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Additive Manufacturing in Finland: Recommendations for a Renewed Innovation Policy

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Abstract

The objective of this research is to define an optimal innovation policy and funding strategy to improve Additive Manufacturing (AM) capabilities in Finnish companies. To do so, we present an international review of innovation programs in the area of AM. In addition, the study replied upon a survey prepared to evaluate factors for AM implementation. The ultimate goal is to help in the definition of a national policy strategy in the area of AM based on the characteristics of the Finnish industrial ecosystem.

The methodology and data collection method involved defining the taxonomy of Finnish AM industry. The target group of the survey was a population of AM experts, and individuals with knowledge on AM and industrial processes. Overall, the survey revealed that research and innovation activities are well positioned in Finland. In order for future innovation policies to further support developments in the field, we estimated that policy strategies need to generate about 6-8 M€/year in national and EU-funding instruments for AM technology transfer, development, and innovation activities. Efforts should be targeted towards strengthening uses of AM in final production. In fact, only 36% of Finnish respondents declared to use AM for final production, while leading countries in AM use it in average more than 50%. Another area in need of development in Finland is the use of AM high performance materials. Moreover, outsourcing of AM services in Finland is 23 percentage point higher in national and 13 percentage point higher in international outsourcing to service bureaus and suppliers. In this regard, future policies and funding strategies should maintain the created momentum. However, there is a need to acquire high-end research and industrial equipment to stimulate AM integration to the existing production systems. This in the end can trigger the creation of new products, processes and intellectual property, enabling innovation and competitive advantage.

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Keywords: Additive Manufacturing; 3D Printing; Survey; Innovation policy; Technology applications; Rapid prototyping; Rapid Manufacturing

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1. Introduction

In recent years, 3D printing (also known as additive manufacturing [AM]) technologies have come to the spotlight of manufacturing (Simpson et al. 2016). Improvements in AM systems along with new material processing capabilities have made the technology suitable for manufacturing applications. The hypothesis is that AM can coexist and, in certain cases, even replace conventional manufacturing techniques based on subtractive and formative methods. However, there are gaps between the technological projection and the practical constraints of the technology (Gibson 2017). To some extent, companies today have two different approaches to find innovative applications using AM. On the one hand, they are looking to replace or repair components for their legacy systems. Examples of these types of uses include spare part applications (Khajavi et al. 2014) and retrofitting existing machine components (Rylands et al. 2016). On the other, they also want to evaluate the impact of new AM designed components for improved functional performance (i.e. part consolidation, topology optimization and decreased weight) (Rosen 2014). In both cases, technology transfer decisions depend on multiple factors. As introduced by Lindqvist et al. (2016), issues such the taxonomy of the company, the country specific industrial ecosystem, the manufacturing practices and company culture, the production volumes and material requirements, as well as the supply chain structure of the companies are critical for the adoption of new AM methods. Indeed, AM systems are impossible to paint with a single brush (Petrovic et al. 2011), as they are able to process multiple materials, which range from plastics and metals to ceramics (Singh et al. 2017) for industrial applications in prototyping, tooling, or final production (Wohlers & Gornet 2016). Moreover, today AM is used in basic research and development activities (Jürgen Gausemeier et al. 2013), as well as medical applications (Tuomi et al. 2014).

To promote successful adoption of AM technologies in Finnish companies, the aim is to find areas in which Finland is underperforming in comparison to other countries and define concrete actions for innovation policy recommendations. In order to develop a suitable policy strategy to create competitive advantage and evaluate the transferability of AM into Finnish companies, the viability of AM applications must be preceded by the strategic alignment of business, manufacturing, and R&D strategy of firms (Mellor et al. 2014). Indeed, “one size does not fit all” and, as such, the same innovation stimulus cannot create the same effect in all companies, as their activities and processes are different in nature. Furthermore, in most cases, the underlining issue on AM implementation relates to technology transfer, technology push, and diffusion of innovation (Flores Ituarte, I. et al. 2016). As introduced by Bailey (1993), all changes in an organization’s technology has an influence on operational and administrative structures within the organization.

Consequently, innovation policies that aim at creating competitive advantage from the implementation of AM, need to consider the taxonomy of the technology users (i.e. company size, technology applications, and AM materials in use). Companies experience various bottlenecks for AM transferability, such as strategic factors, supply chain factors, technological factors, organizational factors, etc…. Considering this prospect, this research defines the taxonomy of Finnish industry regarding the use and practices of AM. We achieved this objective by designing a survey, which allowed us to classify the companies participating by (1) size and demographic groups, (2) technology parameters (e.g. technology applications in the organization and materials in use), (3) factors for AM implementation, and (4) suitable innovation strategies according to their view.

2. Material and Data Collection

The study begun with investigating and comparing public research and innovation investments in AM per country. The studied variables included, country population, GDP and filed patents from 2005 until 2011. The methods for the data collection involved specialized industry reports and different internet sources (i.e. primary sources specialized industry reports, articles and books, secondary sources include internet publications in the field). In addition, empirical data was collected via a survey aimed at defining the taxonomy of the respondents and supporting the drafting of policy recommendations (for more details on the survey see appendix A1).

The survey used complementary channels to gather information. These included email lists of professional organizations that have a relationship with AM technologies (e.g. Finnish Rapid Prototyping Association FIRPA ry), international professional groups using social media channels, such as LinkedIn (e.g. Additive manufacturing user group “AMUG”, Global Alliance of Additive Manufacturing Associations “GAAMA”, etc.), and sub-contracting