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5.1 A History of innovation

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Abstract

Historically speaking, it was not until the British Industrial Revolution that innovation began to be produced in a sustained manner. In this paper, I focus on innovation and its banner-bearers, taking a broad view spanning the dawn of the industrial revolution, the emergence of large and highly vertically integrated companies, and the rise of startups.

Keywords

Innovation, history, Industrial Revolution, vertical integration, startups

1 The Industrial Revolution: The first link in a chain of innovation

The Industrial Revolution, which began in Great Britain, is probably one of the most significant events in world history. Indeed, it is hardly an exaggeration to claim that the chain of innovation began with the Industrial Revolution. How did the Industrial Revolution occur? The phenomenon we now call a “revolution” was actually the product of cumulative innovations built up over a very long period of time.

Let us first review the history of the Britain up to the beginning of the Industrial Revolution. Britain’s advantage over other countries in the lead up to the Industrial Revolution can be summarized in a few key points:

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- (1) Since the Age of Discovery, Britain had been winning the colonial race and had accumulated enormous capital through trade with its colonies.
- (2) The foundation of civic society had been established through the moderate bent of the English Reformation and the suppression of royal power by a citizen-centered parliament, namely, through the “Petition of Right” during the English Civil War and the “Bill of Rights” during the Glorious Revolution.

Having traced this history, let us explore the causes of the Industrial Revolution, focusing on the cotton textile industry. Colonial trade between Britain and India centered on high quality cotton textiles, a product of India’s cheap labor, for which there was high demand. Capitalists took notice of this and thought of building their own factories to produce cotton yarn from cotton, and then cotton cloth from this cotton yarn. However, high labor costs in Great Britain made it difficult to produce goods through the cottage industry as was the case in India. This drove the need for machines to perform labor instead of people.

The mechanical industry, which lay at the heart of the Industrial Revolution, developed in the textile industry. The first link in the chain of innovation was a weaver and machinist called John Kay. In his daily weaving work, Kay noticed that it took more than two workers to weave cloth beyond a certain width, reducing productivity. Accordingly, around 1733, Kay developed a way to fly the shuttle from one side of the loom to the other and invented a machine known as the flying shuttle, which would flip the shuttle and make it slide along a groove. The result of this invention was not only a broader cloth, but also much faster weaving. As a result, woven fabric productivity improved significantly.

This increase in productivity created a massive imbalance in productivity between new and the orthodox process, that is, the spinning process of twisting yarn. Eliminating this imbalance in productivity created a major business opportunity. John Wyatt and Lewis Paul were involved in the early mechanization of the spinning process, which was invented in 1738. This innovation was followed by Hargreaves’ Spinning Jenny and Arkwright’s spinning machine, which greatly impacted the Industrial Revolution. These innovations in the spinning process led to further innovations. Samuel Crompton perfected a machine that twisted finer and stronger yarns through an even more ingenious combination of Hargreaves’ Spinning Jenny and Arkwright’s water-powered machine. The hybrid of these two inventions later became known as the Crompton mule, a name inspired by the animal hybrid of a donkey and a horse. In addition to eliminating the imbalance in productivity between spinning and weaving that had existed since Kay’s invention of the flying shuttle, Crompton’s mule resulted in the productivity of spinning exceeding that of weaving. Moreover, the combination of the bars of the Spinning Jenny and the rollers of the Arkwright water-powered spinning machine made it possible to spin very fine yarns. At this time, Britain had already established price competitiveness against India in terms heavy yarns; with the mule, Britain was also able to compete with India in fine yarns.

The path of innovation during the Industrial Revolution shows that imbalances between related technologies and processes complement each other in promoting their development (Rosenberg, 1979). In this sense, imbalance is the driving force that propels industry and technology forward. In the Industrial Revolution, the prominence of one technology led to an imbalance, resulting in the advancement of other

processes or technologies to resolve this imbalance, which in turn led to the prominence of a new technology. This chain of imbalance giving rise to new innovations is observable in many places.

Why did the Industrial Revolution begin in Britain? The discussion above presents one of the main reasons why the Industrial Revolution began in Britain. Another factor is the establishment of the modern patent system in the form of a monopoly ordinance in 1624, ahead of other countries. The establishment of this modern system of protecting intellectual property rights created a structure of incentives that enabled British engineers to obtain great wealth from their inventions. By protecting intellectual property rights, this system guaranteed that inventions were proprietary and belonged to their inventors. As such, this system laid the groundwork for linking inventions to business.

2 The emergence of big business

The main agents of innovation during the Industrial Revolution were not corporations, but individual inventors and entrepreneurs. Companies were only small in scale. However, the giant corporations that emerged in the United States in the second half of the nineteenth century were of a decidedly different character to their predecessors in terms of the enormity of their output (Chandler Jr, 1977). The railroad industry was the first to establish the basic form of big business. As the railroad network expanded, it became necessary to manage large investments, efficiently transport goods over long distances, and deal with safety issues. This led to the development of a hierarchical organizational structure. The development of the mainline railroad network in the US led to the integration of previously fragmented markets within a larger national market. Consequently, creating systems for mass production and mass distribution became a major business opportunity.

Manufacturing and selling large quantities of products to make a profit was not only the work of machines for mass production, but of organizations. Without the timely procurement and storage of raw materials and the achievement of efficient and reliable modes of production, profits could not be made, regardless of the number of machines. Moreover, the distribution and sale of large volumes of products without excess or deficiency in the vast US market—and, indeed, the world market—required a meticulous organizational response. Meanwhile, the procurement of raw materials and the sale of products in such large quantities were not of a scale that could be handled by existing trading companies, distributors, wholesalers, or retailers. At the time, telegraphs, not to mention computers, were barely in widespread use, and the cost of inter-company coordination in the market was extremely high. In respect to market transactions, it was difficult to expect existing distribution companies to make relationship-specific investments suited to a particular company's mass-production technology. In other words, it was impossible to reap the economies of scale that machines had made possible.

This created a need for companies to internalize their transactions and create larger organizations. Companies sought to achieve economies of scale by integrating business resources complementary to their technology, such as purchasing, distribution, and marketing departments. That is to say, multi-functional organizations were established in which not only production but also purchasing, sales, legal, finance, and

other functions were internalized within the company. In turn, business resources were accumulated within companies over the course of their development into vertically integrated companies.

In general, changes in demand due to economic fluctuations, competition, and other factors, as well as advances in science and technology, can lead to imbalances in and the underutilization of accumulated management resources. Companies will develop new products and diversify in order to make better use of these unused resources. As frequently seen in the chemical and electrical industries, technological development has made it possible to mass produce many different products from the same equipment, resulting in unused resources accumulating within the production process (Penrose, 1980). Product diversification was pursued as a means of eliminating this imbalance, with innovation explored therein.

3 Startups and the use of external management resources

In the twentieth century, many innovations were created by vertically integrated companies that internalized many functions, including research and development. However, the situation has changed since the 1990s, when large numbers of innovations began being produced by companies lacking vertical integration. Since the 1980s, startups centered around Silicon Valley in the US have come to play an important role in leading innovation. As a result of the development of a system for venture capital and a highly liquid labor market, when a new business opportunity was identified, it became increasingly economically rational to take on the challenge despite the possibility of failure.

Rather than relying on large internal resources, these companies generated innovation by strategically utilizing external resources. Since the beginning of the 2000s, there has been an active movement among existing companies, primarily in Europe and the United States, to strategically utilize external management resources to generate innovation. Where they once internalized many R&D functions, highly vertically integrated companies—such as P&G, IBM and GE in the US, and DSM in the Netherlands—came to recognize that combining their internal management resources alone was too slow and costly to produce innovation.

This realization changed the way in which management resources are combined, moving from vertical integration to a more networked form sometimes referred to as “open innovation” (Chesbrough, 2003). Collaboration with startups is becoming increasingly important to open innovation, and established companies have recently begun to invest in and nurture startups. As superior management resources become more diffused across various organizations within society, the less likely it is that the management resources of companies or organizations that have established long-term business relationships will be best suited to driving innovation. In this context, it has become necessary to establish a mechanism to utilize a wide range of innovation seeds.

This paper is a summary of Chapter 2 of Hitotsubashi University Institute of Innovation Research (2017), further details of which can be found in the relevant publication.

References

- Chandler Jr, A. D. (1977). *The visible hand: The managerial revolution in American business*. Harvard University Press.
<http://www.hup.harvard.edu/catalog.php?isbn=9780674940529>
- Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.
<https://hbr.org/product/open-innovation-the-new-imperative-for-creating-and-profiting-from-technology/8377-HBK-ENG>
- Penrose, E. T. (1980). *The theory of the growth of the firm*. White Plains, N.Y.: M. E. Sharpe.
https://trove.nla.gov.au/work/9812420?q&sort=holdings+desc&_=1533604862789&versionId=45118806
- Rosenberg, N. (1979). Technological interdependence in the American economy. *Technology and Culture*, 20(1):25–50.
http://www.jstor.org/stable/3103110?seq=1#page_scan_tab_contents
- Hitotsubashi Institute for Innovation Research, ed. (2017). Introduction to innovation management. Nihon Keizai Shimbun.
<https://www.nikkeibook.com/book/79114>

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