10.5465/AMBPP.2019.257

TECHNOLOGICAL DISCONTINUITIES AND DOMINANT DESIGNS IN THE AUTOMOTIVE INDUSTRY: THE CASE OF FORD, 1896-1914

ALBERTO DI MININ
Scuola Superiore Sant'Anna
Department EMbeDS
Institute of Management
Piazza Martiri della Libertà 33
56127 - Pisa, Italy

GIULIO FERRIGNO
Scuola Superiore Sant'Anna

ALBERTO ZORDAN
Scuola Superiore Sant'Anna

INTRODUCTION

The end of the 19th century saw the introduction of different powertrain technologies that contributed to the birth of the automotive industry. Internal combustion, steam, and electric technologies were competing to become the standard propulsion technology of early automobiles. From an innovation perspective, one of the most relevant models that explains this historical context is the technology cycle, an evolutionary model characterized by the succession of technological discontinuities and dominant designs (Anderson and Tushman, 1990; Utterback and Abernathy, 1975). Discontinuities are caused by the emergence of and experimentation with new technologies that eventually define a dominant new design for an entire industry (Tushman and Anderson, 1986).

The succession of technological discontinuities and dominant designs is a complex and uncertain innovation process (Giachetti and Marchi, 2010; Maielli, 2005), and innovation scholars have questioned how firms can successfully manage such a process (Asgari et al, 2017; Roy and Sarkar, 2016).

In this article, we aim to address this research question through a comprehensive historical analysis of a prominent business case, from 1896 to 1914. More specifically, we investigate how Henry Ford purposefully pursued several business strategies to address the technology war that shocked the automotive industry—a war begun because different technological paradigms for the powertrain (internal combustion, steam, and electric) were competing for dominance in automobile design. Our historical analysis is rooted in open-question interviews with Ford experts and historians as well as archival information we accessed during our visits to several sites of the company.

Ford Motor Company, founded in 1903 by Henry Ford, has frequently been examined by historical studies in the past (Holden, 2005; McKinlay and Starkey, 1994; White, 1986; Williams et al, 1993; Wilson and McKinlay, 2010; Wood and Wood, 2003). Some of these studies have investigated Ford's international expansion outside the American continent (Holden, 2005; White, 1986); others have instead analysed the company's productivity with regard to the assembly line (Wilson and McKinlay, 2010), the production of the Model T (Alizon et al, 2008;

10.5465/AMBPP.2019.257

Williams et al, 1993), or the company's management processes in the 1980s (McKinlay and Starkey, 1994). Taken together, these studies provide a well-documented discussion of the aspects of business that characterized Ford's success. However, one aspect that has yet to be explored is a comprehensive understanding of the early strategies the company pursued, and this is the focus of our research.

We organized our findings according to five strategies pursued by Henry Ford in the period 1896–1914: 1) experimentation with product architecture (1896-1904); 2) short-term partnerships for knowledge exchange (1904-1906); 3) the democratization of product architecture (1906-1908); 4) a transition from rational to emotional advertising (1908-1910); and 5) the vertical integration of an integrated moving assembly line (1910-1914). We find evidence that, while there were particular time periods in which each strategy was the most prominent or significant, the five strategies overlapped. As a matter of fact, none of the strategies should be conceived of as a distinct and independent strategy of Ford Motor Company but rather as the manifestation of a multi-perspective strategy that worked coherently through five powerful mechanisms.

Drawing on these findings, we submit three contributions to innovation research. First, our historical analysis provides evidence on some of the conditions under which the succession of technological discontinuities and dominant designs (Anderson and Tushman, 1990; Utterback and Abernathy, 1975) was managed by an important player in the automotive industry.

Second, our analysis complements prior historical studies that have examined the factors underlying Ford's success (Holden, 2005; McKinlay and Starkey, 1994; White, 1986; Williams et al, 1993; Wilson and McKinlay, 2010; Wood and Wood, 2003).

Lastly, our historical analysis suggests that the strategies Ford launched may have had profound implications not only in shaping the automotive industry at the beginning of the century but also for pioneering strategies that could be implemented by contemporary automakers in the coming decades (Klepper, 2002). From our historical analysis, we can draw relevant conclusions that can be applied in analysing the strategies of Tesla, Inc.

THE CASE: FORD'S STRATEGIES

The research relies on historic Ford archival documents and secondary sources consulted at the Benson Ford Research Centre between July and August 2018. Since technologies and ideas should be framed according to the time and context in which they were conceived (Yin, 2017), we complemented descriptive facts about the history and technology of Ford with informed opinions about the reasons and the ideas that drove the company's advancement. More specifically, we conducted an open-question interview with Ford experts and historians. Their contributions were important to our research for three reasons. First, the experts and historians provided contextualized and accurate information about the company in four different strategic areas: technology, business organization, partnerships and marketing. Second, they led us to access archival material, including printed primary sources, illustrations and artefacts from the company (Stokes et al, 2014). Lastly, with their valuable support, one of the authors visited various historic Ford sites: the Ford Piquette Avenue Plant, built in 1904; the "Secret Room", built in 1907 at the Ford Piquette Avenue Plant; Fair Lane, the Henry and Clara Ford estate, built

10.5465/AMBPP.2019.257

in 1915; the Ford Rouge Plant, built in 1917; and the Henry Ford Museum and Greenfield Village, built in 1929.

We identified five predominant strategies that decisively contributed to Ford's development of the Model T and corroborated its success: 1) experimentation with product architecture (1896-1904); 2) short-term partnerships for knowledge exchange (1904-1906); 3) the democratization of product architecture (1906-1908); 4) a transition from rational to emotional advertising (1908-1910); and 5) the vertical integration of an integrated moving assembly line (1910-1914).

CONCLUSIONS AND LESSONS LEARNED

Ford represents an appropriate case for studying the succession of technological discontinuities and dominant designs in the automotive industry (Anderson and Tushman, 1990). We conducted our historical analysis in a context that is characterized by three main events that shaped the development of the automotive industry at the beginning of the last century. First, in the second half of the 19th century, new propulsion technologies at the modular level—electric powertrains and ICE—caused technological discontinuities: these technologies were implemented alongside previous technologies such as steam and horses to develop more robust transportation. Second, the ICE gained more support than other propulsion technologies, especially when combined with the Panhard configuration imposed over the horseless carriage layout: between 1905 and 1906, a new dominant design of automobiles was defined. Third, within just a few years, Ford Motor Company began to rely on this dominant design and democratized it, mass producing the Model T (Alizon et al, 2008; Williams et al, 1993).

In summary, our case contributes to the business history literature by providing a detailed account of how Henry Ford navigated a succession of technological discontinuities and dominant designs in the automotive industry in the early 20th century (Figure 1). By drawing on open-question interviews with Ford experts and historians and archival information from the company accessed during our visits to historic sites related to Ford, we argue that the company achieved its vision of a "utilitarian car" by (1) experimenting with product architecture, (2) gaining knowledge through a supplier partnership with the Dodge Brothers Company, (3) democratizing the automobile, (4) contributing to a new kind of emotional advertising, and (5) and implementing process innovation. For the sake of simplicity, these strategies have been described in a chronological sequence, identifying the time period in which each one was most prominent; however, these strategies should be conceived of not as distinct and independent focuses of Ford Motor Company but as the manifestation of a multi-perspective strategy that worked coherently through five powerful mechanisms.

Figure 1 about here

Moreover, the article contributes to innovation research in three ways. First, our historical analysis offers proof of the succession of technological discontinuities and dominant designs in the automotive industry. Drawing on a case study about Ford Motor Company, the article discusses in detail the applicability of various innovation models (Anderson and Tushman, 1990; Utterback and Abernathy, 1975) in a well-known business case of the automotive industry.

10.5465/AMBPP.2019.257

Second, our analysis enriches prior historical studies that have analysed Ford's success (Holden, 2005; McKinlay and Starkey, 1994; White, 1986; Williams et al, 1993; Wilson and McKinlay, 2010; Wood and Wood, 2003). More specifically, the article conducts a comprehensive investigation of the strategies that were designed and launched to address the succession of technological discontinuities and dominant designs that shaped the automotive industry at the beginning of the last century.

Third, our historical analysis suggests that Ford's strategies may have had profound implications not only in shaping the automotive industry at the beginning of the 20th century but also for pioneering strategies that might be launched by current automakers in the coming decades (Klepper, 2002).

A comparative perspective between Ford Motor Company and Tesla, Inc.

This article submits five strategies for interpreting how a market leader such as Ford impressively navigated the technological discontinuities in the automotive industry in the early 20th century. When considering the latest developments by Tesla, we cannot help but wonder: is history repeating itself? We believe that we might find evidence of some of the five strategies described in this article in the strategies being used by Tesla (see Figure 2). The American battery-maker-turned-automaker is trying to establish a new EV technology and product architecture in an industry dominated by ICE technology.

Tesla's approach to technological discontinuities and dominant designs can be summarized in three main episodes. First, between 2003 and 2008, Tesla developed a new battery technology, creating the Roadster, a high-performance and long-range EV. However, this car is still based on a product architecture created for ICE automobiles that was merely adapted to host the new technology; this caused some bottlenecks during the product development.

Second, Tesla understood the need to create a bespoke EV architecture for its next car, the Model S (2012): the new configuration presents a wide, flat battery below the seats, while one or two electric engines are placed together on the rear or one on each axle. This allows for increased handling and safety and a roomier interior. The Tesla architecture is being imitated by other automakers for their next EVs, thus they are converging towards adopting this architecture as a dominant configuration for this technology.

Third, in 2010, Tesla partnered with Panasonic to reduce the cost of lithium-ion cells and battery packs, which are the core modules in EVs and are produced in the Gigafactory, the largest battery production plant in the world and one with a high degree of vertical integration. However, modern EVs are still expensive compared to the average internal combustion car: democratizing the electric automobile requires further steps, as the entire production process should be improved. In this respect, incumbent carmakers might be in an advanced position because they are being used to mass produce large product portfolios of automobiles. Some automakers are presenting their reinterpretation of the Tesla EV architecture and are heavily investing in the new technology.

Beyond our preliminary considerations, we believe that innovation research may be advanced through a detailed account of which factors (if any) are enabling Tesla to succeed in democratizing the EV, particularly given today's trend of rapidly evolving and expanding technological change.

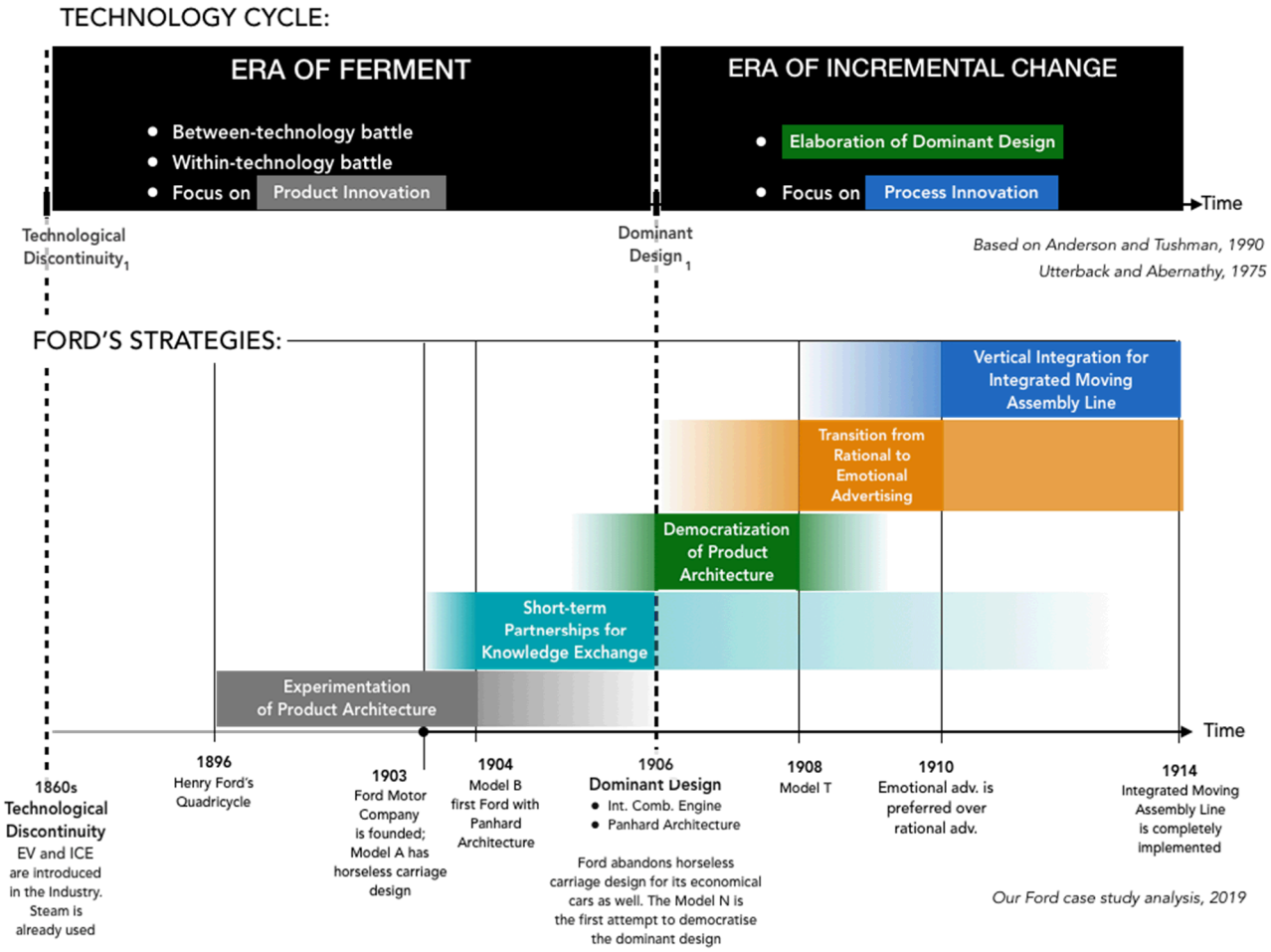
10.5465/AMBPP.2019.257

Figure 2 about here

REFERENCES AVAILABLE FROM THE AUTHORS

10.5465/AMBPP.2019.257

Figure 1. Ford's strategies from 1896 to 1914: a detailed overview



10.5465/AMBPP.2019.257

Figure 2. Technological discontinuities and dominant designs in the automotive industry: historical comparison between Ford Motor Company and Tesla