

ENGINEER 1C03: Cornerstone Design Project

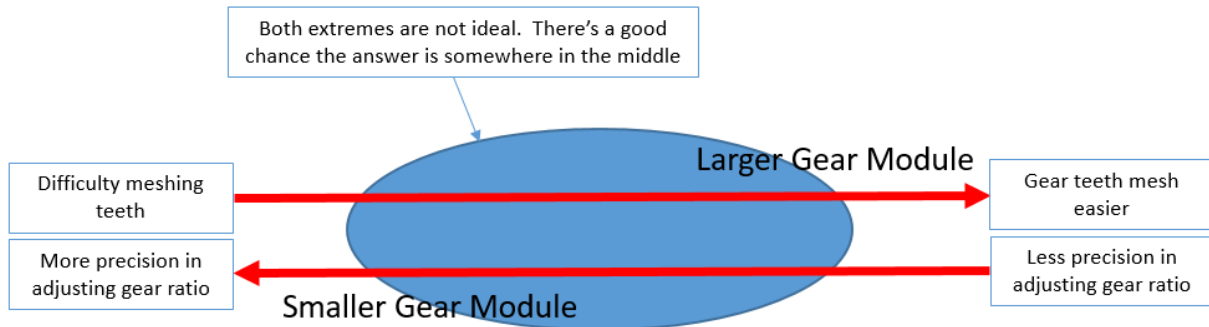
FAQ (Frequently Asked Questions)

Updated: February 25, 2020

- This document will be updated and re-posted to Avenue as to new questions are asked.
- Please note that new questions will be appended to the bottom of this document.
 - In general, questions will not be categorized
- Questions asked via the Google Form (<https://goo.gl/fmnL7A>) or to Jake Nease via email will be answered here (emails sent to Jake will also receive a reply)
 - If you ask a question via the Google Form, but do not see your question posted to the FAQ, it is very likely it has already been asked (possibly in a different way).
- You are, of course, welcome to ask additional questions during office hours. However, those will not be posted to this document.

IMPORTANT DISCLAIMER: I won't always give clear answers to your questions... that's because this is a DESIGN problem, and there are RARELY clear answers. In fact, most design decisions require you weigh factors against each other (thus, the answer isn't necessarily obvious). As an example, let's look at what module you should use for your answers. As you probably are aware, the module is for you to decide.

- You can have a large module, which will make for easy meshing of gear teeth when 3D printed. However, a smaller module is needed for more complicated gear ratios (which you probably have – please refer to Slides 12-13 of Lecture 5 as a reference).
- Similarly, a small module allows you to more precisely tweak your gear configuration to meet the desired output speed. However, gear teeth may not mesh as well.



1. Can you please be a bit more specific about everything?

As questions are asked, I will do my best to answer them. You are tasked with using resources to address the problem, and I am more than willing to act as a resource for you, in addition to acting as a teacher, a coach, and a mentor. However, it is not fair to you and your training as an engineer for me to lay everything out for you in detail.

Why, might you ask? This is a design problem. Like any design problem, there exist many correct approaches to address the problem and likely many correct solutions. To learn to be a problem solver (the *essence* of an engineer!), you must learn to solve a problem where the path isn't necessarily clear. If I were to be very specific (essentially outlining everything that is expected of you), then at the end of the term, I would receive 160 of the same design! That isn't the purpose of this assignment. More importantly, however, you would be working towards getting a good mark rather than towards developing your problem solving skills. Are marks important? Sure! Is your employer going to be more concerned with how well you've developed your problem solving skills rather than the mark you obtained in a first year course? You better believe it!

A design problem can be frustrating, and I certainly can appreciate the need to want as many details as possible. However, the solution to design problems are not found in the back of a text book. I want you to be a little bit frustrated, but I also want you to have fun with the design process.

2. Can we use bevel or helical gears in our design?

You are permitted to use any gears we have discussed in class (spur, worm/worm gear, bevel, helical). Please be aware that bevel and helical gears are more complicated in geometry, and that has implications for 3D printing.

3. What is the mounting bracket?

The mounting bracket is a custom piece that fits inside your prosthetic frame (without physically attaching to it) and holds all the components together. Your gears will need to spin on some type of axles, as will your forefinger and thumb. Your mounting bracket is the piece that everything should connect to (i.e., your gears connect to axles and the axles connect to your mounting bracket). Once complete, it should slide inside the prosthetic frame such that the forefinger-thumb are aligned within the frame as shown in Figure 5 of the Project Specification.

4. Does the mounting bracket have to be able to be attached to the prosthetic hand using a means such as screws or does it just have to fit in the prosthetic and not actually have to be attached?

The mounting bracket does not need to physically attach to the prosthetic frame.

5. How is the MOUNTING BRACKET supposed to attach to the PROSTHETIC FRAME hand model? Is it just supposed to be smaller or actually fit perfectly?

The design of the MOUNTING BRACKET is up to you, so long as it supports all the necessary components (i.e., gears and forefinger/thumb) and doesn't physically interfere with the prosthetic frame. It can EITHER be smaller, or fit perfectly. That is up to you.

6. May the mounting bracket hang over the side of the prosthetic frame (shaped like a u-bracket) ?

Yes, so long as the prosthetic frame is not modified in any way.

7. If using the given rods, do the physical gears that are printed need to be threaded? Or just the gears in the inventor file? Or both?

The gears do NOT need to be threaded. The PLA is soft enough that, you should be able to manually tap your gears to create the thread after printing.

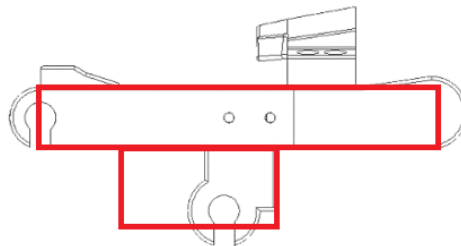
8. Is it better to make the diameters larger and have fewer gears? What is the maximum gear size allowed?

There is no maximum allowed. But you need to consider appearance. If you have a very large gear that significantly extends outside the prosthetic frame, does that look good? Would somebody want to wear it? Will having moving sticking out that far potentially problems?

As mentioned above, the more moving parts, the more complicated the assembly. So, in that sense, fewer and larger gears would be preferred. However, that should be weighed against aesthetics (please see above). You don't want the gears to be too large and make for a very bulky design. Remember, heavier gears may not function as well either.

Like so many design-related questions, the answer is "it depends" and you need to weigh various factors against each other. There are certainly *wrong* approaches on both ends, but there exists more than one correct solution.

You may ask how far can the gear extend outside the frame? There's only one requirement for this (please refer to the figure below from the Project Specification document). If we look at the side profile of the prosthetic frame, it is okay for gears to extend above or below the boxes highlighted in red. You should, however, align your axles (i.e., the center of the gears) so that they do not extend outside these red boxes. Note that dimensions are not given here. That's because it's an approximation. Just be reasonable with your design.



9. If using the given rods, when physically inputting them into the mount, if they go slightly outside the mount and interfere with the "hand", does that matter when physically creating it since we are not actually putting the mount in the hand? Or is it okay if we only take that into account in inventor?

That is acceptable. Since the rods are provided and it's a prototype, this is okay. If you want to achieve the bonus, however, you'll want to make sure the prototype can fit within the prosthetic frame without interference

10. Do all gears absolutely have to have their centre within the silhouette of the frame?

Ideally, yes. If the center of some gears extends beyond this region by 1-2 mm, that would be acceptable. In all cases, the key is to be reasonable in your design.

11. How are we supposed to make the design creative? I assume most people would have very similar designs.
There are any number of ways to be creative, including selection/configuration of gears, design of the mounting bracket, design for assembly considerations and design of the forefinger thumb.
12. Is it okay if the gears are a little messed up on the back face? All of my groups larger gears are mashed on the bottom but it doesn't affect the meshing
Yes, this is acceptable. The gears are meant to be functional. Appearance isn't critical
13. Are we expected to buy axles or 3D print them? or could we do either?
We have axles available that you can use. Alternatively, you can acquire your own. I would caution against 3D printing them since the resolution of the printers can prove to be a significant constraint when design parts to be mated (such as a rod inserted into the hole of a gear)
14. For the threaded rod given to us, if we want to use it should we print the rod out or should we just buy other rods from the hardware store?
If you want to use the threaded rod given to you, go see Kevin, your EPIC IAI. He can provide them to you.
15. Should I make a hole on the gears before I print it out?
If you do nothing else, PLEASE create a hole before printing
16. Are we allowed to add additional holes on the hand inventor file to install axis for gears?
No. the prosthetic frame should be unmodified. Your mounting bracket, however, should have holes for holding the axles. Remember, gears are supported on axles, axles are supported by the mounting bracket. The mounting bracket should slide into the unmodified prosthetic frame.

Consider the design of a protective case for a cell phone. The design of the cell phone (it's shape, where buttons are located, etc.) is a constraint that you must work within if you were to design a protective case for it.
17. How exactly should the forefinger/thumb be made? Is it supposed to be more gears or just 2 sticks that pinch?
The forefinger/thumb needs to attach to the output gears and the "pinching" point needs to be within the 2D functional workspace (Requirement #2 from Project Spec.). But everything else is for you to decide. You can either keep it simple (i.e., 2 sticks that pinch), or you can be creative. You are encouraged to think outside the box and try something new. It may seem frustrating that I'm not telling you how to design the forefinger/thumb, but that's because I want you to really WOW me.
18. Will the forefinger/thumb we design be attached directly to prosthetic hand or will it be attached to the mounting bracket itself?
The forefinger/thumb are part of your design and NOT part of the prosthetic frame. They should attach to the whatever you have designed at the outputs of the forefinger and thumb, and be part of the mounting bracket assembly.
19. Can we attach gears directly to the axle?
Yes, you can attach the gears to axle however you like. In the past, some students have attached gears to an axle that rotates while others rotate their gears about a fixed axle. It's ultimately up to you. The key is to ensure your prototype is robust enough to function properly.
20. Since there needs to be two output locations (one for the thumb and one for the forefinger), does that mean that the gear train has to branch off into two separate paths to reach each destination?
Yes, your gear train will need to branch off into two separate paths. Please refer to slides 2-9 of Lecture 7 for some visual examples to help get you started.
21. Can the motor shaft length be extended?
Yes, you may extend it if it is necessary.
22. Can we use square axles for the gears? (To help them rotate without slipping, and to make sure we get a good quality print)
Yes, you may use square axles for gears. However, you should be warned about printing your axles. You can if you wish, but generally, it is recommended that you purchase standard parts (e.g., from a hardware or craft store).

23. We designed a chassis that works perfectly, and then we realised that it takes about 2 hours 30 min to print it as a whole. Are there any viable options other than just printing the chassis as multiple parts and then putting them back together in some way or the other?
Yes, there are a number of options. Whether you glue them, modify the parts so that they ‘snap’ together, or attach them with fasteners, it’s up to your team to decide what is most appropriate.
24. How does the input gear attach to the motor? Will it attach to the axle itself, or to the hole on the input gear directly?
For the 3D printed prosthetic frame, there will be no actual motor. Instead, you can assume that the rod you use for your input gear is representative of the actual motor (don’t worry about how it would attach to the motor).
25. Should we design a handle for the input gear?
That is entirely up to your team. In the past, some teams have designed a handle while others chose to simply rotate the first gear manually with their finger.
26. Is it required that we shorten the threaded rods on inventor?
Yes, the rods SHOULD be shortened in Inventor to ensure there is NO interference with the prosthetic frame. If you are aiming for the 5% bonus, it is NOT necessary that you CUT the rods.
27. For the probe plots from Inventor’s Dynamic Simulation Environment, does it simply mean the plotted output graph as a PDF file ?
Yes, you can export the plots. If you export them as an excel file, then you can copy and paste the plots into your technical report. Please ensure your plots are INCLUDED in your report, and not attached as a separate document