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The Role of Additive Manufacturing Technology in job creation: an exploratory case study of suppliers of Additive Manufacturing in Sweden

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Abstract

This paper investigates how Additive Manufacturing (AM) technologies, as a process innovation, may contribute to a job creation. Further, the various mechanisms in which AM may contribute to an increase in job creation as well as the types of jobs are analyzed. The analysis also goes beyond AM technologies and incorporates other non-technological factors which foster job creation, i.e. higher wages in BRIC countries, lower quality in BRIC countries, and a rising demand for western-made products. The analysis is based on a case study and the data collected was through interviews with three prominent actors within the AM technologies field in Sweden: technology developers, leading suppliers and users. The main findings indicate that AM (i) contributes to job creation in both the manufacturing sector and in the service sector, (ii) does not bring back mass production jobs from emerging economies such as BRIC, (iii) contributes to job creation in product development stages (e.g. rapid prototyping), and (iv) contributes to job creation in production stages of low-volume batches mainly of complex products. The findings also suggest there are barriers for full exploitation of AM in several areas, including education systems.

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Keywords: Additive Manufacturing Technologies; job creation; 3D printing; exploratory case study; Sweden

1. Introduction

It is extensively discussed that a new process innovation (e.g. emergence of new production methods) creates job losses and hence may even harm the economy in the short term [1]. This is because machines such as robots or 3D printers can substitute (unskilled) labor and which leads to job losses. [2]. This paper challenges this view by focusing on one particular example of process innovation, which emerged nearly three decades ago, i.e. Additive Manufacturing Technology [3] [4]. In Sweden a new strategic agenda for innovation in production was proposed in April 2014, called "Made in Sweden 2030". The agenda was developed by engineering industries in close cooperation with Swedish Production Academy, Swerea IVF, Chalmers, KTH and IF Metall[*]. The agenda identifies six key areas to strengthen production and job creation in Sweden. Three out of these six areas are related to Additive Manufacturing, i.e. flexible manufacturing processes, environmentally sustainable production, and product and production based services. Moreover, a new Swedish association is established in March 2014, aiming to increase the knowledge around Additive Manufacturing, particularly in the production stages. Their belief is that Swedish market lagging behind in comparison to the rest of the world (North America) and Europe (particularly

[*] http://www.produktion2030.se/

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Germany and UK)[†]. There seems to be particular interest on the role of AM on job creation. However, there are several questions to be addressed. Firstly, through which mechanisms AM may create new jobs? Is it through bringing back jobs from BRIC[‡]? And/or through initiating new manufacturing jobs in Sweden that never have been existed before? And/or through initiating new service jobs in Sweden that never existed before (multiplier effects)? Secondly, during which stage of production does AM contribute to creating jobs (type of jobs)? Is it in the product development stage (e.g. rapid prototyping)? And/or is it in the production stage (mass versus low volume production batches)?

The aim of this paper is to analyze the role of Additive Manufacturing technologies on job creation in Sweden. In order to do so, the paper distinguishes between various mechanisms from which jobs can be created in Sweden through AM technologies. Further distinction is made concerning the stage of the production during which AM may create jobs. Empirical analysis in based on exploratory case study interviews with three prominent actors in AM technologies as technology developers, leading suppliers and users in Sweden.

The rest of the paper is as follows. Section 2 provides a literature review aiming to identify several factors, which contribute to the rise in manufacturing jobs in western countries. Section 3 specifies the method, which is used in the empirical part of this study and also briefly describes the companies, which are interviewed. Section 4 provides the results and discussion of the exploratory case study. Section 5 concludes and provides suggestions for further research.

2. Literature Review

This section provides a review of literature with the aim of identifying several factors contributing to the rise of manufacturing jobs in western countries. This section is heavily based on the literature review conducted in [4], in which four driving forces of the rise in manufacturing jobs in western countries were identified: (i) emergence of new process innovations (e.g. AM technologies) in western economies, (ii) rising wage-levels in emerging economies (iii) falling quality of business milieu in emerging economies, and (iv) rising demand for western-made manufacturing. Since the aim of this paper is to highlight the contribution of AM technologies, particular attention is devoted to the first factor.

2.1. Role of new process innovations (e.g. AM technologies) for creating jobs

The cost of producing much smaller batches of a wider variety (with each product tailored precisely to each customer's need) is falling. The factory of the future seems to have a focus on mass-customization, rather than traditional mass-production. This allows for lesser reliance on economies of scale (available through extensive availability of cheap suppliers in China), which could eventually lead to a rise in some manufacturing activities moving back to western countries once again. This is indeed what [5] argued: "disproportionate improvements in the technology for customization in a region can shift the manufacturing toward that region (here referring to the western countries, in particular US)". One prominent example of such "improvements in technology" is the Additive Manufacturing (AM) technology. It is a relatively new manufacturing method (process innovation) that first came into use in the late 1980's[§]. According to CEO of Koenigsegg (A Swedish hyper-car company), AM technology has proven useful for both (i) prototyping (faster and less waste) and also for (ii) production phase (especially in low volume and extremely complex products), because of the lower cost of production in compare with casting techniques [6]. Moreover, the AM technology provides a major gain in productivity which in turn drives down the production cost and hence may even offset the BRIC ' wage/cost advantageous [7]. In addition, combining this competitive pricing with the concept of quicker delivery to customers will provide local suppliers with an advantage over their foreign competitors who are highly competitive in their markets [8].

Moreover, the rising cost of energy and its efficacy is the major barrier for the future of manufacturing and play a significant role in shaping the geography of production. One major cost of energy is associated with waste. AM processes are shown to be capable of producing significantly lower waste compared to conventional methods [8]. Another major source of overall energy costs is the cost of transportation. Much more energy is needed to ship and deliver parts from a long distance than to ship them from a local or regional retailer and supplier. Studies indicates that due to problems such as communication and tool rework and transportation costs, the actual costs of offshore manufacturing can be higher than is estimated in many cases [8]. To sum up, the emergence of new process innovations (such as AM technologies) makes it possible to locate the manufacturing in relatively high-labour costs regions, because of the productivity gains that such new process innovation can offer. Moreover, the ability of AM technologies to meet the new trend toward mass-customized production (both for final products and prototypes) makes it an attractive option for western companies to employ. Moreover, AM technologies can boost service-provider jobs around the manufacturing jobs, i.e. multiplier effects [7]. At the end, since the type of jobs returning are different; there is a need for different skills. This implies there would be more need for high-skilled labour to operate with advanced machinery like 3D printers.

2.2. Role of other factors for creating jobs

Apart from emergence of new process innovations in western countries, [4] we identified three more factors contributing to the rise of manufacturing jobs in western countries. Wage-levels have always been an important motive

[†] http://www.sveat.se/