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HOWE SCHOOL ALLIANCE FOR TECHNOLOGY MANAGEMENT

DIRECTOR'S NOTE

A Significant Milestone

This edition of **Current Issues in Technology Management** *begins Volume 10, signifying the start of our tenth year of publication. We are marking this milestone with an expanded issue, reprinting five articles that have evoked considerable reader interest. They exemplify the balance between research and practical application that has characterized CITM over the years.*

"Introducing Innovation in the Corporate Bureaucracy" by Meieran summarizes the Intel approach to achieving innovation. "How Lucent Power Systems Improved Innovation and Raised the Bottom Line" by McGourty, Tarshis, and Huljak documents the striking results achieved by one company's application of the Alliance Innovation Model research. "New Products: Managing the Fuzzy Front End" by Cooper documents the research underlying the Stage-Gate process and its application to achieving a timely stream of successful new products. Cooper's article is complemented by "Effective Gatekeeping in New Product Development" by Gastwirt, which deals with the important leadership role of "gatekeeping" in new product development. "Getting to Breakthroughs: Approaches and Organizational Structures" by Koen presents the results of his research on critical success factors for achieving breakthrough products.

Another Significant Milestone ... And a Name Change

This year also marks the fifteenth anniversary of the Stevens Alliance for Technology Management. Its educational programs, its research, and its transfer of best management practices, have benefited numerous organizations and thousands of technology professionals since 1991. Readers will note a slightly different name on the masthead of this issue, reflective of the enhanced integration between the Alliance and the Howe School of Technology Management at Stevens. It's very appropriate, at this stage in our evolution, for SATM to change its name to the **Howe School Alliance for Technology Management (HSATM)**. It's especially timely to make this change now, as the Howe School moves into its new home, the Babbio Center for Technology Management, which will become the venue for many Howe School Alliance events.

The Howe School Alliance will build upon the SATM foundation, continuing the programs that have brought value to a generation of technology managers. What will change is the scope and reach of our activities, as we further strengthen our connections with faculty of the Howe School and provide even more value to participating organizations. Go to our website, **http://Howe.Stevens.edu/HSATM** and click on benefits to see the expanded menu of benefits available to Alliance Partners.

We thank all of the organizations that have partnered with the Alliance over the years, and are grateful for your support as we begin this new stage in our development. HSATM may not trip off the tongue as smoothly as SATM does, but we trust that the Alliance will continue to play an increasingly important role with your organizations.

Larry Gastwirt

IN THIS ISSUE.....

STEVENS Institute of Technology

Introducing Innovation in the Corporate Bureacracy

by Eugene S. Meieran

In this world of rapid change, companies are bringing out new products, processes and services at an alarming rate. No sooner is one product or service introduced, than a competitor brings out a new product and service that either obviates the need for your product, or renders it obsolete in terms of performance, cost, customization or all three. The question is, how do large companies, noted for their bureaucracy, slow response to innovation and lack of initiative, manage to stay in business given the rapid introduction of products or services, followed by the rapid growth of the companies started up by more entrepreneurial individuals?

Actually, there are two types of innovation: normal innovation, and radical innovation. Continuous improvement and evolutionary changes in the current practices or services or processes characterize the former. Radical innovation is characterized more by revolutionary changes that fundamentally change the way business is conducted. In this paper, we will concentrate on both of these concepts, and discuss how bureaucratic organizations need to approach both normal and radical innovation in order to survive during the next coming uncertain decade.

"Innovation cannot be legislated! Innovation simply happens."

"Companies are not innovative. Individuals are innovative!"

"This company is so bureaucratic! We cannot innovate here!"

These and similar phrases populate the literature and thinking of people who work for large companies. They are stymied by "the system," which they perceive is stacked against them.The management doesn't understand; the reward system doesn't reward; the financial people don't want to take a risk; the engineers are wedded to their old methods and processes; the task is simply too difficult! Such thinking is characterized by the many examples of missed opportunities; the transistor, the airplane, the operating system, the telephone, etc., none of which were commercialized by existing companies making what might have been considered competitive products. The existing companies simply missed the boat; for example, the railroad companies thought they were selling rail transportation, and did not recognize they were selling passenger-miles; the vacuum tube companies thought they were selling glass tubes, not electronic components.

On the other hand, there are myriad examples of successful companies that have adopted new strategies and tactics to cope with rapidly changing environment. IBM adopted electronic over mechanical systems, and Boeing adopted jet driven aircraft over propeller driven aircraft.

So the question is, what differentiates the companies able to accommodate innovation, either normal or radical, from those companies that constantly and consistently miss the boat? What, exactly, allows a large, necessarily bureaucratic company, to act like an individual or a small, entrepreneurial company? What characterizes such a company, its managers and leaders (these are different!) and its processes, that makes such a company receptive to change, when virtually every force resists such change? This topic is the subject of the remainder of this paper.

Innovation Model

Our model for innovation encompasses both normal innovation and radical innovation. The first part of the model suggests that both forms of innovation involve two significant concepts, creativity and risk aversion. The creativity issue involves newness, challenging the norm, brainstorming, risking failure, accepting the "unacceptable," pushing the envelope. Risk aversion implies protecting the family jewels, resisting change, maintaining business as usual, avoiding expensive decisions on risky ventures.

There is a related issue; timeliness, which refers to company maturity. Timeliness is also related to the physical concept of inertia; the resistance of a physical body to a change in its motion. If we consider the physical metaphor for a company to be a flywheel, Fig.1, we can differentiate between two physical effects as the company matures, i.e. as the flywheel increases in size (particularly at the rim):

1. The resistance to change in momentum increases as the company grows; in order to cause ANY change whatsoever, it takes more and more energy.

2. The flywheel acts as a gyroscope of increasing size; even if the energy is there to change the gyroscope's speed, it is difficult to change its direction.

The causes of increased inertia are pressures brought on by suppliers and customers, the loss of company knowledge and culture through loss of experienced people, fear for one's job, the adoption of standards, etc. Some of these are bureaucratic necessities (standards) while others are undesirable but unavoidable consequences of company growth.

The concepts of creativity vs. risk aversion, and the company's maturity inertia, are illustrated in Figs. 2 and 3. In Fig. 2 one can see that all quadrants of the creativity-risk aversion matrix are useful, but are aimed at different markets or satisfy different needs.

If one wants an immediate solution to a crisis of known dimension, one does not necessarily wait for the "right" solution; ANY expedient solution, even if risky, might do. Creativity is not necessarily an advantage; pragmatism is. However, when dealing with an unknown domain, creativity in the solution space might be an advantage; if practiced through continuous improvement methodologies, this might be relatively risk free.

If there is something REALLY NEW on the horizon that threatens a company's very existence, however, then a risky, highly creative response might be needed. As will be discussed later, such opportunities are more

likely to arise as a result of one's personal drive, knowledge and ingenuity, rather than as a problem-solving capability. This upper right quadrant in Fig. 2 is more often reserved for exploring and exploiting opportunities than for solving problems.

In either case, the flywheel effect must be recognized and dealt with. As seen in Fig. 3, as companies mature, they tend to lose their ability to capitalize on innovation, at least radical innovation. When the company was young, it had little to lose and was more willing to take significant risks in order to penetrate the market. As it matures, it has more to lose or more to protect, and become less risk tolerant. "Protect the family jewels" becomes more important than "risk the business in search of major opportunity."

As companies mature they tend to concentrate on utilizing normal innovation, which might otherwise be described as using new ways to continuously improve their operational performance. This trajectory for continuous improvement can sustain a company's growth for a period of time; generally speaking, however, after some time, other forces cause the company to undergo some major changes. These may be called downsizing, business process reengineering, reorganization, reinvention, etc.; leading to various outcomes, as illustrated in Fig. 4. On occasion, a company can still exploit radical innovation and generate a new business, but this is not a frequent occurrence.

So let us now discuss the characteristics of both normal and radical innovation, from a corporate perspective. We shall use Intel as an example, since it has a reputation as an innovative "high tech" company, it certainly is now large and may be considered mature, and having worked there for 25 years, I know more about it than any other company!

Radical Innovation

Historically speaking, radical innovation often seems (and indeed is) unplanned; someone has a bright idea, pursues this with considerable zeal, persuades someone with resources to sponsor the idea, and on occasion, this works out as a big success, often to the surprise of the new market. Frequently, the idea is regarded as useless when first introduced, especially by the owners of a current capability that is already obsolete, although the current owners are not yet aware of its demise. Radio, telephone, transistors, airplanes, personal computers, etc., are examples of radical innovations which were under-appreciated at their inception.

The characteristics of radical innovation are listed below:

- Essentially single individual achievements
- Essentially opportunistic in approach
- Fundamentally changed the current technology trajectory; challenges the status quo
- Lots of brainstorming, trying things out quickly to see if they work
- Strongly supported by senior company management
- Formed the basis of major company expansion
- Was a LONG, DIFFICULT, often frustrating experience
- Occurred in the early days of the industry

Characteristics of Radical Innovation

Usually, a radical innovation is created by a single individual, whose name is often associated with the product:; automobiles with Ford, airplanes with the Wright Brothers, phonographs and light bulbs with Edison, cameras with Eastman, etc. It is usually created as an experiment with an opportunity in mind, not as a perceived solution to a problem (the Wright Brothers wanted to fly, not carry passengers). It fundamentally changes the way the world operates (replacement of horses by cars; replacement of slide rules and mechanical calculators and typewriters by computers; replacement of candles by electric lightbulbs, etc.) Radical innovation usually involves lots of brainstorming, trying of new ideas at a rapid rate, discarding ideas as they are proved incomplete, incorrect or infeasible. While in order to be successful, radical innovations need strong sponsorship from someone who controls sufficient resources, it is usually a long and frustrating path between concept and success. This path often ends in failure, not always because the innovation is wrong, but because the world is not ready, the customer uses are not fully recognized, whatever.

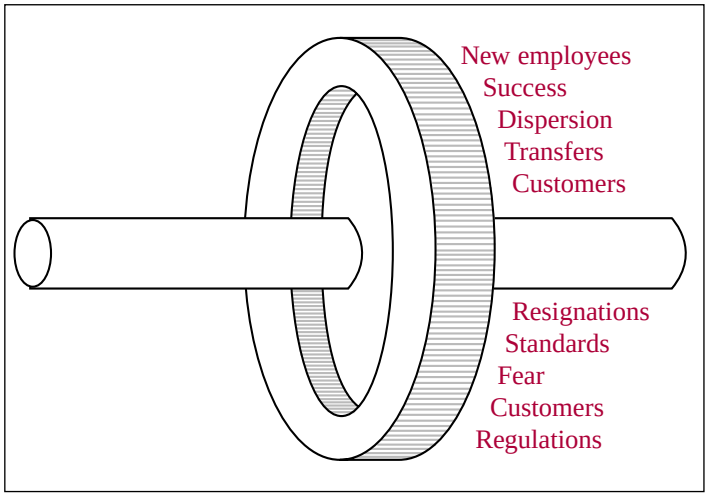

Figure 1: The Industry Flywheel

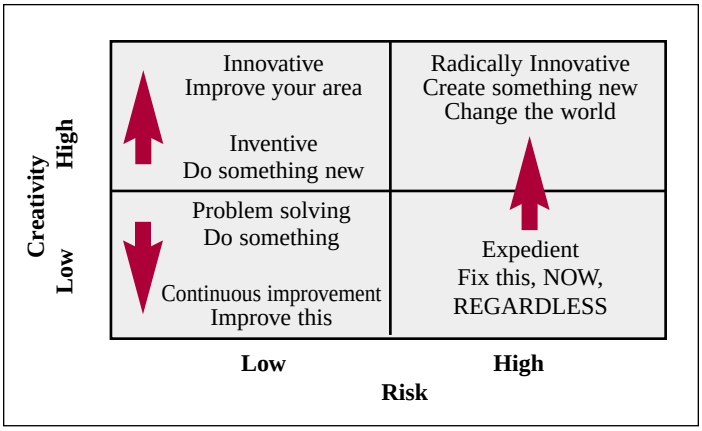

Figure 2: Creativity vs. Risk Tolerance

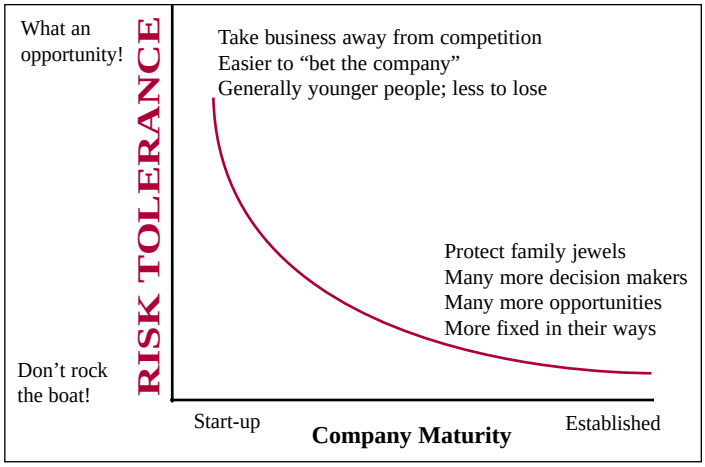

Figure 3: Risk vs. Company Maturity

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Normal Innovation

The characteristics of normal innovation are listed below. Normal innovation may be regarded as a form of continuous improvement, usually in response to a perceived problem or issue. These innovations are frequently team drive; they have no zealous champion putting his or her reputation, financial health or job on the line in defense of the idea.

- Essentially team driven
- Responds to specific problems, opportunities or trends; more reactive
- Long, thought out process that is expected to work
- Driven by a champion, but strongly supported by senior management
- Keeps the company ahead, but does not threaten the status quo so strongly

Characteristics of Normal Innovation

For either or both normal or radical innovation to take hold in a company, there must be a receptive atmosphere; the innovation rarely can stand simply on its own merits. Consequently, even if we know what innovation really is, and what it can do for us as individuals or as members of an organization or company, we need to understand the dynamics of how to garner support from our company in order to nurture innovation if and when it comes. The following model is useful for understanding how a company's culture can be used for this purpose.

*Model for Innovation**

The Stevens Alliance for technology Management has developed a model for explaining how innovative companies apply their resources to capitalize on innovation; essentially, carrying a storage bottle to potential locations to capture the energy of lightning if and when lightning strikes. This model is shown in Fig. 5.

Basically, the model suggests that the innovation receptiveness of companies is enhanced through behavior patterns characterized by the terms inquisitiveness, collaboration, advocacy and goal direction. These behaviors are engendered by the corporate culture, which has its foundation in corporate history. The corporate history is "remembered" through the institutionalization of corporate practices; practices that reaffirm the corporate values and norms. Looking at this model the other way around, a corporation creates practices that appear to enhance performance, through a set of values. These values help mold the corporate culture, which, as time passes and historical records accumulate, rewards certain behavior patterns. If these patterns include the four elements of inquisitiveness, collaboration, advocacy and goal seeking, the company is prepared for recognizing, nurturing, promoting and implementing innovative concepts. A filler discussion of the model is provided in reference 2.

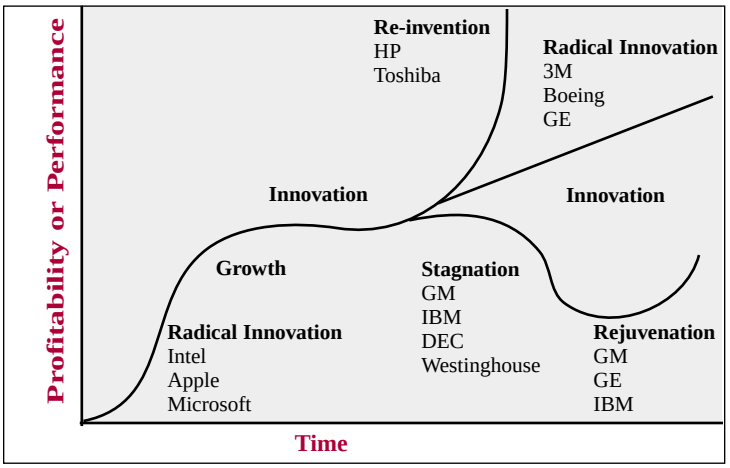

Figure 4: Company Maturity vs. Risk Tolerance

Intel and the Model

During the early 90s, the Alliance studied Intel as an example of an innovative company, from which the Stevens' model was derived. In this section, we will illustrate some of the characteristics of Intel that helped formulate the model, which seems to hold for a number of other innovative companies studied as well as for Intel.

Intel has a history of innovation that has fundamentally changed the way the world operates (radical innovation). The microprocessor and semiconductor memory chips have enabled a revolution in information and knowledge technology that have made computers, for better or worse, an absolutely essential and irreplaceable part of society. Intel was formed and managed for its first years by a group of scientists and entrepreneurs of unparalleled abilities, including the inventor of the integrated circuit (Bob Noyce), the inventor of the microprocessor (Ted Hoff) and the inventor of the programmable, erasable memory (Dov Frohman). The visionary Gordon Moore, the formulator of the famous Moore's Law, which defines the future of our industry and has done so for the past three decades, and the irreplaceable Andy Grove made Intel into a company with sales greater than $25Billion. These examples serve to illustrate the principles of Fig. 4; Intel has a short but distinguished history of innovation that has both built a large corporation and has changed the world.

The Intel culture comes from the founders, Gordon Moore and Bob Noyce, and from the personality of Andy Grove, until recently CEO and President. Andy has a reputation as a no-

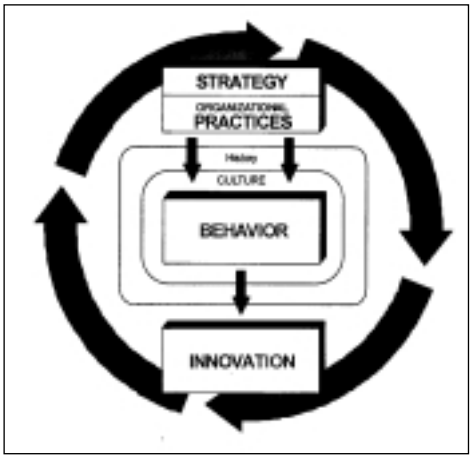

Figure 5: SATM Innovation Model

nonsense manager, as a technical leader, and as a gifted lecturer. The no-nonsense attitude comes out in the Intel culture as discipline, as performing at one's highest level, as constructive confrontation, as resistance to complacency ("only the paranoid survive"). This culture is taught as a "Back to Basics" set of courses to all Intel employees, new and old. Indeed, all Intel senior managers are required to teach one or another of these courses at least four times per year.

Since almost all senior Intel management has been at one time a scientist or engineer, the rest of the innovation model follows almost as a natural consequence. Engineers and scientists are by nature inquisitive, and all are competitive and therefore strongly advocative, in pushing their ideas and processes into the Intel system. Since Andy has a strong and indeed compelling desire to produce, all people at Intel are expected to be strongly goal driven, and are rewarded for this (one of the Intel core values). And finally, since our processes and products are so complex, we are compelled to be collaborative, since otherwise, we simply could not get the job done.

Intel's Competitive Processes for Innovation

1. Policies and Procedures

As a result both our company's success, as well as fear (real or imagined) of being toppled from a leadership position, ("only the paranoid survive")**, Intel has adopted a number of policies and procedures that help enable the incorporation of innovative ideas into our culture. Some of these processes are given in Table 1; many of these processes are specific subjects of the Intel University training classes which every Intel employee attends, or are used as Intel values, against which every Intel employee is measured. All are supportive of Moore's Law, that the ultimate goal for our technology is to increase chip complexity, as measured by the number of active elements on a single silicon chip, which doubles approximately every 18 months.

2. Intel Corporate Values

In more detail, Intel has adopted six corporate values, shown in Table 2. In order to ensure these values get more than lip service, they are used during the review of every employee as a measure of the employee's contribution to Intel's success. Risk taking is a recognized and often rewarded corporate value, even in situations where the consequences of taking a risk have not been entirely positive. As a result of this process, all Intel employees are given a yearly reminder with financial consequences about the importance of all Intel values in their daily job.

3. Grade Level Promotions and the Intel Fellow

Intel also has adopted a special track for employees who desire to be technical leaders but who may not have a strong desire to manage a large group of employees. This is called the Intel Fellow, where senior technical leaders are permitted to work on topics of their choice. The Intel Fellow is a defined job position, towards which any employee may aim; however, only a relatively few achieve Fellow distinction.

The Intel Fellow has certain obligations and responsibilities, which help Intel to be receptive to innovation. The Intel Fellows generally spend some of their time interacting with universities and external laboratories, evaluating new ideas and concepts, and if appropriate, championing these within Intel.Intel Fellows are allowed some freedom in the choice of their day to day work, which often involves some degree of risk taking and exploring of new ideas. We are also used as a sounding board by many senior and junior technical staff, just to see if someone else's ideas seem potentially useful. Most Intel Fellows are members of one or more internal communities which help decide future technical direction, such as the Research Council, Intel Foundation, Academic Relations Council, etc. Currently, there are 20 Intel Fellows, representing a dozed different technical disciplines, ranging from software to hardware, processing to manufacturing, architecture to marketing, computing to communications. By contrast, Intel has about 150 vice presidents, but only 20 Fellows; the Fellows thus believe that each of them is as valuable to Intel as 7 or 8 vice presidents.

Directly confront problems	**Constructive Confrontation Course**
Quickly learn the Intel culture	**Working at Intel course**
Share problem solving methods	**Problem Solving Course**
Take appropriate risks without fear of failure	**Corporate Value**
Highly focused, execution oriented	**Corporate Value**
Own the resolution of problems you discover	**Corporate Policy**
Fuzzy boundaries between departments	**Open Door Policy**
Rewards teamwork	**Achievement Awards**
Tolerates (and responds to) criticism	**Constructive Confrontation Course**
Geographically, technically matrixed	**Organizational Policy**
70% recent college grad hiring	**Corporate Policy**
Share a common language and common goal	**Moore's Law**

Table 1: Intel Policies and Procedures

4. Innovation Day

Every year, Intel holds an Innovation day, where 20 or 30 Intel scientists and engineers at all grade levels are asked to compete for a position that for one year, they are given an opportunity to work exclusively on an innovative project of their choosing. The projects must not be in the line of current day-to-day activities, and should represent out-of-the-box thinking. Intel Fellows and other senior Intel scientists and engineers are asked to be judges of this event. Usually the presenters have posters and working demonstrations to augment their technical presentation.

Discipline
Quality
Results Orientation
Customer Orientation
Risk Taking
Great Place to Work

Table 2: Intel Corporate Values

5. Internal Conferences and External Presentations

Intel sponsors many internal conferences for employees, in all technology fields in which we are engaged. At these conferences, sharing of new ideas and "best known methods." otherwise known as BKM's, are discussed, and their adoption across Intel is ratified or denied. In this way, we ensure that innovative and good ideas are rapidly propagated throughout the company in a controlled fashion.

6. Intel Achievement Awards

Intel employees are eligible for a variety of achievement awards, the highest being the Intel Achievement Award or IAA. This award is made by the Intel Executive staff, and is given to several individuals or groups on a yearly basis in recognition of meritorious

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achievement. In a addition to a financial award, the award recipients and their immediate families are treated to a weekend dinner and reception at an exclusive resort. This coveted award is widely heralded at Intel; we usually have several dozen applicants, from which perhaps 20 are selected. The criteria for selection are rigorous, and often include risk taking and innovation.

Summary

We live in a swiftly moving world, where if we don't adapt and don't innovate and don't keep up, we shall (properly) take our place with a myriad of other companies in the scrap heap of history. This is particularly true of the semiconductor, computer and communications industries, where advances in hardware and software are so fast and so competitive, on so many fronts (globalization, nationalization, technology, marketing, competitors, etc.), that it is bewildering to understand all the ramifications. However, it is recognized that in spite of all this new technology, there is but one driving force. As a parallel to Moore's Law, which drives the technical and economic parts of our industry, it is human ingenuity that drives creation of new ideas that leads to innovation. If we do not manage the process of innovation, we will certainly lose the very ideas and concepts that are essential to being both productive and competitive, as the world changes around us. Intel has created a suite of processes, policies and procedures to help us increase our ability to respond to innovative and creative ideas, without which we would not be able to survive the highly competitive environment in which we now live.
Intel's response to the flywheel's inertia effects illustrated in Fig. 1 may be seen figuratively in Fig. 7. The flywheel is driven by use of a number of policies, procedures, recognition systems, reward systems, and other incentives that compensate for the flywheel's inertia. Without this drive, inertia will dominate, and both normal and radical innovation will be stifled.

Acknowledgements

There are many people within and outside Intel, to whom I am indebted for ideas and concepts that led to this paper. Court Hilton, Sri Sridharan, John Caruthers, Jeanette Harrison, Gordon Moore, Justin Ratner, David Marsing, are Intel people who contributed to the thinking process, and Lem Tarshis, David Hardt, Hossein Nivi, and others too numerous to mention, have provided me with many external ideas. ■

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Eugene Meieran *is an Intel Fellow, having joined Intel in 1972. He received his Ph.D. from MIT in Materials science. Gene was elected to the National Academy of Engineers in 1998. He is on several National Research Council boards, has written about 50 technical papers, and has won three international awards for technical contributions."*

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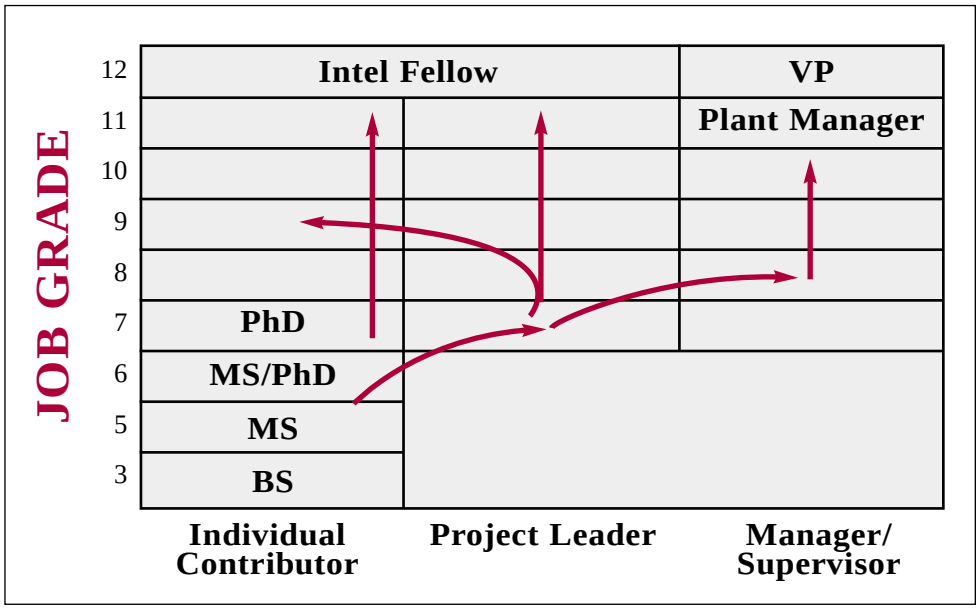

Figure 6: Intel Job Grade Ladder

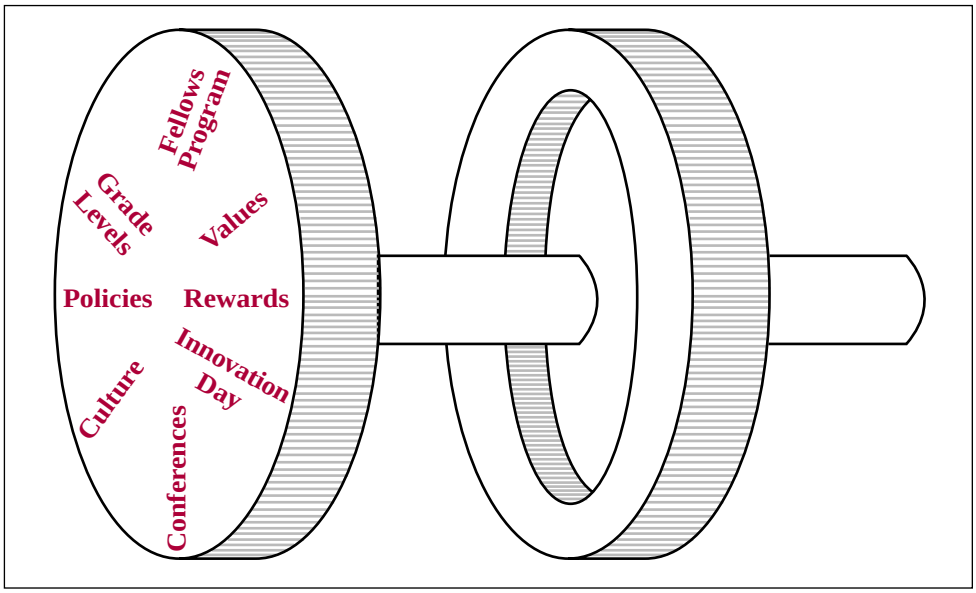

Figure 7: Energy to Drive the Flywheel

How Lucent Power Systems Improved Innovation and Raised the Bottom Line

by Jack McGourty, Lemuel Tarshis, and Robert Huljak

The Alliance for Technology Management sponsored a study of U.S. corporations renowned for their high rates of innovation in the early 1990s. Two of the current authors, Jack McGourty and Lem Tarshis, were principal investigators. The study had two objectives: (1) to identify the factors that differentiate high innovators from lesser ones; and (2) to develop a model that would guide innovation efforts to improve business results. Results of the study were published in 1994.

In the sense used in the study, innovation was defined as the generation of new ideas leading to successful commercialization and utilization. The idea for the research was generated during discussions at Alliance meetings among a group of technology leaders representing Sponsor organizations, including Dr. John Mayo, then president of AT&T Bell Labs, and Dr. Ralph Wyndrum, also from AT&T. Both were major proponents of doing research that would result in an applied framework for organizational innovation.

Based upon detailed interviews of executives from specifically selected innovative companies, the investigators found that highly innovative companies:

- have a serious commitment to innovation;
- pursue it aggressively and strategically;
- develop and support specific policies and practices to create an innovative environment; and
- promote key and definable behaviors among employees, who are the ones ultimately responsible for innovation.

Subsequently, detailed quantitative survey-based studies were made of companies in both the electronic and food industries to validate the postulated model. Using patents and revenue from new products as innovation measures, the postulated model was twice validated. The data clearly demonstrated that what appears to differentiate organizations, in terms of innovation, is their ability to sustain internal environments that promote key and definable behaviors that make up their cultures. Policies, practices, history, and strategy all are used – knowingly or unknowingly – to support the required behaviors.

From these findings, the researchers developed the Stevens Alliance for Technology Management Innovation Model (Figure 1), which has since been used by several organizations to guide innovation efforts. The most advanced use of the Model has been at the Power Systems division of Lucent Technologies. After five years (1995-2000), the results are remarkable increases in both patent productivity and revenue from new products that contributed to a three-fold increase in total revenues for the business. This is how they did it.

Background

Until recently, Lucent Power Systems was the world's leading producer of power supplies/systems for the worldwide telecommunications, data networking, and computer industries. While the company has been growing faster than the marketplace for the past three years, it has actually become number three based upon revenue. Competitors have grown more quickly through acquisitions, while Lucent Power Systems has been limited to organic growth. On December 29, 2000, the Lucent Power Systems business was sold to Tyco International for a reported $2.5B. Key ingredients of the sale were Power Systems' $1.6B revenue, profitability, strategic customer base, global development and manufacturing facilities, strong management team, and the reputation of being the industry's innovation leader.

Even though Lucent (AT&T at the time) Power Systems won the prestigious 1992 Deming Prize, Japan's award/recognition for total quality, its revenue remained virtually flat through 1995. During this same period, the industry enjoyed double-digit growth. In addition, only 20% of Power Systems revenue came from new products and more than 80% of the first shipped new products were being returned by customers as defective. As a result, morale was low and senior management was making most of the decisions in reaction to customer/market concerns and problems.

Furthermore, an earlier (1988-1990) move of personnel from the Bell Laboratories in New Jersey to Power Systems headquarters in Texas had seriously damaged morale. The totally different cultures – that of the laboratory environment and that of the production facility – had not mixed well.

Viewing the situation at Power Systems in 1995, the outstanding reputation of Bell Labs (many employees still carry the Bell Labs logo on employee badges) was attracting the best people, and the receipt of the Deming Prize had added to company pride. However, the drive to win the Prize had exacted a harsh toll, creating a cumbersome bureaucracy in that everything was highly "metricized" and overly focused on paperwork rather than on growth.

More time was spent in filling out forms and putting together charts and reports than in analyzing and proactively correcting problems or identifying and exploiting opportunities. Ironically, in going after the prize, the business had lost sight of what the prize actually was intended to generate – to improve business results.

Several problems that existed at least through 1995 in the areas of strategy, practices and behaviors were identified.

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The most important were:

- Business goals were confused. Management, which had been focused on quality with little emphasis on revenue growth, had inadequately spread the word that growth was now the new strategy.
- There was little, if any, advocacy for new ideas. Most decisions were being made at the top of the organization, and no real empowerment existed. As a result, people would not take risks due to a fear -- real or perceived -- of being punished.
- Collaboration across functions was virtually non-existent. There was a major emphasis on individual technical activities.
- Leadership was confusing its goal direction by not prioritizing work, which created extensive multi-tasking and turmoil for the organization. There was a long list of desired product developments and the list kept changing constantly. People were working on everything, and not concentrating on what was important or critical.

As a result of these factors, employees said, the division had not been innovative and its stagnant business was clearly reflecting that.

New management, coming in mid-1995, was aware of the Alliance Innovation Model and wanted to use it to make some changes. As part of their efforts, management sponsored an initial benchmarking of the organization in 1995 against the best-of-breed sample, using the Innovation Model. The results (shown on Figure 4, discussed below), corroborated the problems cited above.

Basic Principles of the Alliance Innovation Model (Figure 1)

Before illustrating its application to the Power Systems business, let us review the primary tenets of the Alliance Innovation Model:

- Organic growth is highly dependent on innovation, the process of expeditiously introducing high quality new products at targeted costs.
- Sustained innovation, in turn, depends on key individual employee behaviors that translate into innovation-related results. Specifically, the Model identifies four distinct behavioral dimensions (Inquisitive, Collaborative, Advocative, and Goal-directed), common to all leaders in innovation (see Figure 2).
- An organization's history, strategy, policies and practices directly influence these behaviors. By identifying and describing these elements, the Model makes the process of innovation finite and quantitative.
- All of the elements just mentioned are interrelated and part of a system that determines innovative output. Each element can have a positive or negative impact on the others. Through understanding and monitoring these elements, an organization can create an environment that fosters innovation and ultimately attain growth objectives.

Figure 1. The Alliance Innovation Model (McGourty & Tarshis 1994, 1996, 2000)

In an era of increasing competition and rapid change, skill at innovation is a major factor in attaining and keeping a competitive edge. The SATM Innovation Model, illustrated here, serves as a guide to an innovation improvement program.

The model is drawn from the experience of companies renowned for gener-ating large numbers of new ideas leading to commer-cially successful innovations. An extensive survey of 14 best of breed corporations widely recognized as leaders in innovation, along with substantial additional re-search, identified the factors responsible for these companies' success and produced a model for innovation.

The model depicts the inter-relationship of five primary components affecting innovation.

It focuses on key individual behaviors that translate into innovation-related activities. Previous emphases in the literature on personality traits, which are not readily observable and are difficult to measure, have been replaced by these behaviors, which can be measured and provide a much clearer map for organizational change.

A corporation's culture plays a powerful role as social influence within the organization. It informs people explicitly and implicitly of what is or isn't important and expected. It helps to define norms and behavioral patterns. Innovative behavior by individuals is a function of the extent to which that type of behavior is expected, valued and supported by the organization.

The present-day operations of an organization are greatly influenced by past events and history. Such past events include actions or behaviors by founders and other key leaders and the evolution of the organization's core values and behavioral norms. A company's history can have a significant influence on contemporary culture and must be considered when attempting to assess and improve an organization's ability to innovate.

Strategic direction and organizational practices are controllable influences that play a major role in determining an organization's culture. Exemplary organizations systematically translate a clear and aggressive strategy into specific organizational practices that encourage innovation and exploitation.

By understanding and managing each of these inter-connected elements, a corporation can create an environment that fosters innovation and can ultimately join the ranks of those who are already best of breed innovators.

Figure 2. Key Behaviors Needed to Produce a Continual Flow of Creativity SATM Innovation Model (McGourty & Tarshis 1994, 1996, 2000)

A company can raise its level of innovation by fostering specific individual behaviors in its employees. This research identified four distinct behavior patterns – and the specific individual behaviors listed below – that are common to all leaders in innovation.

Inquisitiveness
- Search purposefully for useful new ideas and technologies.
- Challenge each other's ideas in a constructive way.
- Search for and incorporate diverse points of view.
- Seek information from expert sources outside the organization.
- Continuously experiment with new ways of doing things.

Advocating New Ideas
- Encourage and support the ideas of fellow associates.
- Challenge the status quo.
- Pursue ideas despite risks.
- Champion new ideas by promoting them.
- Use failure as a way to develop new ideas.

Collaboration
- Facilitate and encourage informal relationships across the company.
- Encourage constructive conflict while deliberating over new ideas.
- Downplay status differences and encourage input from junior associates.
- Collaborate with associates outside their own functional area.
- Collaborate with people outside the company.

Goal-Directedness
- Work toward specific technological goals and objectives.
- Guide work with both technological and business goals in mind.
- Screen ideas in relation to established technologies and business objectives.
- Create action plans and timetables to ensure technology/business goals are met.
- Actively monitor progress to ensure that technology/business goals are achieved.

How Power Systems Applied the Model

1995-1997

In 1995, management launched an effort to improve and increase product innovation -- output from product development -- in order to achieve total revenue growth. The new General Manager laid out new business objectives:

- Refocus on business growth
- Achieve a higher rate of throughput, getting from concept to market more quickly
- Reduce product development cycle time
- Accomplish the above without adding a lot of staff
- Create an enthusiastic "pull" rather then "push" environment throughout their stage-gate Product Realization Process (PRP), to encourage innovation.

During the two years that followed, using the Alliance Innovation Model as a guide for defining appropriate efforts, business management made it clearly known that the main goal of the business was growth. Additionally, they started to streamline the PRP and make it more user-friendly.

Contrary to an initial hypothesis that the product development process was the cause of the company's limited success with new product introductions, the process itself was independently assessed as being excellent, on paper. What was wrong was that the process was not being properly employed. Instead, it was being used in a manner similar to how Total Quality Management (TQM) has been practiced -- emphasizing form over function.

In the bureaucratic environment that prevailed, employees were using PRP more as a rule than a tool, dotting all the i's, crossing all the t's and doing everything the written guidelines stated, failing to recognize that the goal was commercialization rather than process execution. They had developed risk-aversion (non-advocative) and self-protecting behaviors. They were generating papers instead of ideas, completing forms instead of developing products. To illustrate, one product manager displayed a stack of papers as high as a conference table! These were the actual papers that had to be signed off on, even though the project was a small and simple one.

Between 1995 and 1997, the division began to experience some positive results as patent rates, revenue from new products and total revenue all increased. The organization attributed these results to having stated the new growth objective and to newly structured product development teams utilizing a streamlined Product Realization Process.

Despite its stated growth objective, however, the organization was not yet really committed to growth and was not following through on recommended actions defined by the Innovation Model. This was shown by a second assessment in 1997 using the Innovation Model, as discussed below. Management seemed especially tentative about tackling some of the fundamental advanced behavioral aspects as prescribed by the Model. Virtually all of the innovation efforts languished, with only the PRP streamlining taking permanent hold.

1997 - 2000

In 1997, the third author of this article, Bob Huljak, joined the Power Systems division as Chief Technology Officer (CTO). He realized that, like most companies, Power Systems would require shorter and continuously improving product development cycles to achieve aggressive growth targets in a rapidly changing and highly competitive marketplace.

He was familiar with the SATM Innovation Model and was also aware of the company's limited success in using it to date. He believed it would be productive for the company to initiate new efforts to employ the Innovation Model, backed by a strong commitment from senior management, to improve innovation. He became the advocate/champion for innovation activities.

The new effort began with a reassessment of the environment using the Innovation Model survey, which indicated that the Power Systems culture had improved somewhat since 1995, along with the business results. In addition, the company was having limited success with empowerment, as evidenced by a somewhat greater number of issues being resolved by the product development teams. However, the culture, as measured by the innovation assessment, still was not satisfactory and much more had to be accomplished in terms of bottom line results.

The new CTO looked again at the model. To develop a particular behavioral environment or culture, the model suggests looking

Continued on next page

at gaps in management practices and focusing on those that are likely to have the most impact on innovation. The gaps can be defined by benchmarking with best-of-breed data (the results of the earlier research) as well as by innovative thinking based on insight gained from prior experience. Both techniques were used at Power Systems to describe new practices intended to develop desired behaviors.

Focus on Behavior: Two Examples – Goal Directedness and Collaboration

Goal Directed

To improve its innovation and bottom line, management decided that they would need to change its excessive focus on total quality management programs (initiated earlier by the quest for the Deming Prize) to one of dynamic growth. About this same time in 1997, the organization had another change in top management, a new general manager, Bruce Brock. He called for strong, dramatic and clearly defined growth with a vision, executed by a business team committed to new product development.

The business team began working on the front-end process, better defining, from a business perspective, what products needed to be developed. They focused on prioritization, deciding what it was their organization really should work on and in what order of priority. Priorities were made clear to employees and efforts were made not to change them too frequently.

The Product Realization Process was further simplified, utilizing a small number of gates with clearly defined expectations as checkpoints between empowered teams and management. These gates ensured congruence between customers' and management's defined needs and product development activities.

To further develop the desired behaviors for innovation, senior management issued a formal statement of operating principles for product development. This philosophy was explained to product development teams as the way management expected the process to function. It consisted of eight operating guidelines aimed at reducing dependency on: measurements, management involvement except where needed, and process.
The general philosophy included:

- Treat a product development project as it if were your own business.
- Think about a project from the customer's perspective, the real essence of TQM that had somehow been lost.
- Focus on overall project success, not individual functional metrics.
- Manage risk to an acceptable level. This recognizes that high innovators, who are advocates of new ideas, constantly challenge the status quo and pursue ideas despite risk.
- Use PRP as a tool, not a rigid set of absolute requirements or rules. Skip nonapplicable tasks, but add any that are needed. Do not do anything in a prescribed order if it does not make sense.
- Product development teams should manage the project to meet gate expectations and team members should ensure completion of functional tasks.
- Complete activities between gates without management intervention, as long as hard-to-resolve issues are brought to its attention in a timely manner.
- Urge the continuing collaboration between engineering and manufacturing, from project start to completion.

These principles were given to everyone in the division. They also became part of the orientation package for new employees, outlining to all the culture that Power Systems was striving to achieve.

The division renewed its focus on its definition of innovation; growing more products internally, getting them to market at target costs more quickly and with higher quality. The commitment by senior management had now been made at last.

Collaboration

One of the major efforts between 1997 and 2000 was to effect true empowerment of product development teams. This was accomplished by strengthening the membership of the groups, making sure that each team consisted of committed representatives from all appropriate functions responsible for product development. Between gates, the periodic checkpoints for reviewing progress with senior management, each team was responsible for carrying out development without management intervention -- unless it was required and requested.

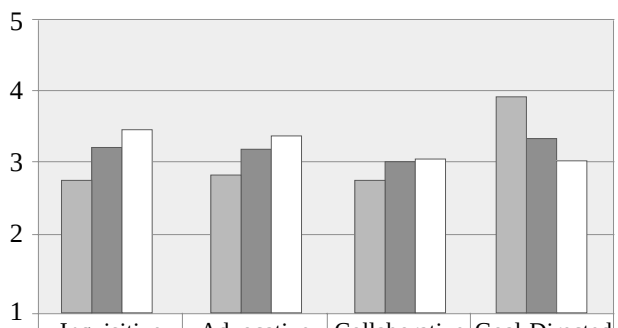
Project managers, empowered to use the Product Realization Process as appropriate and to reduce the amount of management involvement, led the teams. More decisions, therefore, were being made at a lower organizational level. However, it was determined that greater functional skills were needed by some the members of the teams.

For 18 months, management reorganized into functional units, including a discrete project management group. The idea was that employees who needed greater expertise would be more likely to do so in a functional organization.

When it was discovered, for example, that many project managers were not expert enough in leading teams or taking the required responsibility, the organization started appropriate training. The skill gaps relative to the desired competency levels were identified to determine training/development needs for individual project managers.

A recommended self-evaluation model said, in effect "Here's what the business needs from a project manager and here's where you are today." If an employee found himself weak in team leadership, for example, it would be his responsibility to define the needed education, and management's responsibility to provide it. The company, which has a tremendous capability for training people, introduced and improved programs to help develop the required expertise.

Figure 3. **Lucent Power Systems Behavioral Trends**

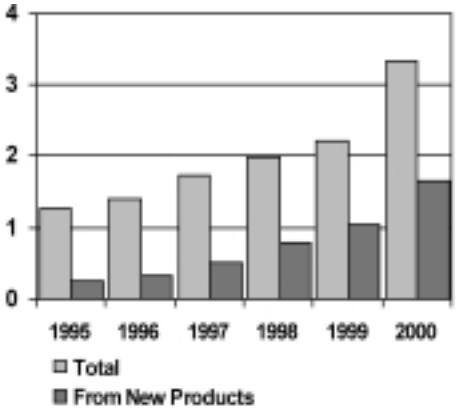


	Inquisitive	Advocative	Collaborative	Goal-Directed
Power 1995	2.7	2.8	2.7	3.9
Power 2000	3.22	3.20	3.00	3.37
High Innovators	3.48	3.38	3.06	3.02

Results

By the end of 1999 and through 2000, the Power Systems division reported spectacular results from its efforts to improve innovation and business results. A third review, in early 2000, of organizational behaviors and practices, using the Innovation Model survey, showed that, over a five-year period, they had made strong progress in approaching the behavioral levels of the highest innovators of the initial Alliance study (Figure 3). Power Systems had made remarkable progress in all four behavioral dimensions defined by the Alliance Innovation Model. They had gained in the areas of inquisitiveness, advocacy for new ideas and collaboration. They had also seen a decline in goal-directedness, a positive sign that they had become less rigid and less dependent on forms.

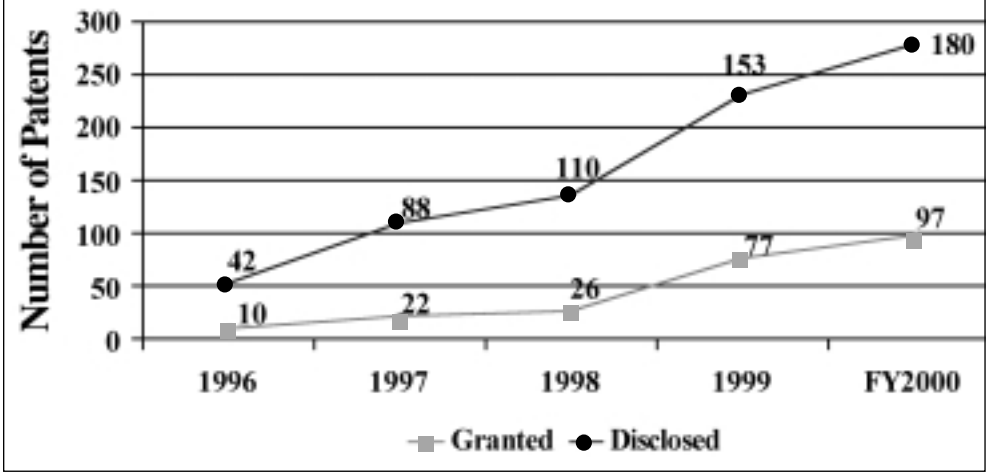
Figure 4. Normalized Revenues



These measurable changes in behavior, which are prescribed by the Innovation Model as indicators of an increase in innovation, were echoed in a dramatic increase in bottom-line results by the end of 2000:

- Total revenue grew 300%. (Figure 4)
- Revenues from new products more than doubled, from 22% to the 50% level (Figure 4). Management believed that 50% of revenue from new products is optimal for their organically-growing business.
- The number of new products introduced went from fewer than 80 in 1995 to almost 200 in 2000.
- The percent of new products being returned early in product life declined from over 80% in 1995 to well under 20% in 2000. Power Systems is now realizing the quality level for new products shipped that had long been the goal.

Figure 5. Patent Activity



- Over the five-year period, the division experienced a 900% increase in patent disclosures and a 450% increase in patents granted. (see Figure 5)
- All this has been accomplished with a small increase in personnel, less than 6% per year in the development area. This increase in employees also included the staffing of new European and Asian design centers, which had not existed in 1995.

Conclusions

The results of the Power Systems innovation project prove that management cannot simply put goals on paper and expect to achieve them. Nor can it take just one kind of action -- such as increasing employee rewards for patent filings -- and expect that it, alone, will accomplish the objectives.

Innovation is based on an inter-related system of organizational practices and behaviors. Power Systems has demonstrated that management can effect a change in culture and can see positive results in as little as two years by following a systems approach, such as that embodied in the Alliance Innovation Model. A business can accomplish innovation if it encourages a particular culture, and the way to develop a particular culture is through the practices put in place.

The key to success is a commitment by senior management. The first effort at improving innovation at Power Systems did not have the commitment and did not achieve the desired results. When the current management became a champion of the effort, however, it succeeded. ■

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New Products:
Managing the Fuzzy Front End

by Robert G. Cooper

Introduction

The new product game is won or lost in its first five plays. Simply put, the front end of the new product process makes or breaks the new product project: Those activities which precede the Development phase - the up-front homework or fuzzy front end - are pivotal activities, strongly correlated with the eventual outcomes of projects. But firms typically devote very little time, money and effort to these early stages, which may account for the unacceptably high failure and kill rates in product development. These were some of the provocative findings of our studies of new product success factors.

High performing businesses in product development had three common denominators:

- *a high quality new product process:*
- *a defined new product strategy; and*
- *sufficient new product resources;*

according to our recent benchmarking study of 161 business units. Strategy is a well-known critical success factor: having a product innovation strategy for the business which ties product development to the business's strategy and goals; which identifies arenas of focus for product development; which has a longer term thrust; and which is clearly enunciated to all in the business. Sufficient spending and resources is yet another familiar success factor: having the necessary people and R&D spending in place.

According to our investigation, however, process has the strongest impact on the business's new product performance - specifically, having a high quality new product process with a proficient front end, and with certain key ingredients built in, was the number one driver of performance.

A High Quality New Product Process

A *high quality new product process* increased new product success rates by almost 40% and the meeting of profit objectives by 88%! Note that merely having a formal new product process had no impact whatsoever; it was *the nature of the process* - what ingredients were built in and the conscientious implementation of the process - that made all the difference. Many of these winning ingredients focused on the fuzzy front end of the process.

1. *Successful businesses emphasize the up-front homework steps in the process - both market and technical assessments - before projects move into the Development phase.*

Too many projects move from the idea stage right into Development with little or no assessment or up-front homework: a "ready, fire, aim" approach. The results are usually disastrous: inadequate up-front homework was a major failure reason. By contrast, solid up-front homework drove up new product success rates by 43 percentage points and was strongly correlated with performance. Projects which boasted solid up-front homework achieved 2.4 times the success rate and 2.2 times the market share as those with poor home work, according to our studies of hundreds of new product projects. More evidence: The benchmarking study revealed that homework is a key ingredient in a high quality new product process, and was significantly and positively correlated with the two performance dimensions, namely *profitability* as well as *impact* of the firm's total new product efforts.

A paucity of homework seems to be the rule in product development, however. Indeed, the benchmarking study gauged the mean quality score on this ingredient to be a very mediocre 57.5 points out of 100. (Note: in the benchmarking study, firms rated their proficiencies on each of the performance drivers on a 0 to 100 point scale; here 100 was "excellent" and 0 meant "very poor"). Similarly, in the projects studies, quality of execution was rated (0-10) for each of 13 key tasks.

The results:

- quality of execution across homework or pre-development tasks was mediocre at best (quality ratings of 5.35 and 5.93 out of ten for the two projects studies); and
- successful teams undertook superior up-front home work (more time, money and effort; also better quality work) and executed the early-stage marketing actions much better than did failure teams.

Message: The fuzzy front end is perhaps the weakest facet of the entire new product process; yet it appears to decide success or failure. So build a detailed homework stage (or two) into your new product process - a homework phase which results in a business case based on facts rather than speculation. Insist that solid up-front homework be undertaken, and ensure that no significant project enters the Development stage missing this vital homework.

2. *Sharp, early product definition, before Development work begins, is one result of strong up-front home work, and is another common denominator of successful businesses and projects.*

A failure to *define the product* - its target market; the concept, benefits and positioning; and its requirements, features and specs - *before* Development begins is a major cause of both new product failure and serious delays in time-to-market. In spite

of the fact that *early product definition is consistently cited as a key to success*, firms continue to perform poorly here: the benchmarking study revealed a modest mean score for the product definition step of 66.8 points out of 100 - hardly stellar performance. More importantly, this same study found that sharp, early product definition was significantly correlated with both the profitability and the impact of the firm's total new product efforts. In a similar vein, the projects studies discovered a very strong impact of product definition on performance: sharp, early product definition enhanced project success rates by 59 percentage points. Such well-defined projects had 3.7 times the success rate and 1.6 times the market share as those which lacked definition; and product definition was significantly and strongly correlated with profit performance.

Message: Sharp, early product definition follows from solid homework (above). This definition includes:

- the target market;
- the product concept, benefits to be delivered, and positioning strategy; and
- the product's requirements and high level specifications.

Make it a rule: no project enters Development without a product definition, agreed to by the project team, based on solid homework and facts, and signed off by senior management.

Sharp product definition is important for three reasons:

- First, it serves as one check that the homework is done - that the front end work is proficient. Try getting a sharp product definition, and signed off by both management and all project team members, *without* solid homework - it can't be done!
- Second, product definition provides clear targets for the technical people on the project team. A major time waster uncovered in the projects study was *changing product specs*; lacking a solid definition of the product, the development team chased moving goal posts, which in turn meant lower success rates and longer times to market.
- Finally, a clearly defined product prior to the beginning of Development, signed off by management, means that there is *functional alignment* - that R&D, Marketing, Sales and Manufacturing all see the product and project the same way.

A high quality new product process increased new product success rates by almost 40% and the meeting of profit objectives by 88%!

3. *Successful businesses and projects emphasize a strong market orientation, and build in the voice of the customer throughout.*

Successful business units, and teams which drive winning new product projects, pay special attention to the voice of the customer. New product projects which featured high quality marketing actions - preliminary and detailed market studies, customer tests, field trials and test markets, as well as launch - achieved more than double the success rate and 70% higher market shares than those projects with poor marketing actions. Further, a strong market orientation increased success rates by 38 percentage points and was strongly correlated with new product performance (projects study). In the bench- marking study, a new product process which emphasized the customer and marketplace via market studies, market research, concept tests, competitive analysis, customer field trials etc., was significantly correlated with profitability of the business unit's total new product efforts.

A market orientation and customer focus was notice ably lacking in many firm's new product projects. Marketing actions were among the most weakly executed in the entire new product process, according to our studies, especially those in the early stages or fuzzy front end. The mean quality-of-execution rating for marketing tasks was a dismal 5.61 out of ten in the chemical projects study and 6.22 out of ten for all industrial products. Further, building in the voice of the customer was rated a mediocre 61 points out of 100 in the benchmarking study.

Message: Spare no effort in building the customer or user into your new product process. This means right from the beginning of the process, namely *ideation*: seventy-five percent of all successful new products saw the new product idea come from the marketplace. So focus on the customer to identify needs and wants and to solicit new product ideas. Next, the customer must be *an input into product design*, and not just an after-the-fact check that the de sign is satisfactory. Where market research was done at all in the front end of projects, we observed that it tended to be mostly of two types:

- research to characterize the market - for example, to determine market size, growth and pricing; to define segments; and to assess the com petition; and
- concept testing - research which presented the proposed product concept to the user / customer, and gauged interest and purchase intent.

Both are valuable studies, and should be a key facet of the early stage activities in any project. But if these two are the *only types*

...process has the strongest impact on the business's new product performance - specifically, having a high quality new product process with a proficient front end, and with certain key ingredients built in, was the number one driver of performance.

Continued on next page

of studies which you do, then your company is missing perhaps the most important market study of all: "the user needs-and-wants study". The latter *determines exactly what the ideal product should be in order to delight* the customer. It fleshes out an idea into a winning product concept; and it is here where you amplify ordinary ideas and translate them into great product concepts.

The challenge is that this *needs-and-wants study* is perhaps the *most difficult* of all to do: it means face-to-face interviews and in-depth discussion with potential customers/users; moving beyond conversation and right into the customer's use system (e.g., spend time in your customer's operation; observe; don't talk... listen; and immerse yourself); working with many customers and many people per customer; moving down the value chain to your customer's customer; and using very knowledgeable people to undertake the research (for example, both a technical person and a marketing/sales person to conduct the interviews together).

Spare no effort in building the customer or user into your new product process. This means right from the beginning of the process, namely ideation: seventy-five percent of all successful new products saw the new product idea come from the marketplace. So focus on the customer to identify needs and wants and to solicit new product ideas.

4. *Successful businesses build in tough Go/Kill decision points in the process, where projects really do get killed.*

Too many projects tend to get a life of their own! In the benchmarked companies, projects moved too far down the process without serious scrutiny: once a project began, there was very little chance that it would ever be killed - the process was more like a *tunnel* rather than a *funnel*. The lack of tough Go/Kill decision points meant: too many product failures; resources wasted on the wrong projects; and a lack of focus. The result was many marginal projects underway, while the truly meritorious projects were starved.

A new product process which features tough Go/Kill decisions is a critical but often missing success ingredient. Having tough Go/Kill decisions was strongly correlated with the profitability of new product efforts. Sadly, this ingredient - tough Go/Kill decision points - was *the weakest ingredient* of all process ingredients studied, with a score of 49.0 points of out 100 across all firms. The front end screens were noticeably weak: in one of the projects studies, for 88% of projects studied, the initial screen was judged as deficient; and 37% of projects did not even undergo a pre-Development business or financial analysis. Most of the critical Go/Kill evaluation points were characterized by serious weaknesses: decisions not made, little or no real prioritization, poor information inputs, no criteria for decisions, and inconsistent or capricious decision-making.

Message: A gating mechanism, featuring a series of rigorous Go/Kill decision points or "gates" throughout the process, is essential. The goal is to move from a *tunneling process* - where projects are rarely killed - to a *funneling process* - where mediocre projects are screened out at each gate, *ideally in the earlier stages*; and resources are focused on the truly meritorious projects. The goal is an *integrated portfolio management process* featuring rigorous gates to scrutinize individual projects, and portfolio reviews to oversee the entire portfolio of projects.

5. *The most profitable projects built in product superiority: a unique superior product, which delivered unique benefits and better value for the user.*

Successful businesses focus on new products which are *differentiated*, offer *unique benefits* to customers, and are excellent value for money for customers. Surprisingly, many companies failed to address this one vital success ingredient in their new product processes. Yet, countless success/failure studies reveal this to be the overriding success factor: in our projects studies, such superior products had five times the success rate, over four times the market share, and four times the profitability as products lacking this ingredient.

Very few firms can point to specific facets of their new product processes which emphasize this success ingredient. Often "product superiority" or "sustainable competitive advantage gained via the product" are *noticeably absent as project selection criteria*. Rarely are steps deliberately built into the process that encourage the design and delivery of such superior products (indeed, quite the reverse is true: the preoccupation with cycle time reduction and the tendency to favor simple, inexpensive projects actually penalizes projects which lead to product superiority).

Product superiority - delivering differentiated products which promise unique benefits and superior value to customers - must be emphasized throughout the new product process, especially in the early stages. This can be done by using elements of product superiority as key screening criteria at Go/Kill gates, and also by demanding that certain actions be included in the process - actions such as *user needs-and-wants studies*, constant *iterations with users* during Development, and *user preference tests* - to ensure that product superiority becomes a goal of the project team.

What Top Performers Do

What should the fuzzy front end comprise? Here are some actions which successful businesses and project teams built into the early stages of a new product project in order to realize the five success factors out lined above:

1. Solid up-front homework means building in a "first cut" or *preliminary investigation* stage, involving:

   - *A preliminary market assessment:* a quick scoping of the marketplace to assess market existence, probable market size, and expected product customers and users. Conduct to determine customer needs, wants and preferences; product perform-

ance requirements; and a definition of the customer's wish list (described in item 3 above).

- *value-in-use* study: assessment of the customer's economics - what economic value the product will bring to the customer (this often involves an in-depth look at the customer's use system, the current solution, and various cost drivers).
- *competitive analysis:* a detailed look at competitors' products, pricing, bases of competing, and performance (e.g., share and profitability).
- *concept tests:* a testing of the proposed product (in concept or prototype form) to gauge interest, liking and purchase intent (and an estimate of expected sales); also price sensitivity

2. *Detailed technical assessment:* a more thought-out technical activity to prove technical feasibility, identify the likely technical solution, deal with technical risks, assess manufacturability (route, costs and probable capital requirements), and deal with safety, health, legal and regulatory issues. This usually involves some physical technical work, such as lab work, modeling, or the development of a crude working model or prototype.

3. *Building the Business Case:* this defines the business proposition and product, provides the justification for the project (the business rationale for the new product), and maps out the action plan through to Launch. Tasks here include detailed financial analysis and business risk assessment.

One Solution: Stage-Gate™ Processes

Numerous firms have implemented Stage-Gate™ processes in order to build best practices into their new product process, *particularly in the earlier stages*. A Stage-Gate process is simply a template or roadmap for driving new product projects from idea through to launch and beyond. It breaks the product innovation process into stages - typically five or six - with each stage comprising a set of parallel, cross-functional and prescribed activities.

Between stages are gates: these gates are quality control check points in the process; they open or close the door for projects to move to the next stage. Here senior management meets with the project team to decide on the merits of the project, and whether or not it should receive funding or resources for the next stage. Each gate has a pre-defined *set of deliverables*: the information that is required to make the Go/Kill decision to the next stage. Each gate also features a list of *criteria*, against which the project is scored in order to make the Go/Kill and prioritization decisions.

Sounds simple, but stage-gate processes are much more complex than the brief description above implies:

- Each stage specifies the required actions, including the details on how to do each task as well as various best practices. These stages thus prescribe the play-by-play game plan, which, if adhered to by the team and leader, maximizes chances for success.
- The gates make the process work: by specifying the deliverables or the desired results of each stage, they make expectations for project teams and leaders crystal clear. Gates mean tough Go! Kill and prioritization decisions based on solid criteria, so that the truly meritorious projects are funded, and the mediocre ones screened out.

Achieving a steady stream of successful new products and reducing times-to-market remain elusive goals. For results, look to the fuzzy front end of the process, for it is here where success and failure are often decided. Consider implementing a Stage-Gate new product process which builds the necessary up-front home work, as well as the other critical success factors out lined above, into your process by design, rather than by accident! ■

Achieving a steady stream of successful new products and reducing times-to-market remain elusive goals. For results, look to the fuzzy front end of the process, for it is here where success and failure are often decided.

The Author

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Effective Gatekeeping in New Product Development

by Lawrence Gastwirt

Every organization concerned with innovation is striving to bring new products to market faster, at lower cost, and with higher probability of commercial success. The literature is full of prescriptions for achieving these three, often conflicting, objectives. One finds repeated references to such concepts as fast cycle time analysis, concurrent engineering, cross-functional teams, voice of the customer, use of systematic processes, etc.

"Gatekeeping" is a relatively new term in the lexicon of product innovation. It will be explained clearly below. It has become very apparent that a key factor distinguishing "best-of-breed" organizations from the rest, in terms of the results achieved from their product innovation activities, lies in their use of effective gatekeeping practices.

This paper summarizes the principles of effective gatekeeping. While this compilation of "best practices" draws upon insights gained from many organizations, I am most indebted to ExxonMobil Chemical Company, an exemplary practitioner whose Innovation Process embodies most of the principles outlined here. I am also indebted to Robert Cooper for the many insights he has provided over the years.

Introduction

It's useful at the start to define the words "product" and "innovation" as used in this paper. By "products" we mean new opportunities in the broadest sense, embracing physical products, processes, software, systems, services, and applications. "Innovation" is the process through which ideas are generated and developed into successful new products.

Product innovation processes typically provide for discrete decision points at intermediate stages along the path from opportunity conception to commercial implementation. These interim decision points are commonly referred to as gates. Indeed, the Stage-Gate process for product innovation, originated and championed vigorously by Bob Cooper, emphasizes the importance of these intermediate decision points in its name.

The generic Stage-Gate process has been described extensively in the literature, so it is unnecessary to go into detail here. A brief extract from Cooper's 1997 article which appears in this publication is sufficient to set the stage for our discussion:

> "A Stage-Gate process …. breaks the product innovation process into stages -- typically five or six -- with each stage comprising a set of parallel, cross-functional and prescribed activities. Between stages are gates: these gates are quality control checkpoints in the process; they open or close the door for projects to move to the next stage. Here senior management meets with the project team to decide on the merits of the project, and whether or not it should receive funding or resources for the next stage. Each gate has a pre-defined set of deliverables: the information that is required to make the Go/Kill decision to the next stage. Each gate also features a list of criteria, against which the project is scored in order to make the Go/Kill and prioritization decisions."

Whether they employ formal Stage-Gate processes or not, many organizations utilize innovation processes that embrace similar concepts, especially intermediate decision "gates". And, whatever the process they employ, every organization has "gatekeepers" -- leaders whose approval is required before resources, initial or continuing, can be expended.

The term "gate" while descriptive, has however, contributed to a somewhat narrow and limiting definition of gatekeeping. Since a gate is an interim decision point on the innovation path, this has resulted in a tendency in some organizations to think of gatekeepers as simply decision-makers, or judges, at discrete points during the project evolution, and to think of gatekeeping as simply decision-making at these points in time.

Decision-making is obviously an important component of gatekeeping. In an effective innovation process, however, gatekeeping is invested with a much richer meaning than just decision-making. As discussed here, effective gatekeeping involves, in addition, many facilitating activities, most of which take place external to gatekeeping meetings. These activities take place continually during the execution of stage activities, as well as after the gate decisions have been made.

It is thus more useful to think of gatekeeping as the facilitating mechanism – the leadership practices and behaviors – that enables project teams to move good projects forward to rapid and effective commercialization. This paper attempts to provide a fuller appreciation of the elements of effective gatekeeping in terms of such practices and behaviors: gatekeeper responsibilities, norms of gatekeeper behavior, selection of gatekeepers, and conduct of gatekeeping meetings.

Responsibilities of Gatekeepers

Innovation is one of the most difficult endeavors any organization undertakes. It helps immeasurably if gatekeepers view themselves as facilitators of innovation, whose ultimate function is to facilitate the rapid progress of the best projects along the path to commercialization. A corollary of this function is to ensure that the less attractive projects – those failing to meet agreed criteria – are terminated before they consume extensive resources, so that the requisite resources can be dedicated to the most attractive projects.

Carrying out their function effectively entails the following gatekeeper responsibilities:

- **Establish, with the full involvement of the project team, specific stage deliverables and unambiguous gate passage criteria, at the start of stage activities.**

This brief statement embodies several of the most important aspects of the gatekeeper's job. Since gatekeepers will eventually decide whether to advance a project, they need to come to grips early on with what it will take to convince them. This should be deliberated with the project team, to ensure that all of the team's wisdom is taken into account, and to achieve their full commitment. The criteria for success should also be decided, as explicitly as possible, before work commences, so that the team's effort is focused on the issues that will impact the decision. This advance planning requires a lot of effort, but a lot less than could be wasted on costly development of wrong things.

- **Maintain contact with each project for which they have responsibility, and mentor the project team during execution.**

  Despite the best planning, surprises -- good and bad -- will always happen as new information comes in. New customer inputs may call for tweaking of product attributes, competitive activities may suggest modifications in approach, etc. Gatekeepers must thus be accessible to project teams during the execution of stage activities to review potential changes in deliverables or criteria. Even in the absence of mid-course corrections, gatekeepers should be in contact to share their wisdom and to ensure more informed decisions.

- **Make timely, firm, and consistent gate decisions.**

  Gatekeepers must make timely decisions: good projects should not be allowed to languish for want of resources, and poorer projects must be terminated as soon as it becomes apparent that they will not achieve the established criteria. The decisions should be clear and firm; killed projects must *really* be stopped so that resources are freed for allocation to the more promising ones. Finally, gatekeeper decisions should be consistent with the pre-agreed success criteria.

- **Set priorities among competing projects.**

  Once a project has met the absolute criteria for gate passage, the next decision is a prioritization decision, taking into account resource availability. This requires that the project be ranked relatively against other projects competing for resources, based upon an assessment of project "value" relative to others. This in turn requires good knowledge of the competing projects and some common bases for comparison.

  Since resources are never unlimited, the best projects can be accelerated only if the less promising ones are culled expeditiously. An effective prioritization or portfolio management process is thus a critical aspect of any product innovation process, to keep the organization from fragmenting resources.

...a key factor distinguishing "best-of-breed" organizations from the rest, in terms of the results achieved from their product innovation activities, lies in their use of effective gatekeeping practices

  Gatekeepers must agree among themselves on the areas of strategic focus of the business unit, and on the criteria that will be applied to prioritize projects competing for resources. Once agreed upon, the criteria must be applied consistently.

- **Commit resources and ensure implementation of the resourcing decisions.**

  With the emphasis on resourcing the most promising projects, resource commitment is clearly a vital gatekeeper responsibility. This has implications for the composition and organizational level of gatekeeping teams, as discussed in the section on gatekeeper selection.

- **Enlist appropriate gatekeepers for the next gate meeting and secure their participation during the next stage.**

  Some organizations change compositions of gatekeeping teams as the project advances and resource commitments escalate (see section on gatekeeper selection). Where this applies, gatekeepers are responsible for enlisting their successors when the project passes a gate.

- **Communicate gatekeeping decisions promptly to the project team members, senior management as appropriate, and other relevant constituencies such as support functions and customers.**

- **Execute and sign any prescribed documentation.**

  A formal system of documentation is required in any quality process, and many processes prescribe forms to document gatekeeping decisions, for example.

- **Act as advocates of projects to higher levels of management, when their endorsement will ultimately be required (see section on gatekeeper selection).**

- **Ensure that projects do not exceed approved budgets or schedules without explicit authorization.**

- **Promote high standards of project management effectiveness by monitoring the quality of execution of the project deliverables and providing feedback.**

  Consistent with the concept of continual mentoring of the project team, this function should be carried out continuously.

- **Promote high standards of execution of the innovation process.**

  This responsibility entails monitoring process performance, recognizing exemplary application, communicating ideas for improvement to the process owner, and adhering to the norms of gatekeeeper conduct (see below).

- **And finally, as an overall responsibility, facilitate project progress by being alert for and helping the project team overcome any potential obstacles to timely project completion.**

This is a formidable list. It invests gatekeeping with a much richer function than simply decision-making. It is what the best gatekeepers do to facilitate the progress of the projects under their purview.

Continued on next page

Norms of Gatekeeper Conduct

As organizations progress toward more systematic innovation processes, the role of the manager must evolve in parallel, from the traditional judge/decision-maker role to the coach/facilitator role embodied in the discussion of gatekeeper responsibilities. This often implies the need for a change in behaviors. Here are "norms of conduct" that gatekeepers must work to cultivate in order to fulfill their responsibilities effectively:

- **Gatekeepers must put high priority on their gatekeeping function and ensure that they never become bottlenecks to project progress.**

  Project progress should never be impeded because of the failure of gatekeepers to fulfill their responsibilities. Leaders must make themselves available for mentoring, decision-making, and facilitation as the project team requires. If circumstances make it impossible for a gatekeeper to fulfill his or her roles, the gatekeeper must make a clear delegation of responsibility, including the responsibility for gate decision-making.

- **Gatekeepers should carry out their coaching/facilitating roles without crossing over the line of micro-managing the details of project execution.**

- **Gatekeepers should prepare themselves for gate meetings by studying the relevant project material in advance.**

  This is a courtesy that should prevail whether or not an organization employs a systematic process, but the institutionalization of this norm of conduct becomes especially important when a formal process is employed.

- **Gatekeepers must restrict their inquiries to questions appropriate to the specific deliverables of the gate at hand.**

  A common trap for gatekeepers is to seek more information than is warranted by the stage of the project. An aversion to risk is common to the culture of many organizations, leading gatekeepers to seek out details "before their time." Remember that risk is being managed through the use of the process, which breaks the innovation path into discrete phases and intermediate decision points before further resources are authorized.

- **Gatekeeper decisions should be disciplined and based on the pre-agreed criteria, with no hidden criteria or last-minute raising of the hurdles.**

- **Gatekeepers must work by the "rules of the game," following the company process and treating all projects consistently, with no favoring of "pet" projects.**

- **Gatekeepers should understand and act consistently with the principle that bringing a project to a rapid, efficient "no-go" decision where appropriate represents a success.**

  Many projects do not deserve to be progressed, and the innovation process must be viewed as a winnowing-out process that focuses resources on the most deserving. This can happen only if the less attractive projects are terminated in a timely manner. Project teams need to look at their projects objectively, and this behavior must be reinforced by gatekeeper conduct.

- **If gatekeepers become aware of a major weakness in the project, they should inform the project team immediately, and not wait for the next gate meeting.**

  This is entirely consistent with the responsibility of gatekeepers to act as ongoing coaches and mentors concerned with speeding up projects, as opposed to judges at fixed milestones.

- **Gatekeepers must support decisions of the gatekeeping team. Once the gatekeeping team decides to continue, individual gatekeepers must provide the resources under their control.**

Selection of Gatekeepers

Gatekeepers are stakeholders in the project, typically managers representing the organizational units involved with the execution and commercial implementation of the project. Since the tasks performed during each project stage typically require the participation of several functions/organizations, gatekeeping similarly requires cross-functional participation.

This introduces the concept of a gatekeeping team, with team members representing such functions as Technology, Marketing, Product Management, and Manufacturing, and perhaps others such as regional management, depending upon the project issues and their importance. The organizational level of the gatekeepers is usually a function of the magnitude and importance of the project.

The fundamental principle in gatekeeper selection is that gatekeepers must be able to commit the human and capital resources needed to successfully complete the next stage (at least) of project activity. This principle often implies a change in the composition of the gatekeeping team sometime during the project lifetime, with the organizational level of the gatekeepers escalating as the project advances through the successive, increasingly resource-intensive stages.

On the other hand, some organizations find it more effective to use an unchanging team of relatively senior gatekeepers throughout the life of the project. This is often the case in relatively flat organizations, and in organizations working on fewer, larger projects. Similarly, for major projects that will eventually entail large resource commitments in the late stages, an organization may elect to employ higher gatekeeper levels at the earlier gates than would be called for by the lower resource levels involved. This approach enhances continuity between the project team and the gatekeeping team and minimizes the disruption that may be caused

As organizations progress toward more systematic innovation processes, the role of the manager must evolve in parallel, from the traditional judge/decision-maker role to the coach/facilitator role...

by a changeover. It does, however, place a greater burden on senior management.

Each organization needs to decide between these two approaches, based upon its own characteristics. Whatever method is chosen, the fundamental principle still applies: gatekeepers must have the authority to commit the resources needed to successfully complete at least the next stage of the project. If an organization elects to employ changing gatekeeping teams as a project advances, gatekeepers should nominate the appropriate gatekeepers for the next gate at the conclusion of each gate meeting, taking into account the resource commitments that will likely be entailed at the next gate and the associated authority levels.

Many innovation projects require the investment of capital funds, sometimes during the development stages and often prior to commercial implementation. Consistent with the above principle, gatekeepers must be able to commit these funds, along with the human resources required.

Organizations generally have well-developed policies and processes for managing their capital investments, including the specification of "gatekeepers" who must approve/endorse the commitment of capital investment dollars. Where processes to manage innovation intersect with processes to manage capital investment, it is of course essential that the processes meld smoothly. An issue that arises in many companies is that capital approval gatekeepers (for any significant capital commitments) are often at the very highest level of the organization, sometimes at the president/executive vice president level.

It is usually unrealistic to expect people at this level to act as innovation project gatekeepers, yet their endorsement is necessary for the capital expenditure commitment. When an individual having the appropriate capital approval authority cannot be on the gatekeeping team, he or she may delegate authority to the gatekeeping team. The ultimate resolution lies in the recognition of the distinction between approval/endorsement and gatekeeping. It is up to the gatekeepers to advocate the project to the ultimate capital approval authorities and secure their endorsement of the necessary capital commitment.

Effective Gatekeeping Meetings

From the foregoing discussion, it should be evident that effective gatekeeping meetings are somewhat anti-climactic events. With clear, up-front definition of the required stage deliverables and the criteria for gate passage, along with on-going mentoring of the project team by the gatekeepers, there should not be any surprises at gate meetings. All involved with the project should have a clear idea, in advance, whether the absolute criteria for gate passage have been met (although a project that meets the pass criteria may have to be assigned a "hold" decision temporarily because of non-availability of resources, if relative priorities place other projects ahead of it.)

Despite the expected absence of surprises, formal gatekeeping meetings should be held at the conclusion of the activities for each stage. A formal meeting ensures that any minority views have been considered and any last minute issues resolved. Also, a formal gatekeeping meeting has the important value of marking progress toward commercialization, or of bringing formal closure to a low priority project.

In addition, the gatekeeping meeting provides the opportunity for the gatekeepers to revisit the portfolio of projects under their purview and consider whether the project under consideration merits continued/additional resources in terms of its relative priority.

For projects that do not pass the gate – which represent the majority of projects in the early stages – the gatekeeping meeting offers the opportunity to recognize an efficient and timely project termination. Such decisions are vital if resources are to be made available for assignment to the more promising opportunities. It is critical to the success of the innovation process for project teams to recognize that a kill decision has been made, to understand why the kill decision was taken, and to appreciate that a quality process, which has considered all of their inputs, has operated to arrive at the decision. The meeting thus contributes to achieving organizational alignment behind termination decisions, and helps people in the often difficult task of "letting go" cleanly and moving on to the next assignment.

Similarly, for projects that get the go-ahead to move forward, the gate meeting affords the opportunity for a formal celebration. It provides a clear demarcation between stages, and ensures clear alignment between the project team and the gatekeeping team on the plans for the next stage and the critical success factors for the project.

Some guidelines that will contribute to effective gatekeeping meetings are offered below:

- *Appoint a "lead gatekeeper," or chairperson of the gatekeeping team, to chair the meeting and serve as the contact person for administrative purposes during stage activities.*
- *Go ahead with a gatekeeping meeting only if all the agreed deliverables are complete. (A deliverable, of course, includes the assessment that a critical project target is unattainable, hence leading to a "kill" decision.)*
- *Ensure that all written materials documenting the achievement of the deliverables – technical reports, marketing studies, freedom of operation assessments, etc. – are in the hands of the gatekeepers sufficiently in advance of the meeting date to permit adequate time for review.*
- *Adopt a standard meeting format and stick to it. This might include, for example, the project team being given an uninterrupted period of time at the beginning of the meeting to present a summary of the deliverables, followed by a question and answer session to elicit further details and address critical issues. The gatekeepers should then go through the list of pass criteria and decide, or perhaps more descriptively, ratify, whether they have been met or not.*
- *Decide in advance the process by which gatekeepers will reach a decision – will a formal scoring system be employed with a quantitative standard for passage, must the decision be unanimous or will it be made by majority vote, etc.*
- *Invite the project team to be present at the meeting, if possible. They may be asked to leave the room if the prioritization decision involves sensitive discussion of other projects competing for resources. If they are not present when the decision is taken, they should be informed of the decision in person immediately after the meeting.*
- *Consider videoconferences and teleconferences.*

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Getting to Breakthroughs:
Approaches and Organizational Structures, *or* How to make the Impossible Possible

by Peter Koen

Disproportionate wealth creation comes from breakthrough products. A study done by Kim and Mauborgne[1] of 30 companies in 30 different industries, highlighted in exhibit 1, indicated that breakthrough products are responsible for a substantial amount of the profit in these companies. While breakthroughs comprised 14% of the product launches, they contributed 61% of the profit.

What do we mean by a breakthrough? Perhaps the best definition comes from the book by Leifer[2] et. al. on Radical Innovation, which classifies a breakthrough as being one that offers a 5-10 times (or greater) performance improvement or a 30-50% (or greater) reduction in cost. A classic example of a breakthrough product is Tagamet, a new class of drug, called H2 antagonists, for healing ulcers more quickly and painlessly than previous drugs. It was the first billion dollar drug in the pharmaceutical industry. Similar breakthrough products include 3M Post-It notepads and the Polaroid camera.

Why don't more companies focus more of their resources on breakthrough products if disproportionate wealth creation comes from them? This dilemma is best explained by Christensen in his classic book, "The Innovator's Dilemma[3]." He indicates that leaders do not embrace disruptive technologies because:

- Disruptive technologies at first have worse performance for mainstream customers. A classic example is the hard disk drive market. Initially mainframe computers utilized 14 inch Winchester drives which had 200 MB of capacity. New competitors were developing smaller drives – such as the 8 inch drive. However, IBM and other companies in the mainframe market saw little use for this niche product and failed to take it seriously. As most companies do, they continued to focus on the current technology in order to improve its performance and decrease its cost. The 14 inch drive market had margins and certainty that appeared superior to the lower margin and uncertain technology of the 8 inch drive market. However, the 8 inch drive fueled the minicomputer market which – over time – proved disruptive to the mainframe market to the extent that the 14 inch drive became obsolete. It was too late for IBM and other companies to take advantage of the new trend since the 8 inch drive developers already had established a foot-hold based upon their skills and manufacturing capacity.
Interestingly, the pattern repeated itself in the 5.25 and 3.5 inch drive markets, where each of the preceding companies failed to take advantage of the new market until it was too late. To quote Bower and Christensen[4], great companies "…fail – not because they make the wrong decisions, but because they make the right decisions…." by listening to their mainstream customers who typically demand enhanced performance with deceased price from the existing technology.
- It is difficult to see the long term potential of the new technology. When the 8 inch drive was first introduced it was difficult to see how a lower performing product could be of value to mainframe companies. It was difficult for these companies

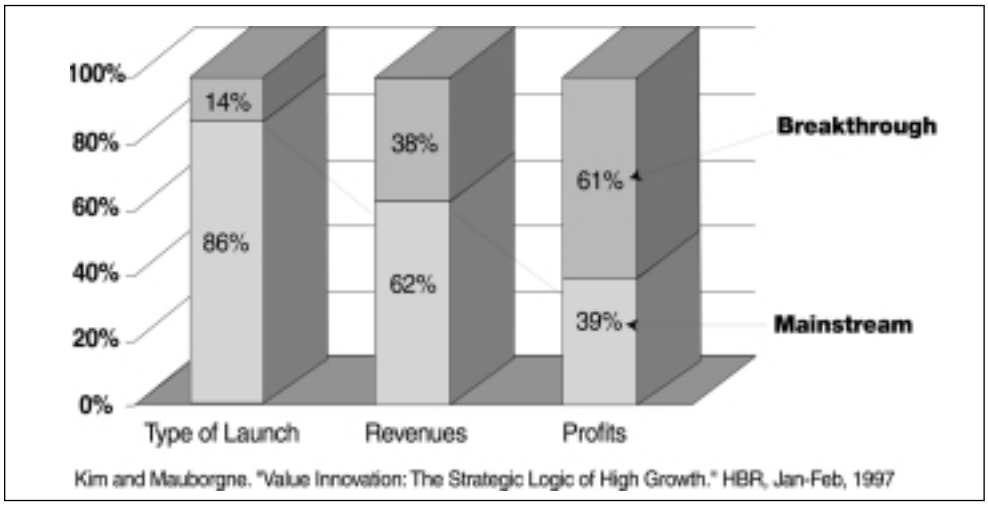

Exhibit 1. *Study done by Kim and Mauborgne of 30 companies in 30 industries showing that while Breakthroughs made up only 14% of the product launches, they accounted for 61% of the profit.*

to envision the rapid rate at which the technology of 8 inch drives would improve in terms of storage capacity. Similarly, it was difficult for vacuum tube makers to take seriously the poor fidelity that was being introduced in the early transistor radios. Today's radios are all made from transistors (i.e. integrated circuits). Just as IBM missed the 8 inch drive technology, so did vacuum tube manufacturers fail to make the leap to the new technology.

Bower and Christensen advocate that the organization that is developing the disruptive technology be isolated from the mainstream until the new technology becomes commercially viable in the new market. They indicate that a separate organization is necessary since the new stream business cannot attain the same profit margin or focus on technologies that are distractive to the main stream business. Based on this challenge I have been investigating the ways in which companies organize around breakthroughs.

Separated Business Development Group

A well documented example is Proctor and Gamble's separated corporate business development group (Whitney and Amiable[5]), which put aside $250 million of seed money to develop at least one major business per year. The team consisted of full time people from brand management, R&D, finance and market research. While they handed off 5 projects to the business sectors, they have yet to develop a profitable business since the divisions have had difficulty allocating people to the new projects. In fact the director of the unit wondered if many would "…survive…" (Whitney, 1997, pg 13), since many of the concepts were several years from the market.

This transition from the internal corporate venture group to the existing businesses is a classic problem of separated business development units which are funded by the corporation. Thus it appears that separated business development, while successful in pursuing new opportunities, has difficulty transitioning the new business or technology to the main stream business. In fact the director of the venture unit indicated that if he "…started over today, he would have the heads of all the business units involved as an advisory council" (Whitney, 1997, pg. 13) to ensure better transition.

To quote Bower and Christensen , great companies "…fail – not because they make the wrong decisions, but because they make the right decisions…." by listening to their mainstream customers who typically demand enhanced performance with deceased price from the existing technology.

The Changing Role of the Corporate Research Laboratory

The Corporate Research Laboratory's (CRL) traditional mission has been to develop and prove the feasibility of high risk exploratory research which would have significant benefit to the corporation. Traditionally these units were relatively independent of the business units – being funded through a corporate tax and free to pursue high risk technologies. However, considerable reorganization in most CRL's occurred during the latter part of the 1990's when firms placed more emphasis on CRL's to produce bottom line results. Most companies "…increased the business-focused level of funding from between 30-50 % to up to 70-80%..." (Glass[6], et. al. 2003, pg 25). This has resulted in much stronger alignment of the CRL with the SBU. The new model that appears to be emerging in successful CRL's is a more integrated approach to breakthroughs that employs the following nine principles:

- **Business Technology Interspersing**. Basic research can provide the fundamental underpinning for a disruptive technology, but often delivers little value to the corporation. In contrast, applied research, which is tightly focused on application and incremental improvement, provides value, but rarely becomes the platform for high impact projects. The new role of the CRL is to effectively link them. This is done through corporate oversight and business stewardship, by assuring that the basic science goals are business-driven rather than science-driven, by integrating corporate and functional research planning, and by executing projects with a cross-functional team made up of both corporate and applied research people.

Continued on next page

What leads to success?

Business-Technology Interspersing

Project Selection based on Market and Technology Trend Analysis

Competitive Advantage, often derived from Science-Based Core Competencies

Aggressive Goals

(External) Scientific Peer Review

Constancy of Purpose

Process Optimization

Very early Prototyping and Field Trials

Full-time Project Team, populated with inventors with demonstrated track records

To quote Deming,

"The quantity and quality of results you get depend on the processes and systems you use to produce the results." Processes are essential for high impact innovation.

- **Market and Technology Trend Analysis**. Companies that first ask, "What sand box should they be playing in?" before focusing on specific products have a consistent track record of high impact innovation. This is a hallmark of successful Venture Capitalists, who first ask what market areas they should be looking at for new businesses, rather than by starting their search with specific new businesses. The new sand boxes are typically identified by evaluating market and technology trends.

- **Science-Based Core Competencies**. Competitive advantage is often derived from the unique core competencies and capabilities of an organization. These reside in the skill of people within the organization. Thus one of the prime imperatives, to achieve a continuous flow of breakthroughs, is to ensure that the organization possesses a skill base that is superior to its competitors and ensures continued retention of the people who posses the competencies. In addition, science-based core competencies typically lead to an intellectual property position which better assures long term competitive advantage and profitability.

- **Aggressive Goals**. Setting aggressive goals with a clear vision is often necessary to achieve success in breakthroughs. An example of this is the way in which Corning senior management set forth a clear aggressive goal to develop the next generation of catalytic converters when they realized the huge potential of the forthcoming reduced emission requirement of the Clean Air Act. Corning, in 1970, directed hundreds of scientists and engineers to focus on this single challenge, and now dominates the marketplace in catalytic converters.

- **Scientific Peer Review**. Review by scientific peers during a project helps evaluate the scientific aspirations of the project and better assures that the science involved meets the necessary standards of excellence and rigor. Many technology projects in companies are not accomplished with the correct scientific rigor. Peer review forces the project team to address the hard scientific issues that in turn will typically result in sounder scientific plans and execution than without such review. Scientific peer review represents a fundamental characteristic for assuring technical rigor in "best in class" companies.

  While scientific peers may exist within the company, I recommend that companies utilize external scientific peers. External peers are more likely to provide a fresh view and opinion of the project, and typically are more forthright in their evaluation of the technical risks associated with the project. The external peers invited to participate are required to sign confidentiality agreements that include non-compete clauses and assign any inventions that occur as a result of the engagement to the company.

- **Constancy of Purpose (Focusing)**. In order to get to the next breakthrough the overall vision should be stable over time. For example, Corning stated the goal of developing the next generation catalyst which would be able to meet the new regulatory standards. This vision was communicated so that the organization clearly knew where they were heading, and that it was unlikely for this vision to change.

- **Process Optimization**. To quote Deming, "The quantity and quality of results you get depend on the processes and systems you use to produce the results." Processes are essential for high impact innovation. These include a process for interspersing business and technology planning, managing high risk technology projects – such as Technology Stage Gate[7] – linking basic and applied research and intellectual property management. It also involves developing a series of value creation metrics which are linked back to the planning process.

- **Early Prototyping and Field Trials.** The author found that all of the 11 breakthrough products on which he performed case studies took significantly longer to get to market because the team failed to identify key constraints in how the product would actually be used. For example, new process analytics equipment developed to measure octane level in the refinery was found to meet the required specifications in the central laboratory. However, the same equipment failed to work when placed near the refinery in a high humidity environment – even when the humidly was controlled. (The humidity needed to be controlled under very tight requirements, which could not be met in a field environment). This unexpected field requirement could have been uncovered had the team done prototyping with an earlier version, and would have saved several years in the product development cycle.

  Similar events have occurred in each of the breakthrough products studied by the investigator. There seems to be an inherent desire by the technology team to complete the design before releasing it for tests in the actual environment so as to not be subjected to criticism for design elements which have not been completed. While this sounds logical, it is actually counter-productive. The actual field requirements will often require additional design changes to what was already perceived as a completed design. Allowing the team to identify many of the unknown constraints earlier, which will be facilitated by early prototyping, helps accelerate breakthrough product development.

- **Full-time Project Team** populated with inventors with demonstrated track records. Numerous studies have demonstrated that people begin to become unproductive once they are juggling more than two projects. Recent work by Amiable[8] indicated that people become more creative when they are focused on a single activity for a significant part of the day and feel that they are doing

important work. This is in contrast to having a highly fragmented day with multiple activities and discussions.

Numerous studies have also shown that a relatively small percentage of all inventors do most of the discovery. It is therefore critical for a company to identify, nurture and retain these leading producers and insure that they are part of the breakthrough discovery teams. Thus this body of work tends to indicate that full-time focused teams composed of inventors with demonstrated track records have higher probability of success than similar teams not organized in the same way.

Conclusions

Breakthroughs will continue to be a challenge for all organizations. Christensen and Bower, in their ground-breaking work, provide a cogent explanation of why companies reject breakthroughs as a result of their relentless focus on their current customers. However, this relentless focus allows them to become blind-sided to new technology developments which often have perceived problems. They advocate developing the breakthrough in a completely separate organization – though these have been problematic since the new concepts have difficulty transitioning to the mainstream. A new organization is emerging, that is only partially separated from the main stream business. Organizations that appear to be having success in breakthrough projects are partially separated organizations which adhere to business and technology interspersing, perform market and technology trend analysis, develop their breakthroughs based on science based core competencies, set aggressive goals, subject the work to scientific peer review, demonstrate constancy of purpose, constantly foster process optimization, utilize early prototyping and use full time project teams populated with inventors with demonstrated track records. ■

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Footnotes:

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[4] Bower, Joseph and Christensen, Clayton, " Disruptive Technologies: Catching the Wave," *Harvard Business Review*, Jan – Feb, 1995.

[5] Whitney and Amiable, "Corporate New Ventures at Proctor and Gamble," *Harvard Business Review*, Case 9-897-088, June 1997.

[6] Glass, J. T., Ensing, I. M. and DeSanctis, G., "Managing the Ties Between Central R&D and the Business Units," *Research Technology Management*, 46(1), 24 - 31 (2003).

[7] Ajamian, G. and Koen, P.A., "Technology Stage Gate: A Structured Process for Managing High Risk, New Technology Projects," In P. Belliveau, A Griffin and S. Sorermeyer, eds. *PDMA Toolbook for New Product Development*. New York: John Wiley and Sons, 267 - 295, 2002.

[8] Amiable, T., Hadley, C. and Kramer, S., T., "Creativity Under the Gun," HBR, August 2002.

Effective Gatekeeping... *continued from page 19*

- *Do not adjourn a gatekeeping meeting without a decision being taken to proceed, terminate, or hold until resources become available.*
- *Choose a tentative date for the next gatekeeping meeting at the conclusion of each gatekeeping meeting. It should be an aggressive target, but consistent with the assigned resources and a realistic work plan. If needed, an extension can be requested later by the project team or initiated by the gatekeepers.*
- *Have an external facilitator present at occasional gatekeeping meetings, to assist from a process standpoint and to help ensure that the spirit of the process is being followed.*
- *The meeting should conclude with an assessment of the effectiveness of the application of the process to the project. Recommendations for improvement of the process should be documented by the lead gatekeeper and transmitted to the process manager.*

Conclusion

The roles of the gatekeepers and the principles of effective gatekeeping summarized above represent significant change from past practices for many organizations. Much effort will often be required, at least during their early application, to implement these principles fully. This vision of effective gatekeeping represents an ideal to which an organization must aspire, however, if it is to achieve the full benefits of its innovation process. ■

The Author

Lawrence Gastwirt *has been Director of the Alliance for Technology Management since 1992. He came to Stevens after a 30-year career with ExxonMobil Chemical Company, where he managed large multi-national technology organizations and business operations of global scope. Larry is co-author of the book, "Turning Research and Development into Profits -- A Systematic Approach". He holds a Ph.D. from Princeton University in chemical engineering, and an MBA in finance and economics from NYU.*

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HOWE SCHOOL ALLIANCE FOR TECHNOLOGY MANAGEMENT

UPCOMING EVENTS

2006 Annual Conference - THE CREATIVITY-INNOVATION CONNECTION

June 7, 9:00-5:00

Babbio Center, Stevens Institute of Technology, Hoboken, NJ

Our Fifteenth Annual Conference is devoted to the topic of creativity, as both the igniting spark of the process of innovation and the insights that move an idea along the innovation path from conception to commercialization. We are presenting four distinguished speakers who will illuminate both the theoretical and the practical aspects of creativity, and will share their experiences aimed at increasing the quantity and quality of creative new ideas:

- **David Tanner**, founder and director of the DuPont Center for Creativity & Innovation, will describe some of the most productive creative thinking tools and discuss how the environment for creative thinking was enhanced at DuPont.
- **Christopher Barlow**, of DePaul University and the Co-Creativity Institute, will discuss the tools, concepts, and skills available for managing complex innovations.
- **Steven Jacobs**, President of Bilcare USA, will focus on leadership for creativity and innovation, drawn from his experiences in leading a successful innovation team for Johnson & Johnson.
- **Anthony Le Storti**, Executive Consultant for IDEATECTS® Inc. and former director of the Center for Creative Studies, will discuss how organizations subtly crush creativity and impede innovation, exploring the "logic of failure" often lurking in policies regarding innovation and creativity.

The Conference will appeal to technology managers, product managers, marketing managers, new business development personnel, project managers, corporate and business unit managers – in short, to everyone interested in energizing innovation and creativity. Please contact Sharen Glennon to reserve your space, **201-216-5381** or **sglennon@stevens.edu**

INFORMATION

For further information on Alliance activities or to submit an article, contact Dr. Lawrence Gastwirt at **212-794-3637 • Lawrence.Gastwirt@stevens.edu**

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