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Creating learning environment connecting engineering design and 3D printing

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Abstract

Engineering education in modern days require continuous development in didactics, pedagogics and used practical methods. 3D printing provides excellent opportunity to connect different engineering areas into practice and produce learning by doing applications. The 3D-printing technology used in this study is FDM (Fused deposition modeling). FDM is the most used 3D-printing technology by commercial numbers at the moment and the qualities of the technology makes it popular especially in academic environments. For achieving the best result possible, students will incorporate the principles of DFAM (Design for additive manufacturing) into their engineering design studies together with 3D printing.

This paper presents a plan for creating learning environment for mechanical engineering students combining the aspects of engineering design, 3D-CAD learning and AM (additive manufacturing). As a result, process charts for carrying out the 3D printing process from technological point of view and design process for AM from engineering design point of view were created. These charts are used in engineering design education. The learning environment is developed to work also as a platform for Bachelor theses, work-training environment for students, prototyping service centre for cooperation partners and source of information for mechanical engineering education in Lapland University of Applied Sciences.

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Keywords: 3D printing, fused deposition modeling, design for additive manufacturing, engineering design, learning environment

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1. Introduction

Engineering education require different methods to combine traditional theory-based learning into hands-on learning. Additive manufacturing (AM) offers a great opportunity to connect practical work into different engineering areas. Different AM technologies enable numerous applications to harness engineering thinking into practice. Engineering design is based on general product development process and it is combined to the generic AM process chain in order to create new way to look AM product design cycle from learning point of view. The generic product development model offers clear start to the new model since it consists of sequential steps covering the process all the way from planning phase to production ramp-up. The model gives the foundation to the design process also from the learning point of view when conceiving, designing and realization are the main actions in the process. (Ulrich et al. 2008.)

Fused deposition modeling (FDM) is the most popular AM technology at the moment even measured by commercial numbers and it offers clear way to harness AM technology into engineering (Aniwaa 2016; Gibson et al. 2015). Even though AM and especially FDM is highly popular now, the learning side of the technology requires continuous investigation and development. The growing demand from the industry towards engineering education requires new kind of thinking in both teaching and learning. Modern engineers need to be skilled in participation and especially in a process, which will lead into the birth of new processes, products and projects. This requires different innovative methods in engineering education, which support the technical and theoretical expertise of an engineering student. (Crawley et al. 2014.) One important factor in AM in to apply the basics of DFAM principle (Design for additive manufacturing). DFAM is a design principle, which redefines the design guidelines especially for AM technologies. It enables the designing of printable object and takes into consideration all the necessary possibilities and limitations of used AM technology. (Thompson et al. 2016; Gibson et al. 2015.)

The aim and purpose of this study is to create a learning environment for mechanical engineering students in Lapland University of Applied Sciences in Finland (Lapland UAS), which combines traditional engineering design and additive manufacturing. For efficient learning of AM technologies, different process charts for learning purposes were created as the platform for the environment.

2. Creating learning environment

The creation of the learning environment is based on the studies provided by the mechanical engineering degree in Lapland UAS. One of the key factors in the degree is traditional engineering design, which combines several course contents into practice. Engineering design forms one way for the students to practice their skill in real-life situation by performing different customer projects. This is used as a starting point in creating the new learning environment in which AM in introduced to the functions of the existing operation. The principle of engineering design environment is presented in figure 1.

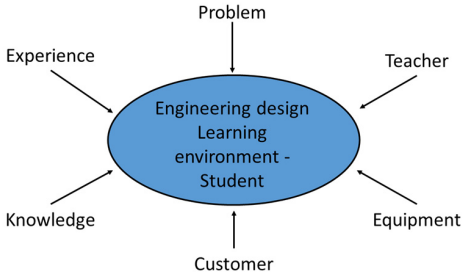

Fig. 1. Principle of engineering design learning environment.