3D Printing Assisted Product Design Addressing Refugees Needs

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Abstract. With one of the largest refugee crises of modern times currently occurring, the need for technology-based solutions to address related pressing issues is eminent. In the past few years, 3D printing has attracted considerable attention as a technology that could help to address specific refugees needs in a customized way. The aim of the presented work was to investigate and demonstrate the contribution of 3D printing to the design of specific products that could easily and rapidly manufactured to assist the refugees integration into the host country. Specifically, the undertaken study focused on facilitating the integration of refugees' children into the Greek society through the design and 3D printed toys for educational purposes. It is demonstrated in this preliminary study that such 3D printed toys can be proven a powerful tool for improving the integration process of displaced people by making the learning of a new language a pleasurable experience.

1 Introduction

In a rapidly and radically changing world, there are many complex societal problems. According to a U.N. refugee agency report [1], Europe is facing the worst refugee crisis with the number people who are displaced exceeding the one of the post-World War II. Many European organizations have tried to solve living and societal challenges of refugees by using new innovative methods and design tools. Considering that the design of ordinary products is user oriented, a more human-centered approach should be used for the development of products that could satisfy the refugees needs. The solutions offered can be products for daily use, services, garments and toolkits to education and training.

Children have been the worst affected by the refugee crisis, facing the lack of proper hygiene, nutrition and education. In the camps of the host countries usually there is no access to learning environments, literacy or basic education. One of the most effective learning techniques is through play because enhances creativity, invention and communication skills. Learning the language of the host country would be a skill for education and integration. Through education the refugee children can gain a sense of self value and reawaken their talents.

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Additive Manufacturing, or widely known as 3D printing, could help to address such issues related to important refugees needs. It has been reported that non-governmental organizations (NGOs) have been exploring the possibilities with 3D printing [2-6]. They have explored different ways of localizing the manufacturing of items needed in crisis such as items for water access, shelter, protection and prosthetics. Recently, attention has been drawn in developing robust and easily deployable 3D printers for humanitarian response works where the printers' operational environment is not well controlled [7].

This study investigates the design and fabrication, using a commercial 3D printer, of a simple educational toy product to facilitate the integration of refugee and migrant children into the Greek society through a playful experience.

2 Methods and materials

2.1 Product design requirements

An educational toy was selected to be designed and 3D printed models to be fabricated. In general, educational toys are specially designed to provide stimulation and learning for young children. By using such toys children can develop skills and abilities through the playing process. For instance, they can help them in problem solving, developing language skills, encouraging the communication with each other and expanding both their mental and physical abilities.

A simple structured toy in the form of a cubical building block was designed. Such shaped wooden toys of various sizes are commercially available and intended for constructive playing that natures spatial and logic-mathematical intelligence, develops logical thinking and creative problem solving. The selected cubical block shape satisfied the following design requirements:

- To encourage the refugee children to learn and develop their Greek language skills by learning the alphabet's letters and forming words.
- The overall size to be as minimal as possible to be easily handled by the young children.
- To not have sharp edges and be safe during playing.
- To be made of Acrylonitrile Butadiene Styrene (ABS) material which is harmless and suitable to prototyping.
- To be lightweight to be easily handled and carried.
- To be easily manufactured and painted with different colours.

2.2 Product design sketches and CAD models

Initially, a series of sketches were created in order to evaluate various ideas about the new toy block designed for the refugee children. These toy blocks had various shape forms such as cuboid, cylindrical cube, triangular prism and others as shown in Figure 1. Since the main function of the toy was to assist the children to the learning of the Greek language a cubical shaped block was selected having dimensions of 40 x 40 x 40 mm. The cube as a three-dimensional object has six square faces where different Greek letters, either capital or in small lettering, could be positioned. The toy set would be consisted of ten cube-shaped blocks in total while the simple form of the blocks provides numerous word formations since they allow easy revolution and horizontal or vertical placement during the playing process. Representative CAD models of the alphabet blocks are presented in Figure 2.

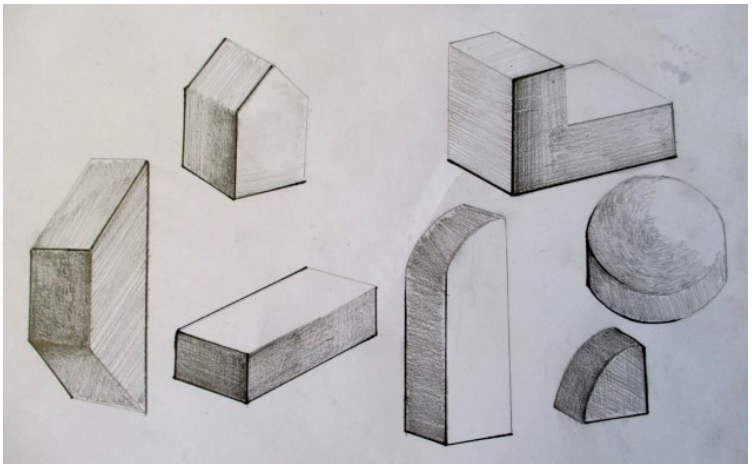

Fig. 1. Sketches of considered shape ideas.

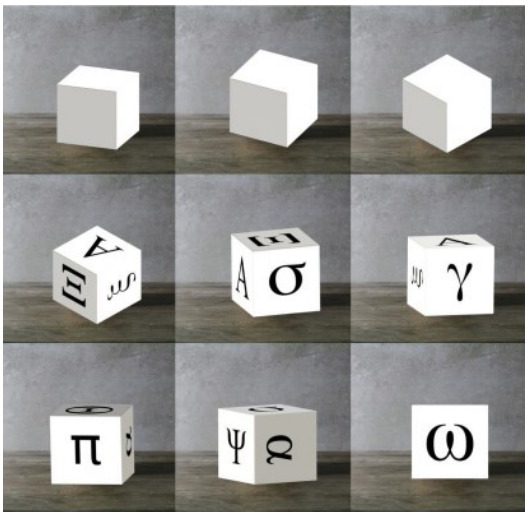

Fig. 2. CAD models of alphabet blocks.

2.3 Physical models fabrication

After having designed the blocks on the computer using a commercial CAD software, a desktop BCN3D Sigma R17 printer was used to fabricate the three-dimensional physical models. A layer thickness of 0.254 mm, infill density 25% and printing speed of 60 mm/sec were selected while the building time for each cube was 2.5 hours. For purposes of minimizing material consumption, the toy blocks were internally hollow. The 3D printer constructed simultaneously four cubes by adding ABS material layer-by-layer, fusing each layer together to make the model. Figure 3 shows four fabricated models at the end of the 3D printing process while in Figure 4 the final 3D printed blocks are presented with the Greek lettering positioned on their sides.

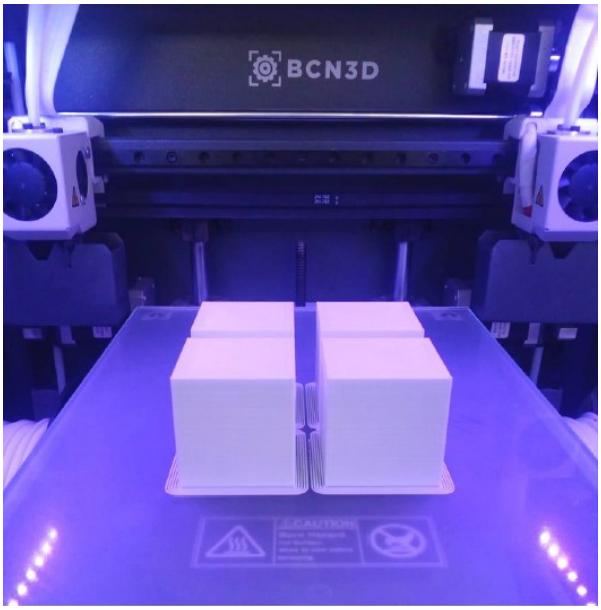

Fig. 3. 3D printed models on the build platform.

Fig. 4. Final alphabet physical models.

3 Discussion – Printed blocks evaluation

By testing the final 3D printed cubical models, valuable feedback and insight were obtained. Compared to adults, small children are unlikely to give any well documented feedback to asked questions. They do not have the same experiences as adults do, so they cannot express themselves in clear and precise way. Moreover, it must be considered that some of the involved children hardly spoke the Greek language. As a result, the kids' genuine impressions and reactions were observed, based on their body language, as they played with the printed cube. The children had no previous experience with such a product while no additional explanations were given.

The process was both unpredictable and demanding as the children needed time to feel comfortable and to start playing with the printed blocks. Since the children are distracted easily and cannot keep their focus to a certain object for a long period of time, the process was of short duration to hold their interest. The evaluation test took place in a playground, a familiar environment for them, and they were already in a playful and relaxed mood. Some children were more excited to participate while others were unwilling to engage.

The group that was selected was consisted of children between six to nine years old (see Figure 5). At the beginning the children started experimenting with the printed lettered blocks by touching them. The next step was to try to put the letters in a formation next to each other. If they did not know any letter they could ask for help. Later on they were asked to find a specific letter and to participate in a quick game of words. They were asked to find the letters of a specific word, or to put some letters in a row to form a word or other word game variations. After that, they were left unguided and free to play with the blocks the way they wanted to.

Fig. 5. Children are playing with the alphabet blocks.

The process with the word games seemed to hold their attention and to stimulate their interest. Judging from their reaction, at the end of the playing process was concluded that they found playing with the printed blocks pleasant and fun. They enjoyed stacking the blocks up, knocking them down and clacking them together. The blocks proved to be right sized as they were big enough to read the alphabet letters on them and not huge to have difficulties in manipulating them. In order to form words, they collaborated often with each other discussing about the right letters. Although not all children responded the same way, it was concluded that the quality of the printed model satisfied the initially set design and functional/educational requirements.

4 Conclusions

This proof-of-concept work explored the prospect of a 3D printed toy to assist to the preparatory education of young refugee children. For this purpose, cubical blocks with alphabet letters on their sides were designed and built using a commercial low-cost 3D printer. Based on this study observations, although the related comments from the observed children were broad to some extent, it was found that the simple in geometry solid blocks had a positive impact on their leaning experience. The children were engaged in a process of forming Greek words, helping them initiate conversations and exchange ideas during the words' formation exercise. Overall, this preliminary study provides encouraging information to researchers and designers to investigate further the development of additively manufactured products that can satisfy important refugees needs related to their easy integration into the educational system and labor market of the host country.

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References

1. The UN Refugee Agency, Available online: http://www.unhcr.org/globaltrends2017/
2. Field Ready, available online: http://www.fieldready.org/
3. Refugee Open Ware, available online: http://www.row3d.org/
4. P. Tatham, J. Loy, U. Peretti, Journal of Humanitarian Logistics and Supply Chain Management, **5**, 188-208 (2015)
5. E. James, D. Gilman, *Hyperlocal Manufacturing and 3D printing in Humanitarian Response* (OCHA Policy and Studies Series, 2015)
6. S. Saripalle, H. Maker, A. Bush, N. Lundman, *Proceedings of IEEE Global Humanitarian Technology Conference* (Seattle, USA, 205-208, 2016)
7. B.L. Savonen, T.J. Mahan, M.W. Curtis, J.W. Schreier, J.K. Gershenson, J.M. Pearce, Technologies, **6** (2018)