Developing Effective Technology Strategies

Winning companies make technology strategy development a continuous and creative business process.

Steve Bone and Tim Saxon

OVERVIEW: *Technology strategy can be both an analytical and creative process. A core team approach and stakeholder analysis ensures shared ownership of the resulting strategy and smooths the path for implementation. A carefully codified description of technology capabilities in terms of their component skills, facilities and organization enables the business to understand what is core to its future success and how to transfer technology to best effect. Although elements of structured and objective analysis are essential, technology strategy is best implemented as a continuous and creative business process.*

We are now seeing organizations approach technology strategy based on core competency methodologies (*1*). This approach views technology as a functional capability (*2*). Its hallmark is that it is activity based, and, therefore, draws upon bottom-up core competency techniques first developed by Klein et al (*3*), together with some of the concepts of business technology evaluation techniques discussed by Stillman (*4*). Parts of the core competency approach that were developed by Gallon, Stillman and Coates are still being successfully used and integrated into the technology strategy process by companies (*5*).

Successful companies now manage technology as an integral part of their business processes. In most cases, the technology they manage is scientific know-how, embodied in people, plant, patents, laboratories, and equipment—"technology cluster" strategies (*6*). Many see technology as only know-how or equipment. However, its application is embodied in the organization through people, business processes, plant, and equipment. Product, manufacturing process and service technology can all be described in this way.

Businesses that recognize the importance of effective technology management manage it like any other organizational resource and process. Technology is seen as consisting of several component parts, as shown in Figure 1. Capabilities underpin competencies within an organization, and some of these competencies are "core." A number of companies utilize some of the bottom-up and top-down core competency thinking that was developed during the mid-1990s.

The combination of the right people with the right skills, using the correct plant and equipment through effective business processes, is fundamental to the delivery of the company's strategic intent. This constitutes a technology capability. Practitioners must distinguish between a technology and a technology capability. A technology can be written down, codified and re-enacted—possibly at another company. If it cannot be totally codified, and is partly embedded in experience or art, then it forms part of a technology capability, to be exploited. This is why technology transfer is successful only when the technology is completely codified or the skill (person) accompanies the technology as part of a technology capability.

After a technology capability is viewed in this way, a business can benchmark it and exploit it in innovative ways. For instance, decisions can be made about whether to develop it internally or to outsource it. Outsourcing or buying-in technology can be made much more effective because skills, facilities and/or business processes can be simply described and actioned.

Deconstructing a technology capability in this way also exposes the exact source of uniqueness that turns a generic competency into a core competency.

Tools and techniques have been developed that make it possible to examine objectively the three constituent parts of a technology capability, benchmark them, scan external important technologies, and develop options for

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the future. The outputs that result can then be used to feed into a strategy to manage the capability. The main benefits of implementing a technology strategy process are illustrated in these examples (*6,7*):

■ An improved link between business strategy and technology strategy allowed a major electronics corporation to increase its ability to react faster and more effectively to changes in the business environment.

■ A technology strategy project in a large manufacturing company created a clear focus on main technologies in which at least 10 percent of the total resources were refocused on the most important technologies and new product development. This led to better quality products, earlier product launches, and increased revenue and profit.

■ A compelling reason for conducting technology strategy projects is to gain protection from sudden technology leaps or unforeseen discontinuities. This acts as a safety cushion to protect the current business or single products from substitution and replacement. An organization's greatest threats are those developments for which it is unprepared.

The increased practice of knowledge management means that much of the tacit knowledge can also be captured and retained as "legacy information." The growing use of the Internet to manage intellectual capital has been a useful driver to describe technical capabilities. For example, one conglomerate is already looking at web-based database approaches to collect and search for technology capabilities in the form of skills, facilities and organization. After it has collected this information, it will use the same business process to collect information in a similar format that is external to the company. Operating units within this conglomerate can then search the database for technology capabilities in other parts of the organization, or external to it, that will be important to the technology strategy.

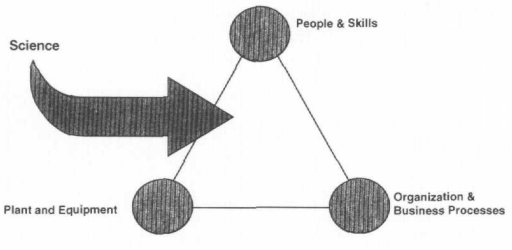

Figure 1.—Defining technology capability in terms of its constituent parts ensures that critical elements are not overlooked.

Practitioners must distinguish between a technology and a technology capability.

Other companies are implementing Web-based processes to manage technology. These processes include intelligence, portfolio management and planning.

Successful Strategy Characteristics

Recent observations of the strategic management of technology reveal some common characteristics among the most successful technology strategy processes.

- Stakeholder analysis is required to identify the key players in the organization and understand their needs and expectations.
- The process is explicit and transparent.
- Top management is involved in a systematic way in making technology decisions, using techniques that increase clarity and objectivity.
- Technology strategy development is a continuous process that is clearly mapped and communicated. It is well linked to the organization, its culture and all other business processes.
- A core team, supported by outside experts, modifies and adapts well-tried and tested approaches (some of these are described later) to suit the needs of the particular organization.

Strategic management of product, process and service-based technology should not be delegated down the organizational hierarchy. Unfortunately, many companies do not see the need to manage technology as a formal process and are thereby disadvantaged.

We have also found that there are a number of important practices to avoid when developing innovative and successful technology strategies, namely:

- Leaving it to one person to develop a technology strategy in a backroom and then present it to the rest.
- Attempting to use prescriptive tools and techniques off the shelf. There is no single standard framework.
- Trying to separate product, manufacturing process and service technologies, as all have complex linkages. Making a decision about one technology will impact the other two.
- Re-inventing the wheel. Companies can learn from those that have been successful and have experience with what works, what has to be modified and what does not work.

The Technology Strategy Process

In the most successful technology strategy process, the starting point is to form an enthusiastic core team. This core team then ensures that all the opinion formers and benefactors (stakeholders) of the technology strategy are approached and interviewed. Companies with an effective technology strategy process use the core team and the stakeholder analysis to:

- Get sign-on.
- Generate internal implementation champions.
- Create a process that is lasting.

After this first part is complete, the actual process starts with an evaluation of the current position of a company's technology base. Here, a systematic and objective approach to identifying the technical capabilities in the organization's manufacturing and development portfolio is essential. Poor analysis at this stage proved disastrous for one telecommunications company entering what appeared to be an attractive cordless video communications market. It failed to systematically identify:

- New entrants coming into the sector on the back of innovative high-bandwidth technologies.
- Its lack of, or external access to, the right software skills (e.g., video compression algorithms, etc).

The initial objective analysis lays the groundwork for developing the organization's future options and for the development of the technology strategy, based both on the business vision and on the "real" potential of the organization's technology strengths.

Figure 2 shows a typical process being used by an OEM supplier to the European electronics industry. This approach is used to first produce a listing of current technology capabilities. Following this, a review of external and new-to-the world technologies is carried out. Once complete, the full list of technology capabilities is measured against the Basis of Competition (BOC) and those that score high are given higher priority. The team examines the future options for each technology, based on the information gained, and implications are made explicit.

Next, the core team considers the optimum implementation of the technology strategy. It is important to point out that although Figure 2 shows implementation as distinct and separate from the rest of the process, in practice it is not regarded as merely an "add-on." The electronics OEM, for example, made sure that, while members of the team changed throughout the process, the core team was responsible for, and rewarded for, the implementation.

Forming a Core Team

The formation of a core team and stakeholder analysis is a fundamental first step. Figure 3 illustrates the model of inputs and outputs that form the basis of this part of the process. To ensure success, it is important to build a *joint team* of key players. In the case of the pharmaceutical development organization that will be described later, the core team also included lead customers. This organization also used the core team to identify the required outputs by analyzing interviews with the key opinion formers and potential users of a

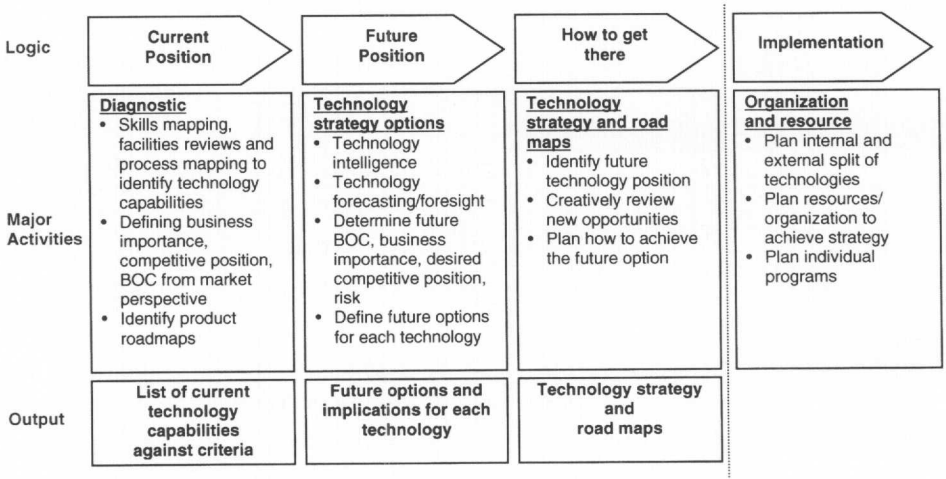

Figure 2.—A consumer electronics OEM uses this framework to describe the stages and activities for an objective audit of its current position and the development of a technology strategy.

strategy (regarded here as the stakeholders). By clarifying exactly what the stakeholders expect as outputs from the process, the activities within the process can be modified to ensure that their aspirations are met or managed. Tools and techniques are selected and modified to fit the outputs required by stakeholders.

An enthusiastic core team, in which all parties are truly committed, is crucial to the success of a technology strategy. An example of a poor technology strategy project occurred when a large healthcare group "told" individuals to work on a prescribed process. It soon became apparent that the aims of the individuals were far from aligned and that the commitment of senior management was lacking. This resulted in a poor-quality output, and the project was finally halted in favor of other less important, but easier to implement, initiatives.

To overcome some of the problems described above, companies have set up steering committees that consist of senior representatives from the business area concerned, other business areas, and senior technology and marketing managers. The core team then reports to the steering committee to ensure that there is a consensus when the team makes recommendations. The members of the team are chosen according to the objectives of the work (e.g., short-term technology performance improvement, threats from new entrants, cost reduction, etc.)

The experts on the core team must have a broad appreciation of business and technology, and should be open-minded and entrepreneurial. In some industry sectors, this type of team is much more difficult to put together. "Not Invented Here," blame, and defensive cultures will often get in the way and need to be combated. In the telecommunications company discussed earlier, not enough effort was made to inject new people or dilute old "strong views" within the team. In this case, the company had been started in Holland 12 years earlier. The founding chairman had done well in growing the company, but could not accept that the old formula for growth could not continue and that new technologies, rapid changes, and new competitors were entering the market. Unfortunately, the chairman had too great an influence on the team's make-up and the technology strategy failed to identify the real threats and deliver the major opportunities to the company.

An enthusiastic core team, in which all parties are truly committed, is crucial to the success of a technology strategy.

Other success factors include:

- One member of the steering committee must be empowered to ensure that progress is being made, and he or she should be measured on their performance, perhaps in terms of the value of new business opportunities identified, or the cost reduction achieved.

- The team's tasks should also be driven by real performance-improvement objectives, and should have some potential for early success. In a recent example of a diffuse chemical conglomerate, performance-improvement objectives were turned into real team metrics, which included:

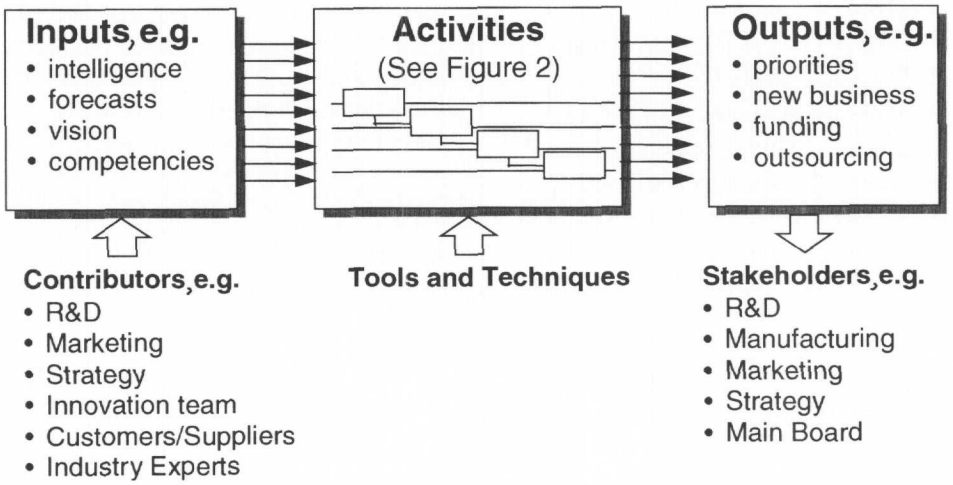

Figure 3.—Technology strategy development should be a business process showing the importance of inputs and outputs and identifying the stakeholders.

• *More focus on technologies that had maximum impact on product cost reduction:* This metric emphasized process control, new catalysis for yield improvement, and technologies to reduce raw material inventories.

• *More externally-sourced new technologies emphasizing the need for technology scanning:* This metric emphasized biotechnology, advanced material equipment construction, and remote electronic sensors.

• *Focus on added-value new products:* This metric emphasized the need for an innovative combination of emerging and older technologies; for example, using new filter membranes in a synthesis that once used centrifuge techniques.

■ The team should have physical space and secretarial help allocated specifically to it. This "office" will serve as a communications center, with electronic mail and fax facilities, as a focal point for gathering and tabulating information, and as a meeting room for the team. In the diffuse chemicals conglomerate above, it was called the "Technology and Innovation Management Center."

Formulate the Diagnostic

To complete the audit, the team uses a number of techniques aimed at identifying the current technology capabilities (see Figure 1) in terms of:

■ *Skills:* A structured and objective way of defining the organization's current technical skills. Skill-skill, skill-facility and skill-business process interactions are also mapped during this stage. A skill could be software design, a specific chemical synthesis route, or a novel, ultra-clean electronic manufacturing technique.

■ *Facilities:* An audit of plant, equipment, test facilities, and laboratories is conducted. At the same time, codified technology (e.g., papers, specifications, drawings, and patents) is noted.

■ *Organization:* A review is conducted of the organizational structure and business processes (e.g., new product development, technology transfer).

The skills, facilities and organization are collated into current technology capabilities. There may be skills and facilities that are left over—e.g., language skills or facilities—and these are examined to identify the reason. There are examples where new and expensive facilities were only rarely used as part of a technology capability (e.g., a new computer system, chemical synthesis and analytical or electronic test equipment). Sometimes these form part of the fabric that is necessary for the company to operate, but often they are not being exploited. The question is then, can they be used more effectively, outsourced or developed into a new capability?

This diagnostic, shown in Figure 4, also identifies technology capabilities that are available to the company but are sourced externally. In some cases, an audit of relevant skills, facilities and organization will be carried out by the suppliers of these technologies. If this is impossible or impractical, then those technology capabilities found outside the company are described as completely as possible in this way. Technologies that can be codified (e.g., patents, specifications, designs) and do not require skills and organization for exploitation are also identified during the process.

The entire list of technology capabilities is measured against the basis of competition. This is obtained from an examination of the criteria that influence customer purchase behavior in the markets that the company addresses. Examples of the basis of competition include cost, color, taste, convenience, and chemical ingredients for a food manufacturer; or quality, speed of delivery, service backup, and large product portfolio for a supplier of electronic components. Such information is vital in order to identify the critical factors for the business, as shown in Figure 4.

The elements of the diagnostic are brought together into a capability analysis, which makes explicit the organization's current capabilities. These are then benchmarked in order to understand the current position, how they differentiate and how important they are to the business in the light of an appreciation of the basis of competition. At the same time, technologies from outside the business are collected and assessed. These could be important to the current or future business and need to be considered in the same way as the organization's current capabilities (i.e., skills, facilities and organization).

A fictitious example of a pharmaceutical organization is shown in Figure 5. It displays the skills, facilities and organization that the company's team brought together into technology capabilities such as cellulose binders and dry lubricants for tablet compression. Measurement of these capabilities against the basis of competition showed that cellulose binders had more impact on companies' current markets (called "critical capabilities"). The team also examined likely changes to the basis of competition. This exercise was one of the keys to the success of this technology strategy when the same list of technology capabilities was measured against this new information:

• Some technologies would become "critical" and therefore needed to be developed and nurtured (e.g., new packaging technologies).

• Some of the company's critical technologies would become redundant (e.g., certain tablet-coating capabilities).

• Some of the technologies not yet available to the company would replace some of today's critical technologies (e.g., fast-dissolving tablet technology).

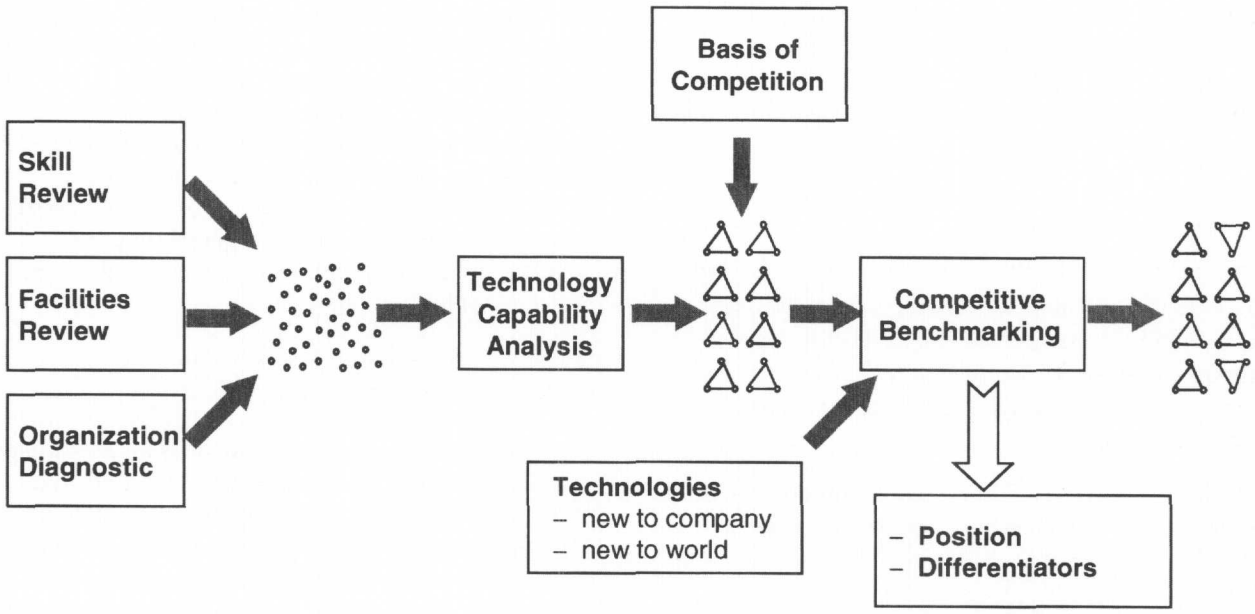

Figure 4.—The diagnostic identifies new technologies and makes the organization's capabilities explicit.

This review process should uncover those technologies that could totally change the rules of the game in the markets and hence radically change the basis of competition (e.g., new drug delivery systems replacing tablets). In the electronics sector, for example, rapid changes in consumer lifestyles are having an effect on the way that electronic products are bought and used. This is driving technology strategies in this area to focus on very high bandwidth (>100Mbit/sec) cordless video communications within the home, low power consumption and mobile organizer/GSM/video-phone device technologies.

Other industry sectors are not experiencing such large changes but could easily face massive market changes brought about by political, economic, social, or technology discontinuities. Sectors here could include retail, banking, news coverage, power utilities, and

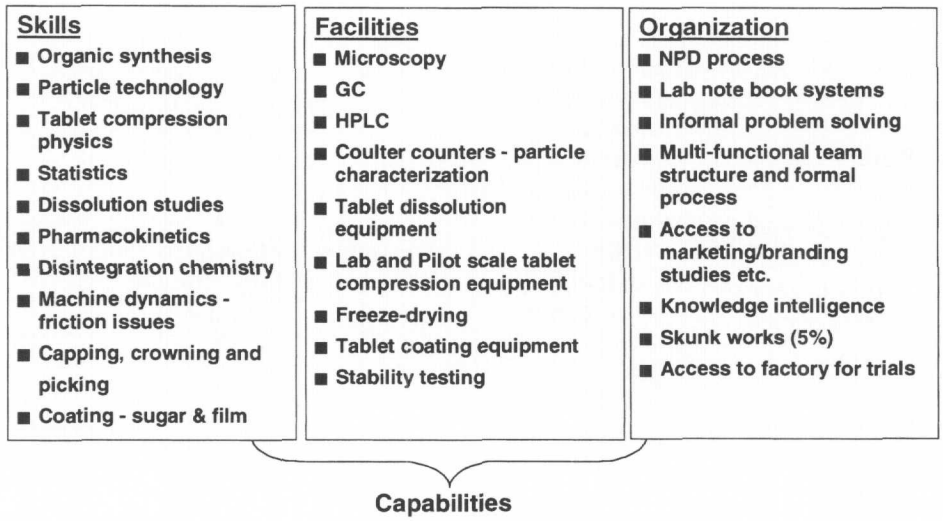

Figure 5.—Skills, facilities and organization are reviewed in order to define current capabilities for a fictitious pharmaceutical organization.

transport. All of these sectors could undergo massive changes for different reasons, and in these cases the technology strategist needs to be very careful at this stage of the process, especially as the core team could be more myopic about the future.

Identify New Technologies

In recent cases, where companies seem to have a good, well-implemented technology strategy, it has proved critical to assemble a list of technologies at *the same level of detail* that are:

- *New to the company,* but available outside (from technology intelligence).
- *Not yet available,* but could represent either a threat or an opportunity (from technology forecasting and foresight).

Collection of information on technology capabilities that are outside the company (new-to-the-company or new-to-the-world) in the form of skills, facilities and organization makes it possible to fill the gaps in these areas. The objective is then to assemble all data against each technology that will enable the team to make objective and informed decisions about options for the future. The process is shown in Figure 6 and includes creativity and understanding of the organizational and cost constraints.

During the development of the full list of technologies, it is also important to get to similar levels of detail. If this is not achieved, then it is impossible to compare "like with like" during the development of strategic options.

It is also important to be innovative in generating new product/market combinations based on the full list of current, emergent and completely new technologies. Leading companies in this area encourage innovation workshops at this stage in order to identify new products and markets. For example, the pharmaceutical development organization described earlier started to develop a set of new products that included rapid-dissolve tablets, new packaging technologies for easier convenience, and a number of other drug delivery devices that could eventually replace much of its classical tablet markets.

Review Strategy Opinions

The completion of the audit produces a set of outputs that includes both short-term actions to improve performance and inputs into technology strategy development. During technology strategy development, the core team develops a set of future scenarios for each technology, based on the current technology position and importance. The different scenarios imply several options for the organization. During this process, the team takes account of the vast amounts of information collected to review options by looking forward to how the world might develop.

Figure 7 illustrates a useful table for making "collective" decisions about future options. For each technology, there are usually three or four options, and each has positive and negative aspects together with time scales, costs, and benefits. The positive aspects could include: easy to implement, lower cost, already have knowledge of supplier of this technology, etc. The negative aspects could be: high costs, higher risks due to uncertainty of future, difficulties to implement within the current structure, etc.

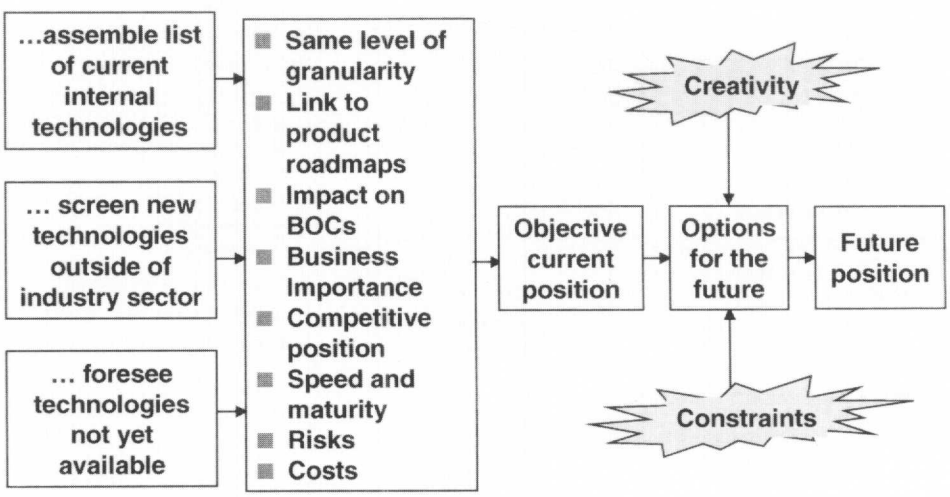

Figure 6.—Current, new and new-to-the-world technologies and information are required to generate a technology strategy.

The options for an electronics company are very different from a pharmaceutical company, but most have generic themes that include:

- Outsource.
- Divest.
- Joint venture.
- Carry out a consortium R&D program.
- Watch the technology development.
- Acquire the technology.

The team uses this table to maximize *total benefits* while minimizing the *total overall costs*. The table can also be used to measure the overall achievement of these benefits. In the last year, we are seeing tables like this being created and developed on corporate intranets.

To create the different scenarios and options, the core team should not be constrained by past management decisions ("we are not in the inhaler business") or to technologies already understood within the company. The team should also use best practices to gather information about new technology trends from different industries and research centers all over the world.

It is crucial that the team develop a clear understanding of the product, process and service links, since different scenarios will affect these three technologies in different ways. It is also critical at this stage to inject external views about technologies from outside the company's understanding. The techniques described here provide a means of enabling a group of managers, or the core team, to structure its thinking and be objective about the future. The techniques also enable constructive debate about the options and, in doing so, allow other options to emerge that may have a significant impact not just on the technology development but on how marketing and business development are performed.

Formulating the Technology Strategy

The team selects one option for each technology. Important criteria are cost, urgency, location, risk, and "practicality." The individual options are then drawn together in a list of technologies and options for the future. This represents the technology strategy. The team then draws up detailed plans for implementing the strategy. Such plans might include:

1. Provision for a clear and repeatable, learned and understood process to enable the business to:

- Understand its *current technologies*—what to keep, outsource or divest.
- Search out *existing technologies from other industries*—what to develop internally, joint venture or transfer-in.
- Identify *new emerging technologies* not widely available—what to research, develop or just watch.
- Identify *technologies for future investment*—listed in order of priority.

2. Technology roadmaps for determining the desired technology option, including internal R&D programs, joint ventures, acquisition, or technology transfer.

3. Redefined business strategy and plans based on new business opportunities that have been identified.

Technology	Basis of Competition		Business Importance		Current Position	Speed of Change	Differentiation	OPTIONS FOR EACH TECHNOLOGY				
	Now	Future	Now	Future				Positive aspects	Negative aspects	Benefits	Costs	Timescale
CURRENT TECHNOLOGIES												
TECHNOLOGIES NEW TO COMPANY												
TECHNOLOGIES NEW TO THE WORLD												
									Totals			

Figure 7.—This table can hold all of the information required for making future technology option decisions so that total costs and benefits can be generated.

4. A list of programs aimed at changing the attitudes and culture of R&D, corporate technology and marketing.

The final output is a "one-page" technology strategy, with supporting roadmaps for each technology and substantial information on how technologies impact customer buying decisions. An example of a one-page technology strategy for the electronics company example is provided in Figure 8. Companies that appear to "get it right" try hard to make things simple. They rapidly converge onto a one-page technology strategy that is easy to understand, compelling and action-oriented. It also represents a working document that is continuously refined and added to.

Large Benefits

Many companies are realizing large benefits from conducting a technology strategy in this way. The benefits include better focus in investments, lower costs and new value creation. One of the most important outputs is a clear future direction for research, development and engineering that can be understood and agreed to by all of the company's stakeholders.

There are many examples of strategies that have failed either because they are not understood by their implementers, or because there is no shared ownership of the actions needed. Without the core team that is facilitated by a transparent and explicit technology strategy process, formulation is only an analytical and intellectual process. Using the approach outlined in this discussion we have found that the core team becomes enthusiastic and knowledgeable about the process of technology strategy development. Creative future technology strategies and plans emerge, and the company becomes more effective and innovative. New profit streams result from the successful implementation of a technology strategy that is developed in this manner.

There is no one "best" prescriptive framework, as each company has its own issues, culture and organization. Clearly, elements of objective and structured analysis are essential, but technology strategy development is best implemented as a continuous and creative business process. ◆

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Technology	Impact & Business Importance	Maturity	Strategic Objective	Timescale	Action
CCD1	Differentiating Medium importance	Emerging	Low risk route to increase position. Will become more important in markets	5-6 years Medium urgency	Develop by internal R&D in IPR strong 1/4" size. JV with X on large area
X1001	Enabling Low importance	Mature	Maintain	3-4 years	Buy in from Y. Start technology transfer now
TRP31	Differentiating High importance	Mature	Spread risks & increase R&D spending. Look out for pacing technologies	6 months	Continue to do R&D. Make HIP and review other pacing technologies - RISK
ZZ6	Pacing Medium importance	Emerging	Maintain watching brief	2 years	Continue to do research with University Z
CTE6	Enabling Low importance	Growth	Sell as soon as possible	1 year	License technology to company W. Offer technology to other companies
CTE4	Enabling Very low importance	Growth	Stop work in R&D. Try to sell IPR	1 year	Stop internal development. Identify companies in CTE markets and start negotiations

Figure 8.—A one-page technology strategy might look like this.