Collaborative Essay – A Paper
Engr 110 - A01, A05
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Housing the Homeless: 3D Printing Technology Use in Developing Countries

Having lived in Canada, a wealthy developed country, I have always found it difficult to envision hardships those in developing countries face on a daily basis. My mom constantly told me to be thankful for the roof over my head because other people were not as fortunate. As I grew older, the reality of all I had to be thankful for made me wish that everyone could have the same opportunities. Now I better understand the poor conditions of those living in inadequate housing in developing countries, but presently there aren't any viable solutions in order to personally make an impact. However, new advancements in 3D printing technology have the potential to eliminate inadequate housing and homelessness in developing countries by making construction more efficient and affordable than traditional building techniques.

In many developing countries, homelessness and inadequate housing remains a major concern because people tend to forget the importance of this well-known issue when it feels so far removed from their daily lives. However, due to the fact that the number of homeless people worldwide is "estimated to be between 100 million and one billion" [1], more people are beginning to understand how serious this problem has become. Despite this obstacle affecting so many lives "housing is still being addressed as if it were a passive element in economic development" [2]. At the current rate of population growth, the issue will continue to progress until a beneficial solution is effectively implemented. This growing demand for basic shelter in urban areas of developing countries has led to a prediction that these communities will need

roughly 25 million new households by the end of the century [3]. Failed attempts to solve the problem in the past have included solutions pertaining to creating policies and actions plans, which do not address the main concern of lowering construction costs.

Conventional policies to combat inadequate housing such as public housing, core housing upgrading, and government assisted self-help programs attempt to solve housing issues in developing countries. However, many experts have decided that these outdated policies do not meet the housing needs, and in the future will need replacing [3]. Most solutions to inadequate housing in developing countries involve a vast number of willing volunteers from developed countries to travel, spending valuable time and money, in order to build homes for the less fortunate. Groups, with little experience or knowledge of construction, commonly travel to developing areas to build houses. However, this costly and time-consuming operation has the potential to greatly improve. In developing countries, construction industries provide only a fraction of homes needed, and the poorest families cannot afford housing constructed by most private firms [3]. Previously, this issue did not have any other viable solutions, but the new advancements in technology could efficiently solve this important problem. It could improve with the help of 3D printing building techniques because overall housing construction would increase productivity as well as become faster and more affordable.

The concept of printing in three-dimensions has been a reality since Charles W. Hull first used the idea in the 1980s [4]. However, 3D printing advancements have evolved far past its original intentions into a common fixture in manufacturing. The techniques used for printing vary, with the two most common types being selective laser sintering (SLS), and fused decomposition modeling (FDM). The technique of selective laser sintering uses a laser to melt powder particles together to create incredibly strong and flexible objects. Whereas, fused

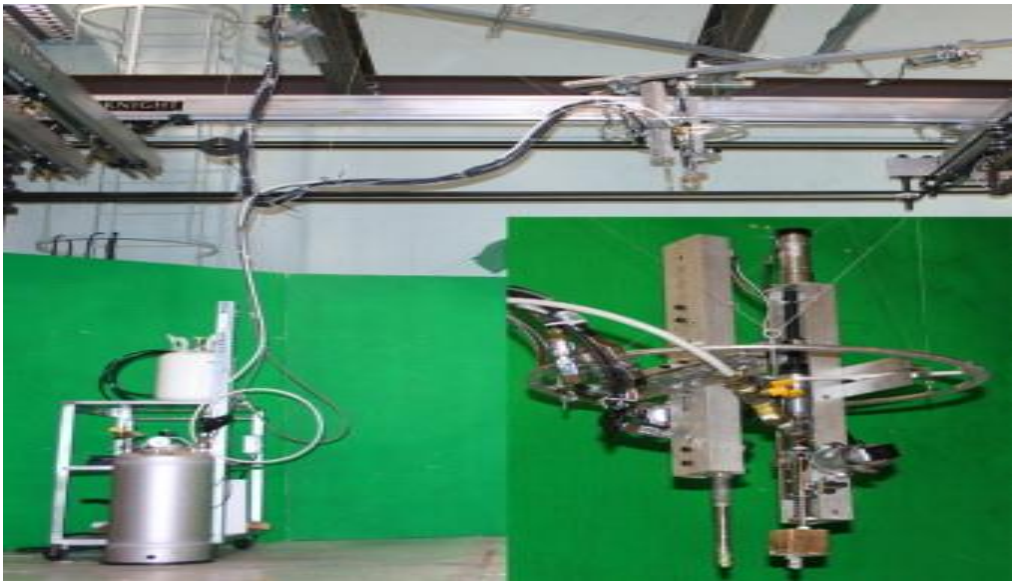
decomposition modeling, composed of extruding a substance that will harden over time; such as a cement material discharging from a nozzle, and then constructing the object layer by layer [4]. As shown in Table 1, a variety of key differences exist between both printer types; however, in terms of cost and accessibility, FDM wins overall. When it comes to three-dimensional printing in construction, large-scale printers remain necessary unless printing in components. Large-scale printers are a possibility for the future as shown in Figure 1, which shows a preliminary design of a printer suspended by cables. As of now this represents the best functioning large-scale printer in terms of accuracy and positioning [6].

Table 1. Comparison of different 3D printing processes [5].

Type of Printer	SLS	FDM
Underlying technology	Laser	Print head
Material used	Powdered material	Heated plastic
Accuracy	++	+
Cost	$$$	$
Advantages	Excellent strength Range of materials Large part size	Excellent strength Inexpensive
Disadvantages	Expensive Powdery surface	Time consuming/slow

+ Level of accuracy
$ monetary value

Figure 1. Experimental Large-scale Printer [6].



3D printing technology may feel out of reach to many people however, the speed of the technology's progress has made it an extremely viable option for the ongoing housing problem. Some common misconceptions include that 3D printers are extremely expensive and inefficiently slow; however, this is not the case when compared with traditional building methods. For example, a 3D printed building including floors, walls, plumbing, and electricity can be completed in as little as 20 hours according to The Department of Engineering at the University of Southern California [5]. Cost is another area where 3D printing excels. This has to do with the nature of the most commonly used material for FDM type printing in construction, a durable and cost efficient ultra-high performance concrete (UHPC) [7]. The main issue with this movement would be the implementation of 3D printers in developing countries. Ideas such as iLab Haiti, where they brought 3D printers to Haiti to produce medical equipment, have succeeded in the past because "they spend as much time and money designing appropriate business models as they do designing products [and] the same should be done with 3D printing" [8].

Currently three dimensional printing has been utilized in construction by a variety of different companies. One example is the Chinese company WinSun where they have accomplished multiple feats in 3D printed construction. Using their "staggering 20 feet tall, 33 feet wide, and 132 feet long 3D printer" [9], WinSun has printed a six storey, approximately 1100 square meter building (Figure 2). Along with that, WinSun managed to print a total of ten, 2100 square foot homes within the span of 24 hours each for under $5000 (Figure 3) [4]. In addition to the accomplishments of WinSun, another company has made strides in 3D printed construction. The World's Advanced Saving Project (WASP), an Italian company, has made strides to print buildings out of natural resources like clay since 2012. As of July 2016, WASP

has successfully built a house “entirely molded with non-pollutant, found in the area [material that is] a mixture of earth and straw mixed with the help of a pan mill and a cultivator” [10], that as of the latest update on August 10, 2016 is standing at a height of 270 cm with a 5 m diameter (Figure 4)[10]. These facts show the potential of 3D printing solutions and what implementing the technology in developing countries could eventually look like.

Figure 2. Six Story Building by WinSun [4].

Figure 3. One of the houses printed in 24 hours by WinSun [4].

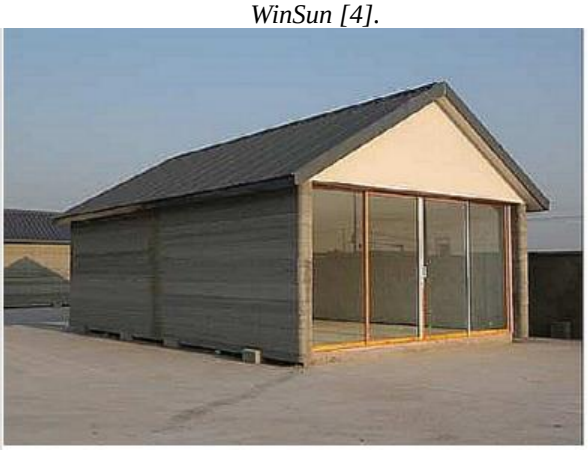


Figure 4. Earth and Straw “House” made by WASP [10].

Now that I am older and have researched the housing problem in developing countries, I am more equipped and knowledgeable about possible solutions. Originally it felt impossible to help those in poor living conditions myself. After all, I realized that understanding the issue and

working towards a solution could contribute to a deciding factor in the elimination of inadequate housing. Research has shown that 3D printing could potentially solve homelessness and inadequate housing in developing countries because of its low cost and efficiency compared to current building techniques. Taking all of the pros and cons of the recent progress made in 3D printing into account, the new solution's benefits greatly outweighs its flaws and so far proves practical and innovative in solving the housing problem.

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