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Local 3D printing of spare parts can reduce operating costs up to 58%

Additive Manufacturing (AM), also known as 3D printing, has some advantages compared to traditional manufacturing technologies. For instance, AM can be used to produce small series of products on short notice, with low setup costs compared to traditional manufacturing. This is especially relevant for expensive technical systems that need spare parts for their upkeep. My PhD research shows that using AM in these so-called service supply chains can have significant financial and operational benefits.

Expensive technical equipment, such as airplanes and weapons systems, usually needs many different spare parts, but only one or a few at a time. In theory, AM is extremely suitable for spare parts production because it does not need expensive tooling and has very low setup costs, unlike traditional technologies like CNC milling and turning or injection molding. I studied how AM can best be incorporated in service supply chains, by investigating four scenarios using a combination of mathematical modelling techniques and field data.

The first scenario, simply switching from traditional to additive manufacturing while still producing the parts at a central location, has some benefits but does not unlock the real value of AM. The second scenario works better: instead of producing spare parts in a central location, firms can print spare parts close to where they are needed. This is especially useful in remote locations, where local AM capacity can quickly provide temporary replacements during spare parts shortages.

Specifically, local AM can reduce operating costs by up to 58% because it allows asset owners to reduce spare parts inventory and to keep their equipment working without expensive conventional emergency shipment methods.

In the short term, we expect that AM will also be successful in other settings where the regular supply mode does not work, or does not work as well. The third scenario, completely eliminating all inventory from the supply chain (i.e. only starting production after a component has failed), is not advisable. On-demand production means that asset owners have to wait for printing and delivery of the spare parts. While inventory-free supply chains are often mentioned as an AM hype, this thesis shows that this is simply too expensive for systems with high downtime costs.

The most successful AM implementations will rely on local AM capacity. This is further supported by the fourth scenario, a new business model: intellectual property (IP) licensing. In this scenario, the original equipment manufacturer (OEM) does not make and sell the spare parts but acts as an IP licensor, allowing others to locally produce the spare parts with their AM equipment. This can be more than twice as profitable for the OEM compared to traditional spare parts sales. IP licensing also allows the supply chain to completely decentralize, with traditional mass-manufacturing facilities being replaced by local printing hubs that can simply download component designs from central servers.

My research shows how AM can be successfully incorporated into service supply chains. Local printing hubs could become especially important in the service supply chains of the future. Fortunately, the network of local 3D printing service providers (PSPs) that supplies this local printing capacity is growing rapidly. With the help of this network, OEMs and asset owners do not need to invest in expensive AM capacity and training of specialized operators to make sure they have the spare parts they need.

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