
DESIGN FOR ADDITIVE MANUFACTURING AND CUSTOMIZATION: A CONTEMPORARY REVIEW

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Abstract

Additive design is one of the most important advanced manufacturing techniques, as it is one of the contemporary intellectual approaches in the field of production and operations management for its vital and essential role in providing a set of economic, social and environmental benefits to the organization using this technology. Hence, the current paper was presented to focus on the additive design, which is one of the pillars of additive manufacturing technology, which is one of the cognitive and intellectual entrances under formation and cognitive and applied framing, and measuring its role in contributing to the improvement of product recommendations and production according to the design provided by the customer. where the problem of the current paper was to measure the possibility of applying additive design technology in the Iraqi industrial organizations and its impact on the allocation of products. The researchers employed the case study method to measure and test the hypothetical research scheme. The Ibn Majid General Industrial Company in Basra was chosen to implement the current study and test the hypotheses. The results of the statistical analysis showed that additive design technology contributes to improving product design and customization.

Keywords: Additive Design, Customization, Sustainability, 3D printer, additive manufacturing, advanced manufacturing techniques, product design.

Introduction

Additive manufacturing (AM), also known as 3D printing, is a digital technology for producing layer-by-layer physical objects from a 3D computer-aided design (CAD) file. The object in all its details and dimensions. Then, the 3D computer design file is split into 2D thin layers by a computer program. Then, the 2D layers are sent to a 3D printing machine one layer at a time. [1] Additive manufacturing is an emerging technology, according to experts, and the

hype around additive manufacturing will generate significant interest for manufacturing organizations in a variety of ways. of sectors. Currently, many manufacturing organizations are evaluating the possibilities of using growing manufacturing technology but do not have a clear overview of the impact and possibilities. Manufacturing organizations may be unable to translate them into tangible results because they do not have the knowledge or the mindset to find appropriate solutions to their problems. However, organizations cannot lean back; if so, they may miss out and not recognize the potential additive manufacturing benefits that create competitive advantages. (2)

AM (additive manufacturing) is on a renaissance today. Although 3D printing is a recent phenomenon, this technology has been used for four decades. Welding is very versatile, as repeated welds are made not to join materials but to create structures freely in the first metal additive manufacturing process that was identified. This was a popular topic of research from the 1970s through the late 1990s. However, the handcrafted nature of such free designs does not easily lend itself to accurate, repeatable structures. In the 1980s the first direct energy deposition machines were created [2].

Additive manufacturing (AM) is a term for a class of technologies that use a computer-aided design-based layered manufacturing process to create parts that are used directly as end-use products. [3] Therefore, it is called additive manufacturing, digital manufacturing, direct manufacturing or electronic manufacturing. Recently, the term “3D printing” has been used to describe an additive manufacturing technology and is widely used in the media which we hope will be considered a driver of a third industrial revolution since it has the potential to revolutionize the way we make almost everything. Rapid prototyping and rapid manufacturing [4]. They are two widely known names to describe additive manufacturing technology prior to the use of the additive manufacturing designation. In the next stage, a series of processes for rapid prototyping are basically established [5]. Then the great research efforts proved that some of these processes can also be used for manufacturing, especially in small businesses. Thus "rapid prototyping" has been combined with "rapid manufacturing"[6].

Through the previous conceptual presentation of the historical development of additive manufacturing, the researcher concludes that the technology of additive manufacturing is a continuous and developed process since its emergence until the present time. This technology is a technology that needs special and tailored materials, processes and supply chains.

Importance of additive manufacturing technology

Additive manufacturing technology is an advanced technology that is attracting significant research interest from both researchers and business professionals. The main research areas are primarily concerned with the important points of the roadmap and the development of guidelines in conjunction with new technological developments [7]. Additive manufacturing can lead to increased energy efficiency, cost and time savings during manufacturing and significant material savings for several low value applications as well as the potential to increase production from start-up to finished components or sub-assemblies. "additive" for industrial applications is a completely new manufacturing technology born in the 1980s[8]. Laser beam melting (LMB) technologies are of particular interest to advanced industries (aerospace, spatial, defense ...) because they offer the possibility of manufacturing complex

geometry of metal parts. However, the industrial requirements in terms of mechanical properties are very severe while there is still a lack of knowledge of the physical mechanisms of the process [9]. Additive manufacturing involves building a three-dimensional solid layer from a virtual model. Additive manufacturing has restructured the industrial production process so that complex engineering that would be difficult to manufacture using traditional production methods can be performed more easily, efficiently and cost-effectively. [1]. Through its role in the manufacturing organization, the Innovation and R&T team identified additive manufacturing techniques as a game-changing tool and envision that it can provide the organization with a competitive advantage. However, industries face many obstacles regarding the adoption of additive manufacturing and integration in the product development process which are the basis for investments in key equipment, lack of knowledge and talent, and mistrust towards parts quality. [3] Additive manufacturing has evolved from Create basic models or rapid prototyping to processes close to pure form and gradually take over traditional methods of producing complex shaped objects. Additive manufacturing is also beneficial in terms of reducing lead times and lowering the cost of producing a few parts [4] Nowadays, additive manufacturing techniques are competitive with traditional manufacturing techniques in terms of cost, speed, reliability and accuracy. Additive manufacturing technology, which includes the comprehensive integration of laser technology, materials science, and mechanical engineering, is an important revolution in the manufacturing sector. Therefore, many experts believe that additive manufacturing technology is a "next generation" technology. The word "rapid" in terms of rapid prototyping or rapid manufacturing is a relative word that can produce components usually within a few hours although it varies greatly by type The device used and the size and complexity of parts simultaneously.

Additive manufacturing technology brings design and creativity to the fore. Additive manufacturing enables engineers to experiment with multiple iterations simultaneously with minimal additional costs. Having creative freedom in the production process, without restrictions on time or cost, is the absolute advantage of additive manufacturing over traditional manufacturing. [5]

With additive manufacturing technology, manufacturing organizations are able to remove limitations and barriers so that design files can be digitally processed in one central location, then 3D faxed to any additive manufacturing operating stations on the worldwide network, thus creating global digital factories. One of the best aspects of the process is that it eliminates the time and costs associated with shipping parts globally. Parts can be created in a digital factory near the manufacturing facility whenever and wherever they are needed. In addition, additive manufacturing technology allows for real-time visibility of parts production and receipt, further saving time and costs for the OEM. [3]

Additive & Traditional manufacturing

Before the Industrial Revolution, the products were manufactured by local artisans using mainly available local materials. They also sold their products primarily to local customers. Many innovations in production methods, mining methods, machinery and tools began to create a new era of traditional manufacturing also called the Industrial Revolution. The Industrial Revolution enabled our world today for its contribution to the achievement of mass

production and the replacement of labour with machines [10]. However, casting, molding and forming are complex processes that involve tools, machines, computers, and robots. Most traditional manufacturing techniques are a subtraction or elimination process [11]. Subtraction means a process; whereby unwanted or unwarranted substances are removed from a substance to obtain the desired product. For example, a wooden lamp holder is created from a wooden block with a lathe, which cuts off the rammed wood to obtain the desired shape [12]. Other processes, that are thrown in are cutting, drilling, filling, turning or grinding. But traditional manufacturing techniques also have inherent limitations which lead to the need for new methods such as additive manufacturing [13]. At the end of the 1980s and early 1990s, rapid prototyping that enabled the production of a 3D object from a template library file began to be adopted. Standard (STL) Additive manufacturing means a group of molding processes by adding materials, stacking layers and contrasting the molding process by removing materials[14]. At present, additive manufacturing processes represent an economic market worth several billions of euros/year. Its applications relate to many technological fields: mechanics, transportation, medical applications, medical material, cosmetics, computer science, tires, plates, inks, textiles, clothing, and art [15].

Additive manufacturing differs significantly from traditional methods and therefore, determining when and how to benefit from The advantages of additive manufacturing is a challenge in itself. In addition, the manufacturing industry is oriented towards optimizing production using traditional methods. Identifying products that benefit from increased sophistication or that are produced in close proximity to customers or understanding the impact on inventory is complex and difficult because it influences factors that are difficult to measure [16]. (Thomas et.al, 2014) The time is easier and more difficult than the corresponding process in traditional manufacturing. It's easier because different additive manufacturing techniques allow products of very different geometries to be created with just one machine and no additional tools are required to create cavities, holes, or any other feature. This means that although machines and manufacturing methods are very different from one another, they can always be used to create the same product [17]. The downside to this is that the choice between technologies and machines becomes more sensitive to cost, time, quantity, and quality [18].

3D printing is revolutionizing traditional production processes, backed by a recent increase in metal 3D printing capabilities. In the near term, 3D printing will be well suited to industries where delivery and time to market are key factors of value - usually with low-volume, high-value parts, such as aerospace and healthcare. Today, and for the foreseeable future, the dynamics of the economy and industry will not support 3D printing that replaces traditional manufacturing for long production runs, and to localize the effects of large-scale production close to end customers [19].

Can be considered one of the factors of success. Decisive for additive manufacturing techniques is the costs of the manufacturing process compared to conventional manufacturing. Especially those potential users/customers who are unfamiliar with the technology cannot oversee the AM cost structure. To understand this structure, full life cycle costs of parts must be considered [20].

The main difference between additive manufacturing and conventional processes is in the limited effect of batch size on manufacturing cost and lead time. Additive manufacturing is a computer-driven design-driven process without the need for individual tools or programming (CAM). Without this upfront investment in production, producing a number of identical parts or the same amount of individual items would mean the same effort. This cost advantage in smaller part sizes allows for affordable single and service parts production [21].

Additive Design

Additive manufacturing offers a large variety of design capabilities for new products. To take advantage of the full potential of additive manufacturing, a specific additive manufacturing design must be adopted [22]. Therefore design guidelines should support the engineer in design development for optimal additive manufacturing. Nowadays there are a large number of academic design guide lines. Yet these academic design guidelines are entering industrial practice too slowly [23]. The main reason is the scientific focus of the Academic Design Guidelines, which makes it difficult for engineers in the industry to understand and apply. Scientific studies have demonstrated the need to impart knowledge of academic design guidelines to professional engineers in industry [24]. Industrial organizations are generally looking at the potential for additive manufacturing based on a new business model or to investigate the role that manufacturing can play. added to its current business model [25]. In the latter case, the economic benefits to be obtained at any stage of the life cycle may be disappointing if the additive manufacturing design is not designed or improved. If the products are already designed for another process eg CNC milling, this is probably the most Economical to produce this part. As stated in Design for Additive Manufacturing, product performance must be maximized by synthesizing shapes, sizes, hierarchies and physical structures, and taking into account the possibilities of additive manufacturing techniques to ensure increased product performance. Several design strategies for additive manufacturing have been developed [26].

The big impact of rapid manufacturing will be on the instructions associated with reducing complex geometries and features such as underlayments, blind holes, and rivets, any simple modification to the design that requires a new set of tools. Because rapid manufacturing is a toolless process, the complexity of the parts is unimportant, and any complex shapes or features produced by the computer design process can be translated directly into the final product [27]. This is in marked contrast to traditional manufacturing processes. Also in injection molding the selection of the correct location of the split line - especially for asymmetric and complexly shaped components - is very difficult and depends largely on the experience of the tool designer. However by adopting rapid manufacturing processes and not using any tools the designers will be completely freed from this task. Using rapid manufacturing techniques it will be possible to reduce the number of parts within the assembly [28]. So the most important design-to-manufacture guideline of part number reduction can easily be achieved. Theoretically the number of parts can be reduced to only one although this may not be practical because parts are generally not used in isolation and their interaction with other components imposes restrictions on the number of parts. Thus with the advent of rapid industrialization techniques there is potential to remove many of the current obstacles [29].

Customization

To create a successful product it is important to meet the needs of customers in the market. Product recommendation is important to reach as many customers as possible because it changes products in a way that suits the customer. In traditional manufacturing with large overheads in the form of production tools, the maintenance is very costly because it will increase the production cost of each product. With additive manufacturing these costs will be eliminated or optimized to the level of guardianship because it does not require any tools or equipment [30]. It completely meets their needs. Consider ordering a personalized mobile phone cover online at a low flat rate with free next day delivery. Additive manufacturing enables the production of one-time items or small batch sizes at reasonable cost and allows for a high degree of reliance, even in linear production [31].

Additive manufacturing allows users to design a job rather than manufacture. This enables interior features that are impossible to produce using traditional manufacturing techniques. Cooling ducts in motor equipment and cooling links, which feature many hollow and arc geometries, can now be designed to maximize efficacy rather than manufacturability [32].

Conclusions

With the increasing needs of companies for advanced manufacturing technology and their attempt to employ it in their production processes to improve the company's competitiveness against its competitors, additive manufacturing technology appeared to help companies serve the customer more and meet the specifications they need in the product with less waste, less time and lower prices, taking into account reducing the environmental effects of the product during the cycle life and beyond. As the additive manufacturing technology brings benefits to the applied companies and as a result of the lack of research and studies that dealt with additive manufacturing technology and as a result of the scarcity in the cognitive, intellectual and conceptual aspect, where the current study is considered one of the most important contributions in additive manufacturing and additive design, which is an addition to knowledge for Iraqi and local companies and offices as a result of addressing the topic Contemporary in the field of production and operations management. In addition to the scarcity of experimental studies that dealt with the topic of additive manufacturing technology, as most of the studies that dealt with additive manufacturing technology were theoretical studies in which the applied aspect was neglected, as the research tried to bridge the applied gap by measuring the impact of applying additive manufacturing in one of the Iraqi industrial companies represented by Ibn Majid Company The general industrial organization and clarifying the strategic implications that the additive manufacturing technology will achieve for the Iraqi industrial organizations if it is applied in them. At the level of a holistic analysis, the results of the study with regard to the impact of additive manufacturing technology on the dimensions of creative business models in the company under study showed that it was more clear and influential in the dimension of the recommendation of the company's business models, followed by clarity and level of influence in the dimension of agility of the business model, then after efficiency and acceleration, and finally after sustainability In the company's business model. It is inferred from the results of analyzing the relationship of the impact of the additive design technology and the dimensions of the business model in the company that

it was more clear and influential in the recommendation dimension, next in terms of importance after the agility of the company's business model and at a lower level in the dimensions of efficiency and acceleration and finally after sustainability in the company's business model. Finally, the relationship of the effect of the added materials and machines was more clear with the recommendation dimension.

The results of the in-depth study of the literature in the field of production and operations management confirmed that the cognitive and applied interaction between additive manufacturing technology (AMT) is one of the controversial topics and problems, which is an intellectual and cognitive transformation at the present time, as it is one of the contemporary topics that are still under construction and theoretical formation and it needs a number of research contributions and applied studies. The results of the statistical analysis showed that the additive design dimension (AD) (one of the five dimensions of additive manufacturing technology) has achieved the first rank in terms of relative importance in implementing the additive manufacturing technology system (AMS) in the research organization, which in turn means the organization's need to develop and improve additive design techniques.

The results of the statistical analysis showed that the recommendation dimension has achieved the first rank in terms of relative importance in the researched organization, which in turn means the organization's need for advanced manufacturing technology, which focuses on the production of recommended products with various degrees and complexity measures to meet the desires of customers through designs and highly recommended products, as the organization's work is characterized by high diversity, it produces ships, oil pipelines and tanks of various sizes and a number of other products. This high diversity requires that the organization possess advanced manufacturing technology that contributes to providing the advantages of dispensing.

Recommendations:

Theoretically, additive manufacturing technology is one of the latest technologies in the industrial environment, as some considered it to represent the fourth industrial revolution. The researcher recommends more research and studies in order to deepen the foundations and knowledge bases for the subject of additive manufacturing technology and its potential repercussions on local manufacturing organizations. The need for the company's management to seek to expand and develop the infrastructure necessary for the success of the process of gradual transformation of additive manufacturing technology, especially since the company adopts a manufacturing-on-demand (MTO) strategy for most of its industrial products and services. Improving the additive design system in the company by modernizing synchronous design techniques through effective involvement of synchronous work teams. From all disciplines to ensure an effective response to production orders and requests from customers and beneficiaries. The success of the additive manufacturing system requires the company to restructure the manufacturing paths and processes by adopting cellular manufacturing plants, which in turn requires the reorganization of work stations, which contributes to accelerating manufacturing processes and reducing the time of the production cycle. Gradual transformation To replace the added materials and machines (plastic, ceramics and others) instead of its traditional materials and machines, and that the company employs the lowest

level of additive manufacturing technology represented by CNC machines, which requires the development of a future work plan for the success of this transformation with the required conversion. The need for the company to seek to raise the level of resource replacement through adopting plans and programs to continuously improve the efficiency of the design and manufacturing system. In it, to get rid of areas of waste and losses in production and manufacturing processes. The need for the company to adopt specific programs that contribute to improving its social sustainability and activating its social responsibility in the areas of attracting more workers and participating in community activities and events.

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