

## THE AUTOMOTIVE INDUSTRY: A SOURCE OF TECHNOLOGICAL AND MANAGERIAL INNOVATION

“We want to hymn the man at the wheel, who hurls the lance of his spirit across the Earth, along the circle of its orbit.”

Filippo Marinetti, *Futurist Manifesto* (1909)

Cars are not simply a means of transportation: they are icons of style, status and affluence. They reflect consumers’ preferences and have always had a prominent place in the collective imagination due to their technology, the mobility they enable, the opportunity for travel and leisure and the enduring fascination with motorsport and racing. The automotive industry means something more than other manufacturing industries.

The history of the manufacturing industry and the history of the automotive industry were strongly intertwined throughout the twentieth century and such ties will probably remain highly relevant in the future. Vehicle production – including passenger cars, light commercial vehicles and heavy trucks – has driven the industrial development of many countries on several continents and has been a source of incessant innovations and technological improvements. Hence, the automotive industry has become an emblem of industrialization itself.

The automotive industry’s role in the economy cannot be compared with any other manufacturing industry. If it were a country, it would be the fourth largest economy in the world. The size of the industry’s revenues – estimated at \$3,500 billion and projected to reach \$6,700 billion by 2030 (McKinsey 2016) – is comparable to Germany’s gross domestic product and is greater

than that of the UK, France, India and Brazil. Moreover, the industry employs approximately 9 million direct workers all over the world.

The automotive industry not only encompasses vehicle production. More than 15,000 parts and components are required to assemble a single vehicle and several industries are involved in their production, such as steel, glass, plastic and rubber, textile and electronics. According to available estimations (OICA 2017) each direct automotive sector job supports at least another five jobs in the supply chain.

The economic importance of the automotive industry is even greater if one considers not just vehicle production but also services related to sales, marketing and maintenance throughout vehicle life. Before reaching the market, a vehicle is enriched by the addition of several services, which are not limited to warranty services but include also sophisticated loan schemes, assistance packages and many other advanced services. In particular, the automotive after-sales activities have come to play a major role and have enabled several car manufacturers to survive during financial difficulties. For example, in Germany after-sales activities generate more than 50 per cent of profit for car manufacturers, while accounting for less than 25 per cent of revenues. Perhaps surprisingly, margins on new vehicle sales are as low as 2.1 per cent (Arthur D. Little 2015). The value and the importance of the after-sales business are expected to grow markedly, especially in areas characterized by an increasing average fleet age such as Western Europe and the United States. The development of such a variety of vehicle-related services has also caused the emergence of new independent (i.e., not owned or authorized by car manufacturers) service chains, such as both local and international repair chains (for example Kwik Fit and Belron, which owns brands such as Autoglass and Carglass).

In sum, the automotive industry has enormous impacts on the economy, both directly and indirectly. Therefore, it is not surprising that it was labelled as “the industry of industries” by Peter F. Drucker, the father of modern management. As Drucker noted, “the automotive industry stands for modern industry all over the globe. The performance of all industry is likely to be judged by it [...] No solution found elsewhere would have much meaning unless it could successfully be applied in the automobile industry” (Drucker 1993: 176).

## The engine of industrialization

On 29 January 1886, the German engineer Karl Friedrich Benz applied for a patent for his Motorwagen at the German Imperial Patent Office. This car was the first in the world to be equipped with an internal combustion engine, which had been invented by August Otto and presented at the Paris Universal Exposition a decade before. Using his and his wife's savings and a loan from a friend, in 1879 Benz had already been able to produce his own two-stroke engine. His first car had three wheels, as the brilliant inventor had not been able to conceive the technical solution to have two steering wheels, which would have provided higher stability to the vehicle. Despite this issue, the engineer of Karlsruhe can be legitimately considered as the inventor of the car.

The technological content of the car immediately aroused people's curiosity and admiration. The car seemed to turn the laws of physics and mechanics on their head. Its speed was a sign of modernity and would be later celebrated by artistic movements and specifically by Futurism (Marinetti 1909). It was also obviously a symbol of manufacturing industries, and cars very quickly started to reflect the "Wealth of Nations" – to quote Adam Smith. While the car was initially a luxury and exclusive product, it soon became accessible to a large number of people, becoming an invaluable means of mobility.

The credit and the responsibility for enabling each American family to have its own car belongs to Henry Ford. From 12 August 1908 to 26 May 1927 15 million Model Ts were produced. In the first month of production, only eleven vehicles came out of the factory. In 1914 the level of standardization of the production process was so advanced (according to Ford's famous statement "A customer can have a car painted any color he wants as long as it's black") that assembling a car required only 93 minutes. This production system was termed *Fordism*. In Europe, Fordism was introduced in the 1930s by Giovanni Agnelli who reorganized the Fiat factory of Lingotto in Turin following Ford's idea that machines and workers should be placed in sequence. The car was assembled along a moving production line: the work was taken to the worker and not vice versa. In the same period, Ferdinand Porsche emerged as the key person in the German automotive industry. Hitler assigned him the task of enabling mass motorization. The result was the well-known Volkswagen (literally "people's car") Beetle, which accomplished the aim of German mass motorization after the Second World War. In France, a similar role was played

by Peugeot, Renault - both firms were established at the end of the nineteenth century – and Citroën, which was founded after the First World War. In Japan, the history of the automotive industry starts with Daihatsu in 1907. Later, in 1933, Toyota Motor Corporation was founded as a spin-off from a textile company.

The myth of the car – “The Machine That Changed the World” (Womac, Jones & Roos, 1991) – has been celebrated since its inception through car races. In fact, participation in international motorsport was a contributory factor in establishing the leadership of the most important car manufacturing countries. The colours themselves reflect the links between cars and manufacturing countries: Italy is represented by the red of Ferrari, France by the blue of Renault, the United Kingdom by the green of Jaguar, Germany by the silver of Mercedes. All these brands linked their fortunes to car races, thanks to the visibility given by the races and thanks to the technological spill-overs.

After the Second World War cars became the symbol of the consumption boom. In that period, the increased production numbers enabled cars to be sold at ever lower prices and made the automotive industry the engine of the postwar economic boom. Moreover, the availability and ownership of cars revolutionized the mobility of people and goods.

Only in the 1970s, when the oil crises disrupted fuel supplies and increased oil costs, did manufacturers and consumers start to focus on new product attributes, such as fuel consumption and safety. Once the concepts of energy saving and environmental protection had become popularized, manufacturers started to adapt their products to these new trends. In subsequent years, Western markets progressively opened up to foreign producers thanks to the reduction of tariffs and to the increase of foreign direct investments (in particular those made by Japanese manufacturers in Europe and North America). Hence, the biggest car manufacturers had to switch from serving their domestic markets to operating in a new global oligopolistic market.

### **At the forefront of technological and managerial innovation**

The automotive industry has assumed a pivotal role in manufacturing because it has been the source of some of the most important technological and – above all – organizational and managerial innovations. Ford’s Model T would

have never been so successful without the introduction and development of the *assembly line* and of managerial methods which made it possible to govern the most vertically integrated firm in the world (Ford had internalized most of upstream activities instead of relying on suppliers). Henry Ford was inspired by the scientific management approach developed by Frederick Taylor who aimed to optimize the efficiency of production tasks. Taylor divided each task into simple movements which were analysed through statistical techniques to identify “the one best way” to complete the task. Drawing on the results of these analyses, workers were then instructed about each movement they had to perform. The efficiency of this system was supported by advanced mechanization.

Over time, Fordism developed a negative connotation because it became synonymous with routine tasks, alienation and bad employment conditions, as depicted by Charlie Chaplin in his movie *Modern Times* in 1936. Henry Ford was also accused of racism, anti-Semitism, anti-communism and opposition to labour unions. However, his approach was intended to establish a profitable cooperation between managers and workers that would generate benefits for both parties such as productivity gains, higher wages and higher levels of consumptions. In fact, as production costs fell significantly, Model T became the first car accessible to the majority of Americans. After all, even socialist scholars such as Henri de Man and Antonio Gramsci considered Fordism as a force of modernization that could have been functional to the working class.

The managerial contribution provided by Alfred Sloan was of great importance as well, even if now partly overlooked. As the leader of General Motors (GM) in the long period from 1923 to 1956, he introduced annual model updates, developing the concept of planned obsolescence. He also applied a new brand and model architecture and pricing scheme, according to which GM’s products were able to intersect with different consumer segments based on purchasing power and customer experience. Hence, he pioneered the concepts of market segmentation and of product and brand portfolio management. For example, he realized that “when owners traded in their cars they were selling basic transportation but demanding something more than that in the new car” (Sloan 1963: 163).

Thanks to Sloan’s leadership GM became the largest manufacturing firm in the world and its results corresponded to those of the United States. His

autobiography, *My Years with General Motors* written in 1963 continues to be one of the essential books of management theory. It is not entirely surprising that the business school of the Massachusetts Institute of Technology (MIT) is named after Sloan and is funded by the Alfred P. Sloan Foundation. Despite having been criticized for giving priority to profits over moral issues (Farber 2002), Sloan's contribution to management innovation remains remarkable.

The managerial revolution of *kaizen* – the approach based on continuous improvement described by Masaaki Imai in his famous book published in 1986 – also took place in the automotive industry. This approach was first applied by Toyota at the end of the 1940s through the so-called Toyota Production System (TPS). The guiding principle of TPS was, and still is, “making the vehicles ordered by customers in the quickest and most efficient way, in order to deliver the vehicles as quickly as possible”. To this end, quality must be built-in during the manufacturing process and all waste (excess inventory, extraneous processing steps, and defective products) must be eliminated completely.

Production-process optimization was just one of the two pillars of *kaizen*. Drawing on this approach several managerial and organizational practices emerged over time, such as “Just in Time”, a production model based on strong ties with suppliers leading to efficiency gains. According to this approach, supplies and components are delivered by the suppliers just as they are needed, thus dramatically reducing or eliminating inventories. Obviously, to work properly “Just in Time” requires that supplies meet predefined quality standards.

The second pillar was a focus on customer satisfaction, which required the firm to be reorganized into cross-functional, customer-oriented teams. Above all, *kaizen* brought about a cultural revolution. Continuous improvement was achieved through the involvement of all workers, who were no longer considered as mere implementers of top-down decisions. Workers were carefully trained and given the opportunity to provide their contribution to continuous improvement. The next step of this revolution was the creation of quality circles, which were groups of workers who met regularly to identify problems in their departments and to develop their own solutions. The effectiveness of this organizational innovation was amazing. As Hamel (2007) reported, in 2005 alone Toyota's Japanese employees had suggested 540,000 improvement ideas.

Many other modern managerial approaches aimed at improving quality have their roots in the *kaizen* revolution, such as:

- Deming's Total Quality Management based on the "plan-do-check-act" cycle;
- Six Sigma, whose goal is to deliver at least 99.9996 per cent perfect products or, in other words, 3.4 non-conforming products per million;
- lean production, the aim of which is to eliminate *muda* (Japanese for waste), to enable all activities along the value stream to create value (Arnheiter & Maleyeff 2005).

These managerial approaches have been applied to almost all industries, including non-manufacturing branches such as services.

The automotive industry is not only a source of innovations related to the internal efficiency of the firm. In fact, this industry has traditionally been a pioneer in relation to innovative consumption practices and business models, as well. The automotive sector is currently driving the "servitization" market trend: products are progressively enhanced through the addition of new services until the service itself becomes the core offering. Nowadays the customer is often offered access to or use of the car instead of its ownership. In other words, a shift away from ownership to access is taking place. Hence new marketing models to provide access to mobility are emerging. For example, a customer may pay a monthly fee to acquire the right to drive a car for a certain mileage and for a certain number of months (usually either 24 or 36). At the end of this agreement the customer may decide to choose another car (renew), hand the car back (return) or keep the car (retain). Car manufacturers are switching to new business models, transitioning from the vehicle business to vehicle-bound services to non-vehicle bound services. In sum, they are switching from being product manufacturers to acting as mobility solution providers (Kessler & Stephan 2013).

In addition, some car manufacturers are experimenting with new marketing and distribution solutions. This is the case of Elon Musk's Tesla, which is trying to revolutionize the experience of buying and owning the car. People do not have to go to a dealership because Tesla sells its cars directly through its website or its own stores, which are "not far from the Apple stores on which they are modelled" (Vance 2015: 266). While in the store people can

autonomously configure the car as they wish. The salespeople are not compensated through sales commission, and the customer may decide to purchase the car in the store or online. In both cases it will be delivered in a concierge fashion. Moreover, if the car breaks down, Tesla comes to collect it providing the customer with a courtesy vehicle. Many issues with the car can also be fixed by Tesla's engineers directly over the Internet by updating the car's software (Vance 2015). Therefore, car manufacturers (or at least some of them) are also at the forefront of the new "omnichannel" marketing practices, which are intended to offer seamless experiences to the customer.

The automotive industry has also been the first to witness the large-scale popularity of the new consumption practices based on sharing. Car-sharing is already well established in many cities and is continuously evolving, from station-based to free-floating models, which is a mobility service enabling the user to locate an available vehicle through an app, to drive it to destination (usually paying on a per-minute basis), and then to drop off the vehicle at any legal parking space (Le Vine & Polak 2017). In addition to these business-to-consumer (B2C) car-sharing services, peer-to-peer (P2P) car-sharing is also gaining popularity. P2P car sharing is based on platforms which match private car-owners and users: private consumers act both as suppliers and as consumers (Münzel, Boon, Frenken & Vaskelainen 2017). Hence the automotive industry is at the forefront of marketing and consumption innovations as well, in particular of those related to servitization and the sharing economy.

### **A pioneer of industry 4.0**

The automotive industry is also a pioneer of the so-called "industry 4.0" (sometimes indicated also as "smart factory" or "factory 4.0"). Industry 4.0 describes "the organization of production processes based on technology and devices autonomously communicating with each other along the value chain" (Smit *et al.* 2016: 20). Industry 4.0 is the result of a series of disruptive innovations in production processes and it has been conceptualized as the fourth industrial revolution following: the first industrial revolution in the eighteenth century, based on steam power combined with mechanical production; the second industrial revolution from the mid-nineteenth century to the mid-twentieth century, based on electricity, assembly lines and mass

production; the third industrial revolution since the 1970s, based on electronics, IT and globalization (Smit *et al.* 2016). In detail, industry 4.0 relies on nine technologies: augmented reality, additive manufacturing or 3D printing, big data and analytics, autonomous robot, simulation, horizontal and vertical system integration, the Internet of Things (IoT), cybersecurity and the Cloud (BCG 2015). The amount of annual investment in industry 4.0 technologies – \$65 billion per year (Geissbauer, Vedso & Schrauf 2016) – is a signal of the leading role of the automotive industry in this revolution.

Car manufacturers – together with component producers – are expected to experience the greatest benefits from industry 4.0. Their manufacturing processes will increase in flexibility, so that they will be able to produce multiple car models with different body styles using only one flexible production line. Overall car manufacturers will increase their productivity by 10–20 per cent thanks to industry 4.0 innovations (BCG 2015). Coordination with component suppliers will be optimized and the production processes will be automatically aligned through advanced data sharing. Hence the just-in-time principle introduced by the *kaizen* revolution in the 1940s will find its complete fulfilment through industry 4.0.

In the new factory 4.0, employees will play a new role that will require them to acquire advanced competence to manage new technologies. Again, car manufacturers are at the forefront of industrial and manufacturing innovation. For example, in June 2017, Seat announced that it had introduced a new training program centered on the future challenges facing Industry 4.0. and aimed at all its 14,000 employees. This program will allow employees to gain in-depth knowledge and direct experience of the new 4.0 technologies that will be implemented in the next few years in Seat's factories, such as virtual reality, collaborative robots, 3D printing and augmented reality.

However, the automotive industry is mostly recognized as a pioneer of industry 4.0 for another reason: the ongoing projects of the self-driving car. This fascinating innovation is explored in Chapter 5.

### **An invaluable perspective on the processes of globalization**

The automotive industry is unique in that it offers an invaluable perspective on the processes of globalization taking place at three different levels:

firm, industry and national level. Such processes are strictly intertwined but in most industries these linkages are usually difficult to observe. By combining the economic and the managerial perspectives, this book aims to make the reader appreciate such intricacies. On the one hand, the economic scenario will be analysed (economic perspective), on the other, firms' decisions and strategies to deal with environmental threats and opportunities will be addressed (managerial perspective).

Globalization has affected the automotive industry for many years, but over the last two decades its effects have been particularly intense. Several elements of these issues are clearly visible both on the supply side and on the demand side. Traditional car manufacturers have sought efficiency gains through alliances and joint ventures and through production offshoring. Manufacturers from emerging markets are trying to establish themselves as global players, first leveraging their home markets and then entering foreign markets, sometimes through the acquisition of Western companies and brands. This is the case of Geely, which purchased Volvo from Ford Motor Company in 2010 (Tse 2015). At that time Volvo was suffering losses but Geely has been able to turn the business around. In 2016 Volvo reported a 66 per cent increase in profits and a 6.2 per cent increase in sales (including +11.5% in China), thanks to a new product innovation and marketing strategy. Again, in May 2017 Geely purchased a 51 per cent stake in Lotus, the well-known British sports car maker. In turn, companies' decisions about the location of their production plants have effects on the hosting countries. The either positive or negative effects of these choices for a country's economy, development and employment can be dramatic.

In the same way that there have been changes in the localization of production, the geographic distribution of demand has also changed. Mature-market customers mostly express demand for the replacement of old cars and are interested in efficient, safe and eco-friendly cars. The demand from emerging markets' consumers has boomed. Such demand is highly heterogeneous and is heavily influenced by culture and by the maturity of the financial sector that offers products related to owning cars. For example, in China (a country characterized by its notable savings culture), some 80 per cent of cars are purchased with cash. In the United States, the opposite happens: 80 per cent of car purchases are financed. A study conducted on 165 car brands owned by 96 companies from 18 countries, operating in 65 countries confirms that the

characteristics of a country's culture impact the performance of car brands (Talay, Townsend & Yenyurt 2015). Hence, while car manufacturers need to expand their markets, they are focused on carefully selecting the target foreign markets to enter, and the models and brands to sell in each specific market.

In this scenario, global players experience a more intense tension between standardization and adaptation of their offerings in international markets. On the one hand, a certain degree of standardization is unavoidable because the automotive industry is characterized by extremely high levels of investment (i.e., fixed costs). In turn, high volumes of each car model have to be sold to break even. On the other hand, consumers are different from country to country and often even within one nation.

Car manufacturers address this issue through a variety of strategies. For example, Tata Motors – the most important Indian manufacturer – opted for a dual strategy. At one end of the market, it focused on product adaptation by developing Tata Nano, a car model priced at less than \$2,500 with the intention of serving the middle and low class of the Indian market (this strategy – as discussed later in this book – was not completely successful). At the other end of the market, Tata Motors purchased two British premium brands – Jaguar and Land Rover – to serve the cross-national affluent segment both in mature and emerging markets.

Hence, even with regard to the effects of globalization, the automotive industry offers important lessons for other industries.