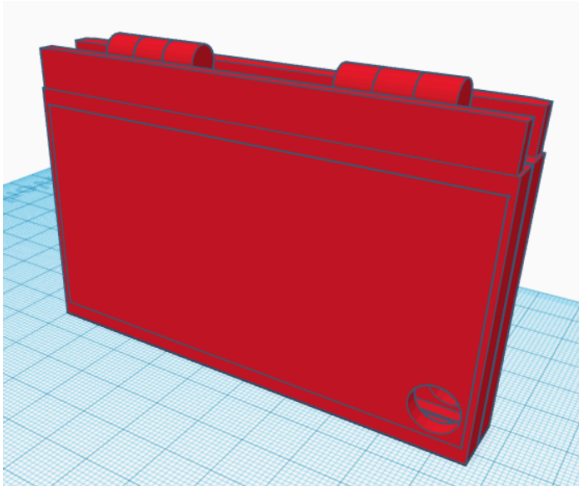
Bridging the Gap Between the Hearing and Hearing Impaired Communities: Enabling Social Sustainability Through a 3-D Printed Device



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1.0 Executive Summary

Our design is a booklet keychain case that different communities can use to communicate with each other. We call this device BGC which stands for “Bridging the Gap for Communication”. This design is needed because it allows people to extend their knowledge and learn American Sign Language (ASL). The key points in developing our design were using open source resources and conducting stakeholder interviews to make sure the solution we came up with would actually help hearing impaired and non-hearing impaired people communicate with one another. The key points in designing our solution were conducting research, modifying open source images and parts, and making sure we met our part requirements. The key points in implementing our solution are making the part open source on Thingiverse and Thangs and working with the hearing impaired community in Huntsville, Alabama to give them our device.

Anyone will be able to go on the internet to find our open source educational keychain device and download the part file to then 3d print the device. This means anyone can use the device to help communicate with people who are hearing impaired. They can also print multiple devices to share with friends. This would encourage people to make new friends with people who traditionally may not be able to communicate with each other. As time goes on, the user can learn sign language and not need to use the booklet. Therefore, this device will help people learn how to communicate with hearing impaired people. People who are hearing impaired could also print out the device to share with people who do not know American Sign Language (ASL), so that the person who does not know ASL can use the booklet to communicate with the person who is hearing impaired. The person who is hearing impaired could keep the device on their key ring or in their pocket to use in situations like this. Therefore, people who do not know sign language can use our device to communicate with hearing impaired people, enabling different communities to communicate with each other.

2.0 Industry Overview

We conducted stakeholder interviews to ensure the solution we came up with would actually help hearing impaired and non-hearing impaired people communicate with one another. We conducted interviews with people who are hearing impaired and people who work with people who are hearing impaired. Our interviewees who were hearing impaired told us that they had trouble communicating with non-hearing impaired people in public and that they face barriers in getting jobs and keeping up with conversations. They said that they need Wifi access to use their mobile translation tools on their phone, and that last minute plans are hard because they need an interpreter. They also felt judged by the hearing community and said more education is needed about deaf culture. Our interviewees who were non-hearing impaired but work with people who are hearing impaired also discussed the need for impromptu communication such as in the grocery store.

Our solution tackles each of these problems by allowing people to extend their knowledge and carry the basic ASL alphabet in their pocket. The proposed design is needed because it allows people to communicate with one another with no Wifi, no prior planning, and it could also be used in emergencies. This device also helps beyond communication by allowing people to learn more about the hearing impaired community. There are no critical timelines that the reader needs to be aware of for our project or device.

3.0 Design, Functionality and Durability

The requirements for our device were the following:

- The device needed to fit in someone's pocket.
- The device needed to not have sharp edges so that it fits comfortably in the user's hand or pocket.
- The text on the booklet needed to be big enough for people to see it.
- The device needed to have a hole or loop to fit on a keychain.
- The device needed to be able to close and hold a booklet.
- The device needed to be 3D printable and less than $10 per assembly.

The BGC device is made up of three parts: a 3D printed case, a laminated paper booklet, and a consumer-of-the-shelf keychain. We designed our 3D printed device by designing a case and adding the print-and-place articulated hinge from an open source resource 3D printed box. We got the box from Printables.com [1] on the internet. The BGC is open source so that anyone can use our device or parts from it to make new and improved devices. Our booklet has the ASL alphabet and number signs. The signs on the booklet are from an open-source image found on Wikipedia [2]. The case has a hole in it to fit a key chain loop. The part is not expensive. Pictures of the device dimensions are shown below in Figures 1- 4. All units are in millimeters.

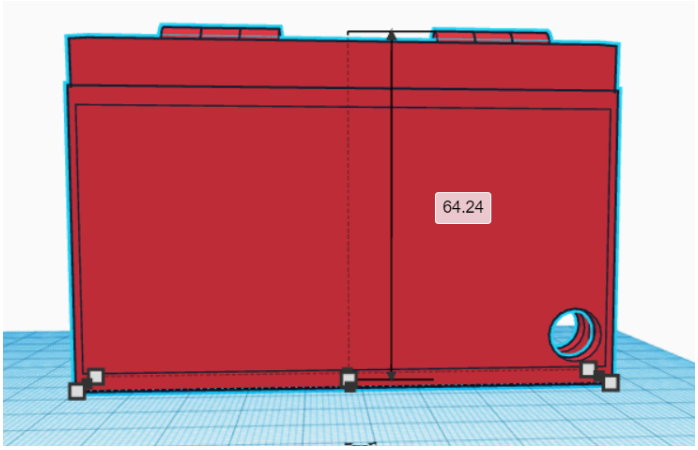

Figure 1: The BGC Height

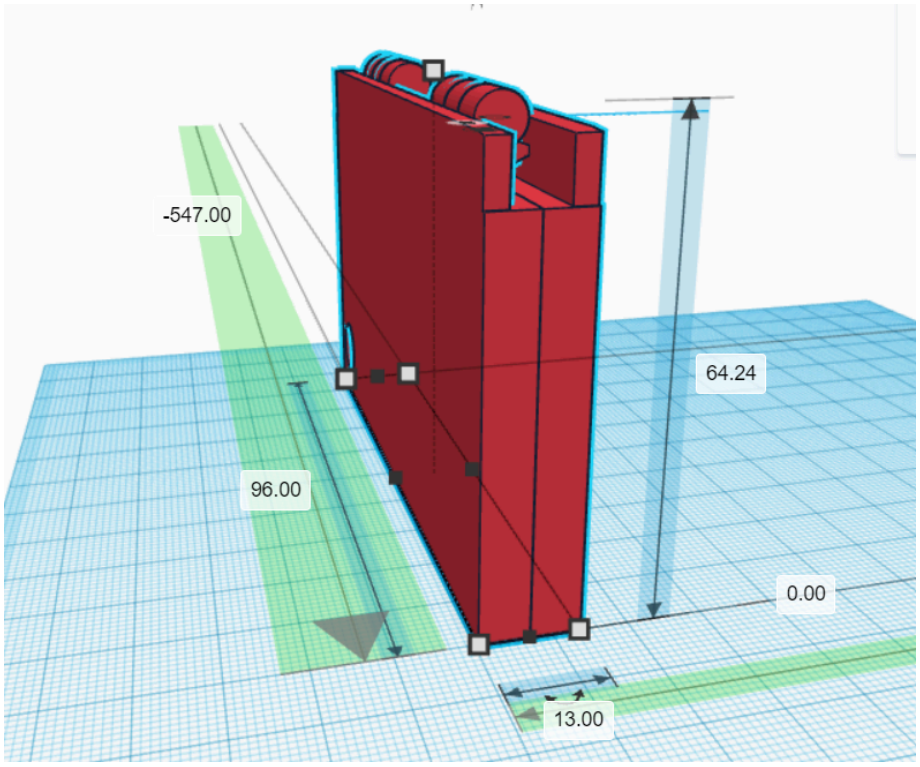

Figure 2: The BGC Side View

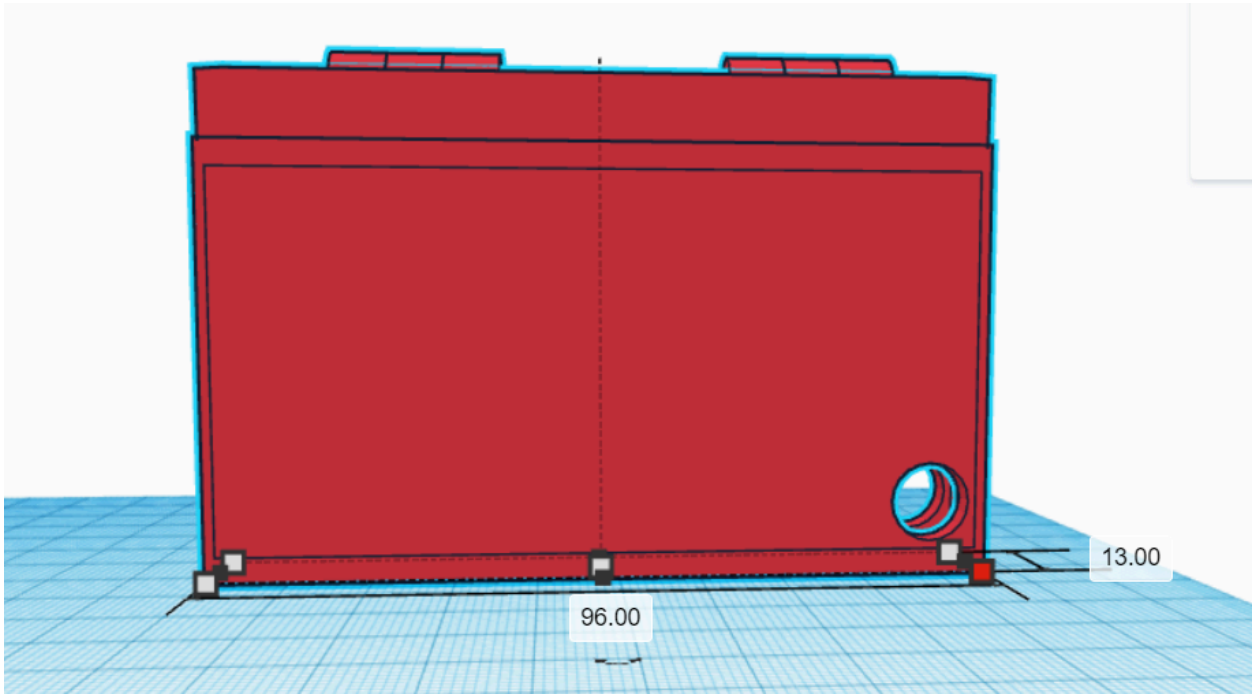

Figure 3: The BGC Width and Length

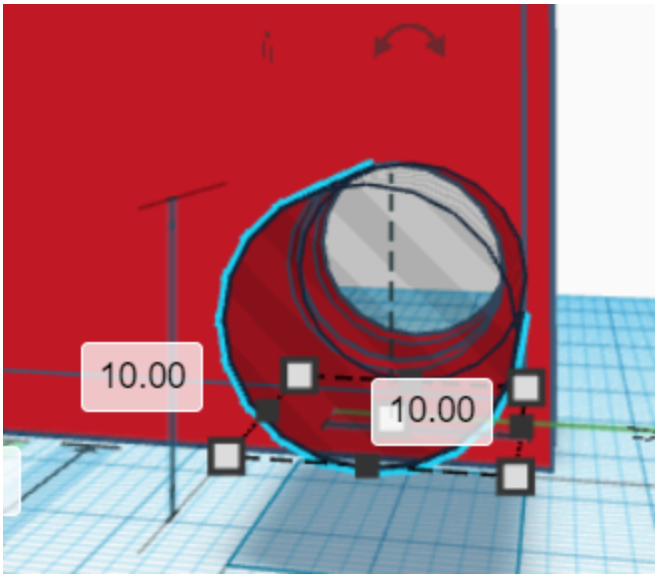

Figure 4: The Key Chain Hole

We recommend older kids and up use this part. They should also only use the part as intended and not for any food purposes. The part should not be left or put near any hot places so that the plastic won't melt. Support material should be used when printing. The user should follow all safety rules while 3D printing the case and printing and laminating the booklet. The anticipated lifetime of the part is for as long as the user wants to use it for. The lifetime of a keychain depends on how the user treats it [3], so we anticipate an average user being able to use the keychain for around 2 years with proper use. If the user accidentally breaks the keychain and wants another one, they can go back to where they found the part online and print out another one.

4.0 Design Integration and utilization of DDM materials and processes

The material we chose for our project is PLA (polylactic acid) filament. We chose PLA because it is affordable, easy to use, and has high strength [4]. We chose a fusion deposition modeling printer as our AM process because it is the most commonly used printer [5], and we wanted to make sure our device would be easily accessible to anyone who would like to print it for themselves or their friends. If the user wants to print the device on a different type of AM process, then they can go on Thingiverse and Thangs where our part is stored, download the file, and edit the part to be suitable for the other printer. We recommend using an FDM printer for this part though because it would be easier to use because our part was designed for FDM, and that is the AM process we have verified our part to work with.

The device can be printed in whatever color the user has and wants. If the user does not have filament in the color they prefer, then they can customize the part to their liking by sanding the part down to make it smooth, painting the part the color they like, and then use a sealing paint to seal the part so that it does not crack or peel. If the user

has the color filament that they prefer, then post-processing in this manner is not required. Our part has support material along the hinges and the sides. We recommend the support material be removed gently. In our experience, one of our faculty advisors broke a prototype by trying to remove the support material too forcefully. If the person printing wants the part to be smooth where the support material was, then they should sand the part down, but this is not necessary if the part is to the smoothness of the person user's liking. If the part prints in a way that the sides are stuck together, use a tool such as a pencil or scissors to move them apart.

Parts of our design are 3D printed, paper printed, and have a consumer off-the-self-part. The paper is easy to print and the booklet will be easy to access for printing because it will be linked in the comments section of our Thingiverse and Thangs part. Most people have access to a paper printer as they may have one in their home or can access one at a public library. We recommend laminating the booklet so that it is waterproof and won't easily be damaged. The consumer-off-the-shelf part is easy to find online or in a grocery or craft store. Therefore, all aspects of our design are easily made, bought, and accessible. Our design does not require maintenance. The plastic case of our part can be recycled and the paper booklet can be recycled if it is not laminated. We recommend getting a latch that is durable, metal, and rust-proof so that it does not break easily and can be re-used in many ways if the user does not want it any more for the keychain.

5.0 Digital and physical infrastructure

Our device is made up of three parts- the 3D printed case, the keychain latch, and the paper printed booklet. The booklet helps people learn how to communicate in ASL or people who just want to do ASL for a hobby. First we created our 3D printed case. We decided to look at open source 3D parts online to use in our design so that we would not have to re-invent our entire part, making our design process easier and more efficient. When we looked for an open source part that we could use, we found one of a hinged box from Printables.com [6]. Then we edited the hinged box on TinkerCAD by removing all of the hinged box except for the hinges and the sides. Then we created our own sides to close up the booklet and added a hole for the keychain latch. For the keychain latch, we decided to use a commercial-off-the-shelf latch. For the booklet, we got an open-source image of an ASL alphabet and number sheet [2], and we used that to put inside the book. To integrate the three parts of our device together you do the following: print the case from a 3D printer, print the booklet out on a paper printer (and laminate if desired), and then purchase a durable keychain latch. Then you put them together.

For system utilization, this device can be used by any person- whether just for a learning purpose or for communication. Users could include large corporations, service bureaus, hobbyist makers, and regular everyday people. Our design will be

disseminated through the internet. Our design is open-source, and we will put it on design repository sites such as thangs.com and thingiverse.com. When we upload our part to these repository sites, we will list out the features of our design on the part description so that people searching for hearing impaired devices can find it easily on the internet. We will also put details referencing the open source part that we incorporated into our device. A link to the booklet image will also be there.

We designed our 3d printed device to be used to help hearing impaired people communicate with people who can hear. We anticipate that mostly people who are hearing impaired will use this device, but non-hearing impaired people can also use this device to communicate with hearing impaired people. A hearing impaired person and a non-hearing impaired person can use the device to help them communicate in various situations- like having a simple conversation or if they need help in an emergency situation.

An example of using this keychain device is the following: a grocery store cashier is helping someone who is hearing impaired check out their groceries. The grocery store cashier would like to tell the customer their total payment, but the customer is hearing impaired and can not hear the cashier. The cashier has the key chain on their work lanyard, and they take out the keychain and take out the signs booklet. The cashier then uses the sign booklet to spell out the customer's price total. If the customer signs back something that the cashier does not understand, the cashier can use the signs in the booklet to figure out how to spell out a response to the customer and to ask the customer to spell out their response. Another example of using this keychain would be someone who is hearing impaired and who doesn't know ASL yet could carry this device on them in case they forget a word or two, and then they could spell out what they need to say using the booklet.

An example of using the device in an emergency situation would be if someone who was hearing impaired was in a car accident and needed to get help from people nearby. The hearing impaired person's phone was damaged or lost in the car crash, so they cannot access their ASL translation app. Thankfully, our device is in their pocket and they can give the device to a passerby, so that the passerby can communicate with them. Therefore, our device would be helpful in situations like this and in other situations where any form of communication is needed.

There are several design continuous improvement aspects of our device. In terms of design, the device could be improved by being made in new materials. For example, metal or harder plastic like ABS would be more durable. Another improvement would be to create a rubber casing to put on the keychain to make it more cushioned and comfortable to handle. If the part is made in metal, we recommend a rubber casing so that the part is not too sharp. Another improvement would be to customize the part. Our part file can be downloaded from the repository sites by anyone, and then they can use their inspiration to customize their CAD file. Another improvement would be to

create different designs to go on the case to be used as part of someone's outfit to look like jewelry or to be customized.

A QR code could be added to the 3D printed case or the booklet to show people where to find the 3D part files on Thingiverse and Thangs. This way, the user could share the design with people who are interested in making their own part. The design could also be updated to have a 3D printed latch instead of a store bought one. Another improvement would be the booklet could come in larger text sizes for people could see the signs better, or the keychain itself could come in larger sizes.In terms of continuous improvement in manufacturing, our device can be printed on desktop 3D Printers that take up less space than traditional subtractive machines and can be in people's homes instead of factories [6].

6.0 Value Analysis

Our part is different from other communication tools because it does not require the internet or Wifi. The good thing about this device is that it is light, transportable, and it could go basically anywhere. The user could strap the device in many places- their pocket, bookbag, jean or overall loops, key ring/keys, lanyards, or necklace. Therefore, this device is transportable in many ways, it is easy to store, and wear. The BGC also educates people on hearing impaired communities. Also, our part can be customized by the user.

7.0 Conclusions

The key aspects of our design are to expand communication across the hearing impaired and non-hearing impaired communities. Our part has three components: a 3D printed case, a paper laminated booklet, and a store bought keychain hook. Our device enables communication by housing a booklet with the ASL alphabet and numbers. We used a Makerbot Sketch printer and any Fusion Deposition Modeling (FDM) printer can be used to print our part. Our part is articulated and print-in-place to be easy to do one print to finish the part. We used PLA because it is easy to find and cheap. We used an innovative digital online repositories to customize our design using open source parts. We will put our design on Thingiverse and Thangs so that other people can access, share with their friends, and improve or use our device for themselves. Because the booklet is separate from the 3D printed case, other booklets could be added with other information. The booklet could be made into other languages. By putting our design online we hope people feel free to download and use our device however they like.

Reference List

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