The Impact of AI & ML in Agile Production

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Abstract— **Nowadays industries and organizations need to be flexible. Every modern organization has one similar goal on their agenda and this is to become "more Agile". The goals of these industries are to obtain a flexible structure in order to be able to stay relevant and competitive. Some of the technologies that make an improvement of the "agile production" possible are related with Artificial Intelligence and, in particular, Machine Learning. These methodologies are being implemented in the design phase of the R&D field of product development by using 3D printing as a tool.**

Keywords—**AI, ML, Agile production, 3D Printing**

I. INTRODUCTION

3D printing has to be considered as a revolution in the field of additive manufacturing. It provides us with the opportunity to physically produce relatively complex objects directly from digitally designed three dimensional models. The prototype is simply built by stacking two dimensional cross sections in successive layers unlike traditional machining, which involves a series of operations. Additive manufacturing also makes it possible to produce objects which were virtually impossible to produce [1].

One of the upcoming trends in optimizing and enhancing performance in additive manufacturing is by implementing artificial intelligence in the production process. This innovation raises the quality of the parts and improves the process. Machine learning allows for in-process detection of any areas of quality concern, enabling operators to ensure proper adjustment made, limiting waste of time and materials. The goal of this implementation is to establish the perfect print with minimum waste of material and for as little time as possible [3].

A direct consequence of this innovation is connected with a huge reduction of materials used. Scraps and waste do not have to be considered anymore, so it is not only a cheaper solution because it requires fewer machines, but also it needs fewer raw materials, less space and time less to create it and to market What? You need an object. Regarding additive manufacturing systems, AI plays a key role, as the introduction of Machine Learning, that permits the machinery to understand the type of work, and from this achievement to propose new solutions to the problems or new projects. The combination and the cooperation of these two factors will lead the future of the Agile Production. In [9] the opportunities and challenges of Industry 4.0 for production engineering and management are analyzed.

Challenges for Bulgarian industrial small and medium sized enterprises to manage change effectively are revised in [8].

The goal of the paper is to evaluate the opportunities provided by the AI, ML and 3D printing to Agile production.

II. APPLICATION OF ARTIFICIAL INTELLIGENCE WITH THE USE OF 3D PRINTING

A. Modelling software

Nowadays, there is a lot of CAD software that allows us to generate 3D models. For example, Sledworks, Autodesk or SketchUp can be found on the market:. With this kind of software, it is easier to generate 3D models with the interception of different solids and large tools libraries, and it is even possible to create a lot of different products quickly. To be able to 3D print your project, you will necessarily have to work on your 3D model using CAD software. AI will be more and more included in these 3D modeling programs in order to help you create the best 3D printable models. Solidworks recently unveiled Solidworks Xdesign, a great tool using AI, while Autodesk developed Dream Catcher a tool allowing work on regenerative designs [4]. It is possible to generate hundreds of designs in only a few hours using this program. It is a great way to develop tools capable of finding defects inside a 3D model, which could make it non-printable. This use of AI could be a perfect solution to start your 3D printing project with viable 3D models.

Instead of spending time on checking printability, design for printing should be considered an efficient and convenient approach, which means all models will be designed to match 3DP in particular. Thus, clients will not consider printability but only follow the 3DP criteria to design with the help of intelligent algorithms and CAD.

3D printing can be summarized in three different steps:

1. Modelling: creation of the model using CAD software.

2. Printing: conversion of the 3D model into a physical object.

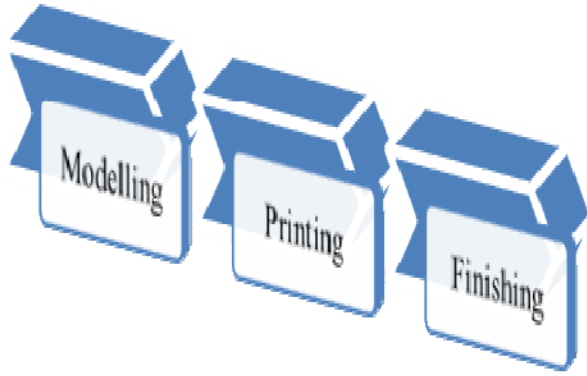3. Finishing: definition of the details using higher resolution hardware.

Fig.1 Steps of 3D printing

We can summarize the 3D printing process with the following diagram:
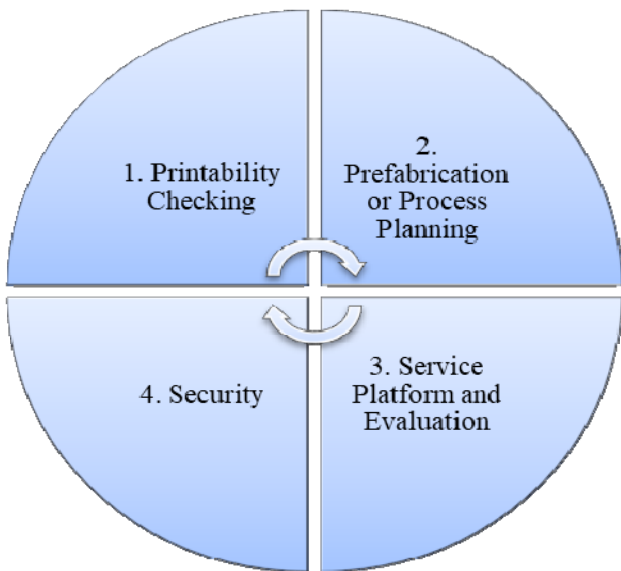

Fig.2 3D printing process

Printability Checking: it represents the level of accuracy of a 3D model in a detailed manner.
- ✓ Original printability checker: helps reduce the complexity of the product that depends on the choice of the indicators.
- ✓ Improvement by Machine Learning.
- ✓ Further Developments.

Prefabrication or Process Planning:
- ✓ Slicing Acceleration.
- ✓ Path Optimization.
- ✓ Further Developments.

Service Platform and Evaluation: methods used in order to fulfil every request in a fast and efficient way.
- ✓ Cloud service Platform.
- ✓ Service Evaluation.
- ✓ Further Developments.

Security: defense against cyber or physical attacks.
- ✓ Attack Detection.
- ✓ Further Developments.

B. Combined use of Machine Learning and AI

To be able to 3D print your project, you will necessarily have to work on your 3D model using CAD software. AI will be more and more included in these 3D modeling programs in order to help you create the best 3D printable models. It is possible to generate hundreds of designs in only a few hours using modeling software such as Solidworks Xdesign. It is a great way of developing tools capable of finding defects inside a 3D model, which could make it non-printable. This use of AI could be a perfect solution to start your 3D printing project with viable 3D models. These two methodologies combined can lead to a future, where there will be not only fully automated systems, but also improvement systems that will not require any human intervention. That means reduction in the scraps and waste and a complete optimization of the production in terms of time, efficiency, quality, availability.

This development path has already had a lot of noticeable results, and it will surely be the upcoming frontier of additive manufacturing. Artificial Intelligence could clearly be included in a 3D printing factory and change the future of manufacturing.

C. Detecting Defects from Printing Process and remeding them using Machine Learning and AI

Artificial Intelligence could clearly help to improve the printing process and avoid errors. There is always a constant desire to improve the additive manufacturing process in order to get the best parts possible. AI and machine learning can also be used in the 3D printer after their printing process. They can detect problems directly, and improve the quality control of 3D printed parts. It could considerably reduce time and material waste. If we already know that 3D printing is a time-saving manufacturing technique, with improvements made using AI, it could become even more powerful. Machine learning, and predictive modeling, a powerful subset of AI, is being used to accelerate the discovery of these new materials. Designers simply enter the desired properties into a program and algorithms predict which chemical building blocks can be combined at a micro level to create a structure with the desired functions and properties.

D. Agile Metal Technology

Which is the method-the sentence does not have a subject A flexible method that allows for the automation of difficult and complex procedures, finding the best solutions.

It is composed of six different modules:

- ✓ Business Case: evaluation of the best materials.

- ✓ Design Optimizer: deep analysis to obtain a suggested modification or to find better solutions.

- ✓ Lattice Generator: aims to find the best solution concerning costs and weight reduction.

- ✓ Support Optimizer: the list of all the supports needed for the process.
- ✓ Post-Processor: considers the timeline and budget.
- ✓ Batch Controller: optimization of the production (price, time and space).
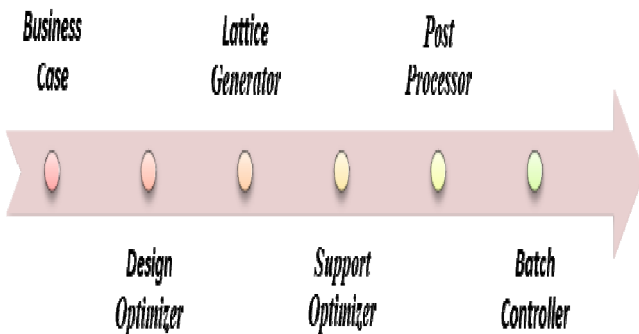

Fig.3 Modules of the Agile Metal Technology

E. Relation of Artificial Intelligence with the Production Implementation

The progress of Artificial Intelligence, in particular in the field of self-monitoring and self-improvement, will end human work, which will just take on a supervising role. The simulation of human movement will replace real movement because it costs less and it can work without stops and without losing efficiency. The following diagram shows the growing capabilities (red) and the emerging ones (black):
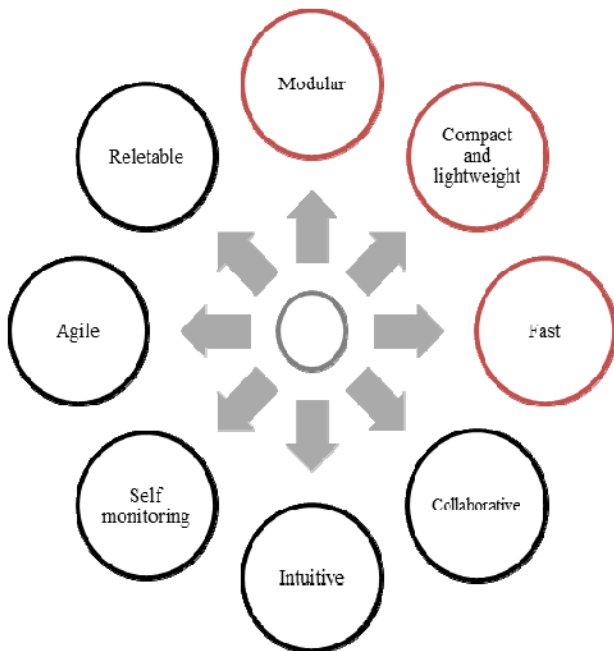

Fig. 4 The growing capabilities (red) and the emerging ones (black) of AI with the production implementation

F. Relation Between Neural Network and AI

Neural Network is a system with the ability to recognize an object due to a period in which it is taught with images or some other different types of inputs. Like AI, it is very important to connect the technology with 3D printing, in particular, thanks to the "brain" it is able to understand errors and learn from the data received [6].

III. CONCLUSION

The development of these new technologies will be an advantage for industries that will always be ready to adapt to every market type, because this solution takes the Agile Production to its highest level. Of course, the production level will increase, and manual work will be cancelled, but this fact will maybe open doors to a world full of creativity in the realization of projects that will always be easier to realize. Hopefully, one day this technology will not be used only in addictive??? manufacturing or in the production process but also in several other fields.

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