

To sum up, it can be seen that, whilst containers have revolutionised shipping and brought several benefits, they have also created a fair share of problems. Appreciating these problems and how to avoid or otherwise address them is an important part of the successful carriage of containers.

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УДК 004.358

### 3D PRINTERS AND 3D PRINTING

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3D printing or additive manufacturing is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. A 3D printer is a limited type of industrial robot that is capable of carrying out an additive process under computer control.

While 3D printing technology has been around since the 1980s, it was not until the early 2010s that the printers became widely available commercially. The first working 3D printer was created in 1984 by Chuck Hull of 3D Systems Corp. Since the start of the 21st century there has been a large growth in the sales of these machines, and their price has dropped substantially.

The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewelry, eyewear, education, geographic information systems, food, and many other fields.

3D printable models may be created with a computer aided design package or via 3D scanner. The manual modeling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting. 3D scanning is a process of analyzing and collecting data of real object; its shape and appearance and builds digital, three dimensional models.

Both manual and automatic creation of 3D printable models is difficult for average consumers. This is why several 3D printing marketplaces have emerged over the last years.

To perform a print, the machine reads the design from 3D printable file (STL file) and lays down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. These layers, which correspond to the virtual cross sections from the CAD model, are joined or automatically fused to create the final shape. The primary advantage of this technique is its ability to create almost any shape or geometric feature. Printer resolution describes layer thickness and X-Y resolution in dpi (dots per inch), or micrometers.

Construction of a model with contemporary methods can take anywhere from several hours to several days, depending on the method used and the size and complexity of the model. Additive systems can typically reduce this time to a few hours, although it varies widely depending on the type of machine used and the size and number of models being produced simultaneously.

Traditional techniques like injection molding can be less expensive for manufacturing polymer products in high quantities, but additive manufacturing can be faster, more flexible and less expensive when producing relatively small quantities of parts. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer.

Though the printer-produced resolution is sufficient for many applications, printing a slightly oversized version of the desired object in standard resolution and then removing material with a higher-resolution subtractive process can achieve greater precision.

Several different 3D printing processes have been invented since the late 1970s. The printers were originally large, expensive, and highly limited in what they could produce.

Fused deposition modeling (FDM) was developed by S. Scott Crump in the late 1980s and was commercialized in 1990 by Stratasys. In fused deposition modeling the model or part is produced by extruding small beads of material which harden immediately to form layers. Control of this mechanism is typically done by a computer-aided manufacturing (CAM) software package running on a microcontroller.

Another 3D printing approach is the selective fusing of materials in a granular bed. The technique fuses parts of the layer, and then moves the working area downwards, adding another layer of granules and repeating the process until the piece has built up. This process uses the unfused media to support overhangs and thin walls in the part being produced, which reduces the need for temporary auxiliary supports for the piece. A laser is typically used to sinter the media into a solid. Examples include selective laser sintering (SLS) with both metals and polymers.

Several projects and companies are making efforts to develop affordable 3D printers for home desktop use. RepRap is one of the longest running projects in the desktop category. The RepRap project aims to produce a free and open source hardware (FOSH) 3D printer, whose full specifications are released under the GNU General Public License, and which is capable of replicating itself by printing many of its own (plastic) parts to create more machines. RepRaps have already been shown to be able to print circuit boards and metal parts.

Because of the FOSH aims of RepRap, many related projects have used their design for inspiration, creating an ecosystem of related or derivative 3D printers, most of which are also open source designs. The availability of these open source designs means that variants of 3D printers are easy to invent. The quality and complexity of printer designs, however, as well as the quality of kit or finished products, varies greatly from project to project.

As the costs of 3D printers have come down they are becoming more appealing financially to use for self-manufacturing of personal products. In addition, 3D printing products at home may reduce the environmental impacts of manufacturing by reducing material use and distribution impacts.

With technological advances in additive manufacturing, however, and the dissemination of those advances into the business world, additive methods are moving ever further into the production end of manufacturing in creative and sometimes unexpected ways. Parts that were formerly the sole province of subtractive methods can now in some cases be made more profitably via additive ones.

Standard applications include design visualization, prototyping/CAD, metal casting, architecture, education, healthcare, and entertainment.

Industrial 3D printers have existed since the early 1980s and have been used extensively for rapid prototyping and research purposes. These are generally larger machines that use proprietary powdered metals, casting media, plastics, and paper.

Companies have created services where consumers can customize objects using simplified web based customization software, and order the resulting items as 3D printed unique objects. This now allows consumers to create custom cases for their mobile phones. Nokia has released the 3D designs for its case so that owners can customize their own case and have it 3D printed.

The current slow print speed of 3D printers limits their use for mass production. To reduce this overhead, several fused filament machines now offer multiple extruder heads. These can be used to print in multiple colors, with different polymers, or to make multiple prints simultaneously. This increases their overall print speed during multiple instance production, while requiring less capital cost than duplicate machines since they can share a single controller.

Distinct from the use of multiple machines, multi-material machines are restricted to making identical copies of the same part, but can offer multi-color and multi-material features when needed. The print speed increases proportionately to the number of heads. Furthermore, the energy cost is reduced due to the fact that they share the same heated print volume. Together, these two features reduce overhead costs.

In 2012, domestic 3D printing has mainly captivated hobbyists and enthusiasts and has not quite gained recognition for practical household applications. A working clock has been made and gears have been printed for home woodworking machines among other purposes. 3D printing is also used for ornamental objects. Web sites associated with home 3D printing tend to include back-scratchers, coat hooks, doorknobs etc.

3D printing has spread into the world of clothing with fashion designers experimenting with 3D-printed bikinis, shoes, and dresses. In commercial production Nike is using 3D printing to prototype and manufacture the 2012 Vapor Laser Talon football shoe for players of American football, and New Balance is 3D manufacturing custom-fit shoes for athletes.

3D bio-printing technology has been studied by biotechnology firms and academia for possible use in tissue engineering applications in which organs and body parts are built using inkjet techniques. In this process, layers of living cells are deposited onto a gel medium or sugar matrix and slowly built up to form three-dimensional structures including vascular systems. The first production system for 3D tissue printing, was delivered in 2009, based on NovoGen bioprinting technology. Several terms have been used to refer to this field of research: organ printing, bio-printing, body part printing, and computer-aided tissue engineering.

An early-stage medical laboratory and research company, called Organovo, designs and develops functional, three dimensional human tissue for medical research and therapeutic applications. The company utilizes its NovoGen MMX Bioprinter for 3D bioprinting. Organovo anticipates that the bioprinting of human tissues will accelerate the preclinical drug testing and discovery process, enabling treatments to be created more quickly and at lower cost. Additionally, Organovo has long-term expectations that this technology could be suitable for surgical therapy and transplantation.

As early as 2010, work began on applications of 3D printing in zero or low gravity environments. The primary concept involves creating basic items such as hand tools or other more complicated devices "on demand" versus using valuable resources such as fuel or cargo space to carry the items into space. Additionally, NASA is conducting tests with company Made in Space to assess the potential of 3D printing to make space exploration cheaper and more efficient. Rocket parts built using this technology have passed NASA firing tests. In July 2013, two rocket engine injectors performed as well as traditionally constructed parts during hot-fire tests which exposed them to temperatures approaching 6,000 degrees Fahrenheit (3,316 degrees Celsius) and extreme pressures. NASA is also preparing to launch a 3D printer into space; the agency hopes to demonstrate that, with the printer making spare parts on the fly, astronauts need not carry large loads of spares with them.

Since the 1950s, a number of writers and social commentators have speculated in some depth about the social and cultural changes that might result from the advent of commercially-affordable additive manufacturing technology. Amongst the more notable ideas to have emerged from these inquiries has been the suggestion that, as more and more 3D printers start to enter people's homes, so the conventional relationship between the home and the workplace might get further eroded. Likewise, it has also been suggested that, as it becomes easier for businesses to transmit designs for new objects around the globe, so the need for high-speed freight services might also become less. Finally, given the ease with which certain objects can now be replicated, it remains to be seen whether changes will be made to current copyright legislation so as to protect intellectual property rights with the new technology widely available.

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УДК 811.111:005.932

## TRANSPORT LOGISTICS AND ITS DEVELOPMENT IN BELARUS

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Logistics involves the delivery of products or services for the client with assured quality and quantity. The discipline of logistics has a long history with its first mention in an article going back to 1898. Nowadays logistics has a larger meaning: it is the management of the materials' flow through an organization, from raw materials to finished goods. Logistics is responsible for delivering the right product to the right place at the right time. Logistics implies the process of planning, implementing, and controlling the effective and efficient flow of goods and services from the point of origin to the point of consumption. It is a highly demanded field in each country that brings great profit to the economy. The logistics industry also depends on the timeliness in which products are delivered to a destination. Promptness is of utmost importance, as delayed delivery can result in significant losses to the recipient of the consignment in most cases. Logistics is divided into different types such as transport, warehousing, procurement, production, information logistics and others.

As we are going to speak about transport logistics in Belarus it is necessary to mention the definition of this term. *Transport logistics* is a system of delivering organization of various material items, substances and so on from one place into another by optimal route. The main notions of of transport logistics also include:

- 1) staff, that deals with realizing of these problems
- 2) classification of vehicles
- 3) pricing

Transport logistics infrastructure includes:

- Transport ways of all means of transport (pipeline, transport nodes: sea, river and air ports, container terminals, railway transshipment and sorting stations, terminals of combined transport )
- Buildings, which help to realize warehousing and storage with their technical equipment, which fulfill tampering with loads and implementation of main functions, for example, complication, decomplication and package.
- Elements of logistics nodal infrastructure, such as distribution centers, centers of logistics services, transport-warehousing objects.
- Devices and means of recycling and information transmission together with appropriate software.

As we know, Belarus stands on the crossroads of centuries-old trade routes from Russia to western Europe, and the Baltic to the Black Sea. As a result the country has developed a good transport infrastructure and it is determined to build on this strength, predominantly through foreign investment. ***On the whole the country is considered to be a very important logistics hub and there is a good opportunity for the republic to make money.***

If we have a look at a special European transportation scheme we will notice that major pan-European transport corridors go through Belarus. These corridors are as follows

- Corridor II connects Berlin via Warsaw and Minsk with Moscow and Eastern regions of Russia;
- Corridor IX b links Scandinavian and Baltic countries via St. Petersburg and Minsk with Kyiv, Chisinau and South European countries
- Corridor IX: joins Helsinki with Chisinau via St. Petersburg, Moscow and Kiev.