

So what does it mean to design? Engineers and architects often use a design process that involves several steps. I'm going to list the steps. They're not often done completely linearly.

The first step would be to identify a design goal, followed by asking questions to clarify and redefine that goal. Then brainstorming ways to meet that goal, selecting alternatives, designing and prototyping, and then testing that prototype. And finally, redesigning if it didn't work.

So it's often nonlinear. We'll get down to the final phase and realize it doesn't work the way we wanted, and we'll go back to one of the previous phases. You might not realize it, but I'm sure all of you have designed before. So whenever you arrange things in your house or room, or if you sketch a picture, if you design your outfit for the day, you're kind of stepping through a design process.

So I'm going to step through the design process using the Cardboard Chair Challenge as an example. I just want to put it in some context and get you started thinking earlier about your design. We'll design the cardboard chair and give you guidance later on the chair.

So the first step for my cardboard chair, let's say, is my goal. So what is my design goal? Your goal might be solving a problem or improving a product or process. And you can refine this goal throughout the process, and I encourage you to. But you need to start with an initial goal. So I might start with a very simple initial goal, that being design a chair out of cardboard. So that is my initial goal.

So then we'd go into the questioning phase. You'll ask questions to help clarify that goal, and I think this is one of the most important phases. You need to understand the needs of the user. You might conduct research. You might collect information. You might go out and observe and interview users. You might look at previous work. For a building, it would be observing and talking to the actual future clients or future users.

For the cardboard chair, there's lots of questions that come up, and I encourage you to ask those questions before jumping in with solutions. So I see a lot of younger students just jump in and start designing before really questioning and trying to clarify what they're doing. I think the more information you have, the better.

So questions that come to my mind about the cardboard chair are how big does it need to be? What's

the seat size that I'm looking for? What materials am I going to use? How high does it have to be off the ground to be comfortable? Who's going to be using the chair? How much do they weigh? Do I want a back on my chair? How strong is cardboard and duct tape, or the materials that I'm going to use?

I might do some research and look at chairs, so do an Internet search or look at chairs in my house. I might even measure some of those chairs to get a sense of the size. Spending some time in that questioning phase, I think, will pay off in the end. You can then, after the questing phase, go back and redefine that goal and make it more clear and achievable.

A redefined goal for the cardboard chair would be design a chair to support a person weighing up to, say, 200 pounds. And the materials I want to use are cardboard, rope or yarn, and duct tape. I did some measurements and I've determined that I want the seat to be a minimum of 14 inches from the ground. I've decided I like backs on my chair, so I want it to be comfortable. I also want it to make a statement and be innovative.

So it's a longer, clearer, more defined goal, and that's how it'll help me start my process. And we'll use that process throughout the course.

Throughout the course we will kind of set up design goals for each of the activities, but you can always change those design goals to fit materials that you have, interests that you have. So feel free to change the goals to meet your own needs.

So brainstorming would be the next step. And you want to come up with lots of ideas, including crazy ones. So you can list ideas. Some people like to sketch ideas. You might actually build some little prototypes in the brainstorming phase. You can do brainstorming alone.

It's also good to do it in a group. If you do brainstorm in a group, you want to make sure you're positive about all your ideas. Encourage craziness, and don't judge the ideas. We'll judge them eventually when we select alternatives. But in the brainstorming phase you just want to come up with and generate a huge list of ideas.

I encourage you to write down or sketch your ideas just so you don't forget them. It's easy to forget your ideas. For the cardboard chair, I might encourage you look at existing chairs to come up with ideas, but be creative. Remember, that's one of your goals.

When you're selecting alternatives, you want to revisit your design goal to make sure the idea you're selecting has the potential to meet those goals. Sometimes that's easy to choose the best alternative. Other times you have to carefully evaluate the pros and cons, and that's fine. I would encourage you to record your reasons for selecting different chairs, because you might revisit this phase if your selected alternative doesn't work out.

Designing and prototyping I purposely put together in a single phase, since I want to encourage you to build early. So you can sketch designs, and that's a great way to help you represent what's going to happen. But actually building a prototype, which is just a preliminary model of your new product or process-- could be a model of a building, in your case it's going to be a model of the chair-- I think is a critical part of the design process. And it's better to start that early. Too often people sketch and draw and try to perfect it on paper, and as soon as they put it together it just doesn't work.

So feel free to build models. Really easy models are fine, so just paper and tape. So for the cardboard chair, you might start just with a sheet of paper, first a sketch, and then you cut the paper and put things together. It'll help you see how things fit together.

Simultaneously design and prototype, and I think the best designs will come from a lot of prototyping, so building a model rather than just perfecting it on paper forever. Many of your models will likely fail. Don't get discouraged. I think you learn more from those failed prototypes than from a perfect prototype.

I build prototypes, I build things to learn, to figure out how it's going to behave. So if you fail often and early, your end product will be great. So for the chair, you might start out with paper and scotch tape, maybe some string. That'll help you experiment just with forms and different designs. I purposely didn't bring any prototypes of chairs because I want to see what you can come up with.

The testing phase for the chair will be sitting on it, possibly leaning back and seeing how it behaves. For buildings, we don't often have the luxury of testing our buildings. We do test them on the computer and test models and test different components of it. We don't get to test the final product.

Reflecting on your design process will also be important. So what worked, what didn't, what could you improve, what would you change? So just iterating through that design process.

So engineers and architects use a design process on a daily basis. Each of the phases of the design process may take hours or months or even years. For example, the engineering school here is planning

a new building at this point and looking at space requirements. So the architects and engineers are really focused on just questioning future users and figuring out space needs. And so they've been spending months in that phase, in that planning and research phase. Engineers also spend months and years on building physical models and computer models.

So in that design and prototyping phase, testing phase, will usually happen in the computer, but they'll test components and pieces. So it's highly iterative. It tends to be collaborative, and it's very rarely linear. It's jumping back to different phases.

So before we start building a chair-- I think that'll be a fun project-- I thought we'd start out with a smaller scale project. So we're going to start out with a marshmallow tower. It's a Marshmallow Challenge. It's a fun and quick design challenge. It was created by Tom Wujec. He's a fellow at Autodesk. Autodesk makes a computer software. He designed it as a way to foster creativity and design thinking.

The goal of the Marshmallow Challenge to build the tallest freestanding structure that you can in 18 minutes or less, and it has to support a marshmallow on the top. The marshmallow has to stay intact. No cutting or microwaving or doing funny things to the marshmallow. The materials you can use for your tower are 20 strands of spaghetti, one yard of tape, and one yard of string.

So ideally you'll work in a team. You're not supposed to suspend the structure or hold it to the sides. You can connect it to the table. The entire marshmallow is supposed to be on the very top. You can break up the spaghetti or string and tape. And I encourage you to post pictures and let us know how the process went.