Biomedical 3D Printing
Assignment #3
Case Study: Design for 3D printing

(Download this doc to fill out and submit)

There are many factors that influence the way in which a part is designed and printed. Some of these things are controlled at the level of design, some while setting up a print, and some after the part is already printed. Find and download an STL file of your choice from a resource mentioned in class. The model should be a **functional part with some level of human interaction**. Provide a link to the part below and paste screenshot of the object by itself and in use if possible.

Name of part: Wrist splint volar based

Link: https://www.printables.com/model/157304-wrist-splint-volar-based/files

Screenshot:


Some of the critical thinking we should do with a model we want to 3D print are as follows:

1. What is the intended use of this part?

   For patients suffering from distal radius fractures as well as post-surgery. Mild to moderate sprains or different conditions of tendonitis. The model provides stability and immobilizations to the wrist joint.

2. Does the model have strength requirements? Explain.
    a. If so, where will the model be stressed while in use?

   The model must have strength requirements to be able to keep the wrist stable. Has to be able to withstand a stretching or pulling force without breaking. Must have minimum tensile strength. The model will be stressed the most around the wrist if the patient accidentally falls on the floor or tries to bend the wrist. The model needs to be stiff and requires impact resistance.

3. Does the model have other aesthetic, surface finish, chemical compatibility, temperature, biocompatibility, or other requirements?

   The model needs to be lean so it cannot scratch the skin of the patient, biocompatible because will come in touch with skin, be able to keep its form in different temperatures (body temperature plus up to 45 Celsius). Moisture resistant (sweat).

4. How large is the model in length, width, and depth?
    a. Can the model be printed or post processed easier if split into smaller pieces?

   The model can change its length and width according to the patient's needs. This can be achieved by measuring the diameter and length of a patient's wrist and resizing accordingly. By using the mirror function, the model can turn into a left-handed splint. The model shouldn’t be printed in 2 or more parts because might lose its function.

5. Does the model have areas that will be considered overhangs?
    a. Can these areas be avoided entirely by changing print orientation?

   Change in the orientation in the printer will help reducing the extra support and materials that can be used.

6. How large is the smallest detail on the model? Does it have features such as thin walls, small holes, etc.?

The model in the stl file does not have any holes but can be made for the Velcro that can be used for straps, instead of just using them around the model to make it stable.

7. Are there any flat sides?
   No

8. Knowing all these details, what is the appropriate material class of the object (polymer, ceramic, metal, multi-material)? Why?

   The maker of the model suggests the use of PLA or PETG. I believe that PETG would work better in this model because even though PLA is strong, it is more brittle than PETG. Also, PETG is more flexible so can be more comfortable plus its temperature resistance is higher than PLA. Last, the model will come in touch with sweat and other liquids, PETG has higher resistance to moisture.

9. Are any parts of the model interacting with pre-existing, non-human geometries?
   a. What are they and how do they interact?
   b. Are these areas critical to the part functions?
   c. Do they need to be very accurate in size?

   The model consists one piece that has the same thickness. The geometry is according to the human wrist, and can change the length and width according to the person that is made for.

10. What printing technology is most appropriate to manufacture this model? (Choose 1)

- If it is material extrusion - Download and install Cura and watch User Guide email: a.wentworth@northeastern.edu User: BIOE5060 Password: BIOE5060 and use non-networked printer Ultimaker S5.

- If vat photopolymerization or powder bed fusion, Download and install Preform using the form 3B/3BL for vat photopolymerization and fuse 1+ for powder bed fusion

- If material jetting - Download and install GrabCAD Print
  User: shibbleswentworth@gmail.com
  Pass: Anatomic123! and use offline with J750 printer template.

11. What post-processing steps will be performed?

    Removal of the support structures, smoothing the model, maybe extra painting if needed and heat treatment to optimize the mechanical properties and relieve internal stresses.

12. Add the STL file to your print prep software. Orient the part and add support if required. Set appropriate parameters (layer thickness, material, printer) (limited to vat photopolymerization and powder bed fusion).

13. Paste screenshot of the object below, including the details of build estimates (material, time). Estimate the part cost if not available.

    The part if someone wants to make it with a house printer, will cost around 6-7 dollars (Material + Machine operating cost). If a shop is selling it the cost will be around 20-30 dollars adding labor, packaging, software design costs and shipping. (ChatGPT was used to understand all the different costs)