Strategic Technology Leveraging: Managing the Next Generation of Complexity

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As the costs and the risks of acquiring advanced technology have escalated, businesses have come under pressure to increase the value of their technology by accelerating the pace of its development and expanding its profitable application. This pressure is driving major changes in sourcing strategies and activities. Companies are concentrating internal R&D activities on core technologies and competencies while developing relations with external partners to apply these and related technologies collaboratively to new products and systems. They are relying heavily on increasingly complex technology outsourcing arrangements, including:

• Traditional but increasingly elaborate licensing and technology acquisition activities

• A wide range of collaborative and preferred supplier relationships

• Joint ventures and strategic alliances

• Consortia and association activities

• Relationships with universities, research laboratories, and government institutions

Many firms report hundreds of such relationships, and this reliance on outsourcing is growing fast. We recently interviewed a broad cross-section of CEOs and CTOs for a book we are sponsoring jointly with *The Economist.* They revealed that their businesses had moved from a 5 to 10 percent dependence on external technology sourcing and partnerships ten years ago (and a 90 to 95 percent dependence on internal R&D) to a 10 to 20 percent dependence today. Most felt that they were now moving even more rapidly (and not without trepidation) to as much as a 50 percent dependence five years down the road. Even companies such as General Motors and IBM, which have built important competitive advantage on their internal R&D competencies, are moving into major new technology partnerships to increase their leverage and share costs and risks. Companies that have been unable or unwilling to establish strong technological positions through internal R&D may find new opportunities as technology-intensive companies seek new partners. Such alliances hold much promise in terms of lower cost and risk, speedier development, and closer links with technologies or customers.

Significantly, however, many companies are having considerable difficulty managing these new arrangements. Few are achieving anything close to the hoped-for leveraging of their investments.

Most firms' technology cultures and management activities have focused on improving the effectiveness of internal R&D. There has been little attention paid to the very different and complex challenges of managing external technology sourcing and leveraging activities or relationships. Although many companies are now moving toward what we refer to as third-generation R&D[1] – in which R&D activities are aligned with strategy and integrated with product development, marketing, and manufacturing – few firms demonstrate the partnerships among corporate, business, and R&D management needed for third-generation R&D to succeed.

Exhibit 1 summarizes the important differences between what we call first-, second-, and third-generation R&D. Most leading firms have made considerable investment to bring their R&D management to the second-generation stage. However, few have completed the transition to the third-generation stage, and fewer still have been able to effectively break through the „not-invented-here" syndrome to create a third-generation R&D management environment that actively encourages working with external parties, whether in academia, government, or industry. Consequently, external technology sourcing and collaborative technology development have generally evolved in an ad hoc way, with no one person or organization having the responsibility for managing these activities for maximum corporate benefit. In general, external technology management processes remain fragmented and uncoordinated with internal R&D and corporate strategy.

Most of the CEOs and CTOs we interviewed feel that their internal R&D activities are operating at about 70 to 90 percent of optimal effectiveness and meeting world-class standards. In contrast, their supplier management and licensing activities for technology development are generally at about 50 to 70 percent effectiveness, their joint ventures and strategic alliances at about 30 to 60 percent, and their other technology sourcing and partnering activities at only about 10 to 40 percent.

Our experience suggests that the pragmatic solution to these issues is an integrated approach to managing both internal and external activities for both sourcing and leveraging of technology. We call this approach „strategic technology leveraging."

Exhibit 1

The Evolution of R&D

	First-Generation R&D	*Second-Generation R&D*	*Third-Generation R&D*
Management and Strategic	*No long-term strategic framework*	*Partial strategic framework*	*Holistic strategic framework*
Context	• R&D as overhead cost center	• Judge-advocate management of R&D	• Partnership philosophy with R&D
	• R&D-driven technology	• Matrix management of each project, each having a strategic framework	• R&D and business strategy integrated firm-wide
Operating Principles	*Fatalistic and isolated*		
	• Line-item funding	• Project-driven funding and resource allocation	• Funding by competitive impact
	• R&D-driven resource allocation		
		• Corporate-driven, fundamental R&D	• Integration and measurement of business and technology objectives
	• Vague, perfunctory measurement		
		• Customer- and supplier-driven project	
	• Poor communications		
		R&D priorities and measures	• Excellent business/technology communications
		• Good project communications	

Strategic Technology Leveraging

Strategic technology leveraging (STL) is a radically different approach to corporate technology management. In the past few years we have helped a number of companies implement it. It requires new strategies, new processes, and a realignment of technology management resources, tactics, and organization. Like all strategic activities within what we call the High Performance Business, STL has as its goal the continuously increasing satisfaction of the organization's key stakeholders: its customers, owners, and employees. STL creates the capacity to address the new issues companies are facing, including the integration of complex outsourcing and partnering arrangements with the management of internal R&D. While there is no one best structure for the management of STL, our work helping clients implement it has revealed a number of factors that together make this integrated activity effective. These are listed in Exhibit 2 and described below.

A Strategic Framework. External technology relationships should be solidly positioned within an integrated technology management strategy. Such a strategy should include:

• A sound risk/value sourcing framework that can be used to assess competing approaches to technology sourcing, development, and application, particularly in terms of the cost and risk of development, the value and profitability of application, and the time to commercialization

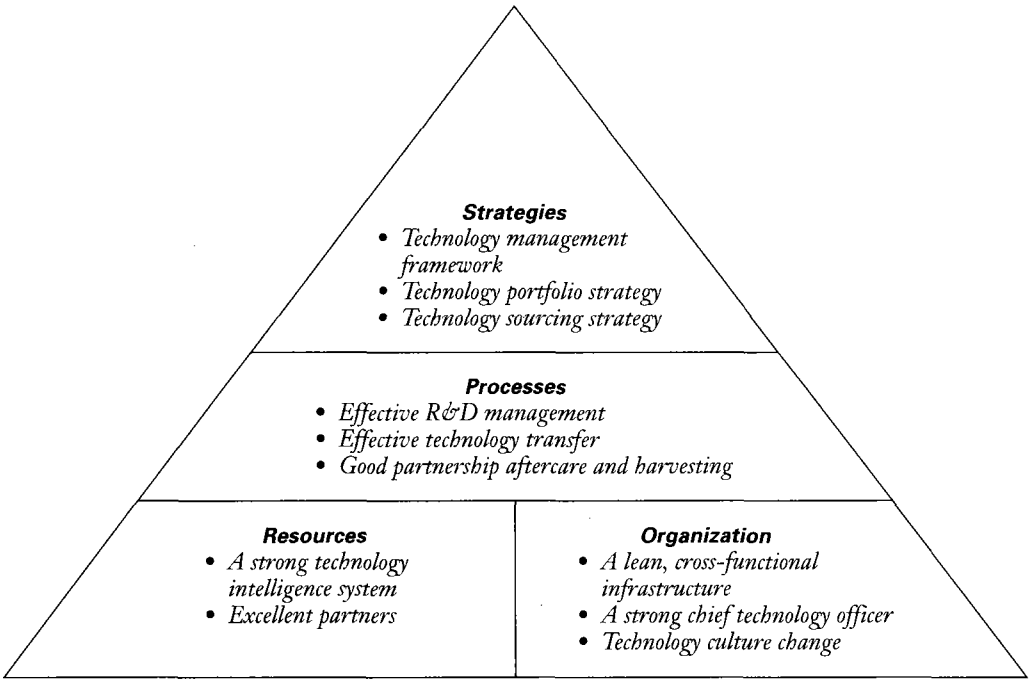
• A strategy for make-buy-or-collaborate decisions that explicitly addresses issues of control, balance, and the sharing of risks and rewards

• An explicit strategy for integrating and coordinating internal R&D and external technology sourcing to address issues of turf, corporate culture, and appropriate mechanisms for communication, reporting, and conflict resolution

• An explicit strategy for exploiting all the corporation's external technology partnerships for maximum advantage, not only to individual products and businesses but to the corporation as a whole

Exhibit 2

Key Success Factors for Successful Technology Leveraging



A Sound Technology Portfolio Strategy. Companies that outsource technologies without maintaining and strengthening their core technology competencies are looking for trouble. Without such competencies, they won't be able to make favorable deals with technology partners or even to adequately assess outside technologies. Worse yet, if they try to outsource core technologies without maintaining adequate control, they can be in real danger of eventually being forced to exit the business.

On the other hand, the not-invented-here (NIH) syndrome can sabotage external technology. NIH is particularly pronounced at large technology companies in the United States and Europe, but even in Japan, „NIH is the biggest single enemy of success," according to Dr. Michia Venohara, one of the prime architects of NEC's postwar R&D strategy.

To balance the need to hold on to core technology competencies with the need to avoid the not-invented-here syndrome, companies should:

• Identify core technologies and competencies and assess their competitive positions

• Value core technologies and competencies and assess the cost of their maintenance and extension

• Review and compare alternative mechanisms for maintaining and enhancing technological competitiveness

• Encourage researchers to work collaboratively

• Identify effective outside sources of technology

A Clear Technology Sourcing Strategy. Few companies give much strategic thought to make-buy -or-collaborate decisions about technology. In general, such decisions are much more opportunistic than strategic. Every technology-based company should have a sourcing strategy that explicitly addresses issues of control, balance, and the sharing of risks and rewards in the context of its overall technology strategy. This strategy will require well-developed measures of:

• The value/impact of the technology

• The cost/benefit of the sourcing or leveraging alternatives

• The company's management effectiveness with the preferred sourcing or leveraging vehicle

Effective R&D Management Processes. Many aspects of STL will be governed by the same principles that apply to successful internal R&D management. In *Third Generation R&D,* the authors identified the following seven management practices as critical to managing R&D effectively:

• A common vocabulary for characterizing R&D projects and their objectives, allowing rigorous communication

• A process that jointly develops clearly articulated, mutually agreed-upon, strategically evaluated project objectives, with clearly defined results

• A process for setting priorities and allocating scarce resources – capable of change in response to market, strategic, technological, and competitive developments

• A backlog of ideas

• An aggressive approach to project design that addresses most significant technical uncertainties as early as possible – that is, a willingness to „stand 'em up and shoot"

• A practical approach to individual project planning, reporting, measurement, and control, aided by appropriate information systems

• An appropriate project-team structure, composition, and authority for the professional management of complex projects, along with appropriate integrative mechanisms

These seven practices have been found to be critical to achieving the seven key objectives of third-generation management: communication, linkages among structural interfaces, a sense of urgency, shared uncertainty, freedom from fear of intelligent failure, willingness to kill projects, and optimized allocation of scarce corporate resources.

In addition to these practices, STL requires particular agility. The purpose of strategic alliances of all kinds is to enhance flexibility and reduce time to market. A cumbersome bureaucratic management process and monitoring system could stifle initiative and defeat the very purpose of the alliance. Technology alliances should be driven by customer needs, not by centralized bureaucratic directives, and should adjust flexibly to changing market needs and conditions. Managers must recognize that the ability to change an alliance effectively – or end it quickly – can be as important as the ability to form and enter it. At the same time, the need to protect proprietary technologies and competencies must be balanced with the need to benefit from the technologies and competencies of alliance partners. All alliances should be reviewed regularly for their current and potential benefit and cost.

Effective Technology Transfer. The transfer of know-how and expertise through both personnel and technical exchange plays a key role in STL. Technology may be transferred as data and information; embodied technology; rights to make, use, and/or sell; or know-how and expertise. Transfer mechanisms include publications and databases; meetings and communications; demonstrations and pilots; equipment and software acquisition; licensing agreements; alliance, partnership, and joint-venture agreements; personnel exchange; and technical assistance. Personnel exchange and technical assistance programs tend to be more effective than other methods of technology transfer because they both convey know-how through direct personal communication. Despite this fact, most technology transfer efforts are focused on the least-effective method of technology transfer – information exchange.

Whatever methods are used, the providers and users of the technology in question must be involved as full and active participants in the process of developing and transferring technology.

Good Partnership Aftercare and Harvesting.

Companies often subject potential alliances to rigorous and unending examination before entering them, only to allow them to languish once they are created. Alternatively, some companies create alliances primarily in order to exploit them. Neither approach works out very well. If both (or all) parties to an alliance don't continue to recognize the need to give to the alliance and support its success, it will surely fail – and there will be nothing left to exploit. What you put into a relationship after the deal is made is usually more important then what you put into the deal in the first place. You can't cut the ribbon and run.

Benchmarking in the area of strategic technology alliances is extremely rare. Few companies make significant efforts to ensure that alliances produce the results they should or could. As many executives have noted, it's easy to find good managers who will manage and be accountable for activities they can control and measure; it's much more difficult to find people or organizations who will take responsibility for managing what they can't control and what is difficult to measure. Except in the case of formal joint ventures, assessing and measuring performance, like measuring the value of technology, can be difficult and subjective. As a result, companies often neglect it.

To succeed, alliances must be managed for success first and exploitation second. They must be staffed appropriately and given carefully designed performance measures. And they must be championed appropriately, with carefully designed ownership and buy-back provisions for risk-taking managers.

A Strong Technology Intelligence System.

Such a system has four principal components:

• Information about industry and customer requirements

• Information about what your own firm is doing

• Intelligence about what your alliances are doing

• Intelligence about what others are doing technologically

Most firms have been able to establish the first two but are having considerable difficulty implementing the latter two. However, such information and intelligence is critical to an effective technology leveraging strategy. The technology intelligence must be integrated into an overall intelligence system accessible to key researchers and decision-makers.

Excellent Partners. Picking a good technology partner can be as tricky as selecting a spouse. Executives point to different criteria for a successful fit. „We want to make sure the other side does not want merely to take from us," notes Shiro Horiuchi, director and member of the Board of Matsushita. NEC targets other high-technology companies. „We are a technology-based company, and we want to make sure the alliance is with a technology-based company, not a bubble-economy company," notes Michia Venohara. A cultural fit is also very important, as are matching objectives and complementary capabilities.

In general, vertical cooperation is easier than horizontal cooperation. It is far easier to form an alliance with a supplier or a customer than with a head-to-head competitor. Of the cooperation between competitors to date, much has been precompetitive. Precompetitive cooperation, particularly among horizontally positioned companies, is easier than sharing product-specific technology, but it rarely pays immediate dividends.

Partnerships to sell and market proprietary technology have the advantage of bringing in money relatively soon. The closer a partnership is to the customer, the closer it is to actual success in the marketplace.

To win in the global economy, companies must stay on top of both short-horizon and longer-term R&D. But while thinking in both time frames, it's important to stay close to the market. Since the point of sourcing technology externally is usually to fulfill customer requirements better or faster, STL tends to drive firms to form alliances close to the market. One advantage of STL, compared with traditional internal R&D strategy, is that it is highly compatible with the customer-driven company.

A Lean, Cross-Functional Infrastructure. Just as it has become increasingly important to manage intemal technology development cross-functionally across R&D, Engineering, Marketing, and Manufacturing, it is now important to manage both internal and external technology sourcing and leveraging cross-functionally. Companies can no longer afford to have technology managed in a fragmented functional mode, with suppliers managed by the Procurement Office, licensing by the Legal Department, acquisitions by Corporate Development, collaborative technology development efforts by product managers, university partnerships and consortia by Technical Affairs, government partnerships by Public Affairs, and R&D by the R&D department. In the future, R&D managers must view external technology sourcing as a helpful complement to their internal activities rather than a threat to their budgets and capabilities. Product and corporate managers must choose the best sources of technology – whether internal or external.

Companies are now experimenting with a number of models for cross-functional technology management. Some companies are pulling together clusters of staff involved in similar technologies or applications across businesses or product lines and establishing mechanisms for more active communications and feedback. Others are moving to expand the responsibilities of internal R&D to include the management of external technology sourcing. Many are incorporating technology review and valuation in all their merger and acquisition activity. Some are establishing active on-line information systems to share technology assets or results gained from outside partnerships, while others are creating clear corporate guidelines and approval procedures for university and consortia activity.

A Strong Chief Technology Officer. To manage technology sourcing and leveraging cross-functionally requires a strong and effective chief technology officer. The CTO's responsibilities need to include at least the following:

• Managing the linkage and interface between corporate and business unit R&D functions

• Integrating and balancing internal R&D and external technology development relationships and activities

• Managing the make-collaborate-or-buy decisions for key technologies

• Coordinating the various corporate development functions, licensing functions, and M&A activities

• Linking these activities with related engineering, manufacturing, and marketing activities

• Building and maintaining strong bridges and communications with outside parties

Technology Culture Change. A key to achieving technological competitiveness in this new generation will be the commitment of senior management to changing the overall technology culture of the company. Business managers must be encouraged to take charge of technology activities involving external sources, even where they cannot exercise full control. Researchers must be encouraged to seek out external sources and applications of selected technologies, even where such external sources or applications may compete with internal resources. And functional managers need to be encouraged to cooperate and collaborate across functions, even where cross-functional measures may not be available.

These are complex and challenging issues, which only senior management is in a position to address effectively. But the game is well worth the candle. Those who master this new generation of technology management processes will undoubtedly enjoy significant competitive advantage in the very near future.

[1] For a full discussion of these ideas, see *Third Generation R&D; Managing the Link to Corporate Strategy*, by Philip A. Roussel, Kamal N. Saad, and Tamara J. Erickson, Harvard Business School Press, Boston, 1991.

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