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FUTURE REPAIR AND MAINTENANCE FOR AEROSPACE INDUSTRY

Deliverable 3.2 **Defined scenarios that will be considered in the following project steps**

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Executive Summary

The global competition forces the European companies to optimize their processes and to become more cost efficient. Additionally they have to meet the high requirements of the aerospace industry because a flexible reaction onto the volatile demand, especially in the spare part industry, is required. Only if the aircrafts are ready for operation and in the air they generate turnover and profit. MRO providers have to meet these requirements to stay in the market and to satisfy their customers. They have to maximize the serviceability of aircraft. The necessary flexibility cannot be achieved by the conventional manufacturing methods so extensive warehousing is conducted. This causes worldwide costs of 4.5 to 6.5 billion Euros every year. 50% are costs because of capital lockup [FrLi09, p. 58]. AM offers a high cost saving potential in this area. The technology produces a part layer by layer and thus does not need any tools and is very flexible. Even complex products can be manufactured without high extra costs. This enables the OEMs to design lightweight products which decrease the fuel consumption of the aircrafts. Additionally waste is avoided to the greatest possible extent because the buy-to-fly ratio of AM is usually close to one. The flexibility of the production reduces the storage and logistics costs and a lean supply chain is possible.

Although there are several advantages, AM is currently hardly used. Thus in this paper different scenarios were developed to describe imaginable exploitations of the technology and to give an outlook how foreseeable developments can be integrated into the existing business models of the market participants.

Today the repair processes need several different process steps. AM can reduce their number with a higher near net shape geometry that needs less finishing. The aim is to get more and more to an automated process with further technology developments so that manual handling is avoided as far as possible.

With regard to EASA formalities there are mainly three different organizations to distinguish which received their names from the paragraph where they are described. The Part 21/J Design Organization is allowed to design parts for aircrafts and to prepare CMMs. A Part 21/G Production Organization can manufacture aerospace parts with regard to the manufacturing instructions. Part 145 Maintenance Organizations are allowed to maintain aircrafts and to repair aerospace parts with the repair information given by the 21/J Design organization. A company is not limited to one approval but can have different ones.

The first scenario envisages that AM becomes an additional repair method in existing MRO chains. During the part's repair it is often the case that the original geometry has to be restored. The application of material can be done with AM which offers a better accurateness than the conventional welding for example. This shortens the finishing process. Currently it is necessary for AM that the parts that have to be repaired have a ground zero where AM can build on. Further developments might enable the direct build up on the existing geometry. This would save another time consuming process step. An important factor is the platform where the part is attached to. It provides the transportation of the heat and guarantees the fixture of it.

The second scenario describes the application of AM as a spare part manufacturing method. Due to the shortfall of tools AM can start to produce products almost instantly and offers a flexible production for the volatile spare part demand. Especially slow-moving parts that generate high costs during storage can be replaced by additively

produced ones. There are some limitations due to the size of the build chamber and the speed or the material choice. But future developments will broaden the area of application and more parts will be able to be produced with AM. This can be done in different ways. On the one hand the OEM can produce the part and send it to the MRO provider which ordered the part. On the other hand it is imaginable that there is a database where the production instructions are saved and the MRO provider can purchase a license to manufacture the part by itself. In this case the supply chain gets considerably leaner and the MRO provider can react much faster. In contrast to the easy access for the MRO provider, the digital availability put the security of the information at risk. If the data is stolen and illegally distributed on the web then the OEM loses profits of the license purchase. For this risk counteractions have to be developed.

The next scenario shows the application of AM even for the design of aircrafts. The primes like Boeing and Airbus can use AM parts to enhance the performance of their aircrafts. Lightweight parts reduce the weight of the aircraft so it becomes more fuel efficient as this is a major criterion when airlines purchase new ones. The assembly effort can be reduced, too. AM can build assembled products or an integrated assembly support. Furthermore parts can be optimized for their application so the durability is going to be higher. Further developments of the accurateness will lead to a shortfall of finishing so parts can be produced just in time. Warehousing can then be significantly reduced while the supply chain gets more agile. So the primes have a higher flexibility within their production as they often have to decrease and increase the in- and output due to a volatile order receipt and counter-orders. The introduction of AM by the primes has the side effect that the technology is officially approved and is integrated in the CMMs. Then the MRO providers latest can use the technology to repair defective parts and gain all the advantages that come along.

The last scenario describes an advanced application of AM in the aerospace. If the technology is well developed it is possible to manufacture spare parts at the ramp. Together with a reliable part monitoring and usage based lifetime prediction, the part can be produced with AM while the aircraft is still in the air. Warehousing and logistics could be significantly reduced due to a flexible on-time manufacturing. Thus costs could be decreased considerably and the MRO provider could become much more competitive, too.

Up to now the introduction of AM in the aerospace industry is hesitant. There are still some problems that have to be solved but nevertheless there are already applications possible. The certification process is difficult because the experience with this relatively new technology is not easy. The build chamber size and the speed of the manufacturing process are both not at the level they need to have for a full application in the aerospace. Nevertheless some of the tier 1 suppliers already research applications and try to bring the technology to the market within the next years to be able to profit by the advantages of AM.

The currently existing business models will be influenced in the future by the use of AM because the technology offers new potentials. The shape of the change can differ enormously. It depends on the development of the additive technology within the next years. The faster the technology will develop the more opportunities are going to be provided. The question is to what extent the Part 21/J design organizations will make use of the technology. One can assume that the better the technology, the higher is the chance that the technology is used more often. This is the case especially if improvements in the areas of surface quality, dimensional accuracy and process control will be achieved. Thus the technology can be used for a much broader area of applications and can cause further changes of the existing business models.