Design…Print…Animate

By Michael Thomas Cherry

Introduction

In February 2015, the Evansville Vanderburgh Public Library (EVPL) was awarded four 3D printers as part of the MakerLab Club, an initiative of 3D Systems and the Young Adult Library Services Association. This initiative sought to build knowledge of 3D design, while increasing young people's access to 3D printers.

This article will highlight a technology camp which was made possible through the support of this grant. Students attending the camp learned how 3D printing is employed in the stop-motion film industry. They discovered how the animation company LAIKA utilizes 3D printing for the creation of characters in their stop-motion films. The Portland-based company is responsible for several Oscar nominated features, including *The Boxtrolls* (2014), *ParaNorman* (2012), and *Coraline* (2009).

In addition to learning about these films, students were tasked with the project of designing and printing a character for their own stop-motion film. They learned how to design three-dimensional characters using computer-aided design (CAD) tools like Tinkercad and learned about the 3D printing process.

The article describes various resources that were used throughout the course of the camp, including videos about LAIKA, animation books, and hands-on activities. The resources provided in this article can be used to design a similar camp that connects 3D printing to animated films.

Planning and Marketing the Camp

The 3D Design and Animation Camp was held on Mondays and Wednesdays in June 2015 at the EVPL's Central Library. Monday's class consisted of students entering 6th through 12th grade, while Wednesday's class consisted of students entering 5th through 8th grade.
Each age group met once a week, for a total of four weeks.

The camp required registration and was limited to thirty students. Limitations were set due to the available amount of technology and the time required to print each student's creation.

Fifteen students attended the Monday programs and the other half attended the Wednesday sessions.

The primary marketing tool for the camp was a summer calendar listing children's and young adult events. The camp was also marketed through social media sites, such as Facebook and Twitter, and was advertised in a local newspaper article written by staff (Cherry, 2015).

Most importantly, the EVPL has held animation camps for teenagers and pre-teens since 2012. The summer camps are one of the library's most popular events. This popularity has largely resulted from a consistent following and word-of-mouth advertising. In the past, students have learned animation techniques including pixilation, light animation, and other unique formats (Cherry, 2014).

Aside from marketing, a 3D printing training was featured as part of a Staff Institute Day which focused on new technologies. Staff had an opportunity to learn about 3D printing and see various objects being printed. While the staff training was not specifically for the camp, it did give librarians an opportunity to explore 3D printing in advance.

Lastly, planning and preparation focused on researching 3D printing. There are various resources that can offer librarians a crash course in 3D printing (Horvath, 2014; Thornburg and Thornburg, 2014; Griffey, 2014).

Jason Griffey's *Library Technology Report, "3D Printers for Libraries*," is an excellent place to start. Griffey's report covers different types of printing and explains standard filaments, such as ABS (acrylonitrile butadiene styrene) and PLA (polylactic acid) plastic. There are additional chapters about creating digital files, as well as popular types of 3D printers for libraries.

In addition, there are a variety of children's books that contain useful information and make great resources for young readers. For example, Maggie Murphy's (2015) *High-Tech DIY Projects with 3D Printing* describes how 3D printers work, in addition to listing useful websites pertaining to modeling software and supplies.

Terence O'Neill and Josh Williams's (2013) book *3D Printing* covers different professions that utilize 3D printing and websites, such as Thingiverse, that allow people to share and print designs.

All of these resources can provide librarians with a basic understanding of 3D printing. They contain important technical advice and ideas for projects, while enriching the library collection.

Getting Started with Design

In their book, *Fabricated: The New World of 3D Printing*, Hod Lipson and Melba Kurman (2013) describe 3D printing as a magic wand that enables complete control over the physical world, while allowing people to create on demand. 3D printing is a type of additive manufacturing whereby materials, such as resin or bio-degradable plastic, are layered to create a three-dimensional object. The 3D model can be created using various design tools and is commonly saved as an STL file (stereolithography), before being sent to a printer.

The first day of the camp introduced students to this process of 3D printing and participants learned how to design a 3D character. Initially, students watched parts of a video by Global News titled, "3D Printing: Make Anything You Want." The video, accessible via YouTube, describes the process of 3D printing and contains some interesting examples, including bioprinting kidneys for organ transplants and fabricating parts of Iron Man's suit. The latter part of the video covers the controversial topic of 3D printed weapons and was edited due to content.
Following the video, the class discussed some of the problems associated with this new technology.

For example, students were surprised at the length of time required to print an object and the cost of 3D printers. We also discussed restrictions associated with 3D printing, such as copyright issues and proprietary parts and filaments.

After some initial discussion, students were introduced to the animation project. The first day required that they design a character using the design tool Tinkercad. Tinkercad is a design tool that allows users to create 3D models online. It does not require software installation, nor is there a cost associated with using Tinkercad. Students can simply set-up an account using an email address and password. Their creations will be stored in their Tinkercad account, much like a portfolio.

To get students started with Tinkercad, librarians screened the "Tinkercad Tutorial Video" created by Autodesk Tinkercad and accessible via YouTube.

Tinkercad uses a palette of three dimensional shapes that include basic geometries, letters, and numbers. Students can drag and drop these shapes into a work plane, then adjust their size or stack objects together to create different shapes.

For example, characters were created from oval shapes resembling Kirby from Nintendo's *Super Smash Bros.* Other students made use of the rabbit ear shape provided in the Tinkercad palette. Eyes, mouths, and other cavities were made from negative shapes using the basic building blocks. Altogether students created robots, aliens, and a mix of other oddities.
Each student completed their character design by the end of the first day. Students were encouraged to limit their character designs to four by four inches. This would assure that the character would fit within the six by six inch printing plate. The height and width of the design were also limited due to the time it would take to print each creation.

If your students are designing with Tinkercad, it will be important that they set their creation to "public" after finishing their design. This will guarantee that staff can access their character via the website's search bar.

The design will be searchable by file name and it can be copied into a staff account and printed from there. Otherwise, library staff will need to know the password and username of each student's individual account.

In addition to Tinkercad, there are a variety of other computer-aided design tools that one can use to create a character. Other examples include SketchUp, Autodesk 123D, and Sculptris. However, these platforms contain more complicated toolbars, whereas Tinkercad is easy to learn and can be used across a variety of age groups.

3D Printing and Stop-Motion Animation

The following week introduced students to the process of stop-motion animation. Students were shown various videos by LAIKA and classroom discussion centered on the use of 3D printing in films like *Coraline*, *ParaNorman*, and *The Boxtrolls*. Many of these videos are included as bonus features on the film DVDs.

For example, the bonus features on the *ParaNorman* DVD include a segment titled, "Building Characters," which illustrates how characters such as Norman are constructed in the puppet department (Universal Studios Home Entertainment, 2012). Georgina Hayns, LAIKA's Character Fabrication Supervisor, describes the creation of a character from two-dimensional drawing to three-dimensional puppet.

The process is fascinating for students to witness as puppets are constructed from metal armatures, goat hair, and ball and socket joints.

The feature titled, "Making Faces," describes the use of 3D printing in the creation of faces. This process, known as replacement animation, has become central to LAIKA's unique art of filmmaking. Brian McLean, LAIKA's Director of Rapid Prototype, states that replacement animation in the past may have required sculpting up to eighty individual faces and eight hundred different facial expressions by hand. According to McLean, 3D printing allowed LAIKA to create thousands and thousands of different facial expressions, pushing the performance of a character to a new level.

"Making Faces" is a great video to show students as it describes how CGI animators create the digital files that are then sent to the printer.

LAIKA uses a powdered color printer and prints must be dipped in superglue, prior to animating. The superglue seals and brightens the colors of the powdered prints. This process is strangely fascinating to watch on the *ParaNorman* DVD.

Furthermore, *The Boxtrolls* DVD contains various bonus features that are equally as interesting, including the segment titled "The Big Cheese: Allergy Snatcher." This segment describes the use of 3D printing in the creation of the film's notorious villain, Archibald Snatcher (Universal Studios Home Entertainment, 2014).

All of these bonus features contained on the DVDs are like opening a treasure chest of wonders. Each feature provides close analysis of the film's production. Students can learn how sets are constructed, how actors and actresses provide voices for characters, and how lighting works, among other important steps in the making of a film. Students attending the camp were amazed by the videos, often checking them out from the library after class and watching them with friends.

In addition to the videos, students were shown books related to the films, such as Jed Alger's (2012) *The Art and Making of ParaNorman* and Phil Brotherton's (2014) *The Art of the Boxtrolls*. The third chapter in Alger's book titled, "Face Facts: How RP Technology Has Raised the Stop-Motion Bar," discusses replacement face animation, describing how thousands and thousands of 3d printed faces are neatly stored and cataloged in LAIKA's face library.

Finally, the remainder of the second day featured a group activity. Students created a pixilation video using cardboard cut-outs, chairs, and other life-size props.
Pixilation is an animation technique whereby humans are the subject of the animated film. It relies on choreographing people through a series of stop motion photographs. Michelle Hlubinka's (2013) "Pixilation: Full Body Stop-Motion Animation" is one of the best resources available for librarians who may not be familiar with this technique. The article can be retrieved on Make Magazine's website under the projects tab.

Printing the Characters

Thirty stop-motion characters were printed between the first and third weeks of the camp. Each character required, on average, three hours to print. This is clearly one of the major disadvantages to the consumer level 3D printers available on the market today.

Since the EVPL received four 3D printers through the MakerLab grant, it lessened the amount of time it would have required to print all the characters on a single printer. Librarians could print the students' creations simultaneously on all four printers.

Staff discovered several obstacles in the process of printing the students' creations and shared these issues with students prior to animating. These issues are important for librarians to understand if they plan on designing a similar program at their library.

First and foremost, it is important to double check the students' designs. Make sure students have grouped all their shapes together in Tinkercad and that the shapes are touching. The slightest amount of space between shapes will determine if the character will print correctly. All shapes should be aligned properly and the character should be rescaled if students ignored the mathematical dimensions provided by Tinkercad.

Secondly, most consumer level 3D printers will print an initial raft to keep the print adhered to the plate. This raft makes it harder to clean around the base of the object after printing. However, the raft function can be turned off prior to printing and this may be a good idea.

Additionally, be aware of scaffolding that will be printed in order to support arms, tails, legs, or other appendages that may otherwise droop if the scaffolding is turned off.

The supports will need to be trimmed off of the final print, either by using an X-Acto blade or similar tool. This could be a delicate and difficult situation depending on the amount of scaffolding. Certain consumer level printers will print better than others when it comes to free flowing parts, such as arms and legs.

Librarians may want to test a print without the scaffolding first, to see if the shape supports itself, or ends up looking like stringed spaghetti.

Moreover, many 3D printers require proprietary cartridges that can be expensive. The cartridges for the Cube 2 printer cost $50.00 apiece and could be purchased in a bundle for a slight discount. The cartridges averaged nearly a dozen prints per plastic spool, depending on the size of the character. All of the printing was completed outside of the camp due to time constraints.

Staff video recorded the printer in action then showed students the video in class. This allowed for discussion on the basic parts of a printer and demonstrated how the printing process works.

Lastly, in addition to understanding basic design tools like Tinkercad, library staff will need to have an understanding of the 3D printer slicing software that is needed to convert an STL file into g-code. G-code is the programming language that can be understood by the 3D printer. It is a set of instructions that directs the heated extruder along its x, y, and z axis as the extruder builds the print. Slicing software will vary depending on the type of printer and manufacturer. This final step in preparing the print provides another opportunity for classroom discussion focused on the 3D printing process.

Animating the Characters

With their characters in hand, camp participants were now ready to create their stop-motion videos. Librarians unfamiliar with the art of stop-motion animation can refer to Ken A. Priebe's (2010) *The Advanced Art of Stop-Motion Animation*.

Priebe's book contains a comprehensive history of stop-motion animation with many different examples from film and television. Chapter three entitled, "Making Puppets," discusses replacement faces and rapid prototyping in LAIKA's film *Coraline*.

The students participating in the camp created their videos using Stop Motion Pro software and an app called Smoovie. There are a number of free or inexpensive apps available that can be used to create an animation video, as well. Some of these apps include Flipbook, Lego Movie Maker, and PicPac, among others.

Students spent the entire third day of the camp creating their animation videos. The software was installed on laptops and participants used cameras to photograph their stop-motion stills. The iPads were attached to desktop microphone stands using iPad attachment clips. This allowed participants to shoot at eye-level without having to hold the tablet.

In addition to their 3D printed character, students were allowed to use other materials including clay, toys, and cardboard buildings. These materials helped to create an environment for their character, as well as provide minor characters and props.

As students worked on their videos, librarians introduced them to different animation tools such as onion skinning, frames per second, and chroma key. Onion skinning allows the animator to see several frames at once. It is often used to refer to a previous shot when positioning a character, whereas frames per second controls the speed of the film. The chroma key is a tool that relies on green screen technology and can be used to create special backgrounds for a film.

3D Printing as a Teaching Tool

The 3D Design and Animation Camp at the EVPL explored the use of rapid prototyping in the animated film industry. Sample videos from the technology camp can be accessed via YouTube by searching "3D Printing at the EVPL." Students attending the camp learned how LAIKA utilizes 3D printing in the creation of characters for their films. In addition, they learned how to design and print a character for their own animated short.

Connecting classroom activities to popular culture enriches learning by recognizing the interests of students. It provides them with a deeper understanding of these interests and a framework for learning about media.

In the animation camp, participants were able to see how 3D printing is revolutionizing the art of stop-motion films, in addition to other fields such as bioprinting, fashion, and the food industry.

As more and more libraries acquire 3D printers, it is important to develop programs that help patrons think critically about technology.

Offering 3D printing services is one way to attract patrons to your library, but offering classes that connect people to culture does more to utilize rapid prototyping as a teaching tool, while encouraging new ways to engage learners.

In conclusion, the 3D Design and Animation Camp was made possible by 3D Systems and the Young Adult Library Services Association. Films like The *Boxtrolls*, *ParaNorman*, and **Coraline** remind us that new technologies can be the fairy wands that bring our ideas to life.

As students create with these tools, they are reminded of the films that inspired their interest in stop-motion animation. Furthermore, they delight in the overwhelming support of the beloved characters around them.

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Biography

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