# **Mechanism Prototype**

## Introduction

In this assignment, a subset of your team will construct prototypes for the mechanisms necessary to transmit power from your robot’s motors to the user’s hand. This includes linkages, constraints, and ergonomic human interface components. As you work on these mechanisms, other members of your team will be working to produce controlled haptic effects and motion in a single actuator. Once both groups have working prototypes, they will work together to design an integrated system.

The goal of this assignment is to **create physical prototypes of the power transmission elements, fixtures and load-bearing elements necessary for the final device**. You don’t have to power these prototypes; for motors, you may use passive/printed mockups or real motors (disconnected from power) if available. If your design relies on sensing position or force within the mechanism, you should integrate these sensors (or form-factor mockups) into your prototypes. Focus on capturing the mechanism’s degrees of freedom, constraints, kinematics, physical structure, and the ergonomics of the human interface.

## Part 1: Refine concept | 1 week

In your early team meetings, you created several possible design concepts and sketches. Look back at these drawings, and try to break them up into distinct components. It is fine to add additional concepts to consideration at this time, if anybody has had additional ideas.

For each concept, try to answer these questions:

* *Can any concepts be eliminated from consideration entirely, due to architecture level assumptions (e.g. actuator type)?*
* *Can this idea be broken down into self-contained engineering/design problems?*
* *Are there any similar components that show up across multiple concepts?*
* *How difficult would it be to build a basic prototype of the concept?*
* *What challenges do you expect you would face if you tried to build it?*

After considering these questions, make a list of relatively simple mechanism prototypes that you would like to create. You should have at least one prototype planned for each of the mechanisms required for the final robot, but they don’t have to be integrated together.

Make detailed sketches of your prototype ideas. This may take the form of a drawing, a block diagram, or both. The designs should be practical; you should be able to explain how you will make or acquire each component. Watch for ideas you may have encountered in existing products. If something you want to build looks similar to an existing commercial product, research the availability and cost to obtain a sample. It might be faster to modify the existing item than to make your own from scratch.

Part 1 deliverables: Conceptual sketches of the areas of the abstract architecture that the mechanism team is trying to fill in. This includes both block diagrams and physical concept sketches. The team has identified the independent mechanisms they need to prototype, and has a few rough concepts for each of them.

## Part 2: Prototype Subsystems | 4 weeks

This is the main segment of the mechanism assignment. Starting from the initial prototype designs you made in Part 1, build physical prototypes of the mechanism of your robot, documenting your work as you go. Before you build something, list the questions you are trying to answer with that prototype. Make the prototype as complex as it needs to be to answer those questions, but no more. Be sure to produce drawings of any custom components you make.

This is an open-ended assignment that will be largely guided by your own decision making as a group. We expect you to build at least two versions of each prototype, with the second version improving upon the first. In most cases, you’ll have to iterate more than two times to get something that works. If you find that a particular idea is just not feasible to implement in the time we have, abandon it and try the next best thing.

Part 2 deliverables: at least two iterations of mechanism prototypes for each of the subsystems the team is trying to address, and lab-notebook style documentation of prototype performance and lessons learned.

## Part 3: Integrate Subsystems | 1 week

Now that you’ve built some prototypes, try to combine them together into an integrated device mockup. It’s still okay to use mockup motors here, but if you have access to the real thing, go ahead and use it.

The final mockup device should be robust and functionally demonstrate the passive kinematics and dynamics of the real thing. Try to make something strong enough to withstand nearly the full load expected in the final device. Expect to perform an in-class demo.

Of course, this is still a prototype, and it will have shortcomings. To complete this assignment, experiment with the prototype, and make a list of all the issues that would prevent it from meeting the finished device requirements. If time permits, and the actuator team has time to help you with low-level controls, you may wish to do some basic power-on testing at this time.

Part 3 deliverables: Any subsystem prototypes that can be integrated together have been combined to form an integrated prototype. A list of known issues has been prepared to drive future development.