Systematize Additive Manufacturing: Improving Accessibility and Productivity

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Abstract

With the rise of additive manufacturing in the new revolution of the industrial process, more and more industries try to replace the traditional methods to enhance accessibility and productivity. Designers and engineers have more rooms to demonstrate or redesign the product to achieve better part tolerance, reduce cost, etc. Also, future space programs like Martian missions require more sustainable and reliable manufacturing processes. Therefore, research that discusses additive manufacturing's potential improvement is necessary to reduce the cost per product and other main principles. First, the upgrade of software and the internet transmission, which consider smart manufacturing, will improve the process and gain accessibility, "The basic idea of smart manufacturing involves flexibility in systems, monitoring, and adaptation to changing needs" (Kumar, 2017). This article's discussion will focus on additive manufacturing potential, especially in systematizing the progress and machines, including the resources. In systematizing the process, the combination and optimization of manufacturing machines will first be analyzed as the internet of things (IoT). Furthermore, as additive manufacturing is more capable of a future space mission, reviewing the systematized process's current on-earth experiment will give a clear view and reliable data result, which will gather more productivity for the systematized approach.

Keywords: Additive Manufacturing; Systematize; Internet of Things; Resources; Space Programs; Transportation; hardware; software.

1. Introduction

Along with the rapid revolution in artificial intelligence and software engineering, more well-developed bots are suitable for works that traditionally require human power. With a lower error rate and cheaper overall producing cost per product, astronauts' operation knowledge will reduce significantly. Therefore, they can process more experiments or possible habitat assembling. Comparing to the previous discussion about the hardware systematization, the upgrade in robotic controls and the reduced effort in producing are mainly relying upon the advance of software. By setting the progress automatically, the combination with the hardware, especially with the raw material sense, additive manufacturing program will be the best option to transport with low mass to Moon or Mars. Besides, the software upgrade will fit the space programs that might require a lower mass for launching. However, the reduced steps and the ability to produce stable finishing products will also overcome some significant traditional manufacturing problems. In a more specific word, the upgrade in CAD or CAM programs will show the result much quicker through additive manufacturing comparing to traditional ones and reduce the waste production to nearly zero.

For the improvement of hardware that generates productivity, each manufacturing process in the old days, such as milling, requires software to create good CAM drawings and codes for the machine to operate, transportation of the raw material, calibrate the tools, and waste recycling to have a product produced. However, today, the Internet of Things (IoT) has been applied to much traditional manufacturing, especially for larger companies, to reduce their cost of production and quality assurance. According to Hester's article, IoT promises to enable all objects, items, and surfaces with wireless identification, sensing, and actuation capabilities, thereby meshing large agricultural, industrial, urban, and infrastructural environments into clusters of wirelessly connected nodes (J.G.D. Hester, 2018). Therefore, IoT should be applied to and adapt to the speedy development of additive manufacturing. Compared to many traditional manufacturing processes established for years, smaller scale and easy accessibility have been a significant advantage given by its producing method. However, to achieve the requirement of possible future space transportation, limited total mass, sustainability in the foreign environment should be optimized using IoT, which has been tested and prototyped by NASA as "Additive Construction with Mobile Emplacement." With optimal process and equipment, the new version of additive manufacturing that fits the rapid production and editing era will be the outstanding choice for today in competing with traditional manufacturing and as the leading method for potential space program application.

2. Methodology

Information and experiment data are consulted from papers on websites of an institution like NASA and others (Mueller, 2017; Williams, 2019); information also gathers from research about a new method of additive manufacturing, optimal processes as IoT, and description of plans for probable space missions (Kading, 2015). As for the discussion about hardware up-gradation, information and technical writings are focus on the IoT, which has a higher possibility of forming a compact system of manufacturing that includes the resources, processes, and prototype editing (Schreieck, 2019). In achieving the software that fits the future programs or today's rapid editing manufacturing, ideas, and information are about optimizing building time and tool or method selection. With developed A.I. technology, the program will automatically choose the right ones to output the best result, which is much sensitive and accurate compared to humans in general (Yim, 2012). For each part of the information gathered, analysis about the application and optimization will occur in IoT and smart engineering. This article will give the potential outcome and overall description after both parts are advanced, which is for the final systematization of additive manufacturing.

3. Analysis

To gain the upgrade program's productivity for the systematized process, a compact form of manufacturing is solid. Compared to the traditional manufacturing methods, 3-D printing already has its advantages in material usage and environmentally friendly. Nowadays, additive manufacturing is suitable for using different building materials, applying the various injecting and heating methods for metal. The cooling and reforming of plastic are the primary development that occurs during the years. However, there are still some shortcomings in additive manufacturing. One of them is the materials' specific requirements, which are usually softer and not recyclable, limiting the trials times and increasing the potential cost to make a prototype. As more come in the sensitive working environment, the machine needs flat and correct temperature to give the best finishing result.

Therefore, to overcome these problems that might heavily impact the future programs or issues of incapable in manufacturing in challenging environment happens on earth today. Engineers and scientists introduce the internet of things (IoT) that gives additive manufacturing more room to improve. IoT is a method of combining many processes to provide the optimal output from separate steps to a single operation, lowering the human cause error and general cost. The advantage in systematizing the hardware side processes is given in "…products can be more geared to functional fulfillment because fewer manufacturing restrictions have to be taken into account" (Würtenberger, 2018). As for machine taking place in material selection and transportation, the IoT summarized the hardware into a single form. The design could be edited more straightforward and save valuable time in redesigning and manufacturing.

Also, additive manufacturing is outstood from various other manufacturing processes due to its capability in the building while remaining a smaller size. While the research shows on most reachable outer planets like Moon and Mars, most on-ground materials are used to print the habitat and form most of the items needed compared to other industrial manufacturing methods. According to Benjamin Kading, "Mars is, in fact, very well suited to the use of Basalt 3D printing because, as …it has a higher concentration of basalt content as compared to the other rocky planets…" (Kading, 2015). Alongside the saying of the IoT version of additive manufacturing, NASA engineers designed a similar form that tested for future lunar and Martian programs called additive construction with mobile emplacement (ACME) (Mueller, 2017). The IoT that introduce by them includes sensing for the right material that could be used in constructing, collection by robots, and filtrating; the system is entirely operated by robots and A.I., with a single button push and initial setup, the systematized additive manufacturing will give better output in producing.

When discussing the possible software upgrading that mainly performs as smart engineering, according to research and personal experience, more and more people will have access to operate a 3D printer, which means the industry of additive manufacturing will continue enlarging. But from the old days to the current, designing and using the app for designing that generates the CAM codes requires professional training, and the people after training are called engineers. To maximize this production method's productivity, people should use the program with minimum training to create their small parts. And this should separate from professional designing, which should still require well-trained engineers to operate to reach particular safety, sustainability, and practical limit. This will allow astronauts to use the machine and produce what they want more comfortable away from the original resource and have limited prototype trails. Besides, to reach better accessibility for a systematized manufacturing process, the software's upgrade will better with the advance in hardware. As the discussion above, when the hardware is advanced, which provides more productivity as a sysrtematize manufacturing process, the software has to be updated to match the version or maximize the performance.

4. Conclusion

In the new era with green power and rapid designing, additive manufacturing is undoubtedly taking place to compete with the traditional ones. With the potential upgrade in hardware that achieves the IoT method used in other industries for years, the more compact system will provide this manufacturing process with more productivity to suit the current environment. Scientists and engineers are building a new type of 3D printer that can print entire habitat for potential space programs. For them, the systematized version of additive manufacturing will indeed be needed to reduce the total weight at launching while keeping it's working performance. Besides the upgraded hardware, to better systematize manufacturing, the software will also fit it up to the version. A more straightforward user interface will reduce the time in training professional designers to make something simple, as for astronauts, this can save their valuable time in the mission. Meanwhile, the better software, including the A.I. system will conbine with the hardwares to achieve better results in sensing, transporting, and building with the material. Overall, additive manufacturing fits will work in this era. However, to make it more reliable in building and for possible space program, which is already the best choise than other methods, it still needs to advance. The achievement has been made, and in the future, systematization of additive manufacturing will happen, and it will give more potential producing that makes everyone enjoy building and designing.

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