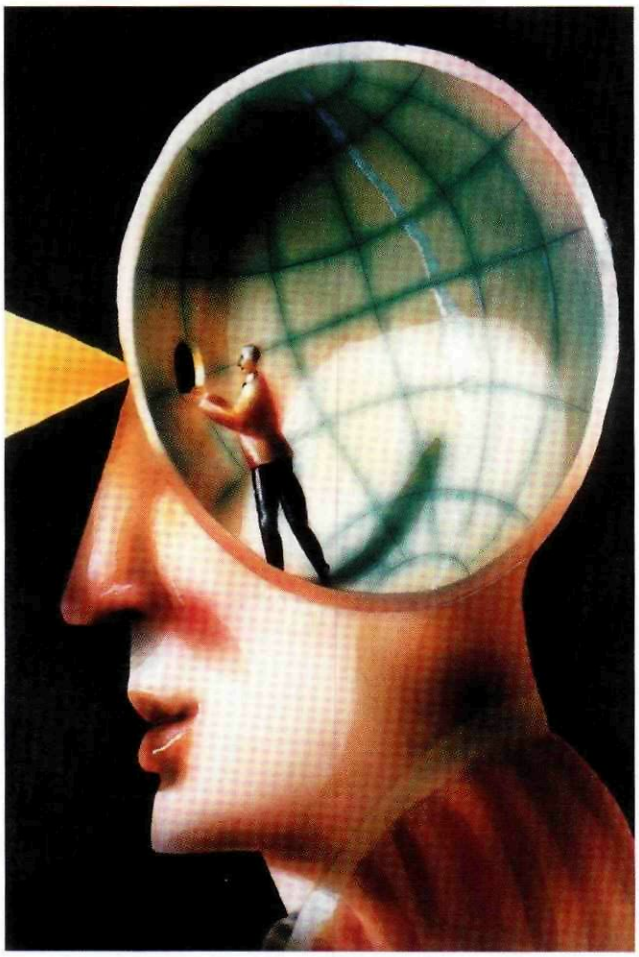
The Era of **Open Innovation**

Companies are increasingly rethinking the fundamental ways in which they generate ideas and bring them to market — harnessing external ideas while leveraging their in-house R&D outside their current operations.

Henry W. Chesbrough



In the past, internal R&D was a valuable strategic asset, even a formidable barrier to entry by competitors in many markets. Only large corporations like DuPont, IBM and AT&T could compete by doing the most R&D in their respective industries (and subsequently reaping most of the profits as well). Rivals who sought to unseat those powerhouses had to ante up considerable resources to create their own labs, if they were to have any chance of succeeding. These days, however, the leading industrial enterprises of the past have been encountering remarkably strong competition from many upstarts. Surprisingly, these newcomers conduct little or no basic research on their own, but instead get new ideas to market through a different process.

Consider Lucent Technologies, which inherited the lion's share of Bell Laboratories after the breakup of AT&T. In the 20th century, Bell Labs was perhaps the premier industrial research organization and this should have been a decisive strategic weapon for Lucent in the telecommunications equipment market. However, things didn't quite work out that way. Cisco Systems, which lacks anything resembling the deep internal R&D capabilities of Bell Labs, somehow has consistently managed to stay abreast of Lucent, even occasionally beating the company to market. What happened?

Although Lucent and Cisco competed directly in the same industry, the two companies were not innovating in the same manner. Lucent devoted enormous resources to exploring the world of new materials and state-of-the-art components and systems, seeking fundamental discoveries that could fuel future generations of products and services. Cisco, on the other hand, deployed a very different strategy in its battle for innovation leadership. Whatever technology the company needed, it acquired from the outside, usually by partnering or investing in promising startups (some, ironically, founded by ex-Lucent veterans).

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In this way, Cisco kept up with the R&D output of perhaps the world's finest industrial R&D organization, all without conducting much research of its own.

The story of Lucent and Cisco is hardly an isolated instance. IBM's research prowess in computing provided little protection against Intel and Microsoft in the personal computer hardware and software businesses. Similarly, Motorola, Siemens and other industrial titans watched helplessly as Nokia catapulted itself to the forefront of wireless telephony in just 20 years, building on its industrial experience from earlier decades in the low-tech industries of wood pulp and rubber boots. Pharmaceutical giants like Merck and Pfizer have also watched as a number of upstarts, including Genentech, Amgen and Genzyme, has parlayed the research discoveries of others to become major players in the biotechnology industry.

From Closed to Open

Is innovation dead? Hardly, as punctuated by the recent advances in the life sciences, including revolutionary breakthroughs in genomics and cloning. Then why is internal R&D no longer the strategic asset it once was? The answer lies in a fundamental shift in how companies generate new ideas and bring them to market. In the old model of *closed innovation,* firms adhered to the following philosophy: *Successful innovation requires control.* In other words, companies must generate their own ideas that they would then develop, manufacture, market, distribute and service themselves (see "The Closed Innovation Model"). This approach calls for self-reliance: If you want something done right, you've got to do it yourself.

For years, the logic of closed innovation was tacitly held to be self-evident as the "right way" to bring new ideas to market and successful companies all played by certain implicit rules. They invested more heavily in internal R&D than their competitors and they hired the best and the brightest (to reap the rewards of the industry's smartest people). Thanks to such investments, they were able to discover the best and greatest number of ideas, which allowed them to get to market first. This, in turn, enabled them to reap most of the profits, which they protected by aggressively controlling their intellectual property (IP) to prevent competitors from exploiting it. They could then reinvest the profits in conducting more R&D, which then led to additional breakthrough discoveries, creating a virtuous cycle of innovation.

For most of the 20th century, the model worked — and it worked well. Thanks to it, Thomas Edison was able to invent a number of landmark devices, including the phonograph and the electric light bulb, which paved the way for the establishment of General Electric's famed Global Research Center in Niskayuna, New York. In the chemical industry, companies like DuPont established central research labs to identify and commercialize a stunning variety of new products, such as the synthetic fibers nylon, Kevlar and Lycra. Bell Labs researchers discovered amazing physical phenomena and harnessed those discoveries to create a host of revolutionary products, including transistors and lasers.

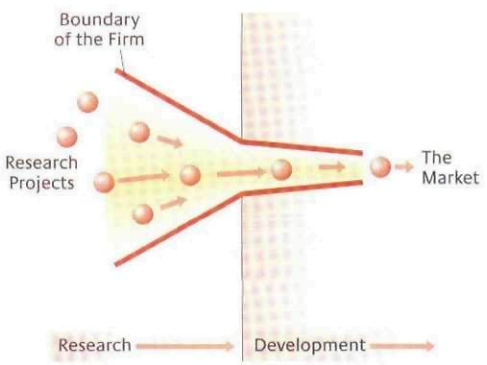
Toward the end of the 20th century, though, a number of factors combined to erode the underpinnings of closed innovation in the United States. Perhaps chief among these factors was the dramatic rise in the number and mobility of knowledge workers, making it increasingly difficult for companies to control their proprietary ideas and expertise. Another important factor was the growing availability of private venture capital, which has helped to finance new firms and their efforts to commercialize ideas that have spilled outside the silos of corporate research labs.

Such factors have wreaked havoc with the virtuous cycle that sustained closed innovation. Now, when breakthroughs occur, the scientists and engineers who made them have an outside option that they previously lacked. If a company that funded a discovery doesn't pursue it in a timely fashion, the people involved could pursue it on their own — in a startup financed by venture capital. If that fledgling firm were to become successful, it could gain additional financing through a stock offering or it could be acquired at an attractive price. In either case, the successful startup would generally *not* reinvest in new fundamental discoveries, but instead, like Cisco, it would look outside for another technology to commercialize. Thus, the virtuous cycle of innovation was shattered: The company that originally funded a breakthrough did not profit from the investment, and the firm that *did* reap the benefits did not reinvest its proceeds to finance the next generation of discoveries.

In this new model of *open innovation,* firms commercialize external (as well as internal) ideas by deploying outside (as well

The Closed Innovation Model

In closed innovation, a company generates, develops and commercializes its own ideas. This philosophy of self-reliance dominated the R&D operations of many leading industrial corporations for most of the 20th century.



as in-house) pathways to the market. Specifically, companies can commercialize internal ideas through channels outside of their current businesses in order to generate value for the organization. Some vehicles for accomplishing this include startup companies (which might be financed and staffed with some of the company's own personnel) and licensing agreements. In addition, ideas can also originate outside the firm's own labs and be brought inside for commercialization. In other words, the boundary between a firm and its surrounding environment is more porous, enabling innovation to move easily between the two (see "The Open Innovation Model").

At its root, open innovation is based on a landscape of abundant knowledge, which must be used readily if it is to provide value for the company that created it. However, an organization should not restrict the knowledge that it uncovers in its research to its internal market pathways, nor should those internal pathways necessarily be constrained to bringing only the company's internal knowledge to market. This perspective suggests some very different rules (see "Contrasting Principles of Closed and Open Innovation," next page). For example, no longer should a company lock up its IP, but instead it should find ways to profit from others' use of that technology through licensing agreements, joint ventures and other arrangements. (Also see David Kline's article, "Sharing the Corporate Crown Jewels," p. 89.)

One major difference between closed and open innovation lies in how companies screen their ideas. In any R&D process, researchers and their managers must separate the bad proposals from the good ones so that they can discard the former while pursuing and commercializing the latter. Both the closed and open models are adept at weeding out "false positives" (that is, bad ideas that initially look promising), but open innovation also incorporates the ability to rescue "false negatives" (projects that initially seem to lack promise but turn out to be surprisingly valuable). A company that is focused too internally — that is, a firm with a closed innovation approach — is prone to miss a number of those opportunities because many will fall outside the organization's current businesses or will need to be combined with external technologies to unlock their potential. This can be especially painful for corporations that have made substantial long-term investments in research, only to discover later that some of the projects they abandoned had tremendous commercial value.

The classic example is Xerox and its Palo Alto Research Center (PARC). Researchers there developed numerous computer hardware and software technologies — Ethernet and the graphical user interface (GUI) are two such examples. However, these inventions were not viewed as promising businesses for Xerox, which was focused on high-speed copiers and printers. In other words, the technologies were false negatives[1] and they languished inside Xerox, only to be commercialized by other companies that, in the process, reaped tremendous benefits. Apple Computer, for instance, exploited the GUI in its Macintosh operating system while Microsoft did the same in its Windows operating system.

How Prevalent Is Open Innovation?

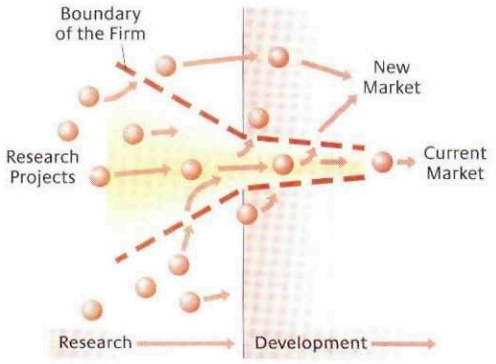
This is not to argue that all industries have been (or will be) migrating to open innovation. At this point, different businesses can be located on a continuum, from essentially closed to completely open. An example of the former is the nuclear-reactor industry, which depends mainly on internal ideas and has low labor mobility, little venture capital, few (and weak) startups and relatively little research being conducted at universities. Whether this industry will ever migrate towards open innovation is questionable.

At the other extreme, some industries have been open innovators for some time now. Consider Hollywood, which for decades has innovated through a network of partnerships and alliances between production studios, directors, talent agencies, actors, scriptwriters, independent producers and specialized subcontractors (such as the suppliers of special effects). The mobility of this workforce is legendary: Every waitress is a budding actress; every parking attendant has a screenplay he is working on.

Many industries — including copiers, computers, disk drives, semiconductors, telecommunications equipment, pharmaceuticals, biotechnology and even military weapons and communications systems — are currently transitioning from closed to open innovation. For such businesses, a number of critically important

The Open Innovation Model

In the new model of open innovation, a company commercializes both its own ideas as well as innovations from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current businesses. Note that the boundary between the company and its surrounding environment is porous (represented by a dashed line), enabling innovations to move more easily between the two.



Contrasting Principles of Closed and Open Innovation

Closed Innovation Principles	Open Innovation Principles
The smart people in our field work for us.	Not all of the smart people work for us* so we must find and tap into the knowledge and expertise of bright individuals outside our company.
To profit from R&D, we must discover, develop and ship it ourselves.	External R&D can create significant value; internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We don't have to originate the research in order to profit from it.
If we are the first to commercialize an innovation, we will win.	Building a better business model is better than getting to market first.
If we create the most and best ideas in the industry, we will win.	If we make the best use of internal *and* external ideas, we will win.
We should control our intellectual property (IP) so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

* This maxim first came to my attention in a talk by Bill Joy of Sun Microsystems over a decade ago. See, for example, A. Lash, "The Joy of Sun," The Standard, June 21, 1999, http://thestandard.net.

innovations have emerged from seemingly unlikely sources. Indeed, the locus of innovation in these industries has migrated beyond the confines of the central R&D laboratories of the largest companies and is now situated among various startups, universities, research consortia and other outside organizations. This trend goes well beyond high technology — other industries such as automotive, health care, banking, insurance and consumer packaged goods have also been leaning toward open innovation.

Consider Procter & Gamble, the consumer-product giant with a long and proud tradition of in-house science behind its many leading brands. P&G has recently changed its approach to innovation, extending its internal R&D to the outside world through the slogan "Connect & Develop."[2] The company has created the position of director of external innovation and has set a goal of sourcing 50% of its innovations from outside the company in five years, up from an estimated 10% this year.[3] This approach is a long way from the "not invented here," or NIH, syndrome that afflicts many large, successful industrial organizations. Recently, P&G scored a huge success with SpinBrush, an electric toothbrush that runs on batteries and sells for $5. The idea for the product, which has quickly become the best-selling toothbrush in the United States, came not from P&G's labs but from four entrepreneurs in Cleveland.

P&G also tries to move its own innovations outside. Recently, the company instituted a policy stating that any idea that originates in its labs will be offered to outside firms, even direct competitors, if an internal business does not use the idea within three years.[4] The goal is to prevent promising projects from losing momentum and becoming stuck inside the organization. (Also see David Kline's article, "Sharing the Corporate Crown Jewels," p. 89.)

The Different Modes of Innovation

Indeed, many companies have been defining new strategies for exploiting the principles of open innovation, exploring ways in which external technologies can fill gaps in their current businesses and looking at how their internal technologies can spawn the seeds of new businesses outside the current organization. In doing so, many firms have focused their activities into one of three primary areas: *funding, generating* or *commercializing innovation.*

Funding Innovation

Two types of organizations — *innovation investors* and *benefactors* — are focused primarily on supplying fuel for the innovation fire. The original *innovation investor* was the corporate R&D budget but now a wide range of other types has emerged, including venture capital (VC) firms, angel investors, corporate VC entities, private equity investors and the Small Business Investment Companies (SBICs), which provide VC to small, independent businesses and are licensed and regulated by the U.S. Small Business Administration. Their capital helps move ideas out of corporations and universities and into the market, typically through the creation of startups. In addition to financing, innovation investors can supply valuable advice for helping startups avoid the common growing pains that afflict many fledgling firms.

With the recent economic downturn and the implosion of numerous dot-com firms, innovation investors have understandably turned somewhat gun-shy. However, though it seems these players are down, they are hardly out. VCs currently have about $250 billion in capital under management, of which $90 billion is idle.[5] When the economy rebounds, innovation investors will likely spot and fund new developments in areas like genomics and nanotechnology, which will likely spur the next economic wave of innovation.

Innovation benefactors provide new sources of research funding. Unlike investors, benefactors focus on the early stages of research discovery. The classic example here is the National Science Foundation (NSF), an independent agency of the U.S.

government. Through its awards and grants programs, the NSF provides about 20% of federal support for academic institutions to conduct basic research. The Defense Advanced Research Projects Agency (DARPA) has also been a key benefactor, particularly for the early work in much of the computer industry.

Some companies are devoting a portion of their resources to playing the role of benefactor. By funding promising early-stage work, they get a first look at the ideas and can selectively fund those that seem favorable for their industry. An interesting development with innovation benefactors is the possible rise in philanthropy from private foundations, especially those backed by wealthy individuals. For example, the billionaire Larry Ellison, chairman and CEO of software giant Oracle, has founded an organization that provides about $50 million annually for basic research in cancer, Parkinson's and Alzheimer's diseases as well as other disorders. Interestingly, the foundation was set up specifically for early exploration — research so embryonic that scientists aren't able to obtain funds through traditional grants, such as those awarded by the NSF.

Generating Innovation

There are four types of organizations that primarily generate innovation: *innovation explorers, merchants, architects* and *missionaries. Innovation explorers* specialize in performing the discovery research function that previously took place primarily within corporate R&D laboratories. Interestingly, a number of explorers evolved as spinoffs of laboratories that used to be a part of a larger organization. Just a year ago, for example, PARC became a separate, independent entity from Xerox. Similarly, Telcordia Technologies was formed from the divestiture of the Bell System and is now home to about 400 researchers with a broad range of expertise, from software engineering to optical networking.

An interesting development with explorers has been taking place with the major government labs, such as Sandia National Laboratories, Lawrence Livermore National Laboratory and the MIT Lincoln Laboratory. In the aftermath of the end of the Cold War, these organizations have been seeking new missions for their work and much of their basic research is finding applications in commercial markets. Consider Lincoln Laboratory, which has conducted radar and other defense research since the 1950s. Technology developed there for missile detection has recently been adapted to cancer treatment, enabling microwave energy to be focused more effectively at tumors.

Innovation merchants must also explore, but their activities are focused on a narrow set of technologies that are then codified into intellectual property and aggressively sold to (and brought to market by) others. In other words, innovation merchants will innovate but only with specific commercial goals in mind, whereas explorers tend to innovate for innovation's sake. For the merchants, royalties from their IP enable them to do more research in their areas of focus. Indeed, such companies rise and fall with the strength of their IP portfolios.

One example of an innovation merchant is Qualcomm, which conducts extensive internal research on telecommunications, including code division multiple access (CDMA), a standard for wireless technology. Originally, Qualcomm manufactured cellular phones and software products such as the Eudora e-mail program, but today it focuses on licensing its CDMA technology and producing the associated chipsets for use by other cell-phone manufacturers. Qualcomm currently boasts more than 100 licensees, including Motorola, Nokia and Kyocera.

Innovation architects provide a valuable service in complicated technology worlds. In order to create value for their customers, they develop architectures that partition this complexity, enabling numerous other companies to provide pieces of the system, all while ensuring that those parts fit together in a coherent way. Boeing, for example, will engineer the overall design of an aircraft like the 747, after which companies like GE can then develop and manufacture the jet engines and other constituent parts. Innovation architects work in areas that are complex and fast-moving, which disfavors the "do-it-yourself" approach. To be successful, innovation architects must establish their systems solution, communicate it, persuade others to support it and develop it in the future. They must also devise a way to capture some portion of the value they create, otherwise they will find it impossible to sustain and advance their architecture.

For example, the dramatic rise of Nokia in wireless communications has been due, in part, to the strong lead it took in establishing the global system for mobile communication (GSM) technology as a standard for cellular phones. Accomplishing that required working closely with a number of other companies, as well as the governments of many European countries. Specifically, Nokia research helped define the now-accepted standards for moving GSM from a narrow- to broad-bandwidth spectrum and the company pushed hard to establish that technology: It willingly licensed the research to others and partnered with companies (including competitors) to develop the chipsets necessary for implementing the standard.[6] Those efforts have helped Nokia to become the world's dominant supplier of wireless-phone handsets, controlling nearly 40% of the global market.

Innovation missionaries consist of people and organizations that create and advance technologies to serve a cause. Unlike the innovation merchants and architects, they do not seek financial profits from their work. Instead, the mission is what motivates them. This is characteristic of many community-based nonprofits and religious groups but also occurs in the software industry. (Also see Georg von Krogh's article, "Open-Source Software Development," p. 14.) Here, user groups help define how a particular software program will evolve. These organizations, which include professional programmers as well as hobbyists, not only

identify bugs (and possible ways to fix them), but additionally might even create a "wish list" of potential features that the next generation of a software product might include.

The evolution of the computer operating system Linux exemplifies this approach. Originally developed by Linus Torvalds, Linux has advanced over the years thanks to the arduous efforts of an informal network of programmers around the world. The software is freely available to anyone, and it has become a viable alternative to commercial offerings such as Microsoft Windows NT.

Commercializing Innovation

Lastly, two types of organization are focused on bringing innovations to market: *innovation marketers* and *one-stop centers. Innovation marketers* often perform at least some of the functions of the other types of organization, but their defining attribute is their keen ability to profitably market ideas, both their own as well as others'. To do so, marketers focus on developing a deep understanding of the current and potential needs in the market and this helps them to identify which outside ideas to bring in-house. Most of the drugs that are currently in Pfizer's pipeline, for instance, originated outside the company.

Another example of an innovation marketer is Intuit, which sells personal financial software products such as the popular Quicken program. For a number of years, Intuit has been able to keep Microsoft at bay — one of the very few companies that can make that claim — by maintaining close and disciplined interactions with its customers to gain in-depth knowledge about their needs. In keeping with the innovation marketer's role, Intuit has become adept at identifying and adapting outside technologies to satisfy those needs. In this way, the company has consistently been able to profit from innovations it did not discover. For example, it acquired two of its popular products — TurboTax (a tax-preparation program) and QuickBooks (small-business accounting software) — from the outside and enhanced both programs to meet its customers' needs.

Useful knowledge has become widespread, and ideas must be used with alacrity. If not, they will be lost.

Innovation one-stop centers provide comprehensive products and services. They take the best ideas (from whatever source) and deliver those offerings to their customers at competitive prices. Like innovation marketers, they thrive by selling others' ideas, but are different in that they typically form unshakable connections to the end users, increasingly managing a customer's resources to his or her specifications. For example, the Web site for Yahoo! enables people to shop, send e-mail, manage their personal finances, hunt for jobs and keep up-to-date on current events.

While Yahoo! targets consumers, other one-stop centers are focused on business-to-business interactions. IBM's Global Services division, for instance, sells IT solutions to other companies, and interestingly, will install and service hardware and software from any vendor, including IBM's competitors. In other words, it will provide the best solution to its customers, regardless of the origin of those products.

ALTHOUGH MANY COMPANIES are focusing on just funding, generating or commercializing innovation, some are continuing to do all three. As mentioned earlier, industrial powerhouses like GE, DuPont and AT&T (with Bell Labs) were the exemplars of this approach in the United States during the 20th century, and the success of those corporations has cast the mold for most central R&D organizations. To this day, a number of companies, called *fully integrated innovators*, continue to espouse the closed innovation credo of "innovation through total control."

IBM in the mainframe computer market is one such example. Thanks to the company's T.J. Watson Research Center and its other internal R&D labs, virtually all of the value-added components inside an IBM mainframe computer come from IBM itself. This includes the semiconductor circuits that power the main processing unit, the disk storage, the high-speed circuitry that routes signals, the tape backup storage, the operating system and the different application programs. To accomplish that, IBM must manage technology advances in both hardware and software within different internal divisions, coordinating future releases of software and new versions of hardware to assure its customers of continued improvements in price and performance.

IBM's mainframe business raises an important point: A corporation can deploy different modes of innovation in different markets. Specifically, IBM is a one-stop center for consulting services and a fully integrated innovator with respect to mainframes. Another important point is that competing modes can coexist in the same industry. In pharmaceuticals, for example, Merck has remained a fully integrated innovator while Pfizer is becoming an innovation marketer. It remains to be seen which of those modes (or perhaps another) will dominate.

All of the different modes will evolve in an open innovation environment, and future ones will probably emerge as well. One possible development is the rise of specialized intermediaries that function as brokers or middlemen to create markets for IP.[7] More than likely, there won't be one "best way" to innovate, although some modes will face greater challenges than others.

Fully integrated innovators, for instance, have become an endangered species in many industries. As ideas spill out of the central R&D labs of large corporations, the other modes of innovation are in a position to profit from them. In fact, these other modes have risen in prominence in response to the perceived limitations of fully integrated innovators. Much of IBM's innovation, for instance, has been migrating from the fully integrated mode toward the one-stop center approach.

The explorer mode depends on external sources of funding because of the considerable resources and uncertainty of conducting long-term research. Outside of the life sciences, this support has dwindled substantially in the past decade, making a number of explorers vulnerable. Recent societal concerns, such as for "homeland security" in the United States, may supply a new impetus for government funding, and already many explorers are making the transition. Sandia National Labs, for instance, is currently developing robots for disabling bombs. It is questionable, however, whether new security research missions will fit with the strengths and abilities of the current explorers or whether a new cadre of them will arise instead.

Innovation merchants also face significant challenges. Although the concept of supplying innovation to a "marketplace for ideas" is attractive in theory, it is devilishly tricky to accomplish. For one thing, merchants must determine how best to gain access to the complementary assets that might be needed to commercialize an innovation. Another issue is that the laws for IP protection are ill-defined at best, making it risky for merchants to limit their revenue stream solely to the marketing of their IP.

Innovation architects encounter a different set of challenges in their roles of organizing and coordinating complex technologies. Although ideas are plentiful, that very abundance can make it extremely difficult to create useful systems. Furthermore, innovation architects, through the harnessing of a broad network of companies, must balance the creation of value with the need to capture a portion of that value. Boeing, for instance, is able to do so by acting as the systems assembler for its aircraft. With other technologies, however, the means by which innovation architects can benefit from their roles is not so straightforward.

Several of the modes of innovation rely on a continued supply of useful ideas and technologies from the outside. Although university research is now more abundant and of higher quality than in the past, the flow of that knowledge into the commercial sector faces several obstacles. Such research is necessarily filtered through the silos of academic departments and that process tends to discourage cross-discipline breakthroughs. In addition, universities are now allowed to patent their discoveries, and although the change has benefited professors (who are able to form their own commercial ventures), it has also taxed the efforts of companies, particularly small firms, to profit from that source of innovation.

Long Live Open Innovation

Today, in many industries, the logic that supports an internally oriented, centralized approach to R&D has become obsolete. Useful knowledge has become widespread and ideas must be used with alacrity. If not, they will be lost. Such factors create a new logic of open innovation that embraces external ideas and knowledge in conjunction with internal R&D. This change offers novel ways to create value — along with new opportunities to claim portions of that value.

However, companies must still perform the difficult and arduous work necessary to convert promising research results into products and services that satisfy customers' needs. Specifically, the role of R&D needs to extend far beyond the boundaries of the firm. Innovators must integrate their ideas, expertise and skills with those of others outside the organization to deliver the result to the marketplace, using the most effective means possible. In short, firms that can harness outside ideas to advance their own businesses while leveraging their internal ideas outside their current operations will likely thrive in this new era of open innovation.

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3. H. Chesbrough, interview with Larry Huston, August 5, 2002. Huston, director of external innovation at Procter & Gamble, noted as well that the "Connect & Develop" initiative had strong support from P&G's board of directors and that there has been a board subcommittee working on the issue.

4. Sakkab, "Connect & Develop," 38-45.

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