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3D PRINTING OF BUILDINGS: CONSTRUCTION OF SUSTAINABLE HOUSES OF THE FUTURE BY BIM

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ABSTRACT

3d printing building technology is a new construction technique started with the invention of 3D printer. Latest technologies were described pointing to Contour Crafting as a promising technique that may be able to revolutionize construction industry in near future. It has many advantages of this technology, such as reduction of the costs and time, minimizing the pollution of environment and decrease of injuries and fatalities on construction sites could be listed. Integration of Building Information Modeling with the 3D printing building technique are mentioned in comparison with the traditional construction techniques. Even though many advantages and benefits of this new technology, of course we have some concerns that are summarized in the conclusions as the technology still has many limitations. A brief description of examples of 3D printing in construction industry are presented (Stupino town, Moscow, Russia - Apis Cor first company to develop a mobile construction 3D printer). Modeling a 3D model of building that will be appropriate for 3D printers is possible in many modeling software programs. One of the most popular formats for sharing such models is STL format common and it has been accepted by many proprietary software. Moreover, integration of BIM method with 3D printing modeling will be effective for energy efficiency, better design, cost reduction and isolation of structure.

KEYWORDS: 3D Printing, Sustainable Construction, BIM

INTRODUCTION

3D printing is a process by which physical objects are created by depositing materials in layers based on a digital model. All 3D printing processes require software, hardware, and materials to work together. Charles W. invented the first 3D printer in 1983 and over the last decades, 3D printing has become one of the fastest growing technologies nowadays. In its early days, it was very complicated and expensive technology. Over the years, 3Dprinting started to be present in everyday life and printers became commonly used in industrial practice. 3D printing can also be referred to as 'additive manufacturing,' especially when referring to its use within a manufacturing setting, and many individuals will use both phrases interchangeably. As the technology

continues to grow, 3Dprinting technology can be used to create everything.

Main areas of use:

- Prototyping
- Specialized parts – aerospace, military, biomedical engineering, dental
- Hobbies and home use
- Future applications– medical (body parts), buildings and cars

3D Printing uses software that slices the 3D model into layers (0.01mm thick or less in most cases). Each layer is then traced onto the build plate by the printer, once the pattern is completed, the build plate is lowered and the next layer is added on top of the previous one. Typical manufacturing techniques are known as 'Subtractive Manufacturing' because the

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process is one of removing material from a preformed block. Processes such as Milling and Cutting are subtractive manufacturing techniques. This type of process creates a lot of waste since; the material that is cut off generally cannot be used for anything else and is simply sent out as scrap. 3D Printing eliminates such waste since the material is placed in the location that it is needed only, the rest will be left out as empty space.

Fig. 1: 3d printed house in China



MATERIALS AND METHODS:

The starting point for any 3D printing process is a 3D digital model, which can be created using a variety of 3D software programs, for Makers and Consumers there are simpler, more accessible programs available or scanned with a 3D scanner. The model is then 'sliced' into layers, thereby converting the design into a file readable by the 3D printer. The material processed by the 3D printer is then layered according to design and process. As stated, there are a number of different types of 3D printing technologies, which process different materials in different ways to create the final object. Functional plastics, metals, ceramics and sand are, now, all routinely used for industrial prototyping and production applications. The different types of 3D printers each employ a different technology that processes different materials in different ways. Similar technique for 3D printing is selective laser sintering (SLS) that laser is used to melt particles of powder together to create an object. Materials used in the SLS technology usually have high strength and flexibility. The most popular ones are nylon or polystyrene.

There is now a wide variety of different material types, that are supplied in different states (powder, filament, pellets, granules, resin etc.). Specific materials are now generally developed for specific platforms performing dedicated applications (an example would be the dental sector) with material properties that more precisely suit the application. Nylon, or Polyamide, is commonly used in powder form with the sintering process or in filament form with the Fused Deposition Modeling (FDM) process. It is a strong, flexible and durable plastic material that has proved reliable for 3D printing. Acrylonitrile Butadiene Styrene (ABS) is another common plastic used for 3D printing and it is widely used on the entry-level FDM 3D printers in filament form. It is a strong plastic and comes in a wide range of colors. Polylactic Acid or Polylactide (PLA) is a bio-degradable plastic material that has gained traction with 3D printing for this reason. It can be utilized in resin format for laser-based stereo lithography (SLA) and digital light processing (DLP) processes as well as in filament form for the FDM process. It is offered in a variety of colors, including transparent, which has proven to be a useful option for some applications of 3D printing.

Process of 3D Printing of Buildings Construction by BIM in Figure 2. A model is prepared in a 3D modeling application.

Fig. 2: 3D Printing Process



RESULTS:

- More expensive than conventional construction due to high cost of 3D printer and lack of familiarity in the industry with 3D printing technologies and applications.
- Currently, a limited number of materials have been used, although experimentation is underway with printers capable of using multiple materials to produce more complex assemblies.
- 3D printers can be large and, therefore, difficult and costly to place on site.
- 3D printing incurs more up-front costs to create the digital model that will result in safe, cost-effective products.
- Printers are currently slow compared to

conventional construction, although they can be operated 24 hours a day, seven days a week.

- The potential of a disruptive impact on the type of skills and labor needed to design and build homes.

CONCLUSIONS:

- To use BIM improve the design details and accuracy of the designed buildings and plan of action will be more specified by using BIM detailed system.
- It is hard to imagine so far that 3D printing could replace traditional construction in next few years. It is more possible, that both technologies will be present in the industry and 3Dprinting may be developed along with the traditional techniques, supporting them, especially in case of more sophisticated building projects.
- Contour crafting is a huge step towards the future. It will affect people's daily lives, the construction industry, and even outer space missions.
- It practicality is incomparable to conventional construction methods. It is cheaper, faster, safer, and easier than any other method. There will be, however, potential problems with labor unions and other construction companies who have been building manually.
- This new technology is an environmental friend, which does not pollute or cause any evil effect to our environment.

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