

What Open Innovation Means for Scientists

Adrian Slusarczyk

Technological innovation is the vehicle by which science has transformed the everyday lives of people in the modern age. From air flight to novel medicines, from cleaner energy sources to the Internet, many of the feats of technology surrounding us today are the result of scientific skill and insight. Yet the work of research scientists and engineers has such a profound practical impact only where it leads to the creation of useful products that make it to the market -- and the way by which this happens is itself in the middle of a rapid transformation.

The process of innovation goes beyond invention in that it also encompasses a viable route for the creators of a technology to profit from it while providing it on large scales to consumers. It gives birth to new products, companies, and even industries. But while the accelerating pace of scientific research and the worldwide expansion of tertiary education present unprecedented opportunities for innovators, companies are finding their internal research less and less effective in creating new products, and that competitors that spend very little on research and development (R&D) often do spectacularly well in the market (1, 2). What is the solution to this puzzle -- and why does it matter for universities and research scientists?

When Edison began working in his Menlo Park laboratory over a century ago, he became the trailblazer of an age of industrialized innovation. Over the following decades leading companies, such as BASF, General Electric and AT&T set up research laboratories for industrial R&D, resulting in products from light bulbs and engines to dyestuffs and painkillers. Universities had only just begun to set up experimental science laboratories and could neither rival nor aid industry. Even in 1930, 70 percent of R&D funding in the United States came from industry, with government and the military contributing 14 percent and a further 12 percent coming from universities (1).

During much of the 20th century, corporate R&D laboratories were the prime drivers of innovation, and the ideas they produced were protected by secrecy and patents. This allowed the high R&D cost to be recouped before competitors could catch up. Henry Chesbrough, of Harvard Business School, used the term "closed innovation" for this approach, because all relevant R&D activity takes place within the walls of the

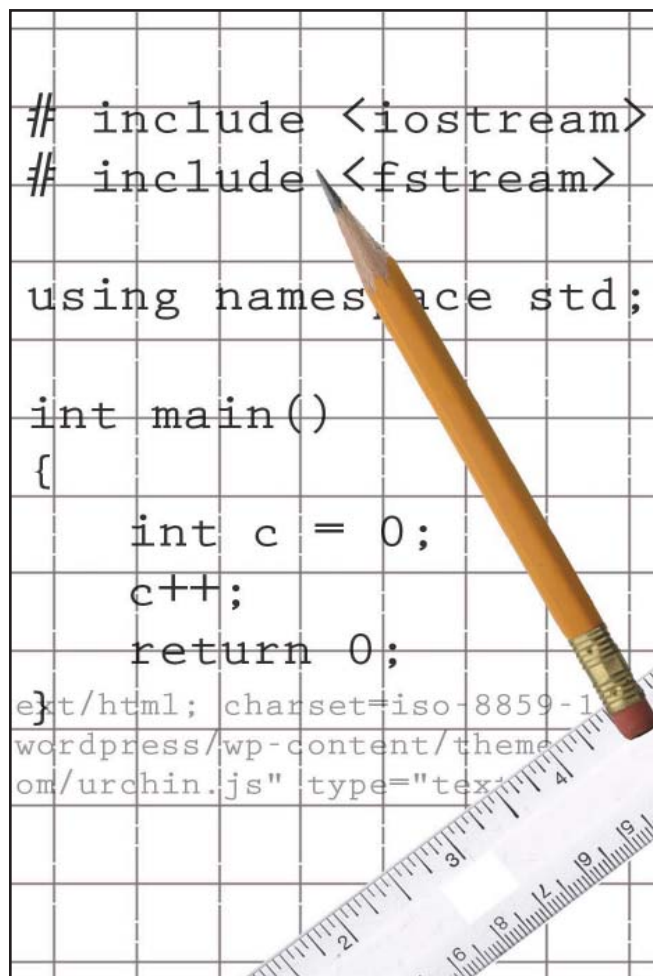
company surrounded by what he calls an otherwise "barren knowledge landscape". The achievements of this paradigm remain impressive: in addition to inventing revolutionary technologies, industrial researchers won several Nobel Prizes, for example for the discovery of ceramic superconductors at IBM (3) and of cosmic background radiation at AT&T's Bell Laboratories (4).

Since the 1980s, however, the logic behind closed innovation has been eroded. The computer industry was among the first to feel the effects. Companies maintaining large R&D facilities have found it increasingly difficult to justify such investment. Xerox's Palo Alto Research Center (PARC)

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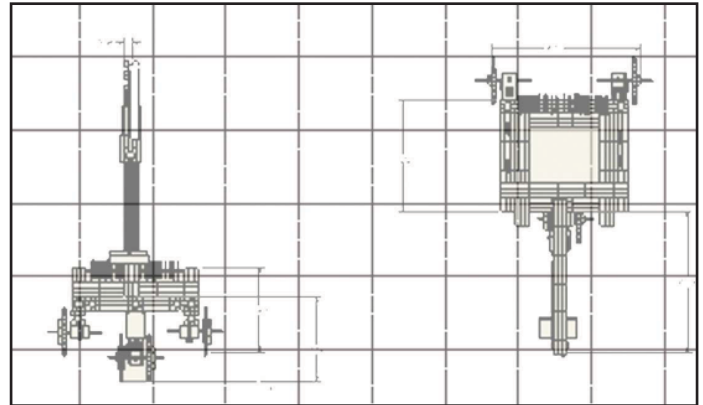
in the 1980s is a case in point: While Xerox's competitive position became increasingly precarious, PARC continued to produce brilliant ideas, such as the Ethernet technology, or the graphical user interface. However, it was spin-offs such as Adobe and 3com, or competitors like Apple -- and not Xerox -- who reaped the benefits. While a number of internal factors have been implicated in Xerox's failure to profit from PARC, including a lack of communication between scientists, product engineers and marketers, Chesbrough argues that one must look at the changes in the R&D environment that had taken place by then to understand why the company's approach did not work out as planned (1).

The post-war era in the USA saw an expansion in government and university contributions to R&D funding from 27 to 66 percent of total R&D spending between 1930 and 1970 (1). This was matched by an expansion in tertiary education, training large numbers of scientists to join the workforce and dispersing expertise. This, together with higher job mobility and new forms of funding such as venture capital (VC), enabled smaller competitors to innovate just as vigorously as the de facto monopolists of old, and often faster. Between 1981 and 1999, the contribution of



companies with over 25,000 employees to total industrial R&D spending in America fell from 71 to 41 percent (1), invalidating the alleged economies of scale of the large closed R&D labs and forcing companies to rethink the way they innovate.

Chesbrough coins the term "open innovation" for a paradigm which recognizes "that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well" (1). This means that companies actively look for, and incorporate, technologies from outside as well as inside their own four walls. Conversely, an internal idea which has promise but doesn't fit the company's own business model may be commercialised by a different route. Strategies to gain access to the now-abundant outside ideas include licensing in technologies and buying relevant intellectual property (IP) from competitors or from universities, buying promising startups with a product that has already found its first customers, investing through corporate VC programmes, and cooperating with universities to keep an eye on cutting-edge research, e.g. by sponsoring graduate students or entire departments. To create value from ideas and inventions that don't fit into the existing business model, companies practising open innovation will try to commercialise them through a new product line, or spin it out as a venture of its own. Should these options not be viable, they can still receive greater returns from selling or licensing the IP to other companies with a better-fitting business model than by shelving the idea.



The transformation of the computer industry illustrates what specific measures companies can take when their sector shifts toward open innovation. This industry had been established by corporations following the closed innovation paradigm such as Xerox, AT&T and IBM. But the diminishing returns on their R&D spending, the success of open innovators such as Intel and the vibrantly innovative start-up scene in Silicon Valley fuelled by VC since the 1980s forced the industry to change gears. Lucent Technologies, emerging

The traditional role of industrial R&D is changing

from the break-up of AT&T, created a New Ventures Group to develop, spin-out or sell IP coming out of Bell Labs that none of the existing business units could use in its product line (1). Intel built R&D sites in the vicinity of major US university campuses and invests in over 1,000 start-up companies through Intel Capital (5). IBM is now an active trader of IP, receiving billions of dollars in royalties every year from other companies (1).

While closed innovation still prevails in many sectors, with military equipment as a classic example of an industry whose business model favours this paradigm, a more open approach is becoming a fact of life in many innovation-driven industries from consumer electronics to pharmaceuticals. In Europe, Philips is using its High Tech Campus in Eindhoven to collaborate with the nearby universities (6). The pharmaceutical industry benefits from a global expansion of public life science research and the proliferation of biotech startups. In 1998, Bayer and Millenium Pharmaceuticals agreed that Millenium would supply Bayer with hundreds of target molecules and receive in exchange all resulting IP for which Bayer has no use, in addition to remuneration (1, 7, 8). After Torcetrapib's failure in clinical trials (5), Pfizer is widely expected to radically restructure its research. Speculation abounds about funding cuts and layoffs in R&D at Pfizer accompanied by acquisitions of biotech companies (9) – perhaps a blessing in disguise for a company that currently spends more on R&D than any other.

Universities will need to define what they see as their role in this new knowledge landscape. Philips' Eindhoven campus is a good example of the inherent opportunities (6). The cooperation with local universities includes the exchange of people and commissioning of R&D projects to university departments. Students can complete course projects with Philips and scientists can join the company for

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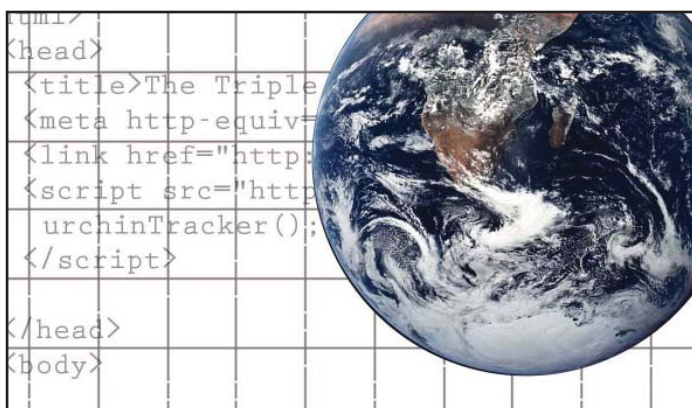
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a longer leave and then return to academia. Philips also keeps an eye on promising start-ups coming out of these universities in the science park on campus, and allows its own scientists to start companies based on inventions for which Philips has no current use. Notably, the company contributes to the funding of state-of-the-art labs and other academic facilities. Philips runs similar smaller-scale facilities in several locations in Europe, America and Asia. "[N]ow, more than ever, science can best be defined as a vast global network", says Philips' Barbara Kux (6).

Other ways for universities to integrate into this network include allowing their academics and students to start spin-out companies based on their work, and to license out or sell IP. The challenges here go far beyond the setup of a technology transfer office. Any decision on IP – in effect, who owns discoveries made in the university – will have ramifications in terms of incentives as well as fairness, practicality and political implications. Education about the commercial context of science and the encouragement of entrepreneurship will be needed for scientists to take a proactive role. And while the potential revenue from royalties, equity and sponsorship is likely to be appreciated in academia, it raises fears about the future funding of fundamental research without immediately obvious commercial utility. Moreover, the difference of cultures between the publication-driven world of academia and the protection of ideas in industry by secrecy and patents will require iteration and compromise to reconcile the practicalities of moneymaking with the ideal of free and open dissemination of knowledge. It is in the context of open innovation that universities and governments must recognise and address these issues.

Looking across the Atlantic promises to be valuable to British institutions in this respect, since American universities like Stanford and the Massachusetts Institute of Technology have an impressive track record of fostering, and benefiting from, the entrepreneurial prowess of their graduates. Over 4,000 companies were founded by MIT students, staff and graduates or spun off one of its laboratories since its foundation, with combined revenues of over 200 billion dollars and 1.1 million employees (10). Over half of these companies were founded within 15 years of graduation, and just under half of them report regular contact with MIT for consulting with faculty, recruitment and other purposes. Founders who have graduated from MIT name the hands-on educational philosophy and inspiration by lecturers who are themselves CEOs of companies as among the chief factors crucial for their own decision to take the plunge. And ahead of favourable taxation and regulation, access to leading

universities and to skilled labour are named by the founders as decisive factors in choosing a location for their venture (10). While it need not be possible, or desirable, to emulate all facets of the different institutional culture at the leading American technological universities, their experience should be scrutinised and critically evaluated by legislators and universities here if the UK economy is to remain competitive

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in the increasingly global markets for ideas, labour and investment.

For the individual scientist, an open innovation framework allows greater flexibility to move back and forth between academia and industry and experience the best of both worlds in terms of relevance, utility and financial returns as well as intellectual freedom. But the traditional role of industrial R&D is changing, with much more emphasis on a commercial mindset and product development rather than fundamental research. While overall R&D spending is increasing, large companies have been cutting jobs in basic science and given R&D managers the additional role of knowledge brokers as well as generators. It remains to be seen whether the public sector can compensate for the opening gap in fundamental research.

The disruptive nature of the transition toward a more open innovation landscape forces companies to adapt their R&D efforts if they want to remain competitive and requires changes in the mindset within academia. But with an understanding of the nature of this transition, open innovation enables scientists better than ever before to fully exploit the potential of their discoveries to create technologies that improve our lives.

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References:

1. Chesbrough, H W, Open Innovation, Harvard Business School Press, 2003
2. Jaruzelski et al., *strategy+business*, **41**, 53-65 (2005):
3. The Royal Swedish Academy of Sciences, The Nobel Prize in Physics 1987, Nobel Foundation
4. The Royal Swedish Academy of Sciences, The Nobel Prize in Physics 1978, Nobel Foundation
5. Intel Corp, Intel Capital Overview, 14 Jan. 2007 http://download.intel.com/capital/download/Intel_Capital_Overview.pdf
6. Kux, B., NZZ Buchverlag, 2005, <http://www.essays2030.ethz.ch/onlineversion/113-124.pdf>
7. Dorey, E., *Nature Biotechnology*, **16**, 1005, (1998)
8. Millennium Pharmaceuticals Inc., PRNewswire, 14 Jan 2007, <http://investor.millennium.com/phoenix.zhtml?c=80159&p=irol-newsmediaArticle&ID=462997>
9. Bloomberg News, Pfizer to cut workforce, R&D budget, The Boston Globe. 12 Jan 2006.
10. BankBoston, MIT: The Impact of Innovation, Boston: BankBoston, 1997.