scientific laboratory at a cost of \$100,000. Ideally, metrics will be directly observable or analyzable properties of the product that can be easily evaluated by the team.

- **Some needs cannot easily be translated into quantifiable metrics.** The need that the suspension instills pride may be quite critical to success in the fashion-conscious mountain bike market, but how can pride be quantified? In these cases, the team simply repeats the need statement as a specification and notes that the metric is subjective and would be evaluated by a panel of customers.

- **The metrics should include the popular criteria for comparison in the marketplace.** Many customers in various markets buy products based on independently published evaluations. Such evaluations are found, for example, in Popular Science, Consumer Reports, on various Internet sites, or, in our case, in Bicycling and Mountain Bike magazines. If the team knows that its product will be evaluated by the trade media and knows what the evaluation criteria will be, then it should include metrics corresponding to these criteria.