ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0077

Research on 3D Printing Application on Equipment Fast Repairing

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Abstract

In order to solve the specific problems of harsh management, low pertinence as well as short of matching force existing in the work of battlefield equipment fast repairing today, this paper analyses the advanced characteristics of 3D printing technology as precisely fast molding, integration printing and distributed manufacturing. It also explores the whole-new thoughts on weapons and equipment fast repairing for application of PLA.

Keywords

3D Printing; Equipment; Fast Repairing.

1. Introduction

3D printing technology, also known as additive manufacturing, or laminated manufacturing, uses three-dimensional digital models to create solid parts layer by layer. The manufacturing materials include ceramic, nylon, resin, titanium, steel and other metal materials. At present, the main technologies are as follows: selective photocuring of photosensitive materials (SLA), selective laser sintering of powder materials (SLS), filament-based melting forming (FDM), thin material layering cutting (LOM) and additive manufacturing of metal materials (SLM, LSF, EBSM, EBF3)[1].

As a new manufacturing technology, 3D printing technology has been widely used in aerospace, automobile, shipbuilding, medicine, food industry and many other manufacturing fields since its emergence in the 1980s. "[3D printing] has changed the concept and mode of traditional manufacturing, significantly reduced product development cycle and cost, and also promoted the material revolution, which is of great value," Premier Li Keqiang said in a signed article published in Qiushi Magazine[2].

In the fast-paced and intense modern war, behind the war is the contest of weapons and equipment and the competition of technological content. The effectiveness of weapons and equipment plays an increasingly important role, and the battlefield maintenance speed directly affects the regeneration combat efficiency. With the development of science and technology, the updating of weapons and accurate and flexible equipment support, new and higher requirements for rapid maintenance are put forward. This paper mainly studies the advantages of 3D printing in rapid maintenance of military equipment and its possible development direction in the future.

2. The reality of equipment rapid maintenance

In the battlefield of weapons and equipment, the speed of wastage has become one of the key factors affecting the success or failure of the war, and one of the core elements determining the speed of weapons and equipment wastage is the speed of maintenance, the importance of rapid maintenance

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is self-evident. At present, although there are many ways to restore the operational performance of the worn equipment, there are still some practical problems[3].

2.1 There are many kinds of spare parts, which are fast to update and difficult to guarantee

Modern weapons and equipment are complicated in composition, with a large number of parts and components. In addition, with the rapid development of science and technology, the updating speed of weapons and equipment is also accelerated. A type 03 automatic rifle with a simple structure is completely decomposed, including dozens of parts such as air holes, gun and 13 parts of reentry machine, while the number of parts of large equipment such as missiles is as high as hundreds of thousands of parts. In the process of continuous upgrading, there will be a shortage of spare parts of many weapons and equipment, so that many weapons and equipment that should play a role have to be retired in advance, resulting in a lot of waste due to insufficient support. The uncertainty of failure occurs throughout the whole process of training and training operations and the shortage of any kind of spare parts may directly adversely affect the final result of the war. However, if the troops are accompanied by a large number of spare parts, it will cause serious problems such as decreased mobility and exposure of location and whereabouts due to excess support. These problems lead to the difficulty of closely matching with the actual needs of the troops.

2.2 Lack of pertinence and effective docking

There are different maintenance methods for different weapons and components. All kinds of maintenance methods differ greatly, and the characteristics of preventive, improvement and repair maintenance technology are also different. For example, the locking wrench of the front guard cover of type 03 automatic rifle is broken, resulting in the fall of guard, which cannot be fixed and can be fired normally. Because the protective wood is nylon injection molded parts, that is, engineering plastics, the commonly used welding gun can not restore its function, and using iron wire to temporarily fix it will affect the aiming problem of the scale to the alignment. The wood front cover locking wrench is an iron fixed link, which is directly connected with the upper casing, with high precision. Poor maintenance may directly affect the use. In addition to the pertinency of equipment maintenance, the produced spare parts should be closely related to the needs of combat tasks, and the sudden depletion of weapons and equipment caused by front-line operations is unpredictable, so the specific type of spare parts cannot be pre-produced. In order to meet the overall needs of the war, the production of the whole system spare parts for a certain type of weapons and equipment in wartime will lead to the occurrence of excessive support. However, it is more difficult to carry out quick maintenance or resume production for some semi-retired or retired weapons and equipment, and it also takes time and effort to produce their special maintenance tools and coordinate suppliers and manufacturers.

2.3 Lack of maintenance personnel and supporting force

In frontline troops have maintenance technology personnel is much, can skilled maintenance skills is lack, such as the armed police force many squadron (even) or group (row) are separate garrison, partial existence position, distance the reality of the contradiction, there is no guarantee that every unit ZhiQinDian equipped with real-time maintenance repairer to weapons and equipment. In addition, there is a certain period of maintenance talent training, and the reality of maintenance talent loss and professional talent generation, there are a lot of "bad repair", "can not repair" phenomenon. In addition, the use of maintenance tools is closely related to weapons and equipment. For many newly installed weapons and equipment in service, due to the lack of professional maintenance personnel's guidance in the running-in stage, the use of maintenance and testing tools inevitably has the problem of long time and large wear, and the maintenance workshops and equipment warehouses dedicated to weapons and equipment can not be stable during combat training. Deployment, management, maintenance and other different functions are distributed in the departments in charge of equipment, and the traditional equipment business management system is not enough to connect with operational

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elements. The inadequacy of these supporting forces will directly affect the maintainability index and combat effectiveness of weapons and equipment.

3. Advantages of rapid equipment maintenance based on 3D printing

At present, the existence of the above phenomenon not only affects the rapid repair speed of the army in the battlefield, but also restricts the consumption reduction and loss stop of weapons and equipment, and further gives full play to the effectiveness of combat effectiveness. The problem can be solved to a large extent through the rational use of 3D printing technology.

3.1 Improve efficiency and enhance the pertinence of maintenance

Distinguish the actual consumption of different weapons and equipment, according to their 3D digital model and spare parts material requirements, apply 3D printing technology in the battlefield, use the corresponding process, quickly print the required spare parts. Especially for the spare parts with complex structure, such as the type 03 automatic rifle wood guard front cover locking spanner mentioned above, the integrated molding features of 3D printing can be applied to complete the maintenance in the same time. This can not only greatly shorten the production cycle, simplify the assembly process, but also effectively improve the generation efficiency of regenerative combat power. In addition, the whole process avoids crowding out wartime productivity and reduces additional costs such as delivery and loading. It effectively reduces the time delay rate caused by maintenance and the risk of aircraft delay, and further solves the practical problem of "only replacing but not repairing" in the case of massive depletion of weapons and equipment.

3.2 Alleviate the contradiction of shortage of maintenance personnel

3D printing has the advantage of saving manpower. One or two people can cooperate with each operation to meet the operation and maintenance requirements. The small 3D printer can be directly carried by a single soldier. According to the PENTAGON News website, on April 7, 2018, a ground crew member of the F-35B Lightning II on board the AMPHIbious assault ship USS Wasp successfully printed the door latch of the aircraft using a high-precision dual-nozzle 3D printer made by Zhejiang Flash Technology Group. At present, the computer equipped with the main body of the PLA is capable of modeling and printing, and the front-line commanders and fighters can master the operation skills through simple training. When performing and training operations in harsh environments such as deserts and gobi, distant sea islands and reefs, mountains and glaciers, which are difficult to effectively implement support, 3D printing will eliminate the need to assign special support teams, and the contradiction between supply and demand of professional maintenance personnel of weapons and equipment can be fully alleviated.

3.3 Improving the effectiveness of overall combat equipment

3D printing spare parts breaks the low efficiency of centralized procurement and production, batch transportation and delivery in the process of traditional weapons and equipment support, and can also be applied in many aspects such as special equipment protection and equipment camouflage manufacturing. For example, the large-scale transport aircraft Y-20, independently developed by China, innovatively uses 3D-printed titanium alloy parts in the production process, which has the advantages of strong structure and light weight, reducing the total weight of the aircraft by 3% and the overall fuel cost during the flight by 45%. Due to its characteristics of accurate printing and distributed production, 3D printing can reduce the pressure of daily maintenance and comprehensive support of weapons and equipment, and greatly promote the rapid maintenance level of the army on the battlefield. By further improving the consumption conversion efficiency, on the premise of ensuring combat performance, the service life of weapons and equipment is extended to the maximum, the dependence on logistics supply chain is reduced, and the overall combat effectiveness of weapons and equipment modules in the support cluster is directly accelerated[4].

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4. Prospect of 3D printing application in rapid maintenance of weapons and equipment

3 d printing technology is currently in the field quickly repair has been made on some applications, such as the western theater army information engineering workstation management committee, the executive director of science and technology innovation with Wang Mingxiao major general team in 3 d printing operations sand table model has reached world leading level, in addition, can also progress in the following several aspects.

4.1 To construct the spare parts 3D model data information system

In view of the fact that weapons and equipment are diverse and rapidly updated, a data information system of 3d structure model of spare parts and corresponding maintenance tools is established. Based on the equipment resume, the data of spare parts and corresponding printing consumables are fully digitized and cloud-based. When printing, the static maintainability information such as service time and component position of worn weapons and equipment will be collected and analyzed in detail, and the biographical information and reasons of wear and tear will be dynamically entered into the system. The system provides printing accuracy and alternative consumables according to equipment characteristics such as reliability, security and testability, and uses different processes according to requirements. There is no need to carry related physical spare parts in the training mission. It can be directly called in the cloud if there is a specific 3D scanning structure diagram, and the production of spare parts can be completed by accessing the system. For spare parts that have been replaced or are being decommissioned and cannot get 3d scanning structure drawings for a while, trained personnel skilled in using modeling software such as C4D and 3DMAX can use 3D scanner for reverse modeling and printing. The whole system can be quickly called, the whole process can be accurately printed, and the whole life can be intelligently sensed.

4.2 Use 3D printing to improve the training level of accompanying support

The idea of promoting the development of accompanying support capability through training level should be set up, and 3D printer should be fully utilized as a "mobile munitions factory" to promote front-line commanders and fighters to have a profound understanding of the important transformative significance of 3D printing. Combined with the actual battlefield, the printing process assessment and quality supervision of spare parts should be highlighted, which should be taken as a military skill to be mastered and trained together with traditional maintenance technology. We will conscientiously organize officers and soldiers to learn operational skills and master operational procedures proficiently, breaking the long-standing negative training thinking that troops dare not or are unwilling to practice for fear of the depletion of weapons and equipment due to operational mistakes. Taking 3D printing training as a new breakthrough point in military training, the competition of 3D scanning, reverse modeling and rapid installation has been carried out to form a mass training craze. In large combat exercises, 3D printing rush repair training close to actual combat conditions is carried out according to the actual needs of different worn equipment. Printing accuracy is the important focus, rush repair speed is the main goal, and the task time of function recovery is the core indicator to continuously improve the training level of accompanying support.

4.3 Improve maintenance efficiency by two-way feedback according to battlefield requirements

On the basis of massive data analysis of spare parts data information system, the bidirectional demand discussion and communication from factory to battlefield are organized centrally. We will solicit opinions and suggestions from officers and soldiers on the use of new weapons and equipment, and assign personnel to participate in pre-research, improve structures, and upgrade tactical and technical performance indicators. The generation mode of new quality combat capability forces the innovation and development of guarantee means[5]. For example, the US Army has developed a printing technology using waste ethylene glycol ester (PET plastic, such as mineral water bottles) and polypropylene (PP, such as yogurt boxes) as materials. About 10 old mineral water bottles are used

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for crushing and granulating with a twin-screw extruder. The vehicle's radio stand was successfully printed in about two hours. Brainstorm and explore materials that are easy to carry and store based on existing 3D printing consumables. On the basis of the service life and performance of equipment innovation printing technology, constantly improve the maintenance efficiency, and gradually to the random support of human and material resources "zero accompanied" transition[6].

5. Conclusion

At present, THE 3D printing industry is booming. The 3DP bonded metal printing method launched by Wuhan Easy Manufacturing Co., Ltd. in 2018 can even reach 100 times the speed of laser sintering method. Its rapid maintenance in the army, especially the printing and preparation of complex metal spare parts, has been close to the speed of traditional manufacturing. Through the establishment of the spare parts data information system, strengthen the 3 d printing operation training, from the factory to the troops two-way advantage of the opportunities for development, overall level of equipment support forces and a new combat power generation to bring greater development.

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