

THREE-DIMENSIONAL (3D) PRINTING AS INTELLECTUAL PROPERTY

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Abstract

The subject matter of this article is the three-dimensional (3D) printing and its protection as industrial property, more particularly as inventions. It indicates the essence of 3D printing and the areas of application of the technology. The protection of the results of 3D printing as inventions is considered, also the advantages and disadvantages of additive manufacturing are analysed. A profile of the enterprises developing 3D printing technologies has been made. The results of the performed patent research are analysed. The filed applications for inventions and the issued patents in the field of 3D printing in a national and international aspect are identified.

Key words: three – dimensional (3D) printing, additive manufacturing, inventions, patent protection, intellectual property

JEL: A20, O3

Introduction

Three-dimensional (3D) printing is a technology that differs from traditional manufacturing processes such as molding and casting. 3D printing technology builds 3D objects by sequentially creating layers on top of each other. Rooted in manufacturing research since the 1980s, 3D printing has become a wide range of technologies that can fundamentally change production processes. (Bechtold, 2015). 3D printing is the subject of scientific research by a number of enterprises, universities, research laboratories involved in the development of modern technologies. In an innovative world where more and more companies are investing in nanotechnology, cybersecurity, robotics, and information technology (IT) results, 3D printing could be a real breakthrough in technology in the near future. There is a tendency for a significant increase in investment in the field of 3D printing. According to the McKinsey Global Institute, by 2025, 3D printing could have an economic impact of \$ 200 billion to \$ 500 billion a year. Additive manufacturing is changing not only industries, introducing a new kind of industry, but humanity as a whole. This technology has an impact on society in every area, but this impact has both positive and negative sides.

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In the present article, the results of 3D printing technology will be considered, and the way in which they are protected as objects of industrial property and in particular as inventions. 3D printing stimulates a more efficient use of resources and transforms the way products are produced. Countries such as China, the United States, Japan, and South Korea are investing billions in the development of technology and the training of skilled specialists that could be realized in this high-tech field.

Companies adopt different modes to protect 3D printing as intellectual property (IP). The products obtained from the implemented technology, the 3D printers, their components, as well as the processes through which the technology is implemented can be protected as objects of IP. The study includes examples from practice that allow a deeper understanding of the issues related to three-dimensional printing in the international aspect.

The object of this article is three-dimensional printing.

The subject is the three-dimensional (3D) printing and its protection as industrial property and in particular as inventions.

The aim of the research is to determine the nature of 3D printing, the areas in which the technology is used, by identifying patent protection. In addition, the aim is to analyze the applicant activity and patents granted in the 3D printing in a national and international aspect.

The thesis of the present study is that one of the important factors for achieving and maintaining economic results and competitiveness of enterprises in today's competitive environment is the creation of innovative products in the field of three-dimensional printing and their protection with a patent for an invention.

The author adopts the hypothesis that at the national level, Bulgarian companies do not protect their products in the field of three-dimensional printing through patents for inventions and do not sufficiently use the potential of intellectual property for successful implementation of patented innovative solutions and the possibility of return on investment and profit generation.

Limitations – only filed patent applications and patents granted in 3D printing will be considered and analyzed in the article. The protected results of 3D printing as utility models, industrial designs, trademarks, and objects of copyright will remain outside the scope of the article.

3D Printing

Essence

Three-dimensional printing or the additive process is a technology for making 3D solid objects using a digital model. It is done by applying successive layers of a certain material, in a way that allows the formation of a specific object. In this

respect, 3D printing differs from traditional techniques, in which material (such as cutting and turning) is taken away to shape objects. (Bechtold, 2015). Three-dimensional printing involves various technologies and processes in which the material is joined or hardened under computer control, which creates a 3D object. The material is usually added layer by layer.

The process begins with the choice of a 3D model, which could be created independently, by choice or borrowed. The file in which the object will be printed is digitally formatted using either 3D printing software or a 3D scanner. The file is then exported to a 3D printer using specialized software that transforms the digital model into a physical object through a process in which the molten material is built layer by layer until the finished object appears.

Alternatively, a 3D scanner for an existing object can be used. This scanner builds a 3D digital copy of an object and places it in a 3D modelling program. The pattern is then cut into hundreds or thousands of horizontal layers in preparation for printing. The file prepared in this way is uploaded to a 3D printer, which creates the object layer by layer. 3D printers use a variety of materials, ranging from plastic to ceramic and from metals to hybrid materials, and the technology used is evolving at a very rapid pace. Currently, the most popular types of materials used in 3D printing are plastics, metals (one of the strongest and most used metals for 3D printing is stainless steel), ceramics, paper, biomaterials, food etc. (Jewell, 2013).

The Massachusetts Institute of Computer Science and Artificial Intelligence Laboratory has developed a 3D printing technique that prints both solid and liquid materials. The wide range of materials used for 3D printing affects many industries by promoting new opportunities for innovation and business development. (Malaty, 2017).

Areas of application

The technology of 3D printing could find application in any industry, as the growing range of materials used significantly expands the applications of this technology. This process supports both the creation of complete products and individual prototypes.

The areas in which the technology is most widely used are:

- *Prototyping*

3D printing was originally developed as a faster alternative to prototyping. Later (in the 1990s) it began to be used for fast tooling, mainly to produce custom shapes. In the late 2000s, due to the declining prices for 3D printers and the increasing quality of 3D printing, the technology began to be used for the direct production of finished products. The fourth phase of application begins in 2010

and involves users who design and manufacture their own items using 3D printers that either own or access them locally. (Birtchnell et.al., 2018).

- *Medicine and dentistry*

The technology of the additive process helps to improve the condition of people in terms of health, by personalizing the technologies for each individual case and individual person. In addition to the production of prototypes and the development of new products for the medical and dental industries, the technology is also used to make models for casting dental crowns, to create implants in the hip and knee joints. It is used in the production of hearing aids, orthopaedic insoles for shoes, personalized prostheses and disposable implants for patients suffering from diseases such as osteoarthritis, osteoporosis, cancer. Technology is also being developed for the 3D printing of skin, bones, tissues, pharmaceuticals and even human organs, and human tissues and organs can be created using specially designed 3D bio-printers. To a large extent, the application of this technology is still decades away from its actual commercialization. [1]

In 2009, the California-based Organovo Laboratory, in partnership with Invetech, produced the world's first MMX bio-printer, which uses "primary or other human cells and shapes them into 3D tissues for medical research, including drug development as well as therapeutic applications". In late 2010, Organovo officially announced that it had generated the first blood vessels with a bio print. (Jewell, 2013).

- *Jewellery*

The process of designing and manufacturing jewellery requires experience and knowledge, as well as the use of specific technologies, which include mould creating, casting, electroplating, silver / gold forging, stone cutting, engraving, and polishing. Each of these technologies has evolved over many years and requires a number of technical knowledges. Three-dimensional printing is used both to improve traditional processes for jewellery production and to eliminate some of the traditional steps that are applied in jewellery production. [2]

- *Automotive industry*

Automotive is another industry in which three-dimensional printing is widely used. Many car companies use the potential of 3D printing in terms of spare parts production. The technology allows spare parts to be developed only after a preliminary order from the customer. In this way, it is not necessary to keep a number of spare parts in stock that are not actually used.

In addition to the above areas, the technology of additive manufacturing is used in many other areas of our lives such as the food and fashion industry, the creation of personalized toys and gifts, its use at home to create 3D objects, as well as in the film industry – in the production of new special effects, when using props and costumes in film and television productions.

Protection of the results of the three-dimensional printing as inventions

Patentable solutions support the development of innovation and technological progress of companies in today's business society. Patents for inventions provide a wide range of values to their holders and a high return on investment in the development of new technologies. Through the use of patentable inventions, a company can make significant profits if it succeeds in exercising its monopoly right properly and benefits from the advantages it possesses as a holder of exclusive rights.

Legal protection over a patentable invention is granted by a patent for invention. Once issued, its holder receives exclusive rights to the patentable invention, which include the right to use the invention (production, trade, offering for sale, etc.), the right to dispose (to grant licenses or sell it to another person) and prohibiting others from using the invention without the consent of the patent owner.

In this way, on the one hand, the interest of the business in access to innovations, in the development of innovative production and the creation of public goods for mass consumption is protected, and on the other hand the interest of the patent owner is protected – he has monopoly rights for a certain period and for a specific territory. IP is the balance between the private interest – of the inventor, and the public interest of users and consumers of innovative goods and services. In order to limit the exclusive nature of the emerging business relationship, both in relation to the inventor and in relation to the user – the company suffers certain restrictions. For example, users may use the patented invention by paying fees and only with the permission of the patent holder, by concluding a license agreement. And the validity of the patent for invention is limited in time and only to the territory of the countries for which patent protection is granted, namely the countries specified in the issued patent for an invention. (Team, 2018).

Inventions

The role of inventions in 3D printing is of great importance to society. They help solve various problems in the field of science and technology, which lead to the development of the technological progress of companies on a global scale. It should be borne in mind that reaching a technical solution to a problem in a technical field is the result of much effort, work, research, and experimentation by the inventor to turn an idea into a useful and workable invention. [3]

An "invention" is most often understood as a novelty created in the field of science and technology. In order to be defined as an invention, the obtained intellectual product must necessarily be a technical solution to a problem, and the task can be in any field of the public economy. The important thing here

is that not the task itself, but that its solution must be of a technical nature. If intellectual work is not a technical solution, as a rule it is not considered an invention and no patent protection for invention can be obtained. (Borisov and Borisova, 2015). In order to be granted a patent for an invention, the invention must meet cumulatively the three criteria for patentability specified in the law – novelty, inventive step and industrial applicability.

The term of the invention's protection is twenty years from the date of filing the patent application. After the expiration of this term, the patent for invention becomes publicly available and the patent owner is not entitled to exercise his exclusive rights. The patent for invention has a territorial effect – it operates in the territory of the state in which it is issued.

Given the issue of patenting inventions in the field of 3D printing, it should be noted that the literature on the interaction of IP and 3D printing is not comprehensive enough, but there is an increase in sources of information with each passing year. Most of the existing literature in the field of 3D printing and IP comes from countries such as the United States, China, the EU and relates mainly to the ways in which the results obtained provide patent protection.

The World Intellectual Property Organization (WIPO) recognizes the link between 3D printing and intellectual property, including in its 2015 report, where 3D printing was identified as one of the three "frontier technologies", along with nanotechnology and robotics, which have the potential to stimulate future economic growth. In this report, WIPO presents data from the first patent applications, showing that this technology was initially concentrated in several countries (the USA, Japan, Germany, France, Great Britain, South Korea, and China). Russia ranked sixth in terms of first patent applications, and India was not even in the top 20. While the United States, Germany and Japan are the countries that filed the earliest patent applications, China is the country that only in recent years has initiated a procedure for claiming inventions for this technology, but at an extremely fast pace. China and the United States are currently at the forefront of application activity, followed by South Korea, European applications submitted to the EPO and international PCT (Patent Cooperation Treaty) applications. (Rimmer, 2019).

In addition, the WIPO Innovation and Growth Report for 2015 states that there is currently a steady increase in the number of patent applications filed in the field of 3D printing. Many specialized companies working in additive manufacturing have managed to create significant patent portfolios in this field. Large manufacturing companies – such as GE and Siemens – have also built significant patent assets in 3D printing and additive manufacturing. Information technology companies – such as Hewlett Packard and Autodesk – are also investing heavily in the field.

The filed patent applications and issued patents for inventions in 3D printing cover both the 3D printers themselves and their components and production processes that support the realization of 3D printing itself. In addition, patents for inventions issued in the field could protect 3D printing materials, such as powders, threads, liquids, and many of the materials used by 3D printers are not specifically designed for this technology. Rather, they are general-purpose materials that could be used in other technologies.

Advantages

The benefits of 3D printing are numerous for companies creating innovation, as well as for humanity as a whole. The technology allows to reduce costs in developing, designing, and testing of new products or improving existing ones. At present, with the help of additive manufacturing, it is not necessary to pay for expensive prototypes, but it is possible to undertake multiple iterations of complex elements using 3D printers quickly and cheaply.

Recognizing the transformative potential of 3D printing, many countries have already adopted, albeit unevenly, different strategies to create an economic and technological ecosystem that is conducive to its development. The European Commission, for example, identifies 3D printing as a priority area for action with significant economic potential, especially for innovative small businesses. (Malaty and Rostama, 2017).

At the same time, lawyers in many countries are considering the capacity of existing legislation and the ways in which they could ensure the protection of this new technology, especially regarding intellectual property. However, it is still unclear whether the existing IP laws could be amended without contradicting the existing provisions. (Malaty and Rostama, 2017).

Disadvantages

One of the main disadvantages of 3D printing is that its use allows the copying of almost any object, with or without the permission of the IP rights holder. If the printed product is used with patent protection, then its printing and use by third parties, without the permission of the patent owner, would lead to infringement of foreign patent rights. Patent proprietors could seek redress from third parties, provided that the person infringing these IP rights places on the market products created using additive manufacturing that, for example, affect an essential element of the patented invention.

As noted in a study by the Big Innovation Centre, the ability to copy physical products easily and cheaply could reduce incentives for businesses to invest in

research and development. Naturally, when this technology is used by other third parties to meet personal needs without economically realizing the created product, then there would be no infringement of patent rights.

Regarding the patenting and use of 3D bio-printing technology, it would be difficult to delineate the boundaries of bioethics and IP law. It needs to be determined how the legal framework related to "tissue engineering" and "regenerative medicine" will be established, and the implications for IP objects and especially for patents at a European and international level. In addition, the implications of granting patents for bio-printing in 3D, bio-printing technologies should be assessed once the patentability of inventions and patent exceptions related to morality, treatment methods, bioethics, and health and safety issues have been established.

Bulgarian enterprises developing 3D printing technologies

1. "SPACECADE" Ltd. is the official representative of the world's leading company 3D Systems for Bulgaria and offers 3D printers and software. In 2017, Spacecade Ltd. started its own production to produce metal parts through the technology for direct 3D printing in metal /DMP/. The company offers services for 3D printing of complex metal parts and assemblies, functional metal prototypes, spare parts, components, and other components. The use of additive manufacturing allows to produce parts with hitherto unattainable complexity and speed, within one working day, which cannot be produced using traditional technologies such as machining, metal casting, plastic injection. [4]

2. "TechnoLogica" is a leading Bulgarian software company, which has been developing complex activities in the field of information technology since 1990. One of the main priorities in the activity of DiTra and an essential part of the 3D solutions of TechnoLogica is 3D printing. The world's leading manufacturer of 3D printers Stratasys has been a major partner of the company since 1996. During this period, more than twenty 3D printers were delivered and put into operation, and hundreds of 3D printing services were performed with the company's own fleet, based on various technologies for three-dimensional printing. [5]

3. "Printivo" is a company that specializes in 3D bio-printing of fabrics. It has created its own bio-printer, five bio-inks and an original methodology for 3D bio-printing of bone tissue. Printivo provides pharmaceutical companies with an on-demand bone graft that can be used to test drugs in preclinical trials. The company works to create and optimize the microarchitecture of tissue structures, improving the vitality and interaction between cells to fully mimic the natural conditions of human tissues. [6]

4. "Prosfitt Technologies" develops medical software and a complete digital service for precise design and 3D printing of prostheses in patients with amputated

limbs. The company is a pioneer in this field and works on joint projects with the International Organization of Persons with Disabilities and with medical centres in Europe, Australia and Asia. [7] The main goal of the company is to increase the ability of people with amputated limbs to move freely by ensuring their mobility and integration into society.

5. "OS Implants" is a company that is revolutionizing the treatment of bone diseases. It develops a 3D printing platform for artificial bones for the production of anatomical and surgical models for the training of students and graduates. It produces individual implants for the personalized needs of people and animals, developed according to the specifics of the patient. [8]

Results / trends in patent activity in the field of 3D printing in the period 2000 – 2020

In the present article a patent research will be performed for patent applications and/or patents granted for inventions according to the methodology for conducting patent studies set by Prof. B. Borisov in "Methodology for patent research", Sofia, UNWE, 1999.

Determining the parameters of the patent examination

Purpose of the patent research

The purpose of the present patent research is to establish the applications for inventions filed and the patents granted for inventions in the field of 3D printing in an international aspect.

Subject of patent research

The subject of the patent research are patent applications and granted patents for inventions in the field of 3D printing, filed with the Patent Office of the Republic of Bulgaria (BPO), the European Patent Office (EPO), the World Intellectual Property Organization, the Chinese Patent Office, The United States Patent Office (USPTO), and the South Korean Office. The scope of the patent research has been expanded outside the territory of Bulgaria, in view of the small number of applications submitted in 3D printing, filed by Bulgarian applicants, nationally to the Patent Office.

Countries to be surveyed

The territories in respect of which the study was carried out are Bulgaria, China, the USA, South Korea, the PCT applications for inventions filed with WIPO and the European patent applications filed with the EPO. With the exception of Bulgaria, the countries which the patent research was conducted for were selected by the PhD student, due to the fact that these territories have the

greatest number of applications for inventions and patents granted for inventions in 3D printing.

Depth (retrospective) of the patent research

The patent examination covers the period from 30 January 2000 to 1 February 2020 or a total of 20 (twenty) years.

Information sources

The following online databases have been used to carry out this patent research:

- The online database of the Patent Office of the Republic of Bulgaria – www.bpo.bg;
- The online database of the European Patent Office – www.epo.org (European Patent Register);
- The Espacenet online database – a database coordinated by the EPO in close cooperation with the EPO Member States. More than 110 million patent documents are available worldwide – www.worldwide.espacenet.com;
- Lens online database /www.lens.org/ – this database provides access to more than 117 million patent documents in over 95 jurisdictions.

Classification of the subject of patent research

Analysing the results of the filed applications for inventions and the patents granted for inventions in 3D printing, we should consider the International Patent Classification (version of the IPC dated January, 2020) and in particular section B – Technological processes, transport, namely:

B33 ADDITIVE MANUFACTURING TECHNOLOGY

B33Y ADDITIVE MANUFACTURING, i.e. MANUFACTURE OF THREE-DIMENSIONAL OBJECTS BY ADDITIONAL DEPOSITION, ADDITIONAL AGGLOMERATION OR ADDITIONAL PLASTING, for example by printing, stereo-lithography or selective laser balancing.

The patent research in the online databases of the EPO and the WIPO shows that companies apply for inventions in 3D printing in section B – Technological processes; transport and in particular, B33 – Additive manufacturing technology.

***Results from the performed patent research
and analysis of the information***

Statistics of applications filed, and patents granted for inventions in the field of 3D printing for the period from January 30, 2000 to February 1, 2020.

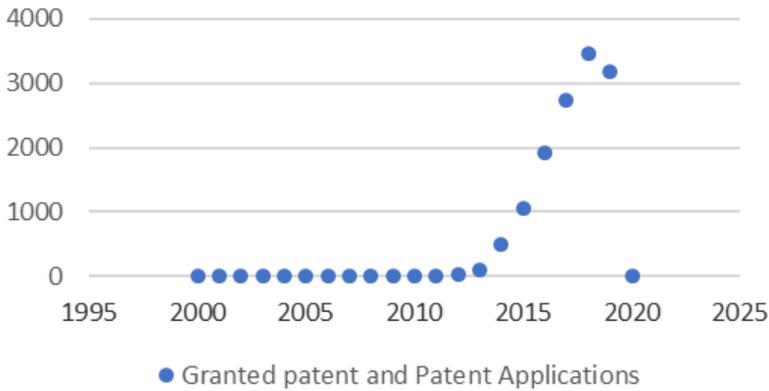


Figure 1: Granted patent and Patent Applications shows a quantitative trend in the subject of 3D printing and by years

For 2000, two patent applications were filed, while for 2001, 2002 and 2003 only one. For 2004 there are nine published documents (the total number of applications filed, and patents issued for inventions), for 2005 – seven, for 2006 – eleven, and for 2007 four results were found. For the following years the results are as follows – for 2008 there is a total of five applications filed and patents issued for inventions, for 2009 fourteen, for 2007 – four, for 2008 – five, for 2009 – also fourteen results, for 2010 – seven documents , for 2011 – 14 results, for 2012 – 29 documents, and for 2013 – 104 results. From 2015 to the present, there is a tendency of accelerated growth of the application activity, as in 2015 there are 1051 documents published, for 2016 – 1931 results, for 2017 – 2744 documents, for 2018 – 3455 results, and for 2019 – 3169 document.

Given the results of the patent research, we could conclude that in the first years of the study period (2000 to 2013), the number of published patent applications and granted patents for inventions in 3D printing is extremely small. In the period 2011 – 2014 the activity of applicants increases, and since 2015 we have observed a sharply increasing trend, as for 2015 – 1051 documents are published, for 2016 – 1931 results, for 2017 – 2744 documents, for 2018 – 3455 results, and for 2019 – 3169 documents. This rapidly growing application activity can be explained by the sharp penetration of 3D technology worldwide, as well as the impact that 3D printing has on modern society.

As can be seen from the results in **Table 1**, China has the largest number of applications for inventions and patents issued for inventions in 3D printing. Given China’s strong position with 9203 documents published, we can definitely conclude that the country prioritizes 3D printing technology and invests sufficient funds to obtain patent protection for the results obtained. The United States ranks second with a total of 1444 applications for inventions and received patents. After

the United States is WIPO with 998 filed PCT applications, followed by South Korea with 822 results and the European Patent Office, which has a total of 588 filed applications and issued patents for inventions. Only one published result was found for the territory of Bulgaria. It should be borne in mind that the most likely reason for the only result found is not only the low application activity, but also the fact that some of the patent applications filed have recently been filed and have not been published yet in the available databases.

Table 1: Total number of applications filed, and patents issued for inventions by Country / Patent Office

Country / Patent Office	Total number of applications filed and patents issued
China	9203
USA	1444
WIPO	998
South Korea	822
European Patent Office (EPO)	588
Bulgaria	1

The ratio between the filed applications for inventions and the issued patents for the period 2000 – 2020 is shown in Figure 2.

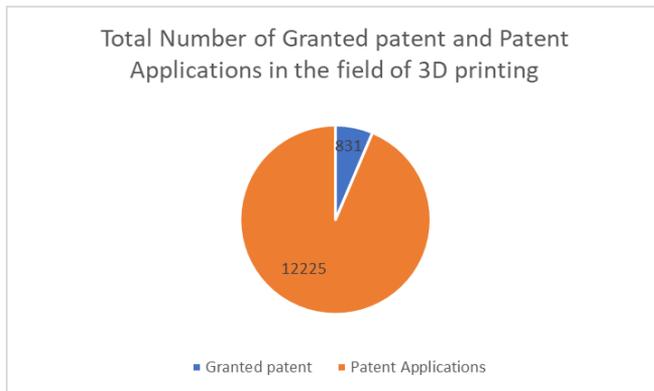


Figure 2: Applications for inventions filed and patents granted for 2000 – 2020

During the period under review, the applications for inventions for the territories of China, the USA, South Korea, the PCT applications filed with

WIPO, as well as the European applications filed with the EPO were a total of 12225 and the number of patents issued was 831.

Table 2: Lists the applicants with the greatest number of applications in the field of 3D printing, namely:

Company-Applicant	Published documents
Hewlett Packard Development CO	231
KINPO ELECT INC	171
XYZPRINTING INC	168
XPAN JIATONG UNIVERSITY	98
SOUTH CHINA UNIVERSITY OF TECHNOLOGY	98
HP	92

Conclusions and recommendations from the conducted patent research

After analysing the results of the patent research, we can conclude that the application activity of companies in the area of three-dimensional printing is low for the period 2000 – 2010. After 2011 there is an increase in patent applications and granted patents for inventions, and after 2015 – a sharp increase in the number of submitted applications for inventions for the studied territories. In the last few years, the companies have increased their application activity several times, reaching their peak in 2018, for which there is a total of 3455 applications for inventions and patents issued in 3D printing.

When analysing the results of the survey, China ranks first with 9203 published results, and in the United States ranks second with a total of 1444 applications for inventions and patents obtained. Between the first two countries, there is a very big difference, with China having an advantage over the other territories studied, especially considering that the total number of applications and patents issued is 13056.

Regarding the results obtained for the territory of Bulgaria, we could conclude that 3D printing is definitely not of interest to Bulgarian applicants, despite its growing importance in the international aspect. It would be good for Bulgarian companies to invest more in R&D and in creating developments in the field of additive manufacturing, given the global prosperity in this area. At the same time, there are a number of Bulgarian companies that freely use foreign inventions that have not received patent protection for the territory of Bulgaria or use patented inventions by foreign companies for which they have obtained licenses.

Given the extremely low patent application activity of Bulgarian enterprises (only one result found) in the area of three-dimensional printing, I believe that

Bulgarian companies should make radical changes to be able to impose on the foreign market and understand the importance of patent protection of their products in the field of three-dimensional printing, due to the economic nature of this type of protection.

Regarding the analysis of the origin of the applicant and patent holders, the leading position is presented by various international companies such as the American Hewlett Packard Development CO, the Chinese Hran Latong University, South China University of Technology and others.

Conclusion

In the future, 3D printing will find an even greater application worldwide, as the areas in which the technology is used are growing with each passing year. As demonstrated in the present study, additive manufacturing also has an impact on intellectual property rights. Legislation in the field of 3D printing should ensure that IP regimes are adapted in such a way as to ensure fair protection for patent holders.

Regarding the application activity in the field of 3D printing and the number of submitted applications for the territory of Bulgaria, we can conclude that additive manufacturing is not a priority for Bulgarian companies, but there is a sporadic performance by them. Only a few companies have real developments and activities in the study area – "Printivo", which specializes in 3D bio-printing of fabrics, "OS Implants", developing a 3D printing platform for artificial bones and "Prosfitechnologies", creating medical software for precision design and 3D printing of prostheses. Businesses need to make radical changes to be able to impose on the foreign market and to understand the importance of protecting their products in the field of three-dimensional printing as objects of industrial property.

The largest representation in the field of additive manufacturing are foreign corporations, which for years have developed and implemented three-dimensional products and technologies – such as General Electric, HP. Although Bulgarian companies could not be compared to large corporations, they also need to understand the importance of additive technology in a global perspective and continue to create their own developments instead of using foreign ones. Most Bulgarian companies establish themselves as distributors of proven international companies that invest significant financial resources in the development, implementation, and protection of products in the field of additive manufacturing, as objects of IP.

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Notes

- [1] See website of "3D Industry", <http://www.3dprintingindustry.com/>
- [2] See website of "3D Industry", <http://www.3dprintingindustry.com/>
- [3] In the present article, the invention will be considered as an industrial property object under Law on Patents and Registration of Utility Models, prom. SG, No. 64 / 09.11.2006, last ed. and ext. SG. No. 92 / 27.10.2020
- [4] See website of "3dsys", <https://www.3dsys.space/>
- [5] See website of "Ditra", <https://ditra.bg/>
- [6] See website of "Printivo", <http://www.printivo.eu/>
- [7] See website of "Printivo", <http://www.printivo.eu/>
- [8] The information about National Contest "Innovative Enterprise of the Year" is available at: <http://www.arcfund.net/index.php?id=2055>

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