Additive Manufacturing in Automotive Sector

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Triple bottom line (3BL) approaches to sustainable supply chain management (SSCM) often involve trade-offs between their three dimensions (economic, environmental, and social). Under some circumstances, however, synergic approaches (typically involving disruptive innovations) might allow simultaneous improvement in one or more dimensions without compromising the others. This entry analyzes one such case: the potential of properly designed additive manufacturing approaches in the automotive spare parts industry to simultaneously boost profits and reduce environmental impact.
It is based on the systematic analysis of the real spare parts business of a mid-size automotive brand in Spain. Its results suggest that such synergic, self-reinforcing opportunities do indeed exist, and might even be further developed by strategically integrating sustainability constituents, while completely changing the current spare parts' business model.

Keywords: additive manufacturing ; disruption ; sustainable supply chain management (SSCM) ; spare parts ; automotive industry ; business model

1. Introduction

Nowadays, the industrial and manufacturing sector is immersed in a real revolution, whose various constituents have been grouped under the umbrella concept “4.0 Industry” [1]. The main characteristics of this concept are the massive use of processes’ acquired data and the use of cyber physical system, that were unthinkable just a few years ago. As a fundamental part of the necessary framework for the development of the above mentioned 4.0 Industry concept, additive manufacturing (AM) is becoming increasingly relevant, as the research activities in new metallic materials, printing processes, simulation and optimization techniques, and algorithms have been endlessly growing. Therefore, AM is likely to be fully incorporated in industrial processes in the near future. Some authors have extensively studied this exponential development in recent years [2][3]. In today’s social environment, not only are the economic and industrial aspects important, but it is also key to consider social changes and impacts, mainly with regard to health and safety [4]. Amid this growing awareness of aspects such as sustainability and energy efficiency, AM offers the possibility of forming parts with exactly the required shape and material, without any waste [5].

2. AM in the Car Industry

There is still no global consensus on the level of savings, sales increases, and impact on other key performance indicators (KPIs) that applying AM to industrial processes might bring about. However, most estimations of the potential impact of AM in the car industry conclude that it could lead to savings of up to 23–25% of production costs in the near future, and could also enable up to 8–11% of additional business volume from products and services not offered so far [6].

The automotive sector currently encompasses a small number of large worldwide manufacturing groups. These groups typically have a global presence, both geographically and in terms of product range; this allows them to diversify and capitalize on important synergies in their activities. As competition increases and mobility needs evolve around the world, the turnover and industrial margin of the main players in the automotive sector continue to decrease. This forces them to explore strategic alternatives that could increase their synergies and, consequently, improve their competitiveness. Furthermore, optimization of the structure of production costs requires cooperation between all the involved stakeholders [7], even including some that up to now were not involved in this sector, such as AM providers. Given the acceleration in these changes (regarding customers, mobility, production, laws, etc.), and the emergence of key new players in the automotive sector, it is imperative not to allocate resources to develop technologies that are not going to be dominant [8].

One of the fundamental pillars of the current business model in the automotive industry is undoubtedly the business known as after-sales [9], as it represents the main source of profit for both local distributors and the manufacturers themselves. Nevertheless, it was not until the end of the 20th century, or even the beginning of the 21st, that “industrial” applications of AM were found in after-sales, such as the Request For Proposals of the American army to supply parts for its aircraft fleet [10] and the subsequent development of the project [11].

In the automotive industry, the level of competition is much higher than in the aeronautical sector, and so is the worldwide business volume.

As mentioned before, a global consensus is far for being achieved regarding how the AM techniques are going to evolve, what the impact will be in the various industrial sectors, and when and up to what extent will the main players within each sector react and really implement AM processes in their value chains. However, the potential impact of AM on the different business models and their respective value chains is so substantial, that there is no single industrial activity that is not reflecting about potential synergies and process improvements.

Introducing AM would affect not just manufacturing activities, but also logistic and strategical aspects; thus, this alternative should be analyzed from a holistic and global perspective. Interesting analyses of the trends and possible evolution of additive manufacturing technologies and their potential impact on industry can be found in [8], [12], or [13].

It should be emphasized that, before any industrial application of AM can be launched in an environment such as the automobile parts' supply chain, an in-depth analysis of the risks that would be faced must be carried out. Two of these risks stand out as particularly critical for business: intellectual property management and liability. The final design of a particular component or system entails significant costs (development, prototyping, testing, re-engineering, etc.) that are protected, up to some extent, by intellectual property. Therefore, it is an asset that should be carefully managed and protected. Civil and/or criminal liability is also a key issue for automotive manufacturers. The failure of any critical component during the service of the car in which it had been installed would have very serious consequences, both economical and image related. An appropriate analysis can be found in several studies [14][15][16].

3. Conclusions

It is still too early to have a clear picture regarding all the potential impacts that the use of AM techniques could have for the industry in general, and for the automotive sector spare parts distribution in particular, as there are still a lot of aspects that must be developed, improved, or even discovered.

One of the first facts to be acknowledged is that, among the different techniques that are grouped under the AM denomination, the differences are enormous. For example, the energy consumption (one of the main costs of AM techniques) is radically different for electron beam melting [17] than for laser selective melting [5], and even for the same techniques, the operating and cost differences when using different types of material preparation, working and printing parameters, and parts' positioning and orientation are very significant.

The implications and potential benefits of applying AM in specialized areas or from particular perspectives have been analyzed in various publications. For instance, nearly nobody currently disputes that AM is the best option for rapid prototyping [18][19] or for very specific niche applications like those analyzed in [20]. Specifically from a social perspective, a comprehensive and highly relevant survey conducted for a representative sample of AM-related professionals is presented in [4]. It identifies a total of 28 fundamental factors enabled by the use of AM techniques that are closely related to critical aspects of modern society, such as working conditions and health. It suggests that AM has the potential to add social value to the adopting companies and improve their corporate social responsibility.

However, there is a lack of published studies regarding the viability of applying AM in large operational activities, from an encompassing business point of view, and supported by real data.

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