

Development of Deployable Systems for Point-of-need Recycling and Additive Manufacturing

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ABSTRACT

A deployable manufacturing system (DMS) is used to recycle scrap metals at the point of need, producing AM-grade metal powders which are subsequently used in 3D-printing for new part production or repair. The DMS creates a closed-loop part life cycle. Old parts are melted, converted to powder, and 3D-printed into new parts. A closed-loop part life cycle at the point of need provides strategic, economical, and environmental benefits. The DMS is effective in reducing lead time, lessening supply chain dependency, minimizing inventory, and lowering shipment costs.

INTRODUCTION

Logistics often comprises a sizable portion of total product costs. Transportation of metal powders over long distances is economically disadvantageous when compared to production of powders at the point of use. Conventional manufacturing involves large-scale production of massive quantities of material at a centralized location. Economy of scale at the centralized manufacturing location allows favorable economics, but shipping product to the customer grows more expensive as the distance to the point of use increases. For heavier consumables such as metal powders, shipments across the world incur substantial costs – for example, the US Army’s costs of logistics for a gallon of gasoline (which is much lighter than metal powder) can exceed the costs of production by as much as 10,000%¹. In general, shipment of heavy consumables over large distances consumes valuable fuel and harms the environment. Although the environmental damage of transportation may be mitigated by the rise of electric vehicles, distributed recycling will still be far more efficient. In addition to energy costs, regulatory requirements for international shipments can be prohibitively slow and expensive². In some cases, intellectual property protection requires mutilation of scrap parts before disposal to prevent counterfeiting³. The cost of disposal for a broken part can be eliminated by simply recycling the material into AM-grade powder and printing a replacement. The turnaround on part replacement with a distributed recycling strategy is in range of days to weeks, whereas lead time can be in the range of weeks to months for centralized manufacturing.

As the world’s mines dwindle away, recycling will be inevitable. Complete metal life cycle management is the way of the future, eliminating vast amounts of wasted energy. Consider the difference between shipping a single 20’ shipping container to a depot where parts are scrapped vs. shipping the entire scrap pile to a recycling facility. The recycling facility will produce bulk material which will subsequently be

¹ Marc Pepi, US ARMY – “A gallon of gasoline costs as much as \$400 at the point of use.”

² Confidential source from the energy industry

³ Ibid