THE CENTER SCHOOL

BRINGING 3D PRINTING TO CENTER SCHOOL MIDDLE SCHOOLERS

A Proposal to LEGO Children’s Fund  |  Danielle M. Villegas
# Table of Contents

**Executive Summary** .................................................................................................................. 2

**Background** ................................................................................................................................ 2

**Objectives** ................................................................................................................................... 4

**Plan of Action** ........................................................................................................................... 5

**Assessment Plan** ....................................................................................................................... 5

**Key Personnel** ............................................................................................................................ 5

**Budget** ........................................................................................................................................... 5

**Implementation Timeline** ........................................................................................................ 7

**Conclusion** .................................................................................................................................. 8

**Works Cited** ............................................................................................................................... 9
APPLICATION:
The Center School
580 Old York Road
Branchburg, NJ 08876

CONTACT PERSON AND INFORMATION:
Danielle M. Villegas
dmv4@njit.edu

APPLICATION DATE:
6 August 2013

EXECUTIVE SUMMARY:
We are interested in gaining financial support to fund an expansion of our computer curriculum to include teaching 3D printing to our special education middle school students. Of the funding programs we analyzed, we believe that the LEGO Children’s Fund is the best match to meet our needs, as our proposed program for 3D printing design fosters both creativity and technology, our middle school students are within the age specifications targeted, and the available funding contributions from LEGO are appropriate for our needs.

BACKGROUND:
3D printing is a young technology that is quickly gaining attention. The website, Educational Technology and Mobile Learning (http://www.educatorstechnology.com) provides a great explanation of what 3D printing is, namely,

> 3D printing is a technology that allows users to turn any digital file into a three dimensional physical product. 3D printing also allows for massive customization and unlike with music and movies, everything that is printed is protected by copyright....In other words, it turns users from being passive consumers to active creators. (Importance of 3D Printing in Education)

3D printing is becoming more affordable as time passes, in return making 3D printers more easily available to consumers. As stated by Katie Alice of the website, Emerging Ed Tech, The emergence of 3D printing has drawn the attention of different business sectors across the world. This high-tech printing method uses many additive layers compounded with each other to create the desired object. A primary driver behind its growing popularity is the ability to create certain constructs more proficiently and cost-effectively than making them by hand or using traditional manufacturing approaches. 3D printing is also making its way into educational institutions. (Alice)
Its rapid adoption has prompted many in the education technology field to start creating curricula to introduce 3D printing. In fact, starting in September 2014, the required curriculum for all students in England will include 3D printing and robotics starting at the kindergarten level. Education Minister Michael Gove was quoted as saying that the changes were necessary to keep up with the high standards of schools in other countries, and that design and technology are linked to innovation and digital industries. This includes understanding how to design and use 3D printing. (Coughlan) With the understanding that technology will be a large part of life skills needed as the children get older, early adoption of such a curriculum puts students at an advantage over those not receiving the same instruction. The Center School has the goal of staying on the cutting edge with its curriculum, especially in light of its special needs student population. It has already implemented the use of laptops and tablets for both the students and teachers with great success, and we seek to expand on those technological skills. Center is looking to add 3D printing to its curriculum for the very reason Michael Gove outlined: to provide our students with the design and technological skill that will help them later in industry.

The Center School is geared towards the education of developmentally different-abled children. The disabilities most served by our school include learning/language disabilities, dyslexia, ADHD, mood disorders/bipolar, depression, anxiety disorders, Oppositional Defiant Disorder, adjustment disorders, Asperger’s Syndrome, motor skills/Sensory Integration Deficit, and tic disorders. As stated on our website,

A long-standing record of creative shared-time scheduling, a strong return rate to local districts, and frequent transition to higher education reflects Center School’s philosophy of preparing students for future educational and vocational experiences. It is hoped that with ongoing support by dedicated members of the Center School community, our services will continue to expand to meet the ever growing needs of our student population. (The Center School)

As a non-profit private school, funds are limited when trying to purchase and employ new technological tools in the classroom. We trust that support from the LEGO Children’s Fund will help provide us with the seed money to purchase additional 3D printers and supplies to run the printers, fund training for the instructors, and fund other supplies such as student workbooks and software (as needed) to get the program started. All funding received for this program would be directed solely for this educational program.

We believe our project is innovative because it helps a group of schoolchildren gain a skill advantage that they might not learn at any other special education program. A 3D printing education for middle school children at the Center School will provide opportunities to create and produce objects that will be helpful as models in science, math, computer, and social studies classes. As many of these children have sensory issues, creating models through 3D printing rather than purchasing models would allow the children to produce objects that will more likely be handled and touched, much in the same way that a cook prefers his or her own cooking. Deeper analytical thought and concentration would be used by these sensory seekers by creating their own models, promoting a better understanding of the manufacturing or creating process of making that particular item, thus promoting a better appreciation of the item. The focus and attention to detail needed to use 3D printing
reinforces the same skills needed to perform in standard academic subjects, but in a more fun, tangible way that the students can relate to more easily. We also recognize that as 3D printing becomes more prolific, a strong 3D printing curriculum will allow students to learn about the creative process of three-dimensional design and production. This knowledge can subsequently provide basic creation and production skills that can help the students in secondary and higher education, vocational school, or in manufacturing jobs upon graduation, and will enhance future opportunities to have much needed skills to help become productive members of the community.

Many of these students are highly functional and can do the same academic work as their typical peers, but need extra support since they are differently-abled. By providing the same opportunities available to their typical peers at an earlier point in their education, these differently-abled students will have more of an equal opportunity to get jobs in manufacturing or do well in higher education endeavors. If the curriculum is started at a younger age than high school, it will allow these special education students a little more time to learn the "ins and outs" of designing and creating objects through 3D printing. The earlier students are taught technology skills, the more familiar, comfortable, and proficient they are as they get older.

Currently, the Center School has one 3D printer that is used for a 3D printing course given at the high school level. The purchase of additional 3D printers and other necessary materials for the middle school will provide one-on-one opportunities for the students to actively learn this technology first hand in a controlled, progressive atmosphere, allowing them to be creative while learning how to use the tools of design and manufacturing.

**OBJECTIVES:**

Our primary objectives include the following:

- Identify and purchase appropriate additional printers for the classroom. (Production and shipping of most printers can take several months.)

- Purchase additional supplies (such as a generous supply of the plastic ABS material used to create the 3D objects) to allow all students to be able to make plenty of models in the learning process—to be purchase simultaneously with the printers.

- Determine and deploy software programs needed to utilize the 3D printers. Establish which software application is the most user-friendly, and whether a freeware application or a paid application is the best choice. If the decision is a paid application, determine its worth based on the cost long-term to maintain and update.

- Identify a curriculum appropriate for middle school students that can be implemented, and identify if additional student materials are needed, such as workbooks or textbooks. If there are no such appropriate programs already published, then time will be needed to develop an in-house solution.
Identify and provide additional training for the teacher(s) given the task of teaching the 3D printing courses to the middle school students. This can be in the form of online training or a workshop.

**PLAN OF ACTION:**
All planning and implementation for the launch of this new program would be completed during the 2013-2014 school year. We have allowed ourselves a full year to put the program together to ensure that we have accounted for sufficient time to research the best printers, software, training, and other materials are to implement this successfully. Once all printers have been purchased and installed, the curriculum identified and additional training/workshops attended by teachers of the course if needed, the middle school courses will start in fall of 2014.

**ASSESSMENT PLAN:**
We will run a pilot program in fall 2014 for the first marking period by choosing one computer class to follow the 3D printing curriculum. The aim of the curriculum is to have the children gain a basic understanding of how to use the 3D design software, progressively create objects that are more complex with each project, understand how the 3D printer works, and 3D printer safety. Based on the results of student feedback and performance in the class, we will make adjustments and update the curriculum as needed.

**KEY PERSONNEL:**
The initial committee that will be in charge of planning and implementation of the program include the following:

- Teachers who will be administering the technology and teaching the 3D printing Curriculum
- The curriculum administrator for the Middle School
- The business manager in charge of manage the accounting for the project
- The middle school teachers (for feedback on student ability)
- Parent volunteers for feedback (preferably ones with some technical background)

**BUDGET:**
The cost of the launch of this program depends on the best pricing we can get on the printers and printer supplies, the cost of teacher training, and any costs for 3D rendering software and student materials. Through preliminary research and analysis, we feel we can keep our costs down, or within an affordable level.
The cost breakdown of consumer-based printers included the following:

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Cost for each printer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solidoodle</td>
<td>2(^{nd}) generation</td>
<td>$499.00</td>
</tr>
<tr>
<td>Solidoodle</td>
<td>3(^{rd}) generation</td>
<td>$799.00</td>
</tr>
<tr>
<td>Pirate 3D</td>
<td>Buccaneer</td>
<td>$397.00-$497.00</td>
</tr>
<tr>
<td>Makerbot</td>
<td>Replicator 2</td>
<td>$2199.00</td>
</tr>
<tr>
<td>Makerbot</td>
<td>Replicator 2x</td>
<td>$2799.00</td>
</tr>
<tr>
<td>Printrbot</td>
<td>Simple</td>
<td>$399.00</td>
</tr>
<tr>
<td>Printrbot</td>
<td>Junior</td>
<td>$499.00</td>
</tr>
<tr>
<td>Printrbot</td>
<td>LC (v2)</td>
<td>$799.00</td>
</tr>
<tr>
<td>Printrbot</td>
<td>PLUS (v2)</td>
<td>$999.00</td>
</tr>
<tr>
<td>Cubify</td>
<td>Cube</td>
<td>$1299.00</td>
</tr>
<tr>
<td>Cubify</td>
<td>CubeX</td>
<td>$2499.00</td>
</tr>
</tbody>
</table>

While we have one Makerbot Replicator on campus already, the cost of purchasing a second machine is exceedingly high. We want to be able to allow the machine sufficient time to print individual student projects, thus more than one new printer is needed. At the moment, based on features, costs, compatible software, ease of installation, and ease of use, we are leaning towards the Solidoodle 3\(^{rd}\) generation printers. While these machines are at the higher side of the low-end cost printers, they provide the most flexibility as they are able to use free, open source software, are enclosed units (for safety), and have the largest printing field to allow the students to make larger objects. Based on an average class size at our small school, we would purchase six units, which would allow each child to have one-to-one experience directly with a printer, rather than sharing only one or two network printers.

The Solidoodle also need filament material to print out the student projects, much like a standard printer needs paper. We wish to have an inventory of filament that will allow the students to produce as many 3D models as needed to understand a given design concept. Since spools of filament cost $43.00 per two-pound spool, this can get expensive. We believe that an initial expense of two spools per printer, totaling twelve (12) spools altogether, would be an acceptable inventory to start.

Fortunately, compatible software with the Solidoodle—as well as many of the other 3D printers—is available through freeware. The most commonly used software applications that can be used with 3D printing are SketchUp and Blender. The savings are significant.

Additional savings have been found as we already have a teacher who has experience with using both SketchUp and the 3D printer. He will not need additional training to learn how to use the technology. He has volunteered to train any additional staff who may be hired in the future to use the printer and software as needed. If teachers need a refresher or additional training on the software or use of the printer, free training is available on the SketchUp website.

Since 3D printing is a new field of study, we will be using the curriculum used by the school’s computer instructor for the high school program. He is willing to adapt much of the
coursework for the middle school level. Costs for printing any student reading or in-class exercises are already part of the school’s regular materials supplies (e.g. photocopies) budget, thus it would not impact the grant request.

However, while we are able to create our own curriculum at low to no cost, we will be contacting CityXProject (http://www.cityxproject.com/), which is an established program that teaches upper elementary students about 3D printing through its workshops. It is in the process of creating a standardized curriculum based on its workshops that we think can be implemented for our program. We do not know the timeline for when CityXProject’s curriculum will be available, or the cost associated with obtaining this curriculum. We anticipate that it will be available in the spring of 2014. We will work with CityXProject to find out if there will be a cost, and how much it will be. Once we have an idea of that cost, we will determine if the per student cost is worthwhile and its impact on our grant request.

To summarize the initial budget, see Table A below.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Cost (in US Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solidoodle 3D Printers – 6 units at $799.00 each</td>
<td>4794.00</td>
</tr>
<tr>
<td>Filament material – 12 spools at $43.00 each</td>
<td>516.00</td>
</tr>
<tr>
<td>Sketch-Up software for each computer/printer</td>
<td>0.00</td>
</tr>
<tr>
<td>Student learning materials</td>
<td>0.00</td>
</tr>
<tr>
<td>Teacher training</td>
<td>0.00</td>
</tr>
<tr>
<td>CityXProject curriculum program kit</td>
<td>(unknown)</td>
</tr>
</tbody>
</table>

**Total initial costs (pre-CityXProject costs):** $5310.00

Table A

**IMPLEMENTATION TIMELINE:**

- September 2013 - Committee meets to make final decision on printer model purchase. Determination of amount of initial supplies inventory made as well.
- October 2013 - Purchase of printer and supplies made to allow sufficient time for building and shipping. Some companies are not expected to ship until the spring of 2014, so the earlier the purchase is made, the better.
- November 2013 - Meet with CityXProject to review their curriculum, and begin collaboration to use their curriculum for our school on our own.
- December 2013-April 2014 - Receive printers and supplies, and have curriculum mapped out for curriculum administrator’s review.
- May 2014 – Curriculum Administrator will review the curriculum with the instructor(s), and work with the instructors to fine-tune lesson plans.
- June 2014 – July 2014 – Summer School break
- August 2014 - Begin installation and testing of 3D printers in the classroom
- September 2014 – Begin teaching the first middle school classes the new curriculum.
- November 2014 – Assess the results from the first class after the first marking period.

7
CONCLUSION:

George Meadows, an associate professor at the University of Mary Washington who specializes in teaching and implementing 3D printing in education, was quoted in the leading education technology publication, *Campus Technology*, as saying,

"One of the things that's happening in...education is that there's a big emphasis on including engineering in...classes."

3D printing fits well, Meadows explains, in a scenario where the student is "designing something, testing it, learning, recording information, going back and redesigning. It's really a great way to do problem solving."

*Children are "helped," he adds, "by something they can get their hands on. It helps them visualize something."* (Schaffhauser)

We understand that the children in our school learn best using visual and tactile references, so seeing and creating three-dimensional objects can help promote better learning for these students through invention.

The children at the Center School are capable of learning and benefitting from this kind of educational supplementation in their computer education. The Center School embraces technology. Technology not only helps our students communicate and function more completely like their neurotypical peers, but it can also be used as a tool to enable the students to participate fully as active members of their community both socially and economically. We understand that students can only benefit from learning technological skills over the course of their lifetimes, so having a good understanding of even the smallest bit of technological knowledge can help them to advance and succeed in higher education and in their future careers.

We are confident that after reading this proposal that you will see that this Center School is an excellent candidate to be a recipient of the LEGO Children’s Fund, as the project fosters creativity and technology in a unique environment that could have a lasting impact not only on the children’s lives now, but also in the future.

Thank you again for chance to apply. If you have any questions about the information in this proposal, please feel free to contact Danielle M. Villegas by email at dmv4@njit.edu.
WORKS CITED:


