

**МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ**  
**ОДЕСЬКА НАЦІОНАЛЬНА АКАДЕМІЯ ХАРЧОВИХ ТЕХНОЛОГІЙ**  
**ІНСТИТУТ КОМП'ЮТЕРНИХ СИСТЕМ І ТЕХНОЛОГІЙ**  
**«ІНДУСТРІЯ 4.0» ІМ. П.Н. ПЛАТОНОВА**

**ХІІ МІЖНАРОДНА**  
**НАУКОВО-ПРАКТИЧНА**  
**КОНФЕРЕНЦІЯ**

**ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ І**  
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**AUTOMATION – 2019**

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**Частина II**

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управління технологічними процесами харчової  
та зернопереробної промисловості**

**Автоматизоване управління бізнес-процесами:  
концепції, методи, алгоритми, системи**

**Штучний інтелект і автоматизація  
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скорочень організацій, представники яких взяли участь у конференції**

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<b>Скорочення</b>	<b>Повна назва організації</b>	<b>Місто</b>	<b>Країна</b>
BNTU	Belarusian National Technical University	Minsk	Belarus
CAFU	CRIAME of Armed Forces of Ukraine	Kyiv	Ukraine
DMTSAU	Dmutro Motornyi Tavria State Agrotechnological University	Melitopol	Україна
DNU	Vasyl' Stus Donetsk National University	Вінниця	Україна
EKSTU	East Kazakhstan State Technical University D. Serikbayev	Ust-Kamenogorsk	Kazakhstan
IAEI SB RAS	Institute of Automation and Electrometry of the Siberian Branch of the Russian Academy of Sciences	Novosibirsk	Russia
IRTC IT&S NAS AND MES	International Research and Training Center for Information Technologies and Systems of the National Academy of Sciences (NAS) of Ukraine and Ministry of Education and Science (MES) of Ukraine	Kyiv	Ukraine
KGES	Kharkiv general education school	Kharkov	Україна
LPNUU	Lviv Polytechnic National University	Lviv	Ukraine
NTU "KhPI"	National Technical University "Kharkiv Polytechnic Institute"	Kharkov	Україна
NTU «KPI»	National Technical University "Igor Sikorsky Kyiv Polytechnic Institute"	Kyiv	Ukraine
NU «OMA»	Національний університет «Одеська морська академія»	Одеса	Україна
NULESU	National University of Life and Environmental Sciences of Ukraine	Kyiv	Ukraine
NUOS	NATIONAL UNIVERSITY OF SHIPBUILDING NAMED BY ADM. MAKAROV	Nikolaev	Ukraine
ONAFI	Odessa National Academy of Food Technologies	Odessa	Ukraine
ONU	Odessa I.I.Mechnikov National University	Odessa	Ukraine
SSU	Sukhumi State University	Sukhumi	Georgia
VNTU	Vinnitsia National Technical University	Vinnitsia	Ukraine
БНТУ	Белорусский национальный технический университет	Минск	Белоруссия
ВНТУ	Вінницький національний технічний університет	Вінниця	Україна
ДВНЗ «КНУ»	Державний вищий навчальний заклад «Криворізький національний університет»	Кривий Ріг	Україна
ДонНТУ	Донецький національний технічний університет	Покровськ	Україна
ІК НАН України	Інститут кібернетики імені В.М. Глушкова НАН України	Київ	Україна
НТУ «ХПІ»	Національний технічний університет "Харьковский политехнический институт"	Харків	Україна
НТУУ "КПІ"	Національний технічний університет «Київський політехнічний інститут» імені Ігоря Сікорського"	Київ	Україна
НУ «ЛП»	Національний університет «Львівська політехніка»	Львів	Україна
ОДАТРА	Одеська державна академія технічного регулювання та якості	Одеса	Україна

## Продовження таблиці 1

<b>Скорочення</b>	<b>Повна назва організації</b>	<b>Місто</b>	<b>Країна</b>
ОНАЗ	Одеська національна Академія зв'язку ім. О.С. Попова	Одеса	Україна
ОНАПТ	Одесская национальная академия пищевых технологий	Одесса	Украина
ОНАХТ	Одеська національна академія піщевих технологій	Одеса	Україна
ОНПУ	Одеський національний політехнічний університет	Одеса	Україна
ОНУ	Одеський національний університет імені І. І. Мечникова	Одеса	Україна
ОТК ОНАХТ	Одеський технічний коледж Одеської національної академії харчових технологій	Одеса	Україна
ПНПУ	Південноукраїнський національний педагогічний університет ім. К.Д. Ушинського	Одеса	Україна
ХНУРЕ	Харківський національний університет радіоелектроніки	Харків	Україна
ХРТК	Харківський радіотехнічний технікум	Харків	Україна
ЦНДІ ОВТ ЗС України	Центральний науково-дослідний інститут озброєння та військової техніки Збройних Сил України	Київ	Україна
ЮНПУ	Южноукраинский национальный педагогический университет им. К.Д.Ушинского	Одесса	Украина

ПОВЕДЕНЧЕСКИХ МОДЕЛЕЙ МУЛЬТИАГЕНТНЫХ РОБОТОТЕХНИЧЕСКИХ СИСТЕМ ( <i>ЮНПУ, Україна</i> ) .....	
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## REVIEW OF THE APPLICATION OF MODERN OF 3D-PRINTERS

**Abstract**

3D-printers are becoming more common in recent years. The use of lower-cost technologies, common materials to create patterns, developing appropriate software has led to the appearance on the market a large variety of 3D-printers. The article provides an overview of the most common printers for plastic, and made recommendations on their use for different purposes.

**Introduction**

At present, the concept of “3D” has become a firmly established part of everyday life. First of all, it is associated with game consoles, the film industry, photography or animation. But now it’s hardly possible to find a person who at least once in his life has not heard of such a novelty as.

Three-dimensional printing (3D printing) turns a computer model of an object into a real-life object. This is due to the application of many of the thinnest layers programmed in a computer program. There are a large number of 3D printing technologies, however, FDM (Fused Deposition Modeling) is the most widespread application, a three-dimensional printing technology in which the construction of an object is due to the melting of the plastic filament, which is fed through the extruder to the work surface. Modern 3D printers are capable of printing from a variety of materials, but the use of ABS and PLA plastic has become most common.

With the production of 3D printers in human life comes the opportunity to use them in education, science, as well as for doing business. Technological progress opens up more and more new opportunities for opening your own, albeit small, business. Such a small business can be the production of plastic products at home using a 3D printer. It can be small elements of old equipment, car accessories, pens for household appliances, business card holders, coasters for tablets, cases for smartphones and much more. Such little things can not be found in stores and the Internet, so manufacturers will always have orders.

Progress in this area has long been constrained by the relative high cost of products obtained by 3D printing. And only in recent years, after the expiration of a number of patents on FDM technology, it became possible to produce inexpensive 3D printers for mass use. Many companies produce such printers for printing with plastic, but their characteristics and cost vary widely, so making recommendations for their use for various purposes is an urgent task.

**Research methods.** At present, the concept of “3D” has become a firmly established part of everyday life. First of all, it is associated with game consoles, the film industry, photography or animation. But now it’s hardly possible to find a person who at least once in his life has not heard of such a novelty as.

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3D printing is the reproduction of a real object according to a 3D model created on a computer. Then the digital three-dimensional model is saved in the format of the STL file, after which the 3D printer, on which the file for printing is output, forms a real three-dimensional product.

The printing process is a series of continuously repeating cycles associated with the creation of three-dimensional models, applying a layer of supplies on the printer desktop, moving the desktop down to the level of the finished layer and removing waste from the surface of the table.

The advantages of 3D printing over the usual, manual methods of model building are its high speed, simplicity and relatively low cost, associated mainly with the cost of consumables. 3D printers can work with various types of colored plastic filament, which can be combined in the process, ceramic powder, photopolymer resins, metal, etc. Currently, the range of possibilities and applications of 3D printing is constantly expanding and changing. Everything turned out to be subject to these technologies - from medical products, for example, human organs - to high-tech objects, for example, a car on the Formula 1 track. However, in the mass consciousness, 3D printers are strongly associated with plastic printing, as This technology is accessible, visual, and can be used for various purposes.

Many companies are currently engaged in the production and promotion of 3D printers of various models and types oriented to printing with plastic. An urgent task is a comparative analysis of their characteristics and development of recommendations for use in various industries. Further in the article, the main printer models that exist in today's market are considered.

MakerBot is one of the main manufacturers of 3D printers [1]. The main model of the company was constantly subjected to changes, both in appearance and in functional features. Figure 1 shows the printer, the widely used MakerBot Replicator 2, which is a device for fairly advanced users and allows you to get products of very high quality and wide functionality. The case of this printer is made with cutouts in the facing panels, which make access to the work platform easy from all sides, provide ventilation of the work area and quick cooling of the products when working with plastic. The frame of the printer is metal, which makes it quite durable. Replicator 2 uses only one extruder, but the size of the working area is significantly increased and amounts to 285 x 153 x 155 mm, but since the printer works almost with PLA plastic, the working area is not equipped with a heated platform.

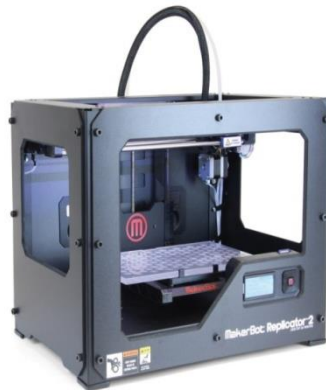


Fig. 1. 3-D Printer MakerBot Replicator 2

Printing is carried out using one extruder and a nozzle with a diameter of 0.4 mm. With a minimum thickness of the applied layer of 100  $\mu\text{m}$  and an accuracy of positioning of 11  $\mu\text{m}$  along the X and Y axes and 2.5  $\mu\text{m}$  along the Z axis, very high-quality models are obtained that make it possible to put Replicator 2 in the class of semi-professional printers. There are also printer options called Replicator 2X (experimental), in which the company has added a heated platform, another extruder and removable panels to close the openings in the trim panels if necessary.

Depending on what materials the printer works with (and Replicator 2 successfully prints with polymer simulators of wood and sandstone from a German manufacturer), the necessary changes are made to its operation mode, such as the nozzle temperature and fan on / off operation.

A proprietary program that works with Replicator 2 is called MakerWare. The program is compatible with Windows 7 and 8, Mac OSX and Linux and is able to work with STL, OBJ and THING files.

One of the significant drawbacks of this printer is its relatively high cost (up to 10 thousand dollars).

3D Systems company offers Cubify Cube 3d printers (Fig. 2), which so far can print in only one color, which is not included in the advantages of the printer, but these printers are very easy to use.



Fig. 2. 3-D Cubify Cube Printer

For printing, all the same popular PLA and ABS plastic are used, which are environmentally friendly materials. The color palette of these plastics is quite rich, has up to 26 shades, so each user will find exactly what he needs. The Cube cooking chamber can handle objects up to 140 x 140 x 140 mm.

When creating models, the printer connects to the computer using Wi-Fi. The software platform that comes with the printer supports many operating systems, such as Windows XP Professional, Windows 7, Mac OSX. Also provided and battery life. In this case, flash drives are used to which boot files are transferred. The advantages of the Cubify Cube printer include the fact that it is a budget printer, which at the price managed to skip ahead even Chinese models. The basic model will cost the buyer 1-2 thousand dollars.

Ultimaker 3D printer Ultimaker 2 (Fig. 3) is a successfully improved Ultimaker Original [2]. It is equipped with a heated platform, a closed housing and an enlarged working chamber measuring 230 x 225 x 205 mm.

The device is equipped with an LCD display and a slot for an SD memory card, which allows you to work offline. Printing is carried out by deposition. The device is characterized by low noise, not more than 49dB - an excellent indicator for domestic or office use.



Fig. 3. 3D Printer Ultimaker 2

The features of this printer include gear feed and a powerful feeder design, which improves print quality and reliability, and also allows the user to change the thread and easily select the optimal thread installation tension. A well-thought-out design allows quick and easy replacement of the nozzles of the print head, the user can select the preferred nozzle to achieve the desired result. Thus, you can print either in great detail or extremely fast. Optimized airflow. The fan will direct the airflow exactly where it should be in order to improve print results.

Recommended materials: PLA and ABS plastic. For battery life, there is an SD card.

Ultimaker 2 is an easy-to-use, high-speed, accurate and reliable 3D desktop printer. Thanks to the beautiful design and very quiet operation (noise within only 49 dB), it is perfect for both work at home and for the office. The print quality of this printer is considered one of the best on the market. Cost - up to 5-7 thousand dollars.

The Malyan Desktop HD 3D printer is a modified design of the Malyan Desktop model (Fig. 4). This model is marketed by the Chinese company Malyan and is an adapted analogue of the famous 3D printer

MakerBot Replicator 2 (they are even very similar in appearance) [3]. The cost of the base model is in the range of 1,5-2 thousand dollars.

To increase the reliability and speed of printing, a high-quality dual-zone airflow is installed on the extruder, the housing is reinforced with metal inserts.

At the same time, it remained inexpensive, since wood is used to make the case. The ability to "change the speed and temperature of printing" on the fly "during printing allows you to improve the quality of the work performed. All fans are fixed on 4 bolts and have a more rigid body. As a result, the printer is much quieter; the aluminum platform has been replaced with a larger interchangeable glass one.

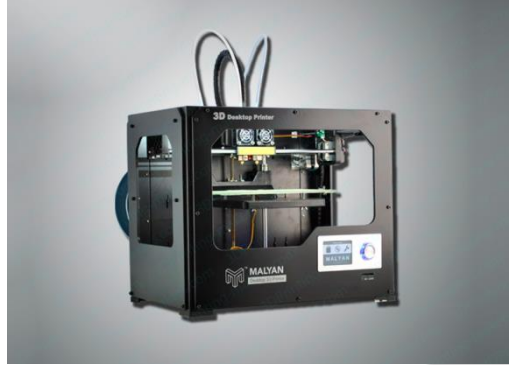


Fig. 4. 3D Printer Malyan Desktop

The dimensions of the print area are 225 x 145 x 150 mm. Interaction interface - SD card or USB cable. The following materials are used for printing: ABS, PLA-plastic, PVA, HIPS, Nylon, etc. The printer can work simultaneously with two extruders, which allows you to make objects in two colors. Supported operating systems - Windows, Linux, Mac. For printing without connecting to a computer, SD cards, X3G format are used.

**Results and discussion.** Most 3D printers creating plastic models are quite versatile and interchangeable. When choosing an apparatus for working with specific models, you can give the following recommendations.

If high accuracy is required and ABS plastic of the original manufacturer is available, you can safely choose the traditional MakerBot Replicator 2, guaranteed to give a good result when used correctly. However, in the case of plastic from a Chinese or Ukrainian manufacturer, such a choice is not justified, because high precision will not be achieved. When printing household models, where high accuracy is not important, but a budget approach is important, Malyan Desktop, which can work with not very high-quality plastic, will be an indispensable assistant. In the middle price range it is better to choose Ultimaker 2, because it allows you to get a plastic model of sufficient quality, numerous computer programs have been developed for it, and it has been on the market for a long time, it has established itself well.

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