A QUICK LOOK INTO THE ADDITIVE MANUFACTURING IN BRAZIL: FIRST IMPRESSIONS

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Abstract: This article aims to analyze the additive manufacturing scenario in Brazil and the existing challenges for its implementation in a more solid way. The work is focused on the basic idea of additive manufacturing, the applications of the process, challenges, and the existing limitations and perspectives within the country, considering sustainability and new approaches to this manufacturing process. This is a short review article that addresses fundamental factors for a very promising production technology that may have its adoption rate accelerated in Brazil.

Keywords: Additive manufacturing; Brazilian scenario; Challenges; Sustainability.

UM RÁPIDO OLHAR SOBRE A MANUFATURA ADITIVA NO BRASIL: PRIMEIRAS IMPRESSÕES

Resumo: O presente artigo tem como objetivo analisar o cenário da manufatura aditiva no Brasil e os desafios existentes para sua implementação de maneira mais sólida. O trabalho buscou uma maior ênfase no conceito de manufatura aditiva, suas aplicações, os desafios e limitações existentes e as perspectivas existentes dentro do país, considerando a sustentabilidade e novas abordagens para esse processo de fabricação. Trata-se de um artigo de revisão que aborda fatores fundamentais para uma tecnologia de produção bastante promissora que pode ter sua taxa de adoção acelerada no Brasil.

Palavras-chave: Manufatura aditiva; Cenário brasileiro; Desafios; Sustentabilidade.

1. INTRODUCTION

Since the beginning, humanity has developed ways of working with existing materials in nature and molding them according to their needs, especially those used for their protection. Authors [1] highlighted that several manufacturing processes were developed over time, supplying the needs of society, and helping in the productive evolution. With the advent of industry 4.0, new technologies emerged connecting quality, flexibility, time, costs and sustainability. New times demanded new ways of thinking and producing parts, highlighting manufacturing processes which reduceds environmental impacts that conventional processes causes.

Authors [2] stated that additive manufacturing (AM) emerges as a new technological concept based on parts production through the addition of material layer by layer, enabling the use of necessary amount of material for the desired product, unlike of what is based on the production system. Even with great advances in the implementation of the use of AM in the world, there are some barriers such as the availability of specialized labor, machine cost, process quality, maintenance, process cost, software, production scale and process parameters, being these also challenges for the Brazilian scenario, as pointed out in research [3].

This happens even with the various advantages presented by this manufacturing process and reveals the need for further development in researches based on AM. The dissemination of the know-how and technology may allow a better balance between direct or indirect importation of parts that today are not manufactured nationally, also contributing to the growth of the national industry. Thus, this article addresses the concept of AM focusing on the Brazilian scenario and the existing challenges for Brazil to enter the AM map at a global level.

2. ADDITIVE MANUFACTURING

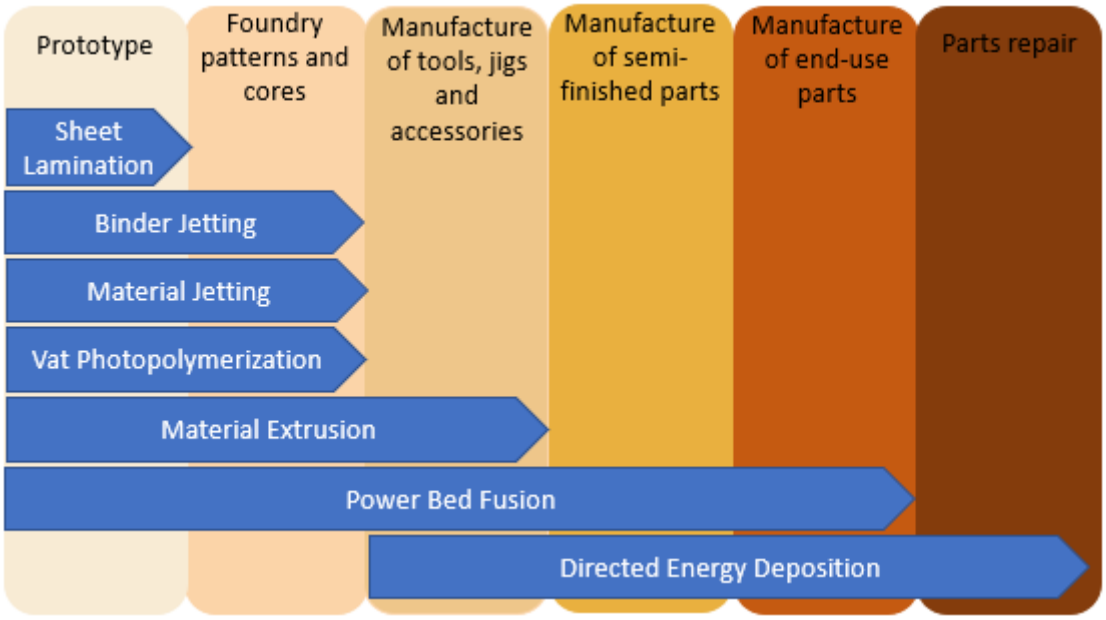
AM is a technology used to produce parts through different forms of interactions with materials, heat sources and ways of carrying out the process, through digital models created in software [3]. The AM, from a 3D model, allows the manufacture of a solid part that is printed layer by layer and with efficient use of the amount of raw material, presenting several advantages when compared to manufacturing processes that are based on the removal of material or shape/geometry changes.

The visualization and manipulation of the digital model in software allows a quick changes for necessary improvements, in addition to identifying possible interferences. Those characteristics make AM a major milestone in industry 4.0, by accelerating product development in a simple and efficient way. According to [4], AM involves fundamental characteristics for its execution, such as design, modeling, materials, machines and their energy sources. Figure 01 highlights the main technologies and applications for the available processes nowadays.

According to the standard ABNT NBR ISO/ASTM 52900:2018 [5] the AM processes are separated into seven categories, based on the technologies used, covering the manufacture of different types of materials, such as polymeric, metallic and ceramic. All these techniques allow parts to be manufactured with fewer steps

which reduces the material disposal, comparing to conventional manufacturing methods, such as machining and forging, for example [6].

Figure 01: Types of MA processes and applications [7].



3. AM APPLICATIONS IN BRAZIL

The possibilities for AM applications are diverse, such as printing parts of hearing aids, orthopedic prostheses and car components. Additionally, the technology offers opportunity of processes improvement and to manufacture parts in a new types of materials. Authors [8] stated that the possibility of reducing weight and to manufacture complex geometries has opened many opportunities within the aerospace and automobile industry. Those sectors can be the vanguard of AM, which allows improvements in the relationship between mechanical strength and weight of various components.

The applications also go to the tooling sector, in which molds for thermoplastics can be manufactured using AM processes, as shown by recent research [9]. This application allows better manufacturing of the necessary inserts within the mold cavities. In addition to manufacturing cooling channels capable of reducing the injection cycle and increasing productivity, the use of AM processes also improves the functional capacity of the molds. In some cases, is possible that only the inserts are produced by AM which also contribute to improvements in the use of the tooling.

The oil and gas industry, one of the sectors most closed to changes and considered to be quite conservative, shows signs of opening up to new technological processes, especially AM. Research shows that about 83% of companies in the oil and gas sector are analyzing the adoption of AM for the purpose of manufacturing spare parts used in their activities, also aligning with the challenges of sustainability, as exposed [10].

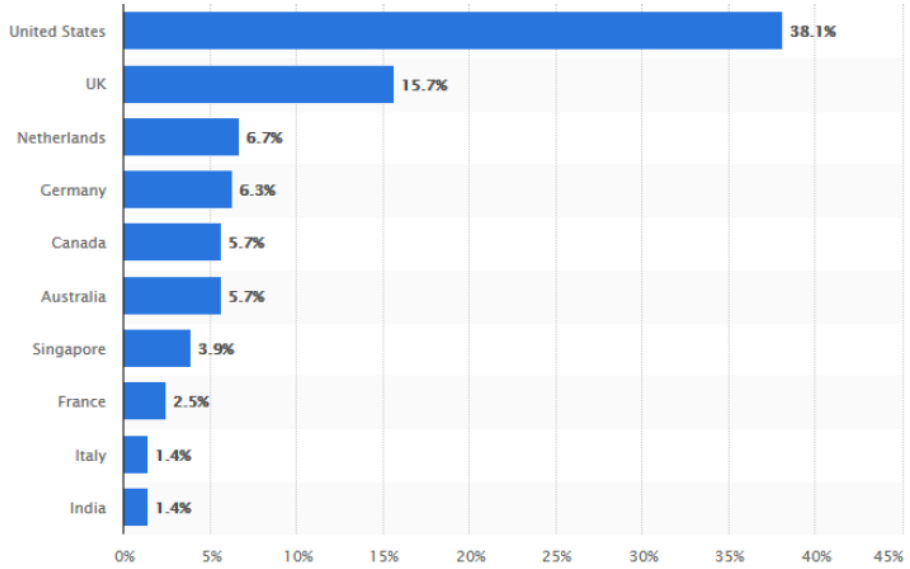
4. CHALLENGES AND LIMITATIONS

Despite being very promising and showing several advantages which rises the interest of certain industrial sectors, AM still presents challenges to its dissemination in the Brazilian market [11]. Even with the advances in the domestic market, this is still a technology without expressiveness when compared to the global scenario, in which Brazil continued out of the top 10 countries which shows highest interest in the technology until the year 2018 [12]. Figure 02 shows the strong participation of countries such as the United States and the United Kingdom, which are quite advanced in the AM market.

According to a study [3], the reasons why the technology is still under discussion are: amount of energy needed to carry out the process; lack of standardization and legal aspects; cost of consumable materials and its specifications; resistance by the industry to changes; lack of qualified labor and the cost of machines and its limitations. In addition to the cost of the process, its parameters and scale are the add-on factors that make it impossible to take a further step with regard to this sector in a national environment.

It is pointed out by authors [13], that the types of materials, the high cost of equipment and maintenance are considered the main barriers for AM to be used. However, an increasing interest on the number of applications by the industry can decrease the equipment costs. Within the Brazilian industrial environment, the challenge is also to find national equipment, suppliers and materials that suit specific applications and guarantee a short-term return on this investment [14].

Figure 02: Worldwide 3D printing market share, as of July 2018, by country [15].



A survey carried out in 2018 pointed out that the main difficulties encountered by companies with commercial or experimental practices in progress for the application of AM were: technological knowledge (13%); technological maturity (53%) and the related costs (40%) [16]. The expressiveness of technological maturity reflects on all issues of technology use, since an increase in technological maturity positively adds

to important market gains, resulting in an increase in the market and greater production capacity with the use of fewer resources.

The main challenges of AM in the industry can be split into 3 major areas - technology, organization and ecosystem [17]. These areas also include national challenges, such as the cost of investment in equipment, operation and maintenance issues. Those aspects can be considered as part of the technology area, while within the organization area, it is also a Brazilian challenge to face the lack of qualified personnel and limited knowledge about MA technologies and design.

While within the ecosystem area, there are issues related to the lack of qualification procedures regulated by the industry and there is a great need for aligned work between the Brazilian industrial sector and the regulatory bodies. In addition to also contemplating issues such as insufficient design quality and lack of digital process chain to facilitate greater control and quality of the parts produced [17].

5. AM PERSPECTIVES IN BRAZIL AND SUSTAINABILITY

The development of AM will make it increasingly accepted in small, medium and large companies, companies that today are looking for more sustainable technologies. As mentioned by [12], Brazil stands out in Mercosur and continues to make very interesting agreements with the United States and some European countries, which may allow legislation on new technologies to be elaborated and consider the interests of all involved parties. In addition, the fact that with legislation and agreements, investments in the country should increase. As an example, some oil and gas sector initiatives with international partners have been developed to accelerate technology and knowledge transfer.

In addition to the challenges, some aspects to simplify the industrialization of AM are already discussed, as the cost reduction in the manufacturing chain, the use of AM in various sectors and companies, the development of new applications and the use of software linked to the process. The latter would help with the design issue, combination of materials, process optimizations to generate continuous technology growth and directly impact the issue of technological maturity, one of the greatest challenges for Brazilian market today.

Other aspects are the standards and norms, here being more related to sustainability, digital security and data format which also increase quality and industrialization in diverse sectors. In this regard it is necessary to develop the integration of AM together with the management support and quality verification methods for the parts produced in the additive process, something that today is expensive and complex to be carried out.

AM is a technology that still has some aspects to be optimized, such as cost and standardization factors, but it is something that is already being worked in Brazil. The advantages of AM are usually highlighted as greater efficiency in the use of material, reduction of waste in production and improvements in remanufacturing, factors that improve the performance of the sustainability factor of the process and products. Although the process has many positive points of its sustainability, some studies show that it cannot be considered a completely ecological process, because

of the large amount of energy required for its realization [18]. It is necessary that the principles of sustainability are aligned, giving greater attention to the issue of energy consumption.

Perhaps one of the most relevant aspects of the sustainability of the AM process is not only the fact that the necessary amount of raw material is used, but the possibility that this material is recycled, once again reducing the environmental impacts of the production processes. According to the magazine [19], polymeric materials from plastic bottles, car parts and electronics are being prepared and transformed into filaments for use in AM machines, being a starting point to stimulate the circular economy.

4. FINAL CONSIDERATIONS

Due to the developments in AM technology and its wide dissemination in other countries, it is evident the need to think about the Brazilian scenario for this manufacturing technology. In AM, polymeric, ceramic and metallic materials can be used, linking several advantages that made areas such as health, aerospace and automobiles carry out their implementation to improve their parts.

Despite the advantages of this technology and its acceptance by certain sectors, there are still some barriers that need to be overcome to bring Brazil as a relevant country in the development of parts obtained by the additive process. Even more, considering the possibility of using recycled material as raw material, something that already exists in the case of polymers and maybe became economically attractive in the case of metals, the sustainability can transform the way of think and use the technology.

Therefore, efforts are necessary to implement AM in the industry, expanding knowledge of projects, materials, technologies used, impacting the manufacturing chain, the quality of the part produced, evolving in more regulations and expanding the sectors with AM application. This would accelerate the use of this technology in the market so that Brazil and perhaps bring the country within the AM map worldwide.

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