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Disruption in the automotive industry: A Cambrian moment

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Abstract The automotive industry is experiencing a moment of innovation. With electronics gaining importance, the need to find sustainable solutions and the rampant availability of sharing platforms, the dynamics of this sector is witnessing a paradigm shift. A host of startups is colonizing every niche of what seems to be the new architecture: shared and self-driven electric vehicles. Old incumbents and emerging startups are interacting to control key technologies and the user interfaces of the future. The mechanical machine is being converted into a computer. The connected car is creating a new ecosystem for entrepreneurial opportunities. This study analyzes a set of 156 venture-backed startups: the nature of the firms, their founders' profiles, their origins, their technological capabilities, and their investors. Our findings and conclusions are: (1) a phase of instability and vibrancy is beginning wherein multiple emerging firms compete to impose their standards, (2) the competitive battle is conducted in the digital arena, (3) disruption is led by outsiders with entrepreneurial experience and deep knowledge of digital technologies, and (4) a final winning dominant design may emerge. Entrepreneurial outsiders and outsiders coming from consumer electronics, electrical companies, and/or digital platforms have a window of opportunity to enter this new market.

1. The automotive industry: A Cambrian moment

In January 2014, *The Economist* published an influential article titled "A Cambrian Moment," which explained a millisecond in time 540 million years ago when life forms began to multiply on earth. The article claimed that something similar is happening now in the economic world due to the force of disruptive new technologies. An entrepreneurial explosion fueled by technological change is transforming the foundations of almost every industry. Digital startups are spawning an astonishing variety of new products and business models. The disruption has hitherto penetrated a stable, oligopolistic industry dominated by a few big players that

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make up the automotive industry. Now, however, car manufacturing is going through its Cambrian moment.

With electronics gaining weight in the technological configuration of a car, along with the need for sustainable solutions and the emergence of sharing platforms, the dynamics of the whole sector is witnessing a paradigm shift. A host of new firms are invading the industry and colonizing every niche of what seems to be the new dominant design: shared, digital, and self-driven electric vehicles. A new era is beginning in which old mechanical incumbents fight against digital giants and emerging startups to control the key technologies of the future.

In this article, we aim to shed light on these startups and why and how they are threatening the very foundations of the old industry. To do so, we first carry out a literature review focused on how the combination of technological change and entrepreneurship creates new industry dynamics. Second, we provide an overview of what the automotive industry means in the global economy today, highlighting the evidence of a renewed entrepreneurial activity. We also analyze the most recent strategic consultancy reports and what scholars say about the current transformation in the industry. Third, we explore the features of a significant set of emerging technology startups to characterize who the new entrants are, in addition to their origins and competitive tools. Last, we show the results and discuss implications and further research avenues.

2. How industries change: Theoretical foundations

Several streams of researchers have analyzed the phenomenon of how an industry is transformed by emerging technologies and entrepreneurial initiatives. In such cases, new technologies are introduced into the market and create competitive destruction of the old (Schumpeter, 1942). Technological change has an unequivocal impact on economic growth (Solow, 1957; Tushman & Anderson, 1986). Technological evolution is characterized by periods of great experimentation and entrepreneurial activity, followed by the acceptance of a new product architecture (Abernathy & Utterback, 1978). Most of the fundamental innovations occur during the first years of an industry's existence when a stream of new entrants competes to impose their standards (Abernathy & Clark, 1985). Researchers have characterized an architectural innovation as the case when new technologies make existing firms' competencies obsolete and create new market linkages, showing that competence-destroying technological waves are usually driven by new firms.

Foster (1988) introduced his famous S-curve model: A given technology is initiated with a phase of slow performance growth, followed by a quick expansion, and then finished with a maturity phase of limited improvement. Christensen (1997) demonstrated that first-movers and entrepreneurs enjoy a decided advantage over incumbents when a new product architecture is about to be born. He introduced the concept of disruptive innovation wherein an old company is overridden by new firms, moving away from immature (yet-to-be improved) technological capacities. It is not necessary for new firms to overcome the old firms' performance; it is enough to overcome the expectations of the old firms' market in some new dimensions of performance. Foster (1988) stated that new firms' strategic flexibility gives them a competitive advantage.

Spencer and Kirchhoff (2006) explored the link between technological change and creative destruction, with special attention to the role of new technology-based firms (NTBFs), showing that NTBFs are a leading driver of creative destruction. They described a set of advantages for NTBFs: low dependence on customers (since they do not yet have an existing customer base), low dependence on former investments, inexistence of organizational resistance to change, and rapid technological improvement (for they are operating before or during the S-curve slope). NTBFs ability to mobilize external resources (like venture capital) increases the possibility of bringing disruptions to the market (Rannikko, 2012). New firms have nothing to lose, while incumbents risk their current strategy, which has been successful so far.

3. The present: An old fortress harassed by a swarm of technology-based startups

3.1. A true global industry

The automotive industry is probably the best example of a truly international industry. It has been a generator and exporter of leading management practices and the source of a continuous stream of high and medium technologies. As stated by Bertoncello and Wee (2015), "as much as any other product, the car has shaped not only the global economy but how billions of people live." It has been a paradigm of an oligopolistic sector in which fierce competition has stimulated fast technology