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ANALYSIS OF 3D PRINTING TECHNOLOGIES IN MODERN DENTISTRY

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Abstract: Today, in an age of high-pitched rapidities and well-controlled discoveries, general public are disagreeable with each their mightiness to accelerate the cognitive semantics of underdeveloped and business a contemporary individual of these distance is the application of accelerated prototyping procedure (rapid introduction of a archetype of the equipment continuance highly-developed to deportment a broadcast of examinations thereon or to rectify it to the examination product). In the day one graeco-roman undergrounds (turning, milling, stamping) were euphemistic pre-owned to constitute prototypes, on the other hand this was troublesome for a character of justifications (such creation of blanks manufactures a comprehensive proportion of waste, the elbow grease be required to be performed by accomplished personnel). in consequence in the 80s of the antepenultimate century, an additional appeared - the phenomenon is not make-believe "at once" (from a workpiece by ever-changing its shape), on the other hand stratum by stratum (moreover, to a certain extent hardly any substances are euphemistic pre-owned - metallic and impressionable powders, indefinite classifications of clay, polymers spiritualist to light), subsequently which the layers are held together. This another look focuses on characteristic 3D printing technologies euphemistic pre-owned in dentistry. Technologies and course of action of 3D publication are presented

Key words: multi–jet modeling, additive technologies, 3D printing, deposition modeling, laser stereolithography, CJP 3d printing technology, selective laser sintering, inkjet application of photopolymers.

3D printing has been recognized as a breakthrough technology that will transform manufacturing. This technology is used in various fields such as dentistry, aerospace, defense industry, art. Recently, he has become the subject of great interest in virtual surgical planning. The technology has a special resonance in dentistry. 3D printing is also known as additive manufacturing, rapid prototyping, multi-level manufacturing, or solid-form fabrication. It is a process in which several layers of material are added one after another under computer control to create a three-dimensional object. The key idea of this innovative method is that the three-dimensional model is cut into many thin layers, and the production equipment uses these geometric data to sequentially build each layer until the final desired product is obtained [1, 4]. The 3D printing process can be divided into several stages: 1. Creating and verifying an object model. A three-dimensional model is created either manually (in one of the CAD systems) or automatically using one of the 3D scanning technologies (scanning using structured light, scanning with a laser, scanning with a coordinate measuring machine, etc.). 2. Dividing the model into layers - the layers are made quite thin (less than 100 micrometers) to make the edges of the object smooth and to simplify the printing process. 3. Printing an object – the resulting set of layers is loaded into a 3D printer, which creates the object in layers. Different 3D printing technologies use different materials to build an object (metal tapes, powders and alloys, photopolymers, plastic films, etc.), because of this, the physical characteristics of objects obtained using different techniques can vary greatly. To date, there are about 9 main 3D printing technologies. They differ in speed, accuracy, material used and other parameters. The choice of 3D printing technology depends on the tasks that you set for the 3D printer, on the

requirements for the products you receive. Laser stereolithography (Stereolithography – SLA). The history of stereolithography dates back to 1980 and was introduced by Charles Hull. The principle of manufacturing solid objects is to sequentially print thin layers of photopolymer UV curing layer by layer. It is used for the manufacture of surgical guide implants due to its high mechanical strength, obturators, removable prostheses, individual spoons, aligners, etc. The curing time and thickness of the polymerized layer are influenced by the dynamics involved in the entire procedure. The kinetics can be controlled by the power of the light source, the scanning speed, as well as the chemical composition and the amount of monomer and photoinitiators. In addition, UV absorbers can be added to the resin to control the depth of polymerization [2, 3, 5]. Advantages and features of the technology: production of models of any complexity; easy post-processing of the manufactured prototype; high construction accuracy and high surface quality; larger than other 3D printers, the dimensions of the working chamber; low percentage of consumables for support; low noise level of parts production. Fusion Deposition Modeling (FDM) – developed by Schott Crump. The thermoplastic filament material is extruded through a temperature-controlled nozzle, and the material hardens immediately (within 0.1 s) after extrusion. The movement of the nozzle head is controlled by the processor, tracks and places the material in a very thin layer on the auxiliary platform. Materials such as acrylonitrile butyrostyrene (ABS), polycarbonates and polysulfones are used. The construction of complex geometries usually requires the use of a second extruder - for example, it can extrude a water-soluble carrier material [10]. The accuracy will depend on the speed of the extruder, as well as on the flow of material and the size of each one. It is this process that is used by most inexpensive 3D printers, which allows you to print rough anatomical models without much difficulty. [6, 8]. Advantages: durable wear-resistant products, low cost of materials, extensive post-processing capabilities. Selective Laser Sintering (SLS). This technology has been in operation since the mid-1980s and was developed at the University of Texas. The fine powder of the material is melted by a

scanning laser to gradually build up the structures. When a powder layer layer is formed, a new thin layer of material is evenly distributed over the surface. A high resolution level (60 microns) can be obtained. No auxiliary material is required, as the printed structures are supported by the surrounding powder [7]. Polymer frameworks (polyamide or polycaprolactone) are used in the manufacture of a facial prosthesis. Selective laser sintering is used in the manufacture of anatomical models, cutting and drilling guides, dental models, as well as for the construction/design of prototypes. The advantages are the ease of autoclaving of the materials used, the full mechanical functionality of printed objects, cheaper materials when used in large quantities, high strength, precision of construction, high-quality surfaces. SLS printing equipment is equipped with large construction cameras (up to 750 mm), which allows you to produce large products or whole batches of small objects in one printing session, does not require support material: the process is practically waste-free [1, 9]. The disadvantages are that the technology is expensive and requires significant climatic conditions such as compressed air. The method of multi-jet modeling (MJM). 3D printing technology based on multi-jet modeling using photopolymer or wax material. It is used in 3D printers of the 3D Systems company of the ProJet series. Prints well: master models for casting into silicone, high-precision prototypes, waxes, burnable master models. Advantages of MJM technology: high accuracy of construction; a wide range of materials (including wax). Inkjet application of photopolymers (PolyJet). The process of spraying liquid photopolymers onto a working platform with inkjet printheads. UV lamps instantly polymerize and cure the material, after which the next layer is applied. This technology uses either a stationary platform and a dynamic printhead, or a stationary printhead and a dynamic platform. The photosensitive polymer is injected onto the assembly platform from an inkjet printhead and cured in layers on a gradually decreasing platform. A wide range of casting resins and waxes can be printed, as well as some silicone-like rubber materials. This technology provides a resolution of about 16 microns and provides easy access to create complex and small

details. CJP 3D printing technology (Color Jet Printing - CJP). CJP is a 3D printing technology based on layer—by-layer gluing and coloring of composite powder based on gypsum or plastic. Prints well: architectural models, miniature figures of people, souvenirs, prototypes for visual evaluation, presentation samples of products. Advantages of CJP technology: − full-color printing; low cost; accuracy up to 0.1 mm [1, 2, 3].

Conclusion. There is a huge impact of three-dimensional visualization and modeling and computer-aided design technologies on all aspects of dentistry. With the help of digital data, it is possible to make precise and complex geometric shapes from various materials, locally or in industrial centers using 3-D printing. Although everything we do for our patients can be done on a 3D printer, technology alone is not enough to meet all the needs of our patient. Recent advances have made it possible to produce frames with lower rigidity with high-resolution functions, which allows them to be used in soft tissue engineering. Technology is also becoming increasingly important in the field of orthopedic dentistry with the increasing use of intraoral scanning systems.

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