Comparison of production strategies and degree of postponement when incorporating additive manufacturing to product supply chains


Abstract

The best-selling products manufactured nowadays are made in long series along rigid product value chains. Product repetition and continuous/stable manufacturing is seen as a chance for achieving economies of scale. Nevertheless, these speculative strategies fail to meet special customer demands, thus reducing the effective market share of a product in a range.

Additive Manufacturing technologies open promising product customization opportunities; however, to achieve it, it is necessary to delay the production operations in order to incorporate the customer’s inputs in the product materialization.

The study offered in the present paper compares different possible production strategies for a product (via conventional technologies and Additive Manufacturing) and assesses the degree of postponement that it would be recommended in order to meet a certain demand distribution. The problem solving is calculated by a program containing a stochastic mathematical model which incorporates extensive information on costs and lead times for the required manufacturing operations.

Keywords: Additive Manufacturing; Ultra-postponement; Supply Chain
1. Introduction

Additive Manufacturing (AM) technologies are a broad set of very promising methods and tools capable to deploy unit-to-unit mass customization and to materialize product manufacturing just in the time and place where demand occurs. The first AM technologies have been available over more than thirty years; and so they are starting to be mature. However, the introduction of AM across the Product Value Chain is still uneven over the different product stages.

Having a look at the early stages of product development (conceptualization, early design, prototyping and testing), at the present time it is possible to state that most of the companies in the industrial sectors duly apply AM technologies to achieve better results. Moving a bit forward to manufacturing stages, many industrial companies use AM for tooling and parallel applications but few companies use AM to materialize the product itself. Furthermore, when arriving to the distribution and point-of-demand application, only very few incipient industry cases use AM to bring value to the product. And finally, when arriving to the end-of-life product stages, even less cases can be found where the material recovery aims to AM reprocessing activities.

The reasons for this unequal application are both technological –some materials and part’s requirements cannot still be meet with AM technologies where in other applications complexity can be meet seamlessly- as well as of economical competence –manly related to the value-added product niche and the cost level achieved-. Building into these ideas, the present study focuses on the importance of delaying production respecting the moment when the demand occurs thanks to AM technologies and the implications of this approach to the entire product value chain competitiveness.

1.1. Postponement and speculative production strategies. Customer Order Decoupling Point (CODP)

As commonly introduced in the literature, a particularly relevant way to improve the efficiency of a product deployment value chain is to postpone any changes in the product to the latest possible moment. When applying this rationale to design, manufacturing and distribution strategies, the concept of postponement relates to the matter of delaying the supply chain processes as much as possible to the moment of the customer purchase, in order to incorporate the maximum features requested by the clients; whilst meeting the supply chain delivery times required.

On the contrary, as opposite approach, the speculation concept relates to the advancement of all transformation activities to the earliest possible moment, much before the demand occurs, in order to reduce product costs and to capture a specific demand forecasted in advance.

The moment in time where the acquisition of the product by a customer happens is referred as the Customer Order Decoupling Point (CODP)[1] and serves as a milestone from which the part design is considered as frozen. In this way, the CODP specifies the position in the product value chain where the postponement occurs. As a consequence of postponement, as introduced by Yang et al.[2], when the CODP moves upstream, the effectiveness and flexibility of the supply chain gets enhanced.

In the general case, companies need to know in which degree for each case is preferable to use some postponement supply chain strategies in the short and in the long term. In particular, with the introduction of additive manufacturing technologies to the range of manufacturing possible strategies to manufacture a product, the assortment of possibilities expands and the solution of the problem increases in complexity; thus requiring a knowledge-intensive mathematical approach.

The impact in the supply chain of delaying the production start to the moment when the demand occurs has been addressed by authors by constructing analytical models [3] and by optimizing the product allocation of resources [4], [5]. The studies combining of the impact in the supply chain of ultra-postponement plus the use of 3D printing technologies are revealing that it will change the way the goods are produced. This conclusion is inferred after performing quantitative analysis comparing total supply chain costs of using 3D manufacturing versus classical manufacturing in different companies [6,7] and by identifying specific business areas of impact of 3D printing in relation to other supply chain strategies [8].
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات