

Licenses As Critical Sources Of Innovation

Part 3: Technological Revolutions & Implications

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There is something inherently comforting and yet bewildering in the cyclical flux of the seasons.

The often sublime shifts from the blossoms of spring to the light and warmth of summer to the beautiful decay of fall influence not only our sentiments and behavior but have been critical inspirations for the developments of technology. Consider how the ability to control fire revolutionized the lives of our human ancestors. Since then we have devoted large efforts to enhance our standard of living and to become, as far as possible, independent of the weather. While the speed of technological progress was relatively slow for tens of thousands of years, it is astonishing how society has changed within the last centuries and even decades. On this seemingly inevitable path to an ever increasing technologically-shaped society, it is important to determine where technological revolutions originate from and what lessons can be learned from the process of innovation.

In the preceding parts of this series on the critical but often neglected role that licenses play in the innovation generation process, we outlined how Japan used licenses to become one of the worlds' most technologically sophisticated countries and how licenses led to the development of crucial medical innovations, such as insulin. In this final article, we will take the discussion one step further. We will focus on a few revolutionary technologies that originated from licenses and that had a substantial economic and social impact. Finally, this paper will summarize the lessons learned from our three-pronged investigation.

To jog our memory, a licensor grants a licensee access to his intellectual property (IP), namely his patents and know-how, subject to certain conditions. If these are not excessively restrictive, it is likely that the licensee will use this newly obtained technological acumen as well as the market insights he obtained from commercialization, to experiment with the technology at hand. The result of such tinkering can be both minor or major product and process enhancements. Occasionally, licensing transactions can even lead to radical innovations which can reshape society, often to the better, but

not necessarily so. As licensing is closely linked to the existence of an intellectual property system, our journey into technological revolutions created via licenses will commence in the early eighteenth and accompany us into the late twentieth century.

Steam Engine

One of the most critical societal shifts of all times occurred during what has been termed the industrial revolution. In this period during the 18th and 19th century pioneered by Britain the unique combination of technology, availability of natural resources and free trade opened up a new era of economic growth. While previously global economies were mostly characterized by manual labour, the development of steam engines that heated up water to create mechanical motion allowed for substantial savings in terms of time and money. Agricultural processes, the production of textiles or passenger and product shipments, to name just a few fields, were revolutionized beyond prior belief.

The underlying technology was born out of necessity. In order to deliver coal for an increasingly demanding British economy mine shafts had to progressively deepened. As manual labour was poorly suited to deal with the resulting problem of excess water in the mines, a technological system was needed. Thomas Newcomen was the man to rise to the challenge. Between 1710-12 he built on the previously existing concepts to create a simple but reliable steam engine that "rais[ed] Water by fire" (Smith 1977; p. 5), and that became "the relevant technological paradigm in mine drainage" (Nuvolari 2004; p. 352).

Interestingly, the patent¹ on the steam engine was already held by another man, Thomas Savery, who was granted the protection in 1698 and persuaded Parliament to extend it by a further 21 years in 1699 (Smith 1977). Savery and Newcomen subsequently collaborated to improve and market the technology. Given the inherent demand for the engines, they also licensed others to manufacture them (Allen 1969).

1. Patents or protection for "projects of new invention" have been available in England since the passing of the Statute of Monopolies in 1623.

Many of these licenses included harsh reach-through clauses, requiring mine operators to return to the licensors up to a third of the profits made by their operations (Allen 1968). After Savery died in 1715 a “Committee of Proprietors of the Patent” was set up to issue licenses until the patent’s expiry in 1733 (Allen 1969; p. 169, cf. Macleod 1988).

These hardworking and “extremely ambitious” (Smith 1977; p.12) licensees erected a variety of different engines of different sizes and materials. Harris (1967), for example, reported that many of the recorded 360 engines between 1712-1781 were built under license. In other words, the licensees frequently experimented with the technology to attempt to improve it. While Newcomen’s original engine was able to lift thirteen Hogsheads per hour in 1712, which he improved to seventy by 1714, his licensees were able to increase this performance to over 250 (Allen 1969). From around 1718 onwards, the licensees started to use iron instead of brass cylinders and thereby substantially improved the manufacturing of the engines and simultaneously lowered their cost (Smith 1977, Allen 1969).

Sewing Machine

Moving on some one hundred years and hoping over the Atlantic let us consider the development of an important technology that dramatically changed the creation of clothes and handling of materials: The sewing machine. While numerous tinkers had experimented with the concept in different ways, especially in England, it seems demonstrative for the change in momentum that the key breakthroughs occurred in the U.S.

In 1846, Elias Howe, Jr. received the world’s first patent for a lock stitch sewing machine, which was able to interlock two threads. While Howe, without the desired success, attempted to commercialise his machine both in the U.S. and England, he found that numerous imitators were trying to free ride on his invention and therefore filed suit. One of these infringers was Isaac Singer, who had originally been asked to repair a copied version of Howe’s sewing machine and decided that he could improve upon it (Harrison 2004).

Howe prevailed in court in 1854 and struck an enforcement licensing agreement with Singer, under which the later had to pay royalties of \$25 per machine (Thompson 1921). As a licensee Singer made substantial improvements, including the rigid arm for holding the needle, a vertical bar to hold the cloth down against the upward stroke of the needle and the treadle, which by freeing both of the operator’s

hands substantially facilitated his work (Thompson 1921). Overall, he “patented 19 improvements of his own over the next 13 years and became America’s largest producer of domestic sewing machines” (Harrison 2004; pp. 38-39). His name remains synonymous with modern sewing machines.

Photocopier

Another century later, the world has moved on and in 1943, in the midst of the bloody battles of WWII, an American engineer and patent attorney called Chester Carlson was granted patent # 2,297,691 for “electron photography.” Carlson, after years of experimenting, had developed a simple method for copying objects written on a glass plate onto waxed paper. As he understood that the realization of the technology’s full potential would require the investment of further considerable resources, both in terms of time and money, Carlson searched for a strong corporate partner. After a long struggle he finally managed to negotiate a license with Battelle Memorial Institute, a non-profit independent research and development organization, which licensed the technology with the intention of turning it into a functional product. In return Carlson was to receive royalties (Harrison 2004; www.xerox.com).

Five years after the patent was first granted, namely in 1947, Battelle was approached by a small company from upstate New York which manufactured photographic paper. Haloid Company, better known under the name Xerox which it took on a decade later, negotiated a license to develop and market a copying machine based on Battelle and Carlson’s technology. Haloid devoted around a quarter of its annual net income to the project for the forthcoming ten years (Jaffe and Lerner 2004). This bet on the technology yielded its first, visible product with the development of the Haloid 1385 in 1951. This manually operated machine was the first electro-static copier sold in the U.S. As it took several minutes to make each copy and therefore was “impractical for work” (Tibballs 1994; p. 115), its market success was rather limited.

It did, however, pave the way for what was to come. In 1959, 17 years after Carlson’s patent award for the underlying technology, Haloid commercialized the first plain-paper office copier. This automatic machine was able to produce seven copies

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per minute and was the foundation of Xerox's massive success story (Tibballs 1994). In the same year, Xerox finally ceased being a licensee and purchased all of the global patent rights on xenography from Battelle. As a small indication of how successful the combined effects of the technological improvements of these patents and Xerox's marketing was, we should mention that by the early 1970s Xerox was sued by the Federal Trade Commission for monopolizing the market for photocopiers, a suit it settled the agreeing to license some of its patents to third parties (Jaffe and Lerner 2004). Tripartite innovation generation through licensing therefore revolutionized the modern office.

Wind Energy

Our final example of a technology that originated through a licensing transaction touches the current climate debate. In the quest for sustainable energy creation wind turbines will play an important role. The beginnings of the modern wind energy industry can be found in Denmark, where numerous individuals were actively experimenting with designing wind turbines to generate electricity. In the mid 1970s the mechanic Karl-Erik Jorgensen used the previously existing designs to build turbine prototypes using glass-fibre blades and an electric motor that could turn the turbine into the direction of the wind. In order to commercialize his enhancement he licensed his design to Vestas. Using Jorgensen's turbine as a basis and improving upon it via intense R&D efforts, Vestas became the world's leading wind turbine manufacturer (Cameron and de Vries 2006, Douthwaite 2002, Jorgenson 1997).

The global number two, Gamesa Eolica, comes from Spain. Vestas essentially created its biggest competitor itself, through a joint venture company with Gamesa in 1994. Vestas extended an exclusive license to Gamesa Eolica for its proprietary wind turbine technology in Spain. The license prohibited Gamesa from operating in other European markets. Despite its initial success amidst heavy growth of the Spanish market, strategic differences between the two partners soon emerged. When Gamesa went public in 2000, using the growing wind energy sector as a key argument to convince investors of its attractiveness, the adversities between the parties became excessively large. As Vestas only owned 40 percent of Gamesa Eolica it realized that it would be unable to obtain managerial control and therefore decided to sell its stake in December 2001 (Wüstenhagen 2003). The termination of the licensing agreement two years later (Gamesa 2004) not only led to the loss of substantial licensing fees for Vestas but to

the creation of its main competitor. Gamesa employed and improved the technology it had originally licensed-in and today is no longer "a net technology receiver" (Gamesa 2004; p. 35). Instead, it creates and transfers its own proprietary technology to others. Licenses remain critical instruments of innovation in the wind energy industry, with both Gamesa and Vestas having further licensed their technologies to Asian companies.

Conclusions

The cases presented in this series, although by no means exhaustive, should serve as a convincing demonstration that licensees can be a critical source of innovation. In this light it is useful to summarize some of the managerial implications from our findings.

First of all, licensors through the inclusion of adequately structured grant-back clauses can obtain valuable know-how and even IP rights, such as access to improvement patents, from their licensees. They could use their licensee(s) as market-based R&D outsourcing partners. Ideally, this could amount to a "hub and spoke" model that could enable the pursuit of intensive (international) R&D at relatively low costs (Brinton 1993; p. 438). The licensor, who developed the core technology (the hub), would grant permission (through licenses with grant-back clauses) to allow other companies to develop the specific applications (the spokes). In this way licensors could benefit from the idiosyncratic innovative capabilities of different licensees and market and improve their core technology via external partners in different parts of the world without losing control over it. In other words, the licensor can "tap into a stream of new product and process ideas and quality improvement potentials it could not possibly generate itself" (Quinn and Hilmer 1994; pp. 52-53). Local licensees will be able to adapt the licensed technology to local conditions, and potentially use their know-how to improve the licensed technology in a manner that may also be applicable to analogue or other regional markets.

If the U.S. licensors in respect of their Japanese technology contracts or Thomas Savery and his crew would have used such a model they would have potentially been able to prolong their control over the technologies at hand for much longer periods of time. Instead of striving for long-term R&D benefits their focus was on short-term financial gain. The consequence for these two sets of licensors was the creation of powerful competitors. Sohio, the first of John D. Rockefeller's oil companies, on the other hand illustrates the potential of grant-back licensing to increase the life cycle of the product for the ben-

efit of both parties. For over 30 years it successfully practiced a “multilateral improvement exchange with most of its licensees” (Evans 2003, pp. 163-4). Comerford (1984; p. 46) therefore succinctly summarizes that a technical collaboration via grant-backs “is infinitely preferable to a ‘once-off’ transfer of technology and a one-way traffic of technical information.” It is not unlikely that such in depth transfers can lead to further co-operation and one survey of 119 LES members for example found that 26 percent of the respondents took equity participations in their licensees (Vickery 1988).

In light of the growing importance of R&D outsourcing (Engardio and Einhorn 2004, Love and Roper 2001), we assert that the considerable innovative potential of licensees has still not been fully used. Overall, such licensing to outsource could allow licensors to keep abreast of novel research, minimise the R&D and commercialisation risks, to benefit from novel uses of their own technologies, to continuously up-date their core competencies, to potentially increase the speed of its technology development and to improve R&D efficiency and flexibility (Piachaud 2004).

Improvements to the licensed technology can be especially valuable to the licensor as they are more likely to be tailored to his competencies than other external innovations. Especially in longer licensing relationships with mutual exchanges, the licensee is likely to have a superior knowledge of the strengths and weaknesses of the licensor’s production, R&D and maybe even sales and marketing competences than third parties. Consider the Bayer Onyx and Adalat cases, in which the respective licensee improvements proved extremely valuable to the German pharmaceutical company. This is important as companies frequently are not searching for the best possible solution per se, but for the solution that is most suited to their current resources and strategy. Research has shown that successful companies “build upon the firm’s existing technological and organizational competencies” (Cooper 1993; p. 53) and that projects with a good match between technological and marketing synergies, which the licensees’ experience can provide, are likely to yield the best results.

The choice of an appropriate licensee is clearly critical if the licensor hopes to benefit from subsequent improvements. Some form of a pre-existing R&D/technological competency, well trained staff, in-depth understanding of customer needs and the ability and commitment to invest into licence-related R&D are important characteristics for a licensee who is intended to improve the technology (cf. Piachaud

2004). The Japanese licensees, who benefitted from the high level of education in their country, invested tremendous efforts, both financially and time-wise, into improving the licensed-in technologies. Haloid essentially risked the whole company’s future through its heavy investments into Xeroxing. The cases of CEREC, Vestas and insulin further indicate the importance of previous know-how and investments into license-related R&D.

A further success factor is the provision of appropriate incentives for the licensee. As grant-backs can discourage licensees from improving the respective technology (Arora et al. 2002, Bessy and Brousseau 2000), excessively restrictive terms are likely to be counterproductive. Licensees should be incentivized to undertake license-related R&D and to then transfer the results. Sirona for example would not have invested such huge sums into the development of CEREC if the licensing contract would have contained a strict grantback clause. An obvious way to encourage licensees to tinker is to reduce royalties if information or rights-to use are granted back. The parties could also agree to lower overall royalties if the licensee promises to invest into license-related R&D. Another option is to use a grant-forward clause, where the licensor also passes on improvements to the licensee. Agreeing to pass on a large amount of know-how to the licensee, and fulfilling that promise, could not only enhance the licensee’s ability to enhance the licensed technology, but could also serve as a motivating tool. A mechanism to compensate the other party for differences in value of transferred technology can be appropriate in such cases. Another possibility is that the licensor pays royalties or milestone payments on any patent obtained from the licensee (Lovell 1969). Licensors can also grant licensees discounted access to needed input materials. Another way of incentivising licensees include equity participations in the licensor. The promise to form a joint-venture to mutually exploit developed technology may be another mechanism to encourage licensee improvement, especially if the organisations in question have complementary skills. Licensees who build up a reputation for granting back valuable improvements are also likely to be able to negotiate more favourable technology transfer arrangements in the future with both the licensor and third parties (Schmalbeck 1974). While in different industries distinct contractual structures are likely to be needed to incentivise licensees, the important point is to reward and not to punish the innovative efforts of licensees.

Finally, devoted post-deal management, such as

monitoring problem resolution, can, despite of the costs and efforts it may require, increase the likelihood of the licensee improving the licensed technology. Recall how Sulzer of Switzerland discovered that its Japanese licensees had substantially improved the licensed engines via the drilling of huge holes into the sides when it inspected their factory (Burr et al. 2004). Requiring the licensee to keep adequate records and inform the licensor of any improvements that he may make is highly advisable (Bills 2004). Zylbersztajn and Lazzarini (2005), in their analysis of technology licensing agreements in the Brazilian seed industry, found that higher monitoring lead to a reduction of the willingness to defect as the parties anticipate that opportunistic behaviour will most likely be detected. The success of such licensing agreements will often depend on how well they are managed. R&D progress, sales figures, the question whether the licensee is adhering to the contractual terms, whether a useful development has been made and can be exploited, and whether they are any problems that may have to be resolved, are all factors that should be considered in progress reviews (Piachaud 2004). In the same vein, it is also sensible to insert a clause that clarifies who pays for patent application expenses and the potential litigation costs. A due diligence clause, which enables a licensor to recapture his technology if for instance it is not adequately being exploited, especially if combined with specific objective milestones, can also serve to be very effective. Overall, Razgaitis (2004; p.151) summarized his survey of U.S. and Canadian licensees by stating that despite these benefits in many situations “post-deal management is [still] overlooked.”

This thought brings us to the end of this little exploration of the licensee’s potential to innovate. We wanted to demonstrate the considerable potential of licenses to serve as R&D instruments and motivate companies to strive for closer interaction with their licensees. To take this argument one step further, specially crafted licenses could be extended to users in order to widen the base of potential innovators. This modular approach to IP, most visible in the field of software, could benefit both sides. Licensors could profit from higher product sales and exciting applications and improvements, and users would highly appreciate the freedom to tailor technology to suit their needs. In light of the necessity of technological progress if we want to sustain our standards of living with a rising population and its numerous adverse side-effects, such as the replacement of human labour by machines and robots, it is

important to involve as many parties as possible in the innovation process. In this way licenses could help democratize technological progress. ■

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