Development prospects of introduction of innovative technologies 3d-printing in Kazakhstan

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Abstract. The article describes material about the main prospects that require research for the implementation and operation of new additive technology in the Republic of Kazakhstan. The main problems of introducing new technologies are considered. New technologies, in the broad sense of their presence, or absence, determine the strategic position of the national economy in the world. The availability of technologies provides scientists or designers with powerful tools for the implementation of new ideas. The lack of technology limits the creativity of scientists and engineers, forcing them to apply outdated technical solutions that are in their possession, rather than those that enable them to achieve the new goals. Therefore, technology itself is a major part of innovation. The market situation is changing and only interested consumers remain. Market trends for the next decade are discussed. Furthermore, the article also discusses the advantages of introducing CAD systems into the educational process and software products of the COMPASS family. The Republic of Kazakhstan needs competent specialists who can apply the most modern technologies. As 3D printing technology advances and more people are exposed to it, they realize it can be applied to many different problems in many different fields; thus the opportunity for innovation is tremendous.

1. The relevance research
Over the past years, industries in Kazakhstan and in other SNG countries have undergone significant transformation. Enterprises have experienced entry into the market, reducing the influence of the government in the economy, interruption of well-established cooperative relations, the disappearance of traditional channels and product markets, the appearance of more efficient foreign competitors, as well as the process of change of ownership.

Additive technologies (Additive Manufacturing, or AM) is a term that is currently applied in almost all sectors and spheres of human activity; heavy industry and dentistry, foundry and cooking, light industry and construction. AM allows the creation of new components which cannot be achieved by any other process, such as successfully conducting research in the field of 3D-printing in tissue engineering to create artificial human organs.

Now there are a lot of different technologies for layering. Currently there is no clear classification in Additive Manufacturing. Each country names and classifies it differently. The main goal of the research is to consider the possibility of the introduction of additive technologies in industrial production in Kazakhstan. The study focuses on the process of layered synthesis in the manufacture of prototypes and models and the definition of the main parameters affecting the quality of the produced parts. The scientific novelty and practical importance of the research of additive technologies for...
Kazakhstan is obvious. Firstly, a new area of technological knowledge for industrial productions created. In addition to the economic efficiency of the implementation of additive technologies in production, it also has a high social value. Additive technology is a completely new technology for Kazakhstan, for which there are no books and methodical recommendations. The research results can be the basis for new developments. [1]

The most widespread types of developed additive technologies are the following: stereo lithography (SL), which is the curing of a photo-reactive resin with ultraviolet laser or another similar power source; PolyJet technology, the layer-spraying of a photopolymer with the following curing of each layer; MIT- the layer-gluing of powder material particles, and 3DP, the inkjet deposition of liquid binder on powder. These technologies were used in military-space production and precision engineering, and were declassified after the expiration of the patent on the above mentioned SLS technology. [2]

FDM is the cheapest method of printing. It is highly popular. Currently, some Russian printers already use this technology, such as PICASO 3D Designer and Kazakh 3DLAB Prusa. In 2017 at the Kirov factory in Petropavlovsk, the first Kazakhstan three-dimensional printer was made.

It should be noted that the classification of the equipment for the additive technologies is not clearly formulated, and is interpreted depending on the producing country. [3]

Analysis of the situation regarding the implementation of additive technologies has shown the following weaknesses for the development of new technologies in Kazakhstan:
- Absence of a clear understanding of equipment, and its purpose resulting in its inefficient use;
- Unprofessional service;
- Lack of technical support.
- No quality advice due to the lack of highly qualified specialists. The main threat to the transfer of new technology in Kazakhstan is human potential.

2. Review of the relevant state
After initial commercialization in the 1980s and 1990s, today 3D-printing has proven itself as an attractive production solution for prototyping. In 2013, 3D-printing was of great interest. Key players quickly benefited from this interest, resulting in an exponential increase in revenue from 2013 to 2016. Since then, the buzz has died out.

The situation in the market is changing, and only interested consumers remain. 2018 was undeniably a huge year for the additive manufacturing industry. First of all it was 3D printing and the launch of new products, but in the industry there were also clear signs of advancement of industrialization. [4]

The Massachusetts University of Technology has made a number of significant impacts on the AM industry, largely through its innovative research projects. Notably, MIT has also launched a new 11-week online add-on course that has the potential to be one of the most important initiatives to reach professionals who have an interest in AM all over the world. [4]

Additive manufacturing is starting to find its place among other manufacturing methods. In particular, focus has now shifted away from the consumer and rapid prototyping, and towards the digitization of workflows and the manufacture of production quality final products. Several industries are now seriously analyzing the benefits and competitive edge that 3D printing can lend their operations, and the most eagerly anticipated technological innovations are catering for these professional users. Although all signs point to a period of seriousness and readjustment in the 3D printing market as it transitions to provide for the needs of this user group, there remains enormous potential for growth over the next decade. IDTechEx forecasts that the global market for 3D printing equipment, materials, software and services is estimated to be worth $31 billion by the year 2029. [5]

IDTechEx conducted exhaustive primary research with companies positioned throughout the entire 3D printing value chain for key insights into the trends impacting growth to 2028, fig.1.
Figure 1. Composite AM market forecast
(Source: https://www.3dprintingmedia.network/composites-additive-manufacturing-market-2028/)

The reader will observe that according to the well-known Wohlers Report, the 3D printing industry grew by 33.5% to $9.975 billion in 2018.

Figure 2. Am Industry Growth (source: Wohlers Reports 2019)

3. Results
This is the theory. In practice in Kazakhstan 3D printing today is mainly used for prototyping or very specific small-scale applications. A number of limitations have to be addressed before 3D printing could viably be used for large-scale manufacturing.

It can safely be said that in Kazakhstan firstly it is necessary to introduce three-dimensional modeling. Existence of 3D electronic modeling is sine qua non for additive technologies. Now you can be offered three options for obtaining CAD-model: from the Internet using existing databases; 3-D computer-aided design and 3-D scanning.
From the above it can be concluded that using computer solid modeling provides a rapid expansion of additive technology and its market price will decrease. The cost of printed products will depend on uniqueness and quality of three-dimensional digital model much more than on material and equipment. All of these suggest that technologies and systems of 3D printing will occupy an increasingly large place in our lives.

There are a lot of 3D modeling software such as COMPASS, 3D Max, AutoCad and many others. This allows to project an object of any shape and size, so the possibilities of Additive Manufacturing are limitless. Highly precise micro parts can be printed now. As for Kazakhstan, we can assume that the most widespread software package for creating three-dimensional models is KOMPAS-3D of Ascon.

A sensation in the world of CAD was the issue of the Russian freely distributed non-profit system of three-dimensional design KOMPAS-3D LT. This system is perfectly suited for educational development works in various sectors of activity. It is targeted mainly at students of technical universities, technical schools and colleges that do a lot of graphic work for different subjects and allows you to organize a real two-stage work process. In university computer laboratories, we can use a professional version, and the LT version on home computers.

COMPASS has successfully been used in more than 450 educational institutions in Russia, Ukraine, Kazakhstan and other CIS countries. Successful usage of the COMPASS in education is largely due to the fact that the company ASCON has released a series of informational and educational manuals to special versions of their packages not only for students but also for pupils. This allows students to work with CAD-systems not only in the classrooms, but also on their home computers, so it became possible to speak not only about superficial knowledge of the software product but about real mastering.

The reason for the choice of this software product is that COMPASS is used by leading machine-building enterprises of JSC "PMZ", a joint stock company "Tynys", which is part of the National Company "Kazakhstan Engineering". JSC "Tynys" works closely with companies such as NC"Kazakhstan Temir Joly" CNPC "Aktobe", "Kazakhtelecom", "Kazzinc","Arcelor Mittal Temirtau", "Kazakhstan Aluminium", "Kazakhmys Corporation", "KazTransOil", "Ust-Kamenogorsk Titanium magnesium Plant" and others. In addition, ASCON is an active participant of foreign economic activity: production of the plant is successfully entering into near markets and far abroad. The company has a huge intellectual potential, highly skilled workers and professionals. Currently there are more than ten companies using COMPASS software in the Akmola region, four of them have acquired the professional version of the product.

Students of University mastering the technique of three-dimensional modeling can demonstrate the three-dimensional image of any product on a flat screen. This is a powerful incentive for the creation
of better products. It is the foundation for the creative development of future specialists. It also reduces the routine work of creating drawings.

With the implementation of CAD systems in the educational process, it has become necessary to improve teaching methods. New ways of the organization forms and methods of the teacher's work with students have appeared. Traditional classes with a large audience and note-taking students lost its meaning (for example on the subject "Descriptive Geometry"). The style of independent work has also changed, giving time for additional material and providing private lessons for some special subjects. Students have the opportunity not only for self-study material, but also for self-evaluation. Now it is possible to do fast or in-depth study of topics which are not included in the required course.

With the necessity to move Kazakhstan’s economy from raw materials to service and technology, the implementation of computer aided design systems and the development of techniques to create three-dimensional models in the educational process is highly relevant. CAD systems and the speeding up of production, including development work will be required to assist the creation of the technology-intensive industrial sector in the Republic. Complying with international standards in the industry and in education will create the conditions for successful entry of Kazakhstan into the world market and its participation in the international division of labor.

The most important task is the comprehensive growth of labor productivity, and the technical equipment of modern industrial enterprise closely connected with the computer aided design systems (CAD). The correct choice of software and supplier of CAD / CAE / CAM systems will have a direct influence on the production, and the direction of development and trends.[6]

4. Discussion
A rather complex situation exists in the production field, and in high school, where the old and experienced engineering staff does not possess progressive methods of computer design and production-support work (preproduction), and the young, who are adapted to innovative technologies do not have enough work experience. The only condition for maximum effectiveness is the identity of the information environment of engineer and student. The relevance of the link between production and high school education has increased. Considering that a large part of cost (about 70%) in the industry accounted for design and technological preparation of production, it must be admitted that the implementation of CAD systems has become an urgent necessity.[7]

In 2018, the 3D printing market comprises multiple different printer technologies. Thus, the perspective direction for 3D printing in the industry is printing with metal powder and laser sintering, but there are two problems: a technological, and a normative.

First, additive technologies do not guarantee that detail will immediately go into production, as we would like. Concerning details for the industry, similar projects should be certified, similar to inspection of details for responsible units. For this, you need to have standards that you can target. Therefore, it is necessary to have standards that serve as examples.

5. Conclusion
Nowadays, when profits of enterprises depend on the speed of response to market needs, it is necessary to use new technologies that provide updating its range of products in short terms. For successful business development you need to respond quickly to growing and changing demands of consumers, this means greatly simplifying, accelerating and reducing expenses of manufacture. Kazakhstan needs new technologies for machine building, thus it needs three-dimensional printing.

Technologies discussed in this article are not only modern and highly effective, but also innovative in its essence, because they enable the generation of new technologies, carrying a new quality.

Besides obvious advantages in speed and often in reducing the manufacturing cost of products, these technologies have important advantage in terms of environmental protection, and in particular, greenhouse gas emissions and "thermal" pollution.[8]

Additive technologies have great potential in reducing energy costs for the creation of a wide variety of products. Without specialists of this technology will not happen in Kazakhstan.
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