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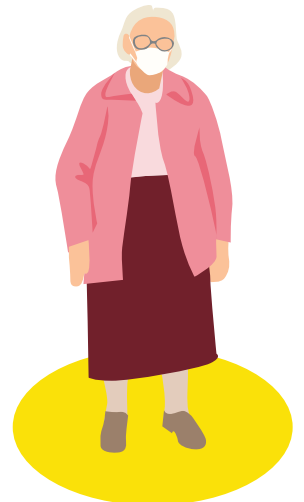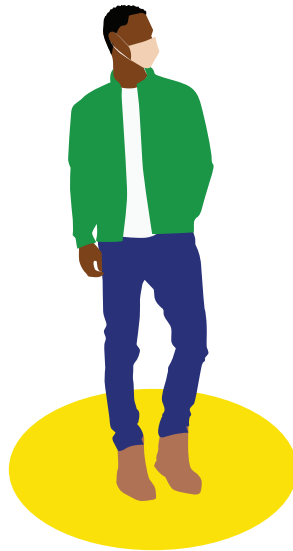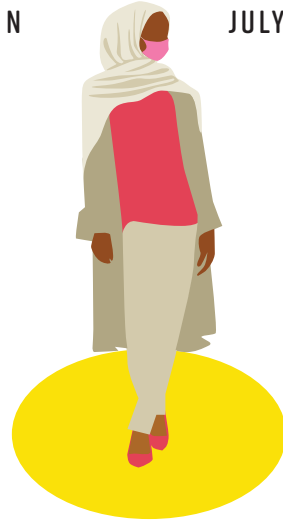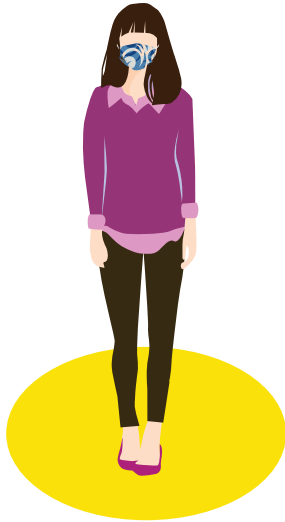
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DESIGN THINKING IN PUBLIC LIBRARY

MAKERSPACES

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n recent years, making activities have emerged as a valuable way to engage participants in STEAM (science, technology, engineering, art and math) practices, including design, fabrication, creative problem-solving, iteration, and collaboration.[1]

Public libraries have played a key role in the expansion of makerspaces around the country, offering patrons opportunities to collaborate, problem solve, craft, and create.[2] Just as public libraries have long played a critical role in democratizing access to information, the growing availability of makerspace technologies in public libraries serves to democratize access to technology and expand opportunities for STEAM engagement and learning. The Build a Better Book project provides a blueprint for libraries to leverage their resources for meaningful making, providing patrons with a valuable opportunity to design for others and connect with their communities.

BUILD A BETTER BOOK PROJECT

The Build a Better Book project (BBB), based at the University of Colorado Boulder, engages youth in an authentic, empathy-driven design experience in which they create inclusive, multimodal learning materials for children and youth who are blind or low-vision (BLV). The library of accessible materials available for BLV youth continues to be extremely limited, leading to sharp disparities in access to information and learning opportunities.

Youth participating in BBB programs use a variety of different maker technologies, including 3D printers and laser cutters as well as basic craft materials, to help address this need. Initially, they engage in empathy-building and immersive tactile activities in order to better understand the unique needs of their end users. They learn how to use different maker tools and assess the relative affordances of each in making learning materials more accessible.

Throughout the design exercise, youth select materials, tools, and technologies that will most effectively enable them to communicate information via tactile and sound elements. Youth designers test their products at different stages with end users, receive feedback, and iteratively improve upon their designs. Youth-designed products span a range of formats, including tactile picture books, museum exhibit elements, board games, and digital products such as apps.

The unique opportunity to support people with different abilities through Making and crafting provides a strong hook, motivating many youth to participate and persist in improving their designs over multiple sessions.

Handcrafted tactile picture book page with braille, created by a ten-year-old designer in a library summer program. (Photo credit: Stacey Forsyth)
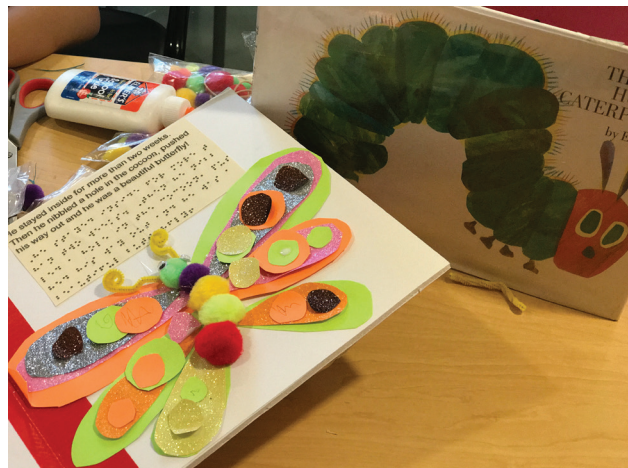
DESIGN THINKING

At the heart of all BBB programs is an empathy-driven design thinking process, in which designers connect with potential end users in order to better understand their needs and perspective. When done well, design thinking enables designers to identify unmet needs and develop new, creative solutions.

We introduce participants to design thinking as an iterative, non-linear process grounded in empathy, as presented by the Stanford University d.school.[3] The process contains the following key steps:

- **Empathize** by connecting with end users in order to learn more about their specific needs.
- **Define** the nature of the problem and determine what aspect of the problem you intend to address through your design.
- **Ideate** to generate multiple ideas for potential solutions.
- **Prototype** to develop and fabricate a possible solution.
- **Test** to get feedback from end users in order to improve a design or consider a different approach.

In BBB programs, we typically introduce youth participants to this process through a hands-on activity in which they work in teams to design a product for an imaginary character. We facilitate this activity with a game called Extraordinaires, in which participants receive an illustrated card that shares information about their specific client, but this exercise also works well using characters from books as unique clients. Each team reviews what they know about their client and considers this information as they brainstorm ideas for a particular product. For example, teams may be tasked with designing a communication device for a teen vampire, a cooking utensil for a snow queen, or a chair for an elderly wizard. Although this is a quick exercise, it serves to emphasize to participants the need to gather as much information about their client as possible, and to use that information in customizing their product's design.

BUILDING EMPATHY

We follow this initial introduction to the design thinking process with a series of empathy-building activities, designed to increase participants' understanding of the unique needs of learners who are blind or visually impaired. This may involve meeting with peers or community members who are blind or have low-vision, viewing videos that help share the perspective and accomplishments of different individuals who have visual impairments, or completing different hands-on activities while wearing vision simulation glasses. Combined, these

activities help to broaden participants' awareness of disability, particularly blindness and vision impairment, increase their knowledge of how to create effective tactile materials, and improve their understanding that different end users have their own unique preferences and abilities.

CHALLENGES OF BUILDING BETTER BOOKS IN LIBRARIES

Early on, we recognized that there were certain challenges inherent in implementing the BBB project in public libraries. Public librarians consistently expressed concern that it would be challenging to have youth patrons return to the library on a regular, ongoing basis to continue working on a longer-term BBB project. The open nature of public libraries meant that we wouldn't always have a consistent number of participants, and we might have a much broader age range of participants than we were planning on.

Other librarians expressed concern that they didn't have a designated makerspace or they lacked maker technology, like 3D printers and laser cutters. Fortunately, involving public librarians in the early design and testing phases of the project enabled us to create a flexible program that is readily adaptable for different settings. Regardless of program format or the level of technology used in the project, librarians across the US have found that the BBB model enables them to engage youth in a motivating, empathy-driven design thinking process.

PROGRAM FORMATS

Initially, librarians' concerns about repeat participation led us to implement short (1–2 hour) "one-off" experiences designed to introduce participants to the BBB project, particularly the need for more accessible books and games. To attract teens to these programs, we designed individual sessions that focused on exploring a specific technology used in the fabrication of tactile books, including 3D modeling and printing, pop-up books, paper circuits, and soundscape design. Although these workshops were fairly successful, in terms of both youth recruitment and engagement, we found it challeng-

ing to complete a full project within the short period of time allotted. Designing more inclusive books is a challenging design task, requiring a series of steps in which designers prototype, test, and improve their products, and this wasn't feasible in a short window of time. Additionally, we realized that many of the same teens were returning week after week to participate in multiple sessions. As a result, we reshaped the program as a longer program with multiple sessions in order for youth to participate in, and complete, an iterative design process. This enabled youth to complete a final project, which, in turn, increased the pride they felt in their design.

Over the past several years, different libraries have implemented BBB in a variety of different ways. Across different public libraries, the program has been implemented as a summer camp (with sessions held over multiple days or weeks); a Design Internship for teens (ranging from one to four weeks); a one-day Make-a-Thon event; a homeschool program and a Teen Maker Program, both taking place over several consecutive weeks; and in multiple instances, as a multi-week collaboration between a public library and a nearby school. These programs have differed in the age of their participants (ranging from elementary students through adults), the technology used (from cardboard and craft materials, to textiles, to 3D printers and Makey Makeys), and the length of their programs (from single day workshops to multi-week programs), but all have one critical element in common: their focus on expanding access to information for specific end users through the design and fabrication of more inclusive materials, including books and games.

In Colorado, AnyThink Libraries began an after-school program in which middle and high school students opted in to weekly BBB workshops focused on different technologies. After learning some fundamental skills in 3D design and printing, using craft cutters to create pop-ups, and sound design using paper circuits, teens became interested in working on a longer-term project that could benefit youth with visual impairments. They were excited to work on games and spent several weeks working to design and fabricate more accessible games,

including game boards and playing pieces for chess and checkers.

Several public libraries have run the program during the summer months, either as a summer camp for younger students or as a more in-depth design internship experience for teens. In Broomfield, Colorado, the public library first tested a summer camp format in which participants attended two times per week over a period of four weeks. Using 3D printed and craft materials, they created tactile adaptations of existing picture books.

The Boulder Public Library restructured its initial weekend workshops as a 5-day design internship for teens. Teens applied for the experience and were selected based on interest and motivation, rather than on their past experience with technology. Over the course of five days, interns gained experience with 3D printers, laser cutters, and sound boards as they worked in teams to design interactive stories, maps, and games. The library later collaborated with a local museum to run a similar internship program for middle school students, focused on creating accessible elements for museum exhibits. The group met weekly in the evening over the course of several months, initially to gain experience with the different maker technologies available and later to design, test, and refine specific exhibit elements, such as a tactile map of the exhibit space.

A critical element of both internship programs was the active involvement of community mentors who were blind. These mentors participated in each class, shared with teens their experience of living with blindness, and provided feedback to teens throughout the design process.

Feedback from teen interns suggested that the mentors' participation was extremely impactful for the youth, broadening their understanding of what it means to be blind in our community and helping to improve their product designs with specific useful feedback.

The Springfield-Greene County Library in Missouri engaged teens in the BBB project through a series of Teen Night workshops. The project's introductory activities—including a design thinking game in which teens design a product for an imagi-

Above: teens use design software and craft cutters to create pop-up book elements. (Photo credit: Stacey Forsyth)

A community mentor who is blind provides teen designers with feedback on their tactile map of a museum exhibit space. (Photo credit: Stacey Forsyth)

nary character and a tactile guessing game—served to hook teens and spark their interest in working on a more extended project.

After learning about 3D Giving Day, a collaboration between BBB and 3Doodler, the maker of 3D printing pens, Youth Services Manager Phyllis Davis connected with 3Doodler to obtain a set of 3D printing pens and filament and worked with teens to adapt picture books and games for children with visual impairments. She developed collaborative partnerships with a local school district and, specifically, with a special education classroom serving a group of preschool children with visual impairments. Through this partnership, she was able to connect her teen designers with actual child "clients," who shared their interests and needs with the teens.

Over the course of several weeks, the teens worked hard to complete their adapted books in time for the first annual 3D Giving Day. According to Davis, "Many of the teens came in on other days to work on their projects. They became invested in the project and there was a lot of intrinsic motivation to finish their projects on time. Having a concrete client who they were designing for really helped."

In New Jersey, 3D Giving Day sparked a shorter BBB implementation: a one-day Make-a-Thon. The Mountain Lakes Public Library encouraged youth of all ages to come to the library's makerspace on a Saturday and engage in tactile book making. The library has also been successful in working with a local public high school. Over the course of a school year, Ian Matty, the library's makerspace manager, has collaborated with a computer science teacher, engaging students in the design of more inclusive tactile materials, including board games and math models and puzzles, as well as accessible apps. They are currently collaborating with a nearby school for the blind to co-design and test new materials.

FINDINGS

Over the past several years, we have found evidence that the BBB model is flexible and highly adaptable, making it suitable for implementation across a wide range of settings. The project doesn't require any one specific tool or technology, but rather can be


Preschool children with visual impairments use their sense of touch to explore a tactile picture book adapted by teen designers in Missouri. (Photo credit: Springfield Public Schools)

facilitated in regular library settings as well as in high-tech makerspaces.

Some programs have utilized makerspace equipment, like 3D printers, whereas others have completed impactful programs using just cardboard and craft materials. With its emphasis on design thinking, the program's value is in the design process itself, rather than in any type of equipment or technology.

The project's focus on empathy and designing for others serves as an effective hook for many youth, including some who otherwise wouldn't elect to participate in a STEAM or maker program. Several librarians have also expressed that the nature of the program motivates youth to continue their participation throughout the design process, in some cases even prompting participants to come to the library outside of regularly scheduled time to work on their projects.

Regardless of program format, it is critical to provide sufficient opportunity for participants to develop, prototype, test, and improve their designs. Design thinking is an iterative process and fabricating effective tactile materials is a challenging design task. Providing sufficient time or opportunity for participants to iterate on their designs increases the likelihood that they will leave feeling satisfied and proud of their designs, rather than feeling frustrated or disappointed.
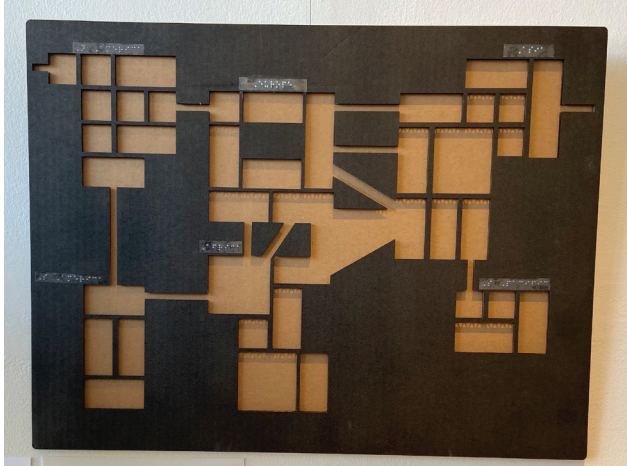
Laser-cut prototype for a tactile game of *Risk*, designed by high school students in New Jersey. (Photo credit: Stacey Forsyth)

Library partners have expressed that the project prompted them to develop new partnerships with community organizations that have benefited their patrons and their programming. For example, BLDG 61, the Boulder Public Library's makerspace, hired one of the BBB community mentors as an artist-in-residence, which helped provide new insights into how the makerspace could adapt certain technologies to make them more accessible for users who are blind or visually impaired. The Springfield-Greene Public Library developed new relationships with the local school district, a rehabilitation center for the blind, and their State Library for the Blind and Physically Handicapped. These organizations collaborated on BBB programs at the library, contributed advice on the design of effective tactile materials, and provided feedback to youth about their products. Perhaps the most important outcome is that the project helps bring together youth interested in technology and connects them with a real-world purpose so that they feel empowered to help others through design.

CONNECT YOUR LIBRARY TO THE BBB NETWORK

Substantial interest in this effort has enabled the BBB project to develop a national network of librarians, educators, and youth engaged in the design, fabrication, testing, and sharing of multi-modal products, like books and games. We have compiled resources on our website (http://buildabetterbook.org) to help interested librarians and educators get started with the project. The website also includes an online design gallery, in which participants can share their digital designs with others or download and remix existing designs. The global need for more accessible learning materials is substantial and we encourage interested libraries to connect with local organizations, including schools and centers for the blind, state libraries for the blind and physically handicapped, and special education departments in nearby school districts, to identify the community's most pressing needs. PL

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