Chapter 1

Open Innovation: A New Paradigm for Understanding Industrial Innovation

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Defining Open Innovation

The open innovation paradigm can be understood as the antithesis of the traditional vertical integration model where internal R&D activities lead to internally developed products that are then distributed by the firm. If pressed to express its definition in a single sentence, open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology. Open Innovation processes combine internal and external ideas into architectures and systems. Open Innovation processes utilize business models to define the requirements for these architectures and systems. The business model utilizes both external and internal ideas to create value, while defining internal mechanisms to claim some portion of that value. Open Innovation assumes that internal ideas can also be taken to market through external channels, outside the current businesses of the firm, to generate additional value.

The open innovation paradigm treats research and development as an open system. Open Innovation suggests that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well. This approach places external ideas and external paths to market on the same level of importance as that reserved for internal ideas and paths to market in the earlier era.

Open Innovation is sometimes conflated with open source methodologies for software development. There are some concepts that are shared between the two, such as the idea of greater external sources of information to create value. However, open innovation explicitly incorporates the business model as the source of both value creation and value capture. This

latter role of the business model enables the organization to sustain its position in the industry value chain over time. While open source shares the focus on value creation throughout an industry value chain, its proponents usually deny or downplay the importance of value capture. Chapter 5 in this volume will consider these points at greater length.

At its root, open innovation assumes that useful knowledge is widely distributed, and that even the most capable R&D organizations must identify, connect to, and leverage external knowledge sources as a core process in innovation. Ideas that once germinated only in large companies now may be growing in a variety of settings – from the individual inventor or high tech start up in Silicon Valley, to the research facilities of academic institutions, to spin-offs from large, established firms. These conditions may not be present in every business environment, and scholars must be alert to the institutional underpinnings that might promote or inhibit the adoption of open innovation .

The Open Innovation Paradigm

The book *Open Innovation* (Chesbrough, 2003a) describes an innovation paradigm shift from a closed to an open model. Based on close observation of a small number of companies, the book documents a number of practices associated with this new paradigm. That book was written for managers of industrial innovation processes, and the work has received significant attention among managers. To the extent that such managers are able to assess the utility of new approaches, Open Innovation has achieved a certain degree of face validity within at least a small portion of high technology industries. Open Innovation has taken on greater saliency in light of the debate about globalization and the potential for the R&D function itself to become outsourced, as the manufacturing function was 20 years earlier.[1]

Figure 1.1 shows a representation of the innovation process under the previous Closed model of innovation. Here, research projects are launched from the science and technology base of the firm. They progress through the process, and some of the projects are stopped, while others are selected for further work. A subset of these are chosen to go through to the market. This process is termed a "closed" process because projects can only enter in one way, at the beginning, and can only exit in one way, by going into the market. AT&T's Bell Laboratories stands as an exemplar of this model, with many notable research achievements, but a notoriously inwardly focused culture.

Figure 1.2 shows a representation of an Open Innovation model. Here, projects can be launched from either internal or external technology sources, and new technology can enter into the process at various stages. In addition, projects can go to market in many ways as well, such as through outlicensing or a spin-off venture company, in addition to going to market through the company's own marketing and sales channels. I labeled this model "open" because there are many ways for ideas to flow into the process, and many ways for it to flow out into the market. IBM, Intel, and Procter & Gamble all exemplify aspects of this open innovation model.

Academic scholars of innovation are trained to be rightly skeptical of new frameworks and concepts. Such concepts often consist of little more than fads and fashions (Abrahamson 1996). At best, such fads distract managers from more important activity, and at worst, fads can actually damage organizations and people. Scholars withhold their support of these novelties, unless and until they can demonstrate a more enduring contribution to the advancement of knowledge.

It is far too soon to claim that the paradigm of Open Innovation will make an enduring contribution to our understanding of innovation. However, it is not too soon to claim that it has

already made an impact on our understanding of innovation. There is growing academic interest in the concept, as well as some nascent research activity that, when taken together, suggests that this may be a fruitful avenue for scholarly inquiry. It is the purpose of this book to document this early scholarly interest, and to point the way forward for further research that can develop the concept more fully.

Anomalies in Innovation

Any model that claims to be a new paradigm for industrial innovation must account for anomalies that are not well-explained in an earlier paradigm (Kuhn, 1962; Feyerabend, 1981). The evidence in *Open Innovation* offers numerous such explanations.[2,3] To take one example here, that will be discussed below, the field of innovation studies has long been aware of the difficulty of capturing spillovers from industrial R&D. These spillovers were regarded as a cost of doing business in the prior paradigm. Open Innovation treats spillovers as a consequence of the company's business model. These spillovers need not be a cost of doing business, they are an opportunity to expand a company's business model, or to spin off a technology outside the firm to locate a different business model.

A second example lies in the treatment of intellectual property. In the Closed model, companies historically accumulated intellectual property to provide design freedom to their internal staff. The primary objective was to avoid costly litigation. However, most patents are actually worth very little, and the vast majority are never used by the business that holds them.[4] In Open Innovation, intellectual property represents a new class of assets that can deliver additional revenues to the current business model, and also point the way towards entry into new businesses and new business models. A recent managerial book, Rembrandts in the Attic

(Rivette and Klein, 2000), proclaimed that companies needed to dust off their IP and offer it for sale to others. However, it did not provide an explanation for why those others would buy the IP. Open Innovation supplies a coherent rationale for why companies should be both active sellers and active buyers of IP.

External Validity

A new paradigm must also explain evidence beyond its initial area of inquiry if it is to have external validity (Yin, 1988). In *Open Innovation*, the evidence adduced to support this model is taken almost exclusively from qualitative evidence in so-called "high technology" industries, such as computers, information technology, and pharmaceuticals (Chesbrough, 2003a;2003b;2003c; 2003d). Yet these industries represent only a few of the many sectors in an advanced industrial economy. It remains an open question whether the concepts of Open Innovation apply to lower-tech or more mature industries. Similarly, the evidence to date is taken from US-based companies. The relevance of Open Innovation to companies operating outside the US remains to be demonstrated.

As will be seen in this book, progress is already being made on these questions of external validity. While the work is only the first wave of research in this area, there appears to be evidence that suggests that Open Innovation's explanatory power is not limited to a small number of companies operating in a small number of US high technology industries.

Antecedents to Open Innovation

Open Innovation follows a long tradition of studying the processes of innovation, and stands on the shoulders of many previous scholars. Business historians have documented the extensive markets for innovation that pre-dated the rise of the corporate R&D laboratory, and often pre-

dated the enforcement of intellectual property law (Lamoreaux, Raff, and Temin, 1999; Lerner, 2000). Innovation was at that time a rather open system. Joseph Schumpeter (1934) gave a powerful impetus to the study of innovation with his comparison of the entrepreneur and the entrenched incumbent firm, and in later work (1942) acknowledged the growing influence of corporations and their R&D activities in the innovation process.

Historical accounts suggest that early R&D activities grew out of the need in many industries to maintain and improve production activities (Chandler, 1990). Because these activities were frequently unique for each firm, investments in R&D were firm-specific. David Mowery documented the rise of the corporate R&D laboratory in American manufacturing, and attributed this rise to the costs of organizing innovation inside the firm, relative to the costs of organizing innovation through the market (Mowery, 1983). From the technology base created by internal R&D, firms naturally moved to exploit their accumulated knowledge to develop new products, thereby enhancing their economies of scope; in many industries large scale dedicated R&D functions emerged, providing a barrier to entry through economies of scale (Teece, 1986; Chandler, 1990).

The benefits of scale and scope for internal R&D (relative to the external market) gave rise to a vertically integrated innovation model where large enterprises internalized their firm-specific R&D activities, and commercialized them through internal development, manufacturing, and distribution processes. The managerial approach used for this proprietary model was summed up by Harvard president James Bryant Conant as "picking a man of genius, giving him money, and leaving him alone" (Conant, 2002).[5] Edison's Menlo Park, AT&T's Bell Labs, and Xerox's PARC were exemplars of this type of innovation model and brought about many inventions and innovations during the 20th century.

To be sure, there were downsides noted to this model in the earlier literature. Richard Nelson observed back in 1959 that basic research generated many spillovers, and that firms who funded this research had only limited ability to appropriate value from these spillovers (Nelson, 1959). Katz and Allen (1985) documented the Not Invented Here (NIH) syndrome that often accompanied the Chandlerian model of deep vertical integration of R&D for economies of scale and scope. Rosenbloom and Spencer (1996) argued that the leading industrial labs were in deep trouble, concluding that this model of innovation was "at the end of an era".

As noted above, these exemplary R&D organizations encountered difficulties when internal research generated spillovers that could not be internally commercialized. In some cases, such technology would be licensed to others, but in the majority of cases it "sat on a shelf" waiting either for internal development or its research proponents to leave the firm and develop it on their own. This led to the Kuhnian anomaly of having the benefits of the innovation accrue *not* to the firm that financed its development, but instead to other firms who were able to capture the benefits of the innovation. Perhaps the best known contemporary example of such spillovers is Xerox PARC (Smith and Alexander, 1988; Chesbrough & Rosenbloom, 2002; Chesbrough, 2002b). While these anomalies were documented, they were not adequately explained under the old model. They amounted to a regrettable but necessary cost of doing business. Indeed, some research scholarship on "radical innovation" (Leifer et al, 2000) suggests that firms need to return to the long term, more patient approach to industrial research, even though there will be inevitable spillovers not captured.

Another rich source of antecedents has been substantial prior work on the importance of external technology, at least when it was "inbound" to the organization. Nelson and Winter (1982) modeled the firm's decision to search for new technology outside of its own organization.

Cohen and Levinthal (1990) wrote about the "two faces" of R&D (which were inside and outside the firm) and also about the importance of investing in internal research in order to be able to utilize external technology, an ability they termed, "absorptive capacity". Nathan Rosenberg asked the question, why do firms conduct basic research with their own money (Rosenberg, 1994), and answered that this research enhanced the firm's ability to use external knowledge. Firms that fail to exploit such external R&D may be at a severe competitive disadvantage (Rosenberg and Steinmueller, 1988). Eric von Hippel (1988) identified four external sources of useful knowledge: 1) suppliers and customers; 2) university, government and private laboratories; 3) competitors; and 4) other nations. Ove Granstrand and his colleagues (1997:13) note that: "The creation of corporate competencies in new fields was a dynamic process of learning, often requiring a combination of external technology acquisition and in-house technological activities and usually resulting in an increase in R&D expenditures. While technology sourcing was rarely a substitute for in-house R&D, it was an important complement to it." Richard Langlois (2003a) has documented the "post-Chandlerian firm", in which innovations develop in a less hierarchical fashion.

If firms cannot (or don't wish to) develop sufficient absorptive capacity themselves, they may utilize strategic alliances in order to gain such knowledge or utilize complementary resources to exploit that knowledge (see Gulati, 1998 for a review of alliances, and also Nooteboom, 1999). This alliance or "network" approach is particularly common in technology intensive industries such as biotechnology (Powell, Koput and Smith-Doerr, 1996; Mowery et al 1996, Bekkers et al, 2002). Finally, geographic location has also been shown to result in knowledge spillovers between firms and from university research in many industries, especially high-tech (Porter, 1990; Baptista & Swann, 1998; Kenney, 2000a).

Many models have been developed to explain how firms can exploit external knowledge. Perhaps the simplest method is to imitate a competitor: such free riding on the product and market investments of rivals is a common way for firms to overcome a first mover strategy (Lieberman and Montgomery, 1998). Consulting with customers who are lead users can provide firms ideas about discovering, developing, and refining innovations (von Hippel, 1988). Public sources are also an important source of knowledge, for example government R&D spending was identified almost 50 years ago as an important stimulus for private R&D (David, Hall, and Toole, 2000). Similarly, university research is often explicitly funded by companies to generate external spillovers (Colyvas et al, 2002). Recently, open source software has emerged as an important phenomenon that utilizes external knowledge in a network structure (Dedrick and West (2004); Lerner and Tirole, (2002); O'Mahoney, (2003); von Hippel, 2005).

Other scholars have studied the use of alliances (Gerlach, 1992) and the construction of networks by firms (Gomes-Casseres, 1996) as another means of actively seeking out and incorporating external knowledge into the innovation processes of firms. The work of Woody Powell and his colleagues (Powell et al, 1996) examines the costs of benefits of networks for innovating firms, while the work of Jeffrey Dyer applies the concept of networks and keiretsu formation to the automotive industry (Dyer, 1996). Nooteboom (1999) examines the use of alliances in technology-based industries and companies.

Other recent research has called attention to the rise of intermediate markets in particular industries (Arora, Fosfuri and Gambardella, 2001a). These intermediate markets alter the incentives for innovation, and also condition the mode of entry of new technologies and new firms into an industry (Gans, Hsu, Stern, 2001). The presence of intermediate markets may interact with more networked structures to change the way in which innovation is organized.

What's New? Contributions of the Open Innovation Paradigm

Given this wealth of antecedents in the academic literature, is there anything new or different about the Open Innovation paradigm? Yes. The first difference is that external knowledge played a useful, but supplemental role in prior theorizing about innovation. The firm was the locus of innovation, and the internal activities of the firm were the central object of study (see for example the works of Alfred Chandler, and his focus on "the first mover" firm in different industries). The exemplars of the internal model were Bell Laboratories, and the many industrial R&D labs that emulated Bell Labs' organization. Even later theories of "absorptive capacity" never specified what the balance between internal and external innovation sources ought to be. In Open Innovation, external knowledge plays an equal role to that afforded to internal knowledge in the earlier conception.

A second area of differentiation is the centrality of the business model in the Open Innovation paradigm. In the "man of genius" mode of the Closed paradigm, one paid little or no attention to the business model in organizing for innovation. Instead, the focus was on securing "the best and the brightest", and then trusting that world class research talent, when sufficiently funded, will come up with valuable new innovations that will somehow find a path to market. In Open Innovation, companies actively seek people of genius from both inside and outside the firm to provide fuel for the business model. In turn, Open Innovation suggests that inventive output from within the firm not be restricted to the current business model, but instead have the opportunity to go to market through a variety of channels (with the current business model perhaps having a right of first refusal).

A third distinction is that earlier innovation theories effectively assumed the absence of any measurement error (either of a Type I or Type II kind) in the evaluation of R&D projects Chesbrough, 2004). This evaluation is done in the context of the company's business model, and whether the project "fits" their business model. If an R&D project was cancelled, there was nothing more to be done about it, and there was no reason to suspect that there was any systematic error in the assessment that led to the project's termination. Innovation processes, in fact, were managed so as to reduce the chance of a Type I or "false positive" evaluation error, which would result when an R&D project went entirely through the process, went to market through the company's business model, and failed. The possibility of a Type II or "false negative" error, where the project does not fit the company's business model, and is therefore not perceived as valuable to the firm, was not deemed important., even though statistical theory suggests that efforts to reduce a Type I error will inadvertently increase the chance of a Type II error (Judge, et al, 1985). And firms typically lacked any process for managing false negative R&D projects.

In Open Innovation, the business model is the cognitive device that focuses the evaluation of R&D projects within the firm (Chesbrough and Rosenbloom, 2002). As a cognitive aide, the business model filters in projects that "fit" with the model, and selects against those that do not. This evaluation is not objective; biases can and do exist. While firms rightly seek to minimize the incidence of false positives, the alert firm also must incorporate additional processes to manage false negatives, in order to appropriate value from them and identify potential new markets and business models from them.

A fourth and related distinction is that prior concepts accorded little or no recognition to purposive outbound flows of knowledge and technology (in contrast to the unwitting outbound

flows that are termed "spillovers", which were discussed above). Even when firms went outside to absorb external knowledge, it was for the purpose of internal development, manufacture and sales. In the Open Innovation paradigm, enabling outward flows of technologies allows firms to let technologies that lack a clear path to market internally seek such a path externally. In so doing, the internal businesses of the firm now compete with these external channels to market (such as licensing, ventures, and spin-offs that can create additional value) for new technologies. These external channels, in turn, can provide important evidence of emerging or neglected technical or market opportunities (in a way, a second opinion), constituting one means to manage "false negative" R&D projects. These channels have to be managed as real options, as opposed to the more traditional net present value approach for allocating budgets to projects (Bower, 1970).

A fifth point of departure lies in the assumptions of the underlying knowledge landscape. While the abundance of knowledge has been known since at least the time of Hayek (1945), this insight did not penetrate the door of the industrial R&D model. In the proprietary model of innovation, useful knowledge is scarce, hard to find, and hazardous to rely upon (a root cause of the Not Invented Here syndrome). In Open Innovation, useful knowledge is generally believed to be widely distributed, and of generally high quality. Even the most capable and sophisticated R&D organizations need to be well connected to these external sources of knowledge.

This is well illustrated in Merck's annual report for the year 2000. Although the company is widely respected for its excellent internal research, the report stated on page 8: "Merck accounts for about 1 percent of the biomedical research in the world. To tap into the remaining 99 percent, we must actively reach out to universities, research institutions and companies worldwide to bring the best of technology and potential products into Merck. The cascade of

knowledge flowing from biotechnology and the unraveling of the human genome – to name only two recent developments – is far too complex for any one company to handle alone." Importantly, these external sources extend well beyond universities and national laboratories, to startup companies, specialized small companies, individual inventors, even retired technical staff or graduate students.

A sixth differentiation is the new and proactive role for IP management in the Open Innovation model. While the practice of proactive IP management is hardly new to certain industrial firms (think of Dolby Laboratories or Gore, Inc, the licensors of Goretex), prior theories of innovation treated intellectual property was a byproduct of innovation, and its use was primarily defensive. This would enable firms to practice their (internal) technologies without being blocked or held up by external IP. Should such blockage arise, IP could be cross-licensed or bartered to restore the status quo ante. In Open Innovation, this is but one of many possible uses of IP. IP becomes a critical element of innovation, since IP flows in and out of the firm on a regular basis, and can facilitate the use of markets to exchange valuable knowledge. IP can sometimes even be given away through publication, or donation.

A seventh area of difference is the rise of intermediaries in innovation markets. While intermediaries have been observed in related areas such as technology alliances (Nooteboom, 1999), they now play a direct role in innovation itself. As innovation becomes a more open process, intermediate markets have now arisen in which parties can transact at stages which previously were conducted entirely within the firm. At these junctures, specialist firms now provide information, access, and even financing to enable transactions to occur. The growing importance of intermediaries is perhaps most elaborated in the Pharmaceuticals industry (such as Innocentive, or Yet2.com), but it is emerging in many industries (such as NineSigma, or

YourEncore). This is difficult to explain in the Closed model (or perhaps it is regarded as a curiosity of little research interest). It is a significant trend to understand in the new paradigm.

The eighth and last distinguishing point out of this new approach is the development of new and different metrics for assessing the performance of a firm's innovation process. Classical metrics include the percentage of sales spent on (internal) R&D, the number of new products developed in the past year, the percentage of sales from new products, and the number of patents produced per dollar of R&D. New metrics will expand or perhaps substitute for some of these measures. Questions of how much R&D is being conducted in within the firm's supply chain (rather than R&D occurring simply within the firm itself) become more important. What percentage of innovation activities originated outside of the firm – and how this compares to the industry in which the firm operates - may be another. The time it takes for ideas to get from the lab to the market, and how that varies by channel to market (internal, outlicense, spin-off, etc.) will be still another. The rate of utilization of patents owned by the firm will be still another, as unutilized patents may have alternate paths to monetizing value. Investments in outside firms may also become importantn (Chesbrough, 2002a).

Table 1.1

Points of Differentiation for Open Innovation, relative to prior theories of innovation
1. Equal importance given to external knowledge, in comparison to internal knowledge
2. The centrality of the business model in converting R&D into commercial value
3. Type I and Type II measurement errors (in relation to the business model) in evaluating R projects
4. The purposive outbound flows of knowledge and technology
5. The abundant underlying knowledge landscape

6. The proactive and nuanced role of IP management
7. The rise of innovation intermediaries
8. New metrics for assessing innovation capability and performance

In sum, while Open Innovation draws extensively from an earlier body of academic scholarship, it offers a number of distinctive perspectives and interpretations of that prior scholarship. In our judgment, these are sufficient to warrant consideration as a new paradigm for understanding innovation. The final assessment will of course remain with the reader. We modestly hope that younger scholars will find inspiration in these pages, and take up the opportunity to work in this area. More experienced scholars may find important connections with their own work, which might enrich the Open Innovation approach, and shed additional light on their work in turn.

Conclusion

The field of innovation studies arguably operates in Pasteur's Quadrant (Stokes, 1997), in that the processes and practices of industry actors often extend beyond the bounds predicted by academic theory. Close observation of the experiments that some of these firms have enacted reveals that the inwardly-focused, vertically integrated model of industrial innovation so celebrated by Chandler (1990) and others has given way to a new, and not yet well-understood model (Langlois, 2003a).

While the contours of the new model of innovation remain obscure, it is clear that any adequate understanding will require a more externally-focused perspective, involving the actions

of multiple actors in a far more distributed innovation environment. Such a new model will require close study of the innovation activities of the organization from multiple levels of analysis (including individual, group, organization, community, and institutional). It will likely provide a more satisfying account for current Kuhnian anomalies in our theories of innovation (such as spillovers, unutilized IP, NIH, spin offs), even as it raises new research issues (the provision of long term research, the limits of business models, the links between innovation and IP management). It may even point the way to new innovation actions not yet witnessed much in industry. This could include the greater use of purposive outbound knowledge flows by companies, the emergence of a secondary market for intellectual property, and the creation of new organizational roles and practices for identifying, incorporating, and adding value to external knowledge sources. The final chapter in this volume will consider these points at greater length.

REFERENCES – NOW COMPLETE!!

Abrahamson, Eric, 1996. "Management Fashion, Management Fads", Academy of Manangement Review, vol 22/1 (January)

Arora, Ashish, Andrea Fosfuri, and Gambardella, Alfonso, 2001a. Markets for Technology, (MIT Press: Cambridge, MA)

Baptista, R. and Swann, P. (1998) Do firms in clusters innovate more? *Research Policy*, **27**, 5, 525-540.

Bekkers, R., Duysters, G. and Verspagen, B. (2002) Intellectual property rights, strategic technology agreements and market structure: the case of GSM. *Research Policy,* **31**, 7, 1141-1161.

Bower, Joseph, 1970. "Managing the Resource Allocation Process", Division of Research, Harvard Business School

Chandler, A.D. (1990) *Scale and Scope*. Cambridge, MA: Belknap.

Chesbrough, H., 2002a. "Making Sense of Corporate Venture Capital", *Harvard Business Review*, vol. 80(3), March: pp. 90-99

Chesbrough, H., 2002b. . "Graceful Exits and Foregone Opportunities: Xerox's Management of its Technology Spinoff Organizations", Business History Review, vol. 76 (4) winter, 2002: 803-838

Chesbrough, H., 2003a. Open Innovation: The new imperative for creating and profiting from technology, (Harvard Business School Publishing: Boston, MA)

Chesbrough, H., 2003b. "The Era of Open Innovation", *Sloan Management Review*, vol. 44, #3 (Spring):35-41

Chesbrough, H., 2003c. "Open Innovation: How Companies Actually Do It," *Harvard Business Review*, vol. 81 (7), July, 2003: pp.12-14

Chesbrough, H., 2003d. "Open Platform Innovation: Creating Value from Internal and External Innovation", *Intel Technical Journal*, vol. 7 #3 (August). Online at: http://www.intel.com/technology/itj/2003/volume07issue03/art01_open/p01_abstract.htm

Chesbrough, H., 2004. "Managing Open Innovation: Chess and Poker", *Research-Technology Management*, vol. 47 (Jan.-Feb.) 2004:13-16

Chesbrough, H. and Rosenbloom, R.S. (2002) The role of the business model in capturing value form innovation: evidence from Xerox corporation's technology spin-off companies. *Industrial and Corporate Change,* **11**, 3 (June), 529-555.

Chesbrough, H., Vanhaverbeke, W., and J. West, 2006. Open Innovation: Researching a New Paradigm, (Oxford University Press) , forthcoming

Cohen, W. M. & Levinthal, D. A. (1990) Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, **35**, 128-152.

Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R.R., Rosenberg, N. and Sampat, B.N. (2002) How do university inventions get into practice? *Management Science,* **48**, 1, 61–72.

Conant, J. (2002) *Tuxedo Park*. New York: Simon & Schuster.

David, P.A., Hall, B.H., and Toole, A.A. (2000) Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy*, **29**, 497-529.

Davis, Julie, and Suzanne Harrison, 2001. Edison in the Boardroom, (John Wiley: New York, NY)

Dedrick, J. and J. West, 2004. "An exploratory study into Open Source platform adoption," IEEE Proceedings of the 37th Hawaii International conference on Systems

Sciences

Dyer, Jeffrey, 1996. "Does Governance Matter? Keiretsu Alliances and Asset Specificity as Sources of Japanese Competitive Advantage, Organization Science 7: 649-666

Feyerabend, P.K., 1981. Problems of Empiricism, (New York, NY: Cambridge University Press)

Gans, J, D Hsu, and S Stern, 2001. "When does startup innovation spur the gale of Creative Destruction", DRUID conference presentation, June 2001, NBER working paper 7851

Gerlach, M., 1992. Alliance Capitalism, (University of California Press: Berkeley, CA)

Gomes-Casseres, 1996. The alliance revolution: the new shape of business rivalry, (Harvard University Press: Cambridge, MA)

Granstrand, O., Patel, P. and Pavitt K., 1997. "Multi-Technology Corporations: Why they have "Distributed" Rather than "Distinctive Core" Competencies". California Management Review, Vol 39, No 4

Gulati, R. (1998) Alliances and networks. *Strategic Management Journal,* **19**, 4, 293-317.

Hayek, F., 1945. "The. Use of Knowledge in Society," American Economic Review, vol. 35. (September): 19-30

Judge, G, RC Hill, WE Griffiths, H Lutkepohl, TC Lee, 1985. The Theory and Practice of Econometrics, (John Wiley:New York, NY)

Katz R., and T. Allen, 1985. "Organizational Issues in the Introduction of New Technologies," in The Management of Productivity and Technology in Manufacturing, P. Kleindorfer, editor, (New York: Plenum Press)

Kenney, M., editor, (2000a) *Understanding Silicon Valley: Anatomy of an Entrepreneurial Region,* Stanford: Stanford University Press.

Kuhn, T., 1962. The Structure of Scientific Revolutions (Chicago: University of Chicago Press)

Lamoreaux, N, D Raff, and P. Temin, 1999. Learning by doing in markets, firms, and countries, (University of Chicago Press: Chicago, IL)

Langlois, Richard, 2003a. "The vanishing hand: The changing dynamics of industrial capitalism", Industrial and Corporate Change. Oxford: Apr 2003.Vol.12, Iss. 2; pg. 351

Leifer, R., McDermott, C.M., O'Connor, G. C., Peters, L.S., Rice, M.P., Veryzer, R.W., and Rice, M. (2000) *Radical innovation: how mature companies can outsmart upstarts,* Boston: Harvard Business School Press.

Lemley, Mark, 2001. "Rational Ignorance at the Patent Office", UC Berkeley School of Law Public Law and Legal Theory working paper #46 (February)

Lerner, Joshua and **Tirole**, Jean, 2002. "Some Simple Economics of Open Source" . Journal of Industrial Economics, Vol. 50, No. 2(June), pp. 197-234

Lerner, J, 2000. "150 Years of Patent Office Practice" , (January 2000). NBER Working Paper No. W7477

Lieberman, M.B. and Montgomery, D.B. (1998) First mover (dis)advantages: retrospective and link with the resource-based view. *Strategic Management Journal*, **19**, 1111-1125.

Mowery, D. C., Oxley, J. E., Silverman, B. S. (1996) Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal*, **17**,(Winter Special Issue), 77-91.

Mowery, 1983. The Relationship Between Contractual and Intrafirm Forms of Industrial Research in American Manufacturing, 1990-1940, Explorations in Economic History (October): 351-74

Nelson, R. R. and Winter, S.G. (1982) *An Evolutionary Model of Economic Change.* Cambridge, Mass.: Harvard University Press.

Nelson, R. R., 1959. "The Simple Economics of Basic Scientific Research," J. Political Economy, 67, June, 297-306

Nooteboom, B. 1999. Inter-Firm Alliances: Analysis and Design, (Routledge: London)

Porter, Michael, 1990. The Competitive Advantage of Nations, Free Press: New York, NY

O'Mahony, Siobhan. "Guarding the Commons: How Community Managed Software Projects Protect Their Work." *Research Policy* 32, no. 7 (July 2003): 1179-1198.

Powell, W.W., Koput, K.W. and Smith-Doerr, L. (1996) Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. *Administrative Science Quarterly,* **41**,116-145.

Rivette, Kevin and David Kline, 2000. Rembrandts in the Attic: Unlocking the Hidden Value of Patents, Harvard Business School Press: Cambridge, MA)

Rosenberg, N. and Steinmueller, W. E. (1988) Why are Americans such poor imitators? *American Economic Review*, **78**, 2, p229 - 235.

Rosenberg, Nathan, 1994. Exploring the Black Box: Technology, Economics, and History, Cambridge University Press: Cambridge, England

Rosenbloom, Richard, and Spencer, William, 1996. "Engines of Innovation: Industrial Research at the End of an Era", Harvard Business School Press: Boston, MA

Sakkab, Nabil, 2002. "Connect & Develop Complements Research & Develop at P&G", Research-Technology Management, vol.45 (2):38-45

Schumpeter, J.A. (1934), *TheTheory of Economic Development,* Cambridge, Mass., Harvard University Press.

Schumpeter, J.A. (1942) *Capitalism, Socialism, and Democracy.* New York: Harper and Row.

Smith, D. K. and Alexander, R.C. (1988) *Fumbling the Future*. New York: William Morrow.

Stokes, Donald, 1997. Pasteur's Quadrant: Basic Science and Technological Innovation, Brookings: Washington, DC

Teece, D. (1986) Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. *Research Policy,* **15**, 6, 285-305.

von Hippel, Eric (1988) *The Sources of Innovation*. New York: Oxford University Press.

von Hippel, Eric, 2005. Democratizing Innovation, (Cambridge, MA: MIT Press)

Yin, R., 1988. Case Study Research: Design and Methods. (Newbury Park, CA: Sage Publications)

FIGURES

END NOTES

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[1] For a alarmist assessment of the trend, see Forrester Research, which estimates that 3.3 million R&D jobs will move offshore over the next 12 years (http://www.nytimes.com/2003/10/05/business/05ECON.html?tntemail0). For a more hopeful assessment, see the McKinsey Global Research Institute, http://www.mckinsey.com/knowledge/mgi/offshore/, which estimates that the US will capture 78% of the value created from offshore R&D employment.

[2] The entirety of Chapter 1 of that book examines the experience of Xerox's Palo Alto Research Center, and offers a different interpretation of the root cause of Xerox's problems with PARC. Xerox was judged to be effective in utilizing PARC technologies that fit with Xerox's copier and printer business model. The failure was that Xerox could not conceive of an alternate business model through which to commercialize technologies that did not comport with that model. By contrast, the profile of IBM in Chapter 5 showed a company that did reconceive its business model.

[3] One paradox posed in Open Innovation was the surprising ability of Cisco to keep up with Lucent and its Bell Labs. As the book noted, "Though they were direct competitors in a very technologically complex industry, Lucent and Cisco 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, to come up with fundamental discoveries that could fuel future generations of products and services. Cisco, meanwhile, did practically no internal research of this type.

Instead, Cisco deployed a rather different weapon in the battle for innovation leadership. It scanned the world of startup companies that were springing up all around it, which were commercializing new products and services. Some of these startups, in turn, were founded by veterans of Lucent, or AT&T, or

Nortel, who took the ideas they worked on at these companies, and attempted to build companies around them. Sometimes, Cisco would invest in these startups. Other times, it simply partnered with them. And more than occasionally, it would later acquire them. In this way, Cisco kept up with the R&D output of perhaps the finest industrial research organization in the world, without doing much internal research of its own." (p. xviii)

[4] While comprehensive evidence of these points is not yet available, some elements are already in the literature. Lemley (2001:11-12) cites studies that report a large fraction of patents are neither used, nor licensed by firms. Davis and Harrison (2001) report that more than half of Dow's patents were unutilized. Sakkab (2002) states that less than 10% of Procter & Gamble's patents were utilized by one of P&G's businesses.

[5] I am grateful to Scott Gallager and Joel West for identifying this example.

Figure 1.1:
The Current Paradigm: A Closed Innovation System

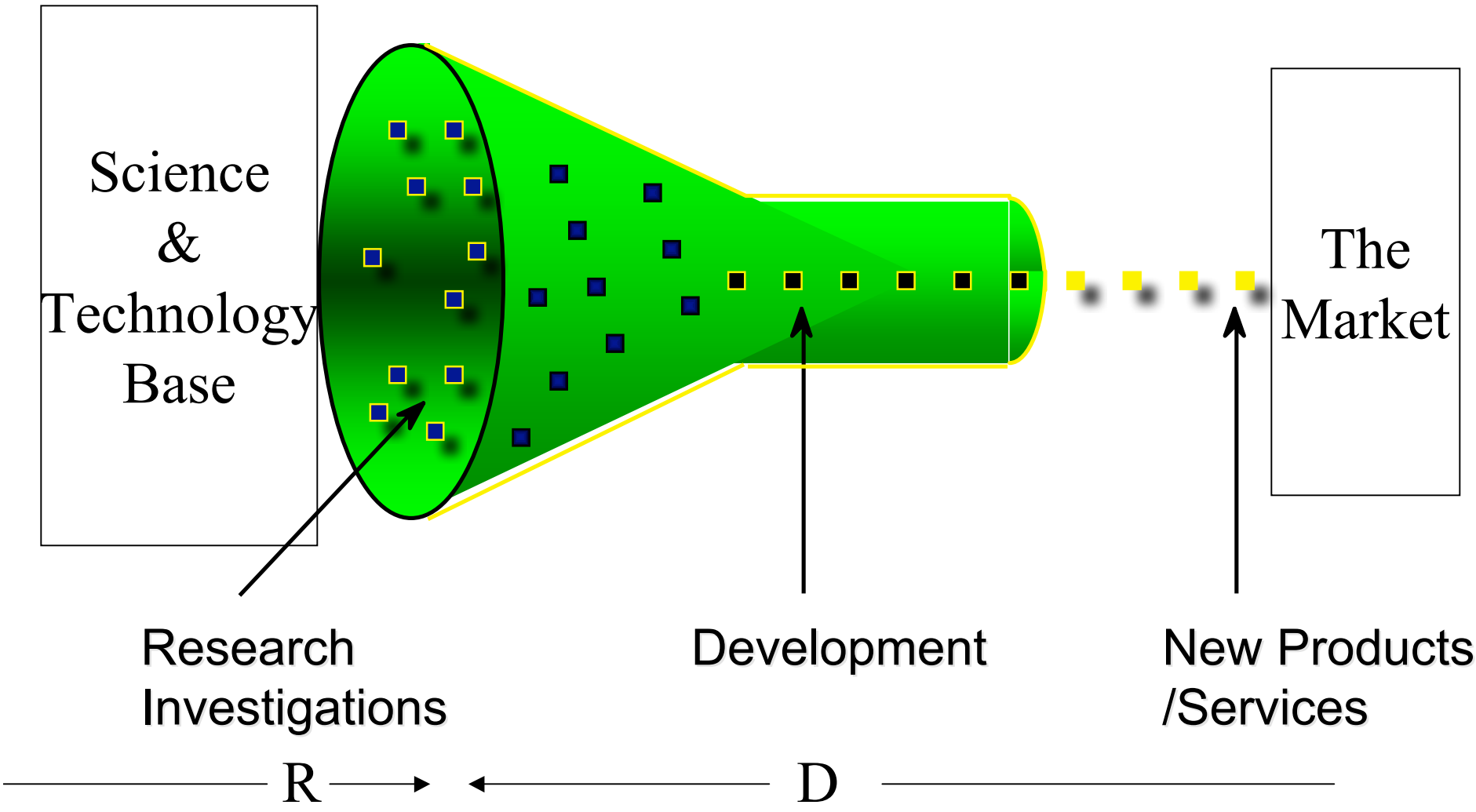

Figure 1.2:
The Open Innovation Paradigm