Encouraging and Managing Innovation

Larry Pendergrass, Keithley Instruments, Inc.,

Innovative technical products can make money for both their users and their producers. Creating them requires an engineering organization that fosters the natural innovative spirit of engineers, while meeting stakeholder expectations.

Profitable Innovation

Engineers are natural innovators and are expected to turn out novel products for diverse marketing opportunities, and do it within the framework of a company's business model. However, the engineering organization must be set up to reinforce this innovative spirit and get the most out of each product development team. The deployment of these teams requires the setting and balancing of multiple priorities. For example, many engineered product companies have to prioritize opportunities and resolve conflicts between new technology investment, new product platform development, smaller incremental product rollouts, and the release of specialized or customized products based on these platforms. All of these opportunities require innovative engineering, all can be profitable, all are necessary for a well-balanced organization, and all can go on simultaneously if R&D activities are effectively managed.

Such product line issues are frequently framed in terms of balancing opportunities in the short-term (incremental product rollouts and specialized or customized options), medium-term (new product platforms), and longer-term (generating breakthrough technologies) against their payoffs. While short-term activities may have less than a two-year cycle time in development, the longer-term activities my have a cycle time of four to seven years, depending on the technology and product types. Different product opportunities and time frames may require different types of innovation or engineering mindsets.

For instance, the opportunity space for innovation while working on a rapid-response to a customer's product option request is very different than the innovation in creating a breakthrough technology. A good deal of day-to-day engineering activity is aimed at rapid delivery of new or updated products to market and tends to be concentrated in a company's "bread-and-butter" product lines. Long or unpredictable development schedules can be very costly due to the burn rate of project expenses, lost sales because of delayed shipments, and opportunity costs associated with delayed start-up of the next project. So the financial mindset typically associated with product development activity involves shortening time-to-market to improve profitability.

The intensity of short-term product development activities can be so overwhelming that work on longer-term technology development is often forgotten. An organization may become mainly reactive and less proactive to the needs of the market place. Engineering can get into a rut with a limited scope of innovation, resulting in ho-hum products that may do little more than meet basic customer needs. To avoid this, some engineering resources must be devoted solely to longer-term development activities, and the engineers that work on them should have fewer constraints on the types of innovation they investigate. The aim is to keep a steady stream of innovative products flowing that provide a high level of value-added benefits to customers, and a high level of profitability to the producer.

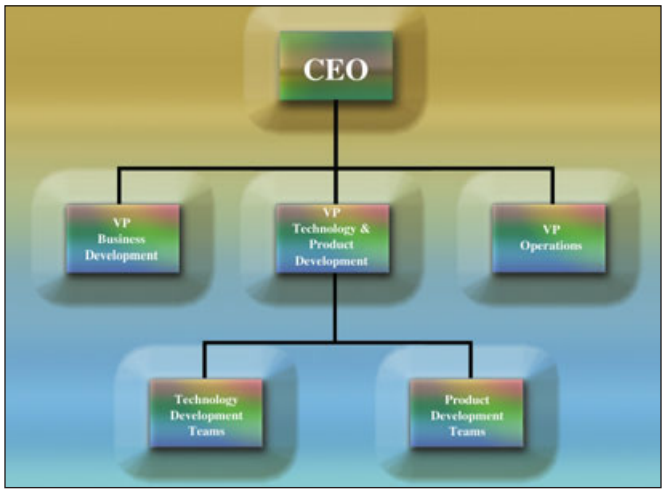

Figure 1. Partial organization chart for technology, product, and business development.

Project Team Model

The structural model for many product engineering organizations is a group of teams, with each team assigned to a particular product or product line. (See partial organization chart in ***Figure 1***.) The way these engineering teams are set up can help manage risk, encourage innovation, and improve the odds for success.

Some teams work on new products, some on product line extensions, and some are involved with upgrading and maintaining existing product lines. Team activities depend on where the product is in its life cycle. Naturally, the financial objectives are growing sales and profitability. The engineering objectives are inventing or improving solutions to customers' problems—well-designed solutions that are economical, have a clear marketplace contribution, and are difficult for the competition to imitate. Internal financial pressures dictate accomplishment of these objectives in the shortest time practicable, without undue risk, while conserving company resources. This always involves tradeoffs in project scope, costs, and scheduling.

Most of the objectives and activities just described have a relatively short-term time horizon. So where does technology innovation fit into the organization and business model? Historically, the right breakthrough technologies, effectively implemented, help an organization more easily meet all its objectives. However, the development of new technologies can take a company outside its financial and engineering comfort zones. It involves financial commitment and risk. Although the risk taken is usually proportional to potential reward, increased uncertainty may cause a company to under-invest in long-term goals. The amount a company is willing to undertake depends on its resources, the strength of various stakeholder interests, and the ratio of risk to reward for each project.

An innovative organization is one that looks for ways to encourage creativity in everyone.

So how much should a company invest in product teams that work on these longer-term, risky new technology goals? This depends a great deal on the company's type of business, its maturity, the issues it faces on an annual basis, the position of the competition, etc. If a company tries to invest too heavily in longer-term goals, its other goals may flounder. If the investment is too lean, products may become stale and the competition may take market share. For an engineered products company in today's business environment, the ratio probably needs to be about 90/10 or 95/5 with regard to short-term/longer-term activities.

The organizational structure may be such that any given engineer serves on more than one product development team. However, it's best if the technology development team has a unique set of members, and they devote at least 90% of their time to activities involving new technologies and acquiring core competencies that could benefit the firm in the future. Delegating short-term product development work to the technology team, or "loaning" its members to product development teams in a role other than simply consultation will tend to disrupt technology R&D. Conversely, product team members should focus about 90% of their time on short and mid-term activities, but keep 10% of their time untied to product releases and free to pursue other activities, such as pet ideas and technology education. This will allow some contribution to the longer-term needs of the organization.

A major element of the technology team's charter is idea generation, centered on breakthrough technologies. Team members should be looking for convergence and synergies in new technologies and potential product platforms. From time to time, the team may generate an idea for a new product line concept, but the scope of their research should encompass technologies not associated with any particular product line that the company currently produces.

This is risky business. A company's executives, board of directors, and various stakeholders must be willing to invest in this type of activity, where it is not at all clear what such a team will produce. Perhaps only one idea in ten will result in something of commercial value. It could be a new product platform, a technology that leapfrogs existing product capabilities, or it could result in nothing financially viable. Visions of the latter are what motivates companies to dilute technology team R&D by giving it product development assignments. One way to avoid this is to keep the technology team small enough that the organization can afford to not use it for current project work. Other resources should be used to solve technical problems and keep product development projects on schedule.

Creating an Environment for Innovation

An innovative organization is one that looks for ways to encourage creativity in everyone. Since engineers are by nature creative, a major organizational goal should be development of a culture that enhances this. The way engineering teams are led and managed has tremendous influence on innovation—positive or negative.

It is incumbent on company executives and organizational development specialists to work with project managers and team leaders to optimize team structures. All organizations reflect the most significant issues facing a company. Each organization is a compromise, with a major focus on fixing the biggest problems of the day. But these problems change over time. To reduce the need to change a structure too frequently, an organizational model should be developed that gives due consideration to longer-term time horizons and larger strategic issues facing the company.

It is also important to have a set of clear objectives, responsibilities, and measurements for each team. This includes the technology development team, whose efforts may otherwise lack focus. A further requirement is periodic monitoring of team goal set-

ting and activities, with an eye to continuous improvement. However, the role of executive management should be leadership in establishing overall objectives (destinations), not creating a detailed map of the course taken. Leave the details to the engineering teams.

These steps help avoid the perception that an engineering class system has developed, with some teams or team members residing in an ivory tower. Such perceptions are damaging to morale and the teamwork that must continue between project teams and the technology team. Technology teams are, after all, part of an engineered products business. As such, their existence is encouraged by virtue of the positive and measurable business impact they have.

Inter-team cooperation can be further enhanced and encouraged by clearly defining the roles of each team. For example, the technology team needs to take responsibility for developing new technology to the point that implementation risks are reduced to a reasonable level before turning it over to project teams. Proceeding successfully from invention to implementation requires a thorough and practical understanding of the application. It must be clear how an untried technology can intersect the product plans with minimal risk and can be used to solve customers' problems or improve internal processes.

In most engineering organizations, when engineers have proven their technical prowess and have demonstrated leadership, they are given their first role as a project manager. For this reason, many project managers in engineering companies were once the best engineers in their fields. However, management is a career change, and many engineers step up to this challenge without fully understanding the nature of the change. They may not understand their personal value as a manager, which involves setting objectives, developing people and businesses, and then stepping aside as their team takes credit. Instead, they hold on to the idea of "value through technical knowledge". At first, this type of leadership may seem very much appreciated by a team with whom the manager has worked previously. However, it will soon be thought of as "micro-management", as over time the manager loses his/her technical edge and others on the team are not allowed to develop into technical decision makers.

How Do You Measure Innovation?

Nancy Thomas, Keithley Instruments, Inc.

Measures of innovation can be highly subjective, but there are some general guidelines that help a company create internal metrics. The rationale is employing the right amount of scarce resources and improving their deployment to ensure they meet R&D goals and other corporate objectives, such as long-term profitability. Frequently, an input/output model is used in making these measurements. The variables should be tailored to the company's overall business model and operating environment.

It's important to recognize that some outcomes are difficult to trace to innovation. These include such things as competitive position (market share), operating efficiency, growth in profitability, and customer satisfaction. Even the inputs may be difficult to quantify, such as expenditures actually devoted to R&D, the time frame associated with these expenses, and product lines that result or benefit from them. Carefully define what the company wants to achieve with its innovation metrics before settling on the inputs and outputs. Then create a mechanism for capturing the data best suited for these objectives.

When choosing the metrics, consider possible 'stages of outcome' associated with R&D. For example, measures of immediate outputs could include the number of published papers or patents issued. These outputs could be some of the inputs to the next stage, which would transform them to intermediate outputs, such as circuits, production processes, etc. (Figure 2). Intermediate outputs could then be transformed at the following stage into pre-ultimate outputs, which are products and or services. While it might be tempting to call the latter ultimate outputs, consider the company's measurement objectives and the economic value of products and services to customers. In other words, how profitable are the products and services for both the supplier and the user? To answer this question, develop a balanced and complementary set of information from the different stages of innovation and their outcomes.

While it is difficult to apply financial metrics to the measurement of innovation, thoughtful allocation of costs and benefits provides valuable R&D insight, if not oversight. Allocations may be by market, product line, or specific customer. Nonetheless, beware of bias in the selection of metrics and individual assessment of results. Due to the complexity of innovation processes, isolating the precise impact of products and allocating them to specific innovative inputs is difficult. Therefore, the process must be well defined and consistently applied. With these precautions, at least relative measurements should be useful.

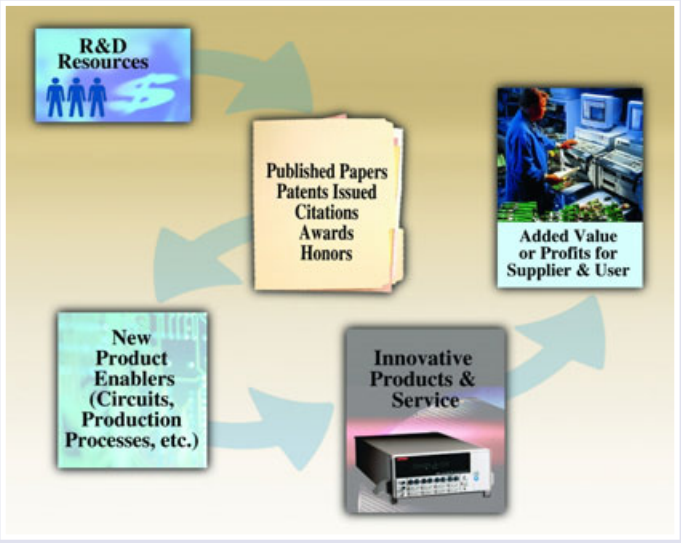

Figure 2. Input/output model for technical innovation.

This tends to quash innovation.

In product development teams, innovation can be encouraged by developing a technical leader while focusing the project manager on excellence in management principles. In fact, it is often beneficial to have a project manager lead a team of engineers that are skilled in an area other than the manager's expertise. The project manager clearly needs to be technically respected by the team, but may be respected for accomplishments in another related field. He/she needs to understand how to ask questions and probe for an engineer's grasp of the problems at hand. But it is frequently best if the project manager is not an expert in the technical area being managed. This will reduce micro-management and improve innovation.

A project manager must know the mechanics of managing a project's scope, schedule, and resources. This person should also understand how to motivate team members to get the best out of them, make the team an enjoyable one with which to work, and be a visionary in terms of objectives. These things set the environment for innovation, but do not establish a project's technical direction. Appointing a respected technical leader to work with team members in setting technical direction empowers the team to be innovative. This leader and team members should be the experts on technology and establish the technical areas that are pursued in meeting product objectives. They are the ones who must reduce the risks associated with the product's critical performance requirements, development costs, and time to market.

Another reason for using this team structure is that project managers are often responsible for salary reviews and other monetary rewards to team members. If these are not part of the technical leader's function, team members will be more independent and less hesitant to speak up on technical issues. As long as engineers are paid fairly for their contributions, and don't feel financially threatened for offering constructive critiques, this too can be good for innovation. Other benefits of this structure are enabling project managers to supervise more engineers, to take a larger more strategic view, and to see more directly what is going on.

People go into engineering because they want to be creative and like to solve technical problems; their satisfaction is derived from a sense of accomplishment when they do this. Still, most people like to be recognized for their accomplishments. While it's difficult to plan, schedule, and measure innovation (see sidebar), public recognition of results will encourage engineers.

Recognition can come through internal means such as personal statements from one of authority, public recognition at employee gatherings, presentation of work at symposiums, publication in application notes or journals, filing patents, etc. Many companies have a patent disclosure and disclosure review process to uncover possible patents to file. Recognition through a small monetary award and public thanks for all disclosures, whether a patent is filed or not, is one way to encourage greater participation in innovative thinking. Even if an innovation is not patentable, an internal patent disclosure committee can still provide recognition of an engineer's creativity. Another way to recognize and encourage creativity is to give engineers time to write bylined white papers and technical articles for publication, which describe their innovations. At Keithley, we have also established awards for technical achievements, and show recognition through the Joseph F. Keithley QSII (Quality, Service, Innovation, and Integrity) Award.

Avoid Counterproductive Environments

The flip-side of the coin is avoiding things that discouragement innovation. Disrespectful, destructive contention in teams will do this, especially if an authority figure becomes overly directive. So, technical leaders and project managers must watch out for it and guide discussions in positive ways that are not threatening to team members. Where there is destructive contention and lack of mutual respect, or people aren't really listened to, this eventually leads to no contention. People will not speak up, and all ideas are not brought out for consideration because there's no positive payoff. Without constructive contention, innovation suffers.

Another enemy of innovation is a risk averse environment. This can develop when there is too much emphasis on short-term financial results, which may be accompanied by overly lean staffing, too many projects and goals, and excessive stress on shortening product development cycles. Although thoughtful leverage of existing technologies and designs can be a good practice to improve development cycle times, too much leverage can kill innovation. When projects start generating cookie-cutter products, they are unlikely to be innovative.

Finally, it is important to recognize that innovation can come in many ways, and in many forms. Innovation is more than just creating new technologies. Managers need to be skilled in recognizing and rewarding innovation in all areas of business. For example, innovation can take the form of cost reduction technologies or quality improvement methods. It can take the form of innovative methods of risk management or business approaches, such as make/buy decisions and contract manufacturing. It can be seen in innovative methods to motivate, develop, and reward people.

Innovation will suffer if managers do not adequately account for opportunity costs when setting goals for the organization. For example, decisions to continue with a cost center when it is no longer the company's core competency, rather than outsourcing this activity, carries with it an opportunity cost, i.e., foregoing some innovative activities. Look for opportunities to free internal resources that are no longer working on core competencies and use these resources where there is the best chance of being innovative. Make these reviews a regularl part of innovative efforts, since yesterday's core competencies may not be tomorrow's. Continually assess externally available technologies to determine those that are worthwhile to adapt. Acquire them via outright purchase, joint ventures, or strategic partnerships.

Recognize that some of the most important partnerships take place between your own marketing, engineering, and manufacturing groups. For example, Manufacturing has much to say to Engineering about the direction a design is taking and can contribute greatly in innovative thinking toward the major goals of the project. Manufacturing strategy and R&D strategy should align with each other, understanding that the primary goal of both organizations is to make money for the company. However, the sub-goals of the two organizations are, by their very nature, different and yet compatible. A design should be manufacturable with existing

processes if possible, or have a business case so compelling that it warrants investment in new manufacturing methods and equipment. Engineering must earn Manufacturing's trust that production avenues currently available have been explored before seeking development of new processes.

It's a Jungle Out There

Global market pressures are making innovation more important than ever. Competitors near and far are looking for ways to capture more market share. A review of competition may reveal some who are grappling with environments like those described in this article, where innovation is not encouraged. However, don't expect this to be the norm.

Many of your global competitors take a long-term view of market opportunities. Some can afford to devote large amounts of money and manpower to engineering and production. And yet, some of the techniques described in this article do not cost a great deal of money. Some may be nothing more than cultural and mindset changes to get the most from your people. Look at your organization critically. Ask what you can afford. Don't starve innovation with an overly shortsighted view. On the other hand, if you put too much on your plate, you may not hold the course and will see little innovation make it into your products. Strike a careful balance in your organization. KEITHLEY

About the Author

Larry Pendergrass is VicePresident of New Product Development for Keithley Instruments, Inc. in Cleveland, OH. He has spent over 20 years in engineering and management for various engineering companies such as Hewlett-Packard Co. and Agilent Technologies, Inc. He has a M.S. degree in Physics from U.C. Davis.

KEITHLEY

Keithley Instruments, Inc. 28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168
1-888-KEITHLEY (534-8453) • www.keithley.com

No. 2520
0304