FORMS and BODIES

Lesson Plan

Figure 1. Rebecca Horn, “Finger Gloves,” 1972.

Figure 2. Sonya Clark, “Eye to Eye,” 2001.

MODULE GOALS

Many creative workers, including studio artists, jewelry makers, fashion designers, and developers of medical prosthetics, create objects to be worn on the human body. Sometimes these objects adorn the body, sometimes they extend its capabilities, and sometimes they create connections between bodies. When artists use digital fabrication to create objects for the body, or a body, they often need to attend more closely to physical properties such as scale, shape, and weight to ensure a successful ‘fit.’ In this module, students are challenged to create an artifact to be worn by a specific body. They will learn how to use the measuring tools in TinkerCAD, in concert with measurements taken in the physical world, to tailor their object to the body of the particular person they are working with.

ESSENTIAL QUESTIONS

- What novel decorative and functional potentials for wearable objects does digital fabrication enable?
- In what kinds of ways, literal and metaphorical, can an object be a ‘good fit’ for a particular person? What kind of research might an artist have to do to ensure a wearable piece of art is a ‘good fit’ for the body wearing it?
- What new challenges does designing artwork for a body present? How can an artist creatively overcome those challenges?

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MEANING AND ACQUISITION

- Students will become familiar with the measuring tools in TinkerCAD, and how to use them to have more precise control over the shape and size of their created objects.
- Students will develop an awareness of the particularity and diversity of human bodies, through the process of designing an object intended for one particular human body.
- Students will gain experience and sensitivity in digitally designing objects for use in the physical world.
- (If students have access to a multi-material printer.) Students will become familiar with the multi-color tool in TinkerCAD to produce an object with intentional aesthetic or decorative complexity.

FORMATIVE ASSESSMENT STANDARDS

- Students engage in close observation and research of the person they are making their object for, including, but not limited to, bodily measurements and interviews **(Cn10.1.IIa, Cn10.1.IIIa)**.
- Students develop and plan an artistic response to the information gathered in the above research, considering how they will adorn, extend, connect, or otherwise attend to the body of the recipient **(Cr1.2.8a , Cr1.2.Ia)**.
- Students engage in critique, discussion, and revision of their work, both with peer artists and the ultimate recipient of their designed object. Students leverage the potential of digital design for iteration and revision before committing to physical fabrication **(Cr3.1.8a, Cr3.1.IIa)**.

SUMMATIVE ASSESSMENT STANDARDS

- Student's artifact, in form and content, demonstrates attention to, and research of, the context for the piece. Specifically, it reflects a thoughtful 'fit,' physically and thematically, to the body it was made for **(Cr3.1.Ia)**.
- Student's artifact demonstrates skillful and thoughtful use of the digital, mechanical, and physical materials/tools used to make their object **(Cr2.1.IIa)**.
- Student's artifact demonstrates a creative solution to the challenge of adorning, extending, connecting, or otherwise transforming a body **(Cr2.3.Ia , Cr2.3.IIIa)**.

FORMS and BODIES

Lesson Plan

MATERIALS

- Computer with internet access and mouse
- (free) TinkerCAD account for each student
- Cura or Slic3r software to prepare models for printing
- 3D Printer (Make3D uses a Prusa i3 MK3S, but this lesson can work with any model)
- (optional) Multi-material printer upgrade for multi-color prints (Make3D uses The Prusa Multi Material 2S kit)

PROPOSED ACTIVITY

1. Students will encounter and discuss the work of several artists and designers who create objects to be worn or attached to human bodies (see attached Case Studies). Specifically, they will look at artists who:
   - Extend the forms and capabilities of bodies
   - Adorn, decorate, or beautify bodies
   - Connect bodies together
2. Students will choose a specific person, who they know in real life, for whom to design a wearable art piece. They will collect relevant physical (e.g. measurements) and nonphysical (e.g. interview responses) data about the person to inform their development of an object that both physically and conceptually 'fits' its intended wearer.
   - Students will likely not complete this step all at once, but rather iteratively return to and collect more information from their chosen person as they develop their concept.
3. Students will use additive and subtractive modeling tools in TinkerCAD to digitally sculpt their object, and will use its built-in measuring tools, in concert with their measurements of their chosen person, to create an object particularly suited for that person's body.
4. (Optional, if multi-material printer is available) Students will deploy the multi-color options in TinkerCAD and multi-material settings in Cura or Silc3r to thoughtfully use color to decorative or conceptual ends in their project.
5. Students will export their design as an STL, prepare their model in Cura or Slic3r, and 3D print their final wearable object.
   - Since the piece will likely only be 'complete' when worn by its intended recipient, a possible extension might be for students to photographically document the object being worn, and for the photo(s) to be exhibited.

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://www.marthagarzon.com/contemporary_art/wp-content/uploads/2012/07/Rebecca-horn.jpg

Figure 2. Retrieved from http://sonyaclark.com/project/communicatools/

FORMS and BODIES

Case Study 1: Extending Bodies

A number of artists use traditional and digitally-fabricated materials to add new parts and new functions to bodies. How might the body you're creating a piece for be extended to create new abilities or new experiences?

STELARC

Stelarc is a performance artist who has created a variety of temporary alterations to his body using medical instruments, prosthetics, robotics, Virtual Reality systems, the Internet and biotechnology. He has permanently embedded an extra ear on his arm, which sends the sounds it hears to the internet for public access. He has also created a six-legged robotic exoskeleton controlled by his arm motions. He is interested in creating and exploring what he calls "Alternate Anatomical Architectures" (Stelarc, 2019a, para 1).

Stelarc's (2019b) "Third Hand" piece is a robotic hand controlled by his abdominal and leg muscles, which was used in a series of performances.

Figure 1. Stelarc, "Third Hand," 1980.

REFERENCES

Stelarc. (2019a). Biography. Retrieved from http://stelarc.org/?catID=20239

Stelarc. (2019b). Third hand. Retrieved from http://stelarc.org/?catID=20265

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://stelarc.org/?catID=20265

FORMS and BODIES

Case Study 1: Extending Bodies

REBECCA HORN

German artist Rebecca Horn made a number of prostheses that extend functions and structures of the body in ways that are "deliberately clumsy and functionless" (Watling, 2012, para. 5). Her playful, awkward extensions look at ways of extending the body outside of traditional medical and scientific notions of bodily improvement.

Of her Finger Gloves, Horn said "I feel, touch, grasp with them, yet keep a certain distance from the objects that I touch. The lever action of the lengthened fingers intensifies the sense of touch in the hand. I feel myself touching, see myself grasping, and control the distance between myself and the objects" (Watling, 2012, para. 2).

Horn's Pencil Mask transforms the wearer's face into a drawing tool. Horn herself noted that the "pencils are about two inches long and produce the profile of my face in three dimensions...The pencils make marks on the wall the image of which corresponds to the rhythm of my movements" (Tate Modern, 2004, para. 1). Consequently the marks made by the mask a directly linked to the body wearing the mask. Different facial profiles and different bodily movements yield different drawings.

Figure 1. Rebecca Horn, "Finger Gloves," 1972.

Figure 2. Rebecca Horn, "Pencil Mask," 1972.

REFERENCES

Tate Modern. (2004). Pencil mask. Retrieved from https://www.tate.org.uk/art/artworks/horn-pencil-mask-t07847

Watling, L. (2012). Finger gloves. Retrieved from https://www.tate.org.uk/art/artworks/horn-finger-gloves-t07845

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://www.marthagarzon.com/contemporary_art/wp-content/uploads/2012/07/Rebecca-horn.jpg

Figure 2. Retrieved from http://www.marthagarzon.com/contemporary_art/wp-content/uploads/2012/07/Pencil-Mask-1973.jpeg

Neri Oxman

Neri Oxman's "Wanderers" series fabulates extensions of human bodies that would allow them to survive in the hostile environments of other planets in the solar system. Oxman researched synthetic biology, as well as the distinct chemical and environmental properties of different celestial bodies to design 3-D printed wearable organs specialized for each world. Oxman noted that "[t]he wearables are designed to interact with a specific environment characteristic of their destination and generate sufficient quantities of biomass, water, air and light necessary for sustaining life: some photosynthesize converting daylight into energy, others bio-mineralize to strengthen and augment human bone, and some fluoresce to light the way in pitch darkness" (Oxman, n.d.-a).

Figure 1. Neri Oxman, "Zuhal, Saturn's Wanderer," 2014.

"Zuhal" is designed as a "wearable vortex field" (Oxman, n.d.-b), which can nullify the high-intensity winds of the planet Saturn. Its fibrous surface is also designed to contain bacteria that can convert the hydrocarbons on Saturn's moons into edible matter.

"Mushtari" is designed as a single gastrointestinal strand that can absorb nutrients from Jupiter's atmosphere, and is designed to contain genetically engineered bacteria that convert sunlight into edible matter (Oxman, n.d.-a).

Figure 2. Neri Oxman, "Mushtari, Jupiter's Wanderer," 2014.

REFERENCES

Oxman, N. (n.d-a). Mushtari. Retrieved from https://neri.media.mit.edu/projects/details/mushtari.html

Oxman, N. (n.d-b). Zuhal. Retrieved from https://neri.media.mit.edu/projects/details/zuhal.html

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from https://neri.media.mit.edu/assets/projects/NeriOxman___Wanderers___Zuhal3.jpg

Figure 2. Retrieved from https://neri.media.mit.edu/assets/projects/NeriOxman___Wanderers___Mushtari.jpg

Case Study 1: Extending Bodies

Jen Owen, Ivan Owen & "e-NABLE"

Jen and Ivan Owen's e-NABLE project is a large-scale effort coordinating designers, volunteers with access to 3-D printers, and people with varied limb differences to provide free or low-cost prosthetic arms (Owen, 2014).

Figure 1. A variety of prosthetic hands made by e-NABLE volunteers in collaboration with their intended recipients.

The project began as an individual collaboration between Ivan Owen, and Richard, a South African man who had lost his fingers in a woodworking accident. After seeing video of a mechanical hand Owen had made for cosplaying, Richard contacted him about creating a similar hand for himself. A later collaboration with a 5 year-old boy named Liam resulted in the first open-source 3-D printable prosthetic hand (Owen, 2014).

Since that time, an enormous worldwide network has developed to connect volunteers with individuals who want to extend their bodies to more easily operate in a world designed for people who have two hands and five fingers. Because every body is different, e-NABLE volunteers typically have to work quite closely with the people requesting a hand or arm, to ensure it fits their body and their needs. There are over a dozen different designs now freely available, open-sourced, and able to be customized for a variety of bodily needs (Owen, 2014).

REFERENCES

Owen, J. (2014). About us. Retrieved from https://enablingthefuture.org/about/

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from https://enablingthefuture.org/wp-content/uploads/2019/11/ec5.jpg

REFLECTION QUESTIONS

1. Stelarc's "Third Hand" was carefully designed to match the dimensions of his existing hands, and Rebecca Horn had to tailor her projects so they would fit and function with her body. The volunteers in the e-NABLE project have to make sure the hands and arms they make fit the shape, and the desires, of the bodies they are made for. What are the potentials for digital fabrication for accommodating the wide variety of bodies that exist? What possibilities are there for contributing to a material world that doesn't assume that everyone has the same or a similar body?
2. Think of the person you are developing your project for. What particularities of their body will you need to consider in designing your object(s)? What needs or desires do they have that might be met by a bodily 'extension'?
3. Some of these bodily extensions, like the e-NABLE hands, are functional, while others, like Rebecca Horn's prostheses, function in a way that is deliberately impractical. Neri Oxman's pieces are science fictional - their functions exist only in the stories Oxman tells about them. How do you, and the person you are creating for, feel about functionality? Do you feel your end-product needs to "work" in a literal sense, or can it function as a prop for fabulation? What choices will you have to make in the development of your object to make it function in the way you and/or the object's recipient, desire?

FORMS and BODIES

Case Study II: Ornamenting Bodies

A number of artists and designers use traditional and digitally-fabricated materials to adorn, decorate, or beautify the body. How might your designed object reflect its recipient's conception(s) of beauty?

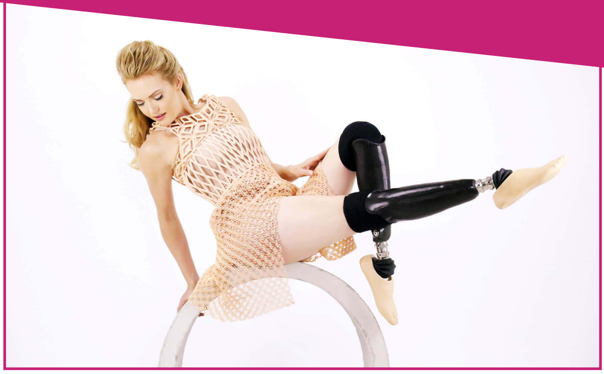


Figure 1. Danit Peleg, "Paralympic Dress," 2016.

DANIT PELEG

Israeli designer Danit Peleg has released two fashion collections comprised entirely of 3-D printed attire. Her first collection, "Liberty Leading the People," from 2015, was the first fashion collection to be entirely produced by 3-D printing (Rofé, 2018).

For the 2016 Paralympic Games opening ceremonies, Peleg was commissioned to design and fabricate the dress worn by American Paralympian Amy Purdy. Peleg drew inspiration from the composition and coloration of Botticelli's "Birth of Venus" painting, connecting the imagery of that painting to themes of rebirth in Purdy's life narrative (Peleg, 2018).

Because Peleg and Purdy lived in different countries, they didn't meet in person until just prior to the ceremony. However, as Peleg needed to design the dress specifically for Purdy's body, they used the mobile app Nettelo to scan Purdy and send her measurements to Peleg to work from.

Figure 2. Danit Peleg, "Liberty Leading the People," 2015.

REFERENCES

Peleg, D. (2018). Paralympics dress: How I 3D printed Amy Purdy's dress at the Paralympics opening ceremony. Retrieved from https://danitpeleg.com/paralympics-dress/

Rofé, S. (2018). Press kit. Retrieved from https://danitpeleg.com/press-kit/

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from https://danitpeleg.com/paralympics-dress/

Figure 2. Retrieved from https://danitpeleg.com/liberty-leading-the-people-2/

FORMS and BODIES

Case Study II: Ornamenting Bodies

Figure 1. Rebecca Strzelec, “Adam & Rebecca,” 2008.

Figure 2. Rebecca Strzelec, “Self-Portrait, 1984,” 2009.

REBECCA STRZELEC

American artist Rebecca Strzelec frames her work as a “continuing investigation of the ways wearable objects interact with the surface of the body” (n.d., para. 1). Her jewelry designs include a series of “self-portraits” in the form of necklaces depicting her teeth at different ages, mapping her own body’s growth in an artifact she can wear on her body. Her series of brooches, “The Age of Bears” draws visual inspiration from the layered rings in bears’ teeth as they age, and their similarity to the layers of 3D printed objects.

Figure 3. Rebecca Strzelec, “The Age of Bears 1,” 2010.

REFERENCES

Strzelec, R. (n.d.). Statement. Retrieved from http://www.personal.psu.edu/ras39/Rebecca%20Strzelec_Statement.html

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://www.personal.psu.edu/ras39/adam_rebecca.jpg

Figure 2. Retrieved from http://www.personal.psu.edu/ras39/self_portrait_1984.jpg

Figure 3. Retrieved from http://www.personal.psu.edu/ras39/age_of_bears_1.jpg

NORA FOK

England-based artist Nora Fok creates jewelry both by hand-knitting nylon thread and through digital fabrication processes. Her work draws forms from mathematical principles, the natural world, and spaces where the two intersect. These include pieces like her "Cantor Cheese" bracelet, which is based off of the Cantor Set, a mathematical model consisting of nesting circles (Fok, n.d.-a), and "Disc Florets," derived from the mathematically regular patterning of the center of a chrysanthemum (Fok, n.d.-b).

Figure 1. Nora Fok, "Cantor Cheese," 2010.

Figure 2. Nora Fok, "Disc Florets," 2008.

Figure 3. Nora Fok, "The Spirit of Aqualegia," 2004.

REFERENCES

Fok, N. (n.d.-a). Cantor cheese. Retrieved from https://www.norafok.com/archive/?i=Cantor%20cheese

Fok, N. (n.d.-a). Disc florets. Retrieved from https://www.norafok.com/archive/?i=Disc%20florets

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from https://www.norafok.com/archive/?i=Cantor%20cheese

Figure 2. Retrieved from https://www.norafok.com/archive/?i=Disc%20florets

Figure 3. Retrieved from https://www.norafok.com/archive/?i=Aqualegia

FORMS and BODIES

Case Study II: Ornamenting Bodies

LIMBITLESS

Limbitless is a non-profit organization, affiliated with the University of Central Florida, that works to provide free 3D printed bionic arms to children with limb differences. It was founded in 2014 by Albert Manero, John Sparkman, and Dominique Courbin, then-students at the University of Central Florida (Limbitless, n.d.-a).

One aspect of Limbitless's practice that distinguishes it from other, similar programs is the attention paid to the aesthetics of the prosthetics. Limbitless collaborates with the children and families requesting the prosthetics to find not only a physical 'fit' but an aesthetic one, based on the input of the recipient. The children are able to access an online interface through which they customize the limb they will receive before it is fabricated (Limbitless, n.d.-b).

Figure 1. Several of Limbitless's prosthetic designs.

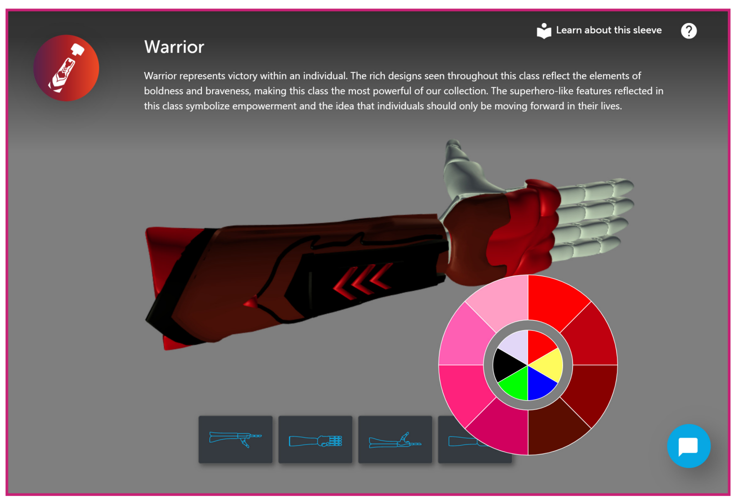


Figure 2. The web interface recipient children use to aesthetically customize their prosthetic.

REFERENCES

Limbitless. (n.d.-a). Our story. Retrieved from https://limbitless-solutions.org/ourStory

Limbitless. (n.d.-b). Our work. Retrieved from https://limbitless-solutions.org/ourWork

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from https://limbitless-solutions.org/press

Figure 2. Retrieved from https://limbitless-solutions.org/ourWork

REFLECTION QUESTIONS

1. The question of what is considered beautiful is extremely context-dependent. Standards of beauty are constructed, and particular to the time, place, and culture of their construction. Furthermore, individual tastes may internalize, complicate, or reject broader standards of beauty. Beauty is certainly not a one-size-fits-all proposition! What does the person you're designing your object for consider 'beautiful'? How could you find this out? What questions could you ask them, besides the obvious "What do you think is beautiful?" that would reveal things about their tastes, preferences, and desires?
2. Both Nora Fok and Rebecca Strzelec drew upon concepts and forms from domains such as mathematics and biology. They are both working within a long history of drawing from the natural sciences for decorative ends. What scientific concepts could inspire forms that fit your target person's idea of beauty?
3. Rebecca Strzelec's "The Age of Bears" brooches take advantage of a kind of layering that 3D printers do as an inevitable part of their process. Nora Fok's "Cantor Cheese" contains shapes within shapes that could only be produced by a 3D printer generating all of the forms at once. Danit Peleg's clothing is built on the repetition of identical geometric forms enabled by digital modeling. And Limbitless's customization wouldn't be possible if their limbs weren't 3D printed on-demand. What other beautiful forms can digital fabrication enable that might be impossible or very difficult using traditional making methods? What is something you could make to adorn the body of your chosen person, using 3D printing, that you couldn't make solely out of yarn, clay, or other materials?

FORMS and BODIES

Case Study III: Connecting Bodies

Some artists and designers create wearable pieces designed for more than one person to wear at once. What kinds of interactions could your object prompt?

SONYA CLARK

American artist Sonya Clark works with a variety of materials that have meanings tied to deep personal and social histories. These materials include human hair, combs, and the threads of the flags of the Union and Confederacy from the American Civil War. One body of her work uses the traditional glass beads of the Yoruba people of West Africa, to whom she traces part of her heritage (Clark, n.d.-b).

Clark's "Communicatools" series features a number of artifacts designed to foster connection between people. Of these pieces, Clark has said that "these devices connect eye to eye, heart to heart, and head to head to yield empathetic and perhaps even telepathic communication" (Clark, n.d.-a, para. 1).

Figure 1. Sonya Clark, "Eye to Eye," 2001.

Figure 2. Sonya Clark, "Promise," 2004.

REFERENCES

Clark, S. (n.d.-a). Communicatools. Retrieved from http://sonyaclark.com/project/communicatools/

Clark, S. (n.d.-b). Yoruba. Retrieved from http://sonyaclark.com/concept/yoruba/

IMAGE ATTRIBUTIONS

Figure 1. Retrieved from http://sonyaclark.com/project/communicatools/

Figure 2. Retrieved from http://sonyaclark.com/project/communicatools/

REFLECTION QUESTIONS

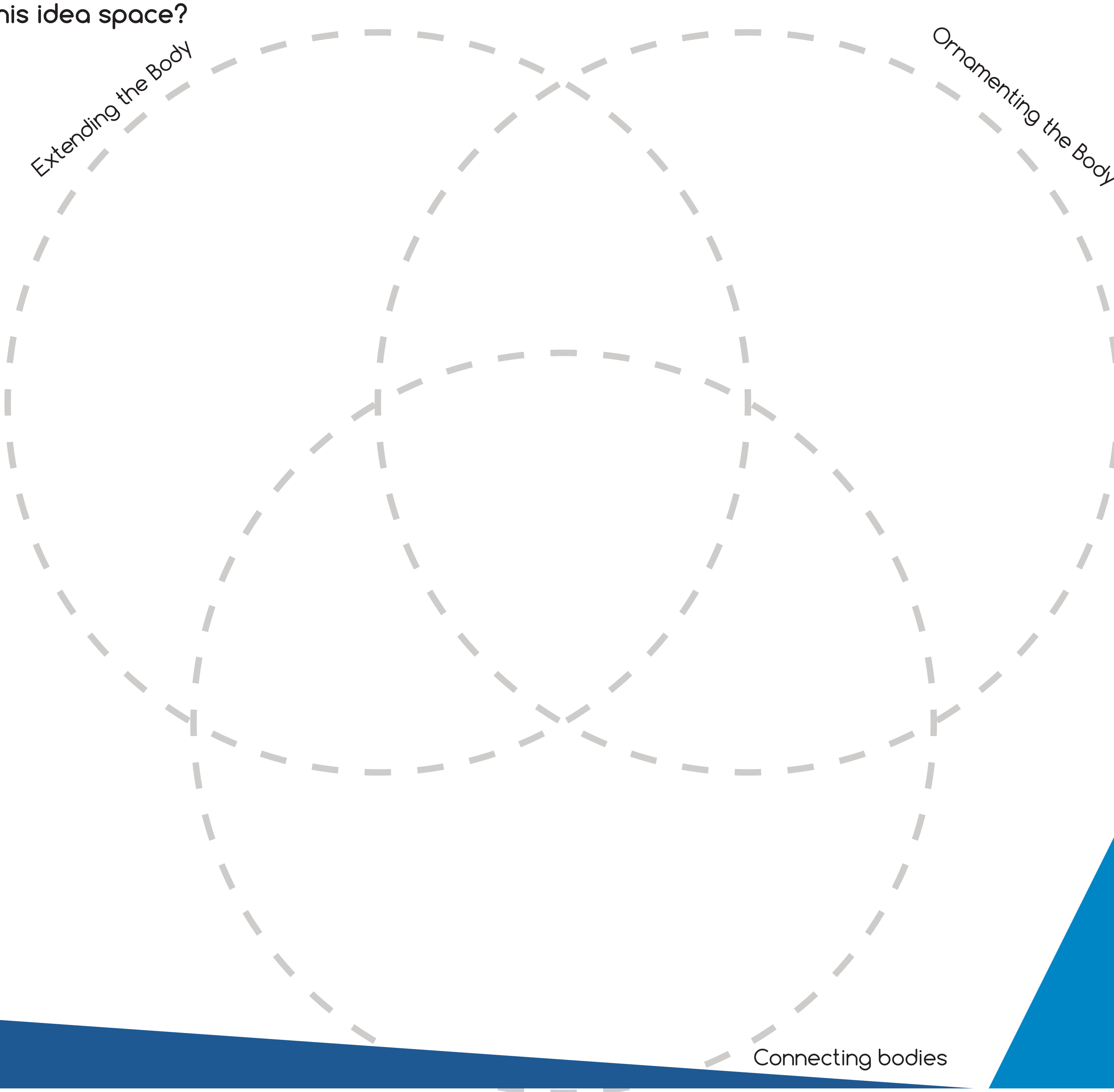
1. Sonya Clark described her Communicatools as “connect[ing] eye to eye, heart to heart, and head to head to yield empathetic and perhaps even telepathic communication.” What other ways might an object connect two bodies? How might an object connect two bodies in a metaphorical or non-physical way? (How does a wedding ring or a friendship bracelet connect two bodies, for instance?)
2. What kinds of “empathetic,” “telepathic,” or other forms of communication could be enabled by an object? What objects or materials do you use every day to communicate with others? How could your project enable a new kind of communication between two bodies?
3. Does the chosen recipient of your object have a particular person they feel connected to? How could the object you make respond to, augment, or embody the connection those two people share?

FORMS and BODIES

Handout I - Concept Development

BRAINSTORMING

After learning about and discussing artists who extend the body, ornament the body, and connect bodies, brainstorm your own ideas by writing or sketching them in the 'idea space' below. Develop **at least one concept for each category, and at least one concept that overlaps or fits between two or more categories** in the 'idea space.' **Can you think of an idea that would be completely outside of this idea space?**



FORMS and BODIES

Handout I - Concept Development

RESEARCH

Who is the person you plan to develop your object for?

Write down **at least three questions you will ask this person** to give you ideas for what might make your wearable art a 'good fit' for them. If you're thinking of adorning their body, you might try to find out their ideas about what is beautiful. If you're thinking of extending their body, you might try to find out about dreams, goals, or favorite activities.

What **physical measurements** will you need to take to ensure a 'good fit' physically? Remember, **every body is different**, and careful measurements will help ensure your wearable artwork is distinctly made for your chosen person. Make note of what measurements you will need to take.

NOTE: As your project develops, you may have to go back and collect more data from your chosen person. Don't stress about getting everything you might need right now.

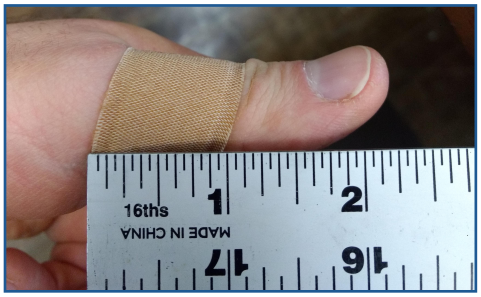
MEASURING AND MODELING IN TINKERCAD

NOTE: This tutorial expects that you already have a basic familiarity with modeling in TinkerCAD. If not, don't worry, TinkerCAD has a number of built-in tutorials at tinkercad.com/learn/ that can acquaint you with the basics.

This tutorial focuses on how to get accurate measurements in TinkerCAD so that your model will be well-suited to the body that will wear it. The first step is to record measurements in the physical world. Since we're working in three dimensions, you'll likely want to get the length, width, and height of the relevant part of the relevant body. I've measured my thumb for the purposes of this tutorial:

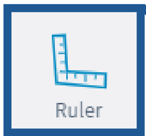

knuckle width: 15/16" (.94")


knuckle depth: 11/16" (.69")


knuckle length: 1"

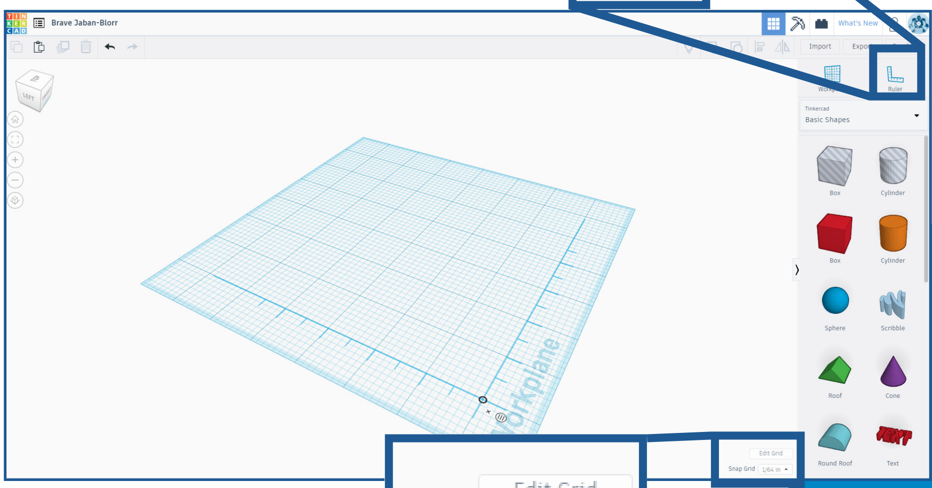
(If you want whole body measurements, the app Nettelo can use a mobile camera to capture them.)

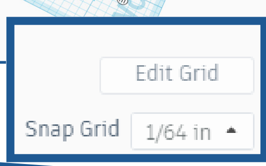
In TinkerCAD, you'll want to drag a ruler from the **"Ruler" button** in the upper-right into your workspace. Its location is not important - its presence in your project will allow you to measure.



You'll also want to click **"Edit Grid"** in the lower-right, and set the units of measurement to match your recorded measurements. My ruler was in inches, so I'll use that.

Set "**Snap Grid**" to a small distance (e.g. 1/64" or .5mm) to allow for precise sizing and positioning.

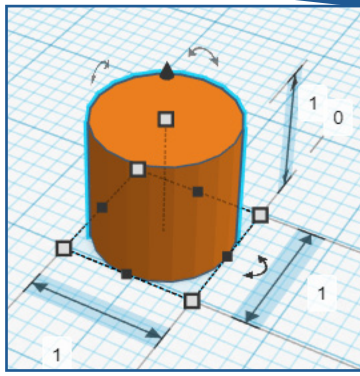


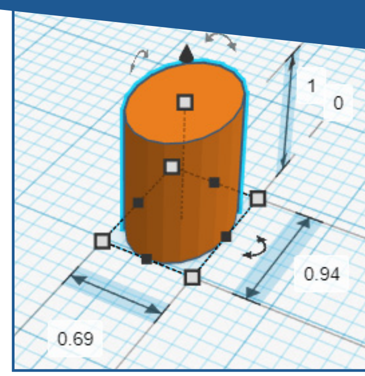


FORMS and BODIES

Handout II - TinkerCAD Tutorial

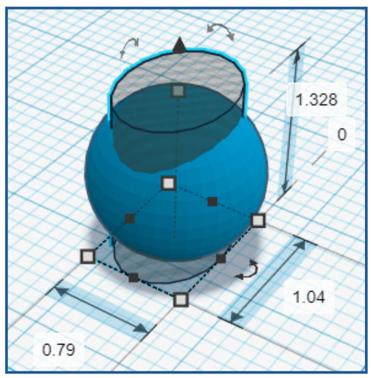
To provide a frame of reference to work from, you may want to put in a shape and set it to the dimensions of the body part you measured. A cylinder is a good fit for a digit or wrist. I'll use that for my thumb.

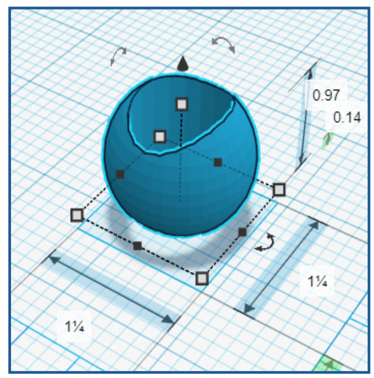




Because you have a ruler in your project, the cylinder will have its height, width, and depth measurements labelled. You can just type your measurements (in decimal form) into those boxes to resize your shape.

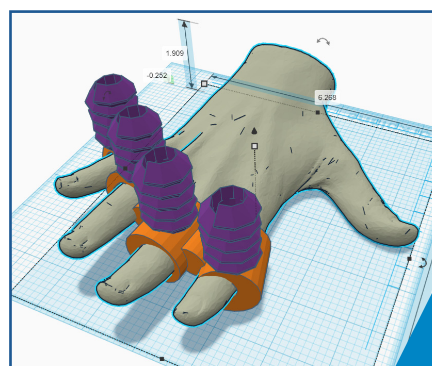
You can build your wearable object around this shape, or add other shapes for other parts (I could measure out the other knuckles of my thumb, for instance).





Another potentially useful strategy would be to turn this shape into a "hole," and increase its dimesions slightly, then use it to carve out from another shape. In the images to the right, I'm making a sphere into a ring that could slide over my thumb.

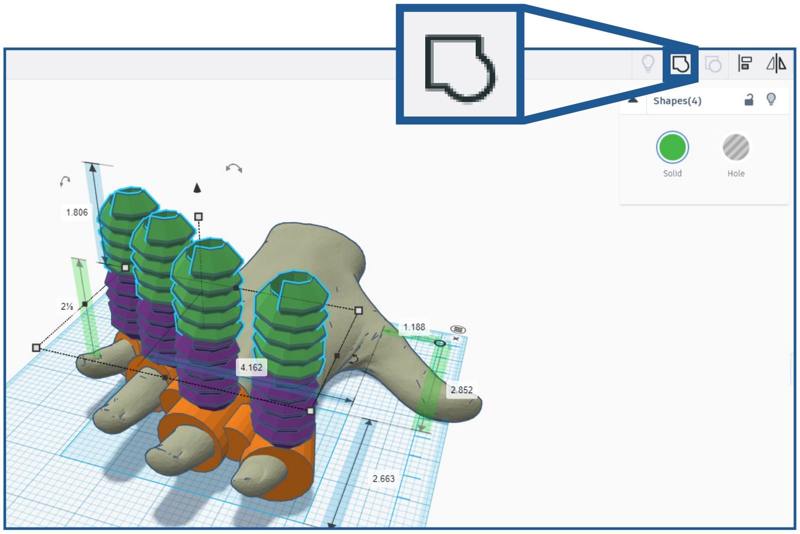
Another potentially useful tool could be scanning in a body part to build around. Options for scanning include:



- **Photogrammetry**, which uses multiple photos to capture a 3-D model. This can be less accurate, but requires no special hardware. Common free/cheap apps include: TRNIO (iOS), Qlone (iOS/Android), and COLMAP (Mac/Windows).
  - COLMAP is the only 100% free option, but also the most technically complex. A full tutorial by Dr. Peter Falkingham is available at https://sketchfab.com/blogs/community/tutorial-using-free-photogrammetry-software/
- **3-D Scanning**, which uses special hardware to capture 3D information from the world. Common 3D scanners are the Structure Sensor for iPad and the Kinect Sensor for PCs (which can work with free software such as KScan or 3DScan).

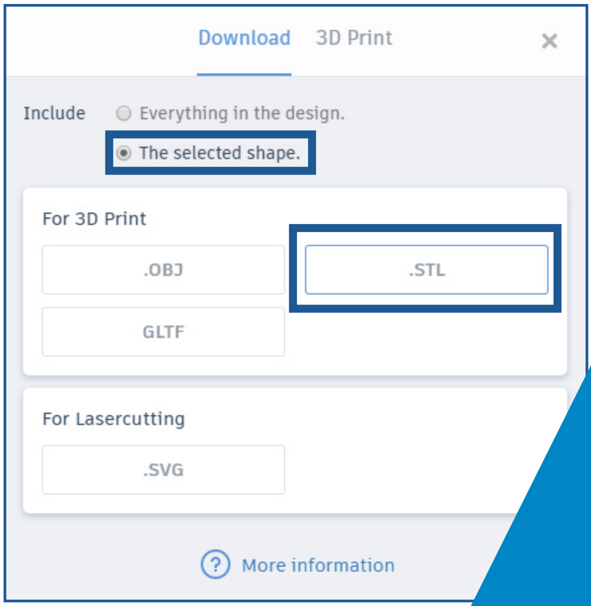
TIPS FOR MULTI-MATERIAL PRINTING AND TINKERCAD

If you have access to a multi-material printer, you may want to make use of it for this project, especially if you want to leverage the potential for multi-color printing in a piece designed to adorn or beautify the body.



Eventually, you'll be exporting a separate .STL for each color in your design. To make this easier down the line, it's useful to group together same-colored elements as you add them, so it is easier to select them all at once. To do this, hold **Shift, click on multiple shapes, and press the Group button in the upper-right**. As you work, you can keep adding new shapes to the approriate group.

NOTE: When using a multi-material printer, the colors of your final piece aren't determined by the colors in your TinkerCAD model, but by the colors of filament in your printer!



When time comes to export your model, you'll need to export each same-color group as a separate .STL.

One by one, select each color group, then press the **Export** button in the upper-right. Make sure **"The selected shape"** is clicked under "Include", then click **".STL"**.

To keep your files organized, save them to the same folder, and give them the same filename, with the color at the end, e.g. "knuckle-art_orange.stl," "knuckle-art_green.stl," etc.

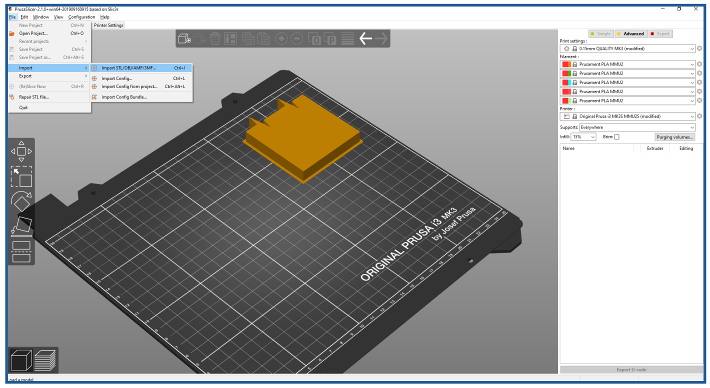
FORMS and BODIES

Handout III - Multi-Material Tips

SLICING YOUR MULTI-MATERIAL MODEL FOR PRINTING

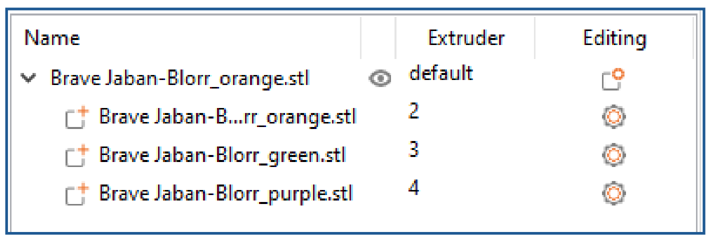
NOTE: This tutorial uses the slicing software PrusaSlicer, which is a version of the open-source program Slic3r, with pre-sets built in for Prusa printers, like the ones we use. Setting up and slicing your file for your own printer may involve different software and processes.

After opening up a blank project, choose **"File>Import>Import STL/OBJ/AMF/3MF,"** and choose one of the saved .STL files for your project.

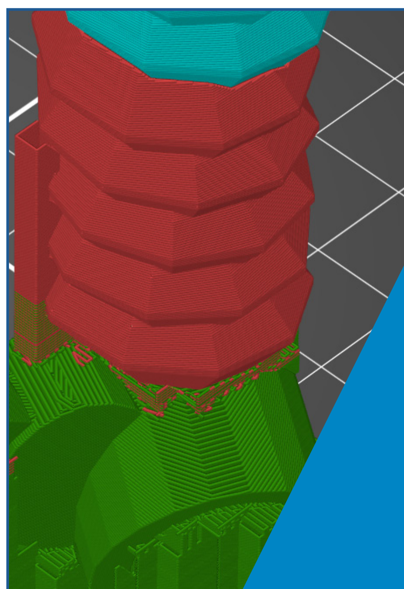


Then, right-click on the imported model, and choose **"Add Part."** Select all of your remaining files, and import them. This should add them to your model, but all in the same color.

On the right side of the screen, you should see a list of your model's parts. If you see a ⚠ symbol, click on it to fix any structural issues with the model.



In this area, you can also set each part to use a different **extruder**, meaning a different source of material. Give each section a different extruder, so each section has its own color. **Remember, the colors you see in the program are not necessarily the colors your project will have - those are determined by the colors of filament in the printer.**



At this point, you can position your object on the print bed (leave room for the "wipe tower" in the corner - this is where the printer places blended filament when changing colors). And, if desired, use commands like **"Place on Face"** ( ) to lay it flat on the bed to reduce print time.

Set "Supports" to "Everywhere," (and say "okay" if it asks to turn on Bridging Perimeters to make the supports work better).

Click on **"Slice Now"** to get a sliced model, from which you can export the G-Code to use with your printer (make sure all other settings are prepped for your make and model).