Session 14

Prototype Practicalities

Prototyping

In This Session:

A) Prototype Planning (30 minutes)
- Student Handout
- Student Reading

B) Prototype Materials (60 Minutes)
- Student Handout

C) Budget (60 Minutes)
- Student Handout

Home Improvement
- Student Handout

In this session students begin planning how they will construct their prototypes. In *14A: Prototype Planning*, prototypes are reintroduced as students strategize plans and create their specifications for developing a prototype. In *14B: Prototype Materials*, students consider what materials they will use to develop their prototypes. Finally, in *14C: Budget*, they use a spreadsheet program to develop budgets for the project. The Home Improvement activity, *Your Work Schedule*, helps students structure their time for working on their prototypes.

Supplies

- Spreadsheet software program
- Computers
- Materials to demonstrate what may be used in prototypes:
  - Wood
  - Foam
  - Plexiglass
  - Metal
  - Canvas fabric
  - Bubble packing
  - Cotton balls
  - Duct tape
  - Tubing
  - Sandpaper
  - Sponges
  - Steel wool pads
  - String or twine
  - Glue
  - Masking tape

Session 14, Activity A

Prototype Planning

Goal
Understand what a prototype is.

Outcome
Students will be ready to begin building their prototypes.

Description
This is the first part of Step 8 of the design process: Build the Prototype—develop project specifications and create a working prototype. Revisit the difference between a model and a prototype. Students begin to think about how they are going to develop prototypes and get ideas from one another.

Supplies
None

Preparation
None

Procedures
What Is a Prototype?

1. Have students refer back to the design process checklist in *11A Handout: Checking in on the Design Process*, Step 8: Build the Prototype.

2. Ask students the difference between a model and a prototype (this was introduced in *12A: Thinking Again About Design*).

   Model: A visual representation of a total design (or some aspect of the design) that is nonfunctional.
   Prototype: A working model used to demonstrate and test some aspect of the design or the design as a whole. A prototype is produced before the final version.

3. Discuss the purpose of prototypes (learning, communication, integration, and milestones):

   - Learning: Prototypes are often used to answer two types of questions: "Will it work?" and "How well does it meet the users' needs?"
   - Communication: Prototypes allow better communication of product ideas. They are visual, tactile, three-dimensional representations of a product.

   - Integration: Prototypes are used to ensure that components and subsystems of the product work together as expected.

14A: Prototype Planning (continued)

- Milestones: Prototypes are used to demonstrate that the product has achieved a desired level of functionality—providing tangible goals and demonstrating progress.

4. For an example of the development of a prototype, refer to *14A Reading: ZIBA Designs Dial Soap Dispenser*.

Prototyping Suggestions

Discuss the following prototyping suggestions:

1. Prototype early and often: Don't wait until you have the final design. To see if something will work, make a quick prototype.

2. Divide and conquer: Divide large problems into smaller challenges and solve these through prototyping.

3. Flatten the problem: Translate three-dimensional problems into two dimensions to make simpler prototypes that demonstrate a concept.

4. Make it simple: Use simple materials; the goal is to test an idea or a concept quickly and cheaply so that you can improve the design.

5. Go big (or small): Build a full-scale version of the prototype. Something that looks good on paper may not feel good in your hand or be too small or big to manufacture.

6. Mix it up: Mix up your materials when prototyping—use anything that will make it easy to build and test your concept.

From Requirements to Specifications

1. Have students take turns getting feedback from each other (and mentors) about their ideas for creating prototypes.

2. Explain the difference between *requirements* and *specifications*. Requirements are general ways that the designer-engineer will meet the needs of the users. Specifications are more specific and often measurable needs for the product design; they serve as guidelines for designing and engineering the product.

3. Have students develop a set of specifications for their prototypes. Spell out in precise, measurable detail what the product should do and what is required in order to achieve this. This can be done by building on their chart that they developed for design requirements in *11B Handout, The Perfect Fit: Meeting Needs Through Design*. Ask a few students to share their design requirements charts and discuss the specifications that they might include in their charts.

14A: Prototype Planning (continued)

Name of Product: Bass Space

Brief Description: A device used to hold a beginner bass player's fingers together in the correct bass playing position.

User Needs	Design Requirements	Design Specifications
Device needs to fit different sized hands	Material needs to be ductile so that it can change form depending on size of hands	Thermoplastic material that can be molded onto one's hand

4. Remind students that as they plan their prototypes, they will have lots of sketches of their ideas before developing the prototype and may develop a few prototypes.

Wrap Up
Be sure that students have a clear idea of the difference between making a model and building a prototype.

Follow With
In *14B: Prototype Materials*, students consider materials for their projects.

Prototype Planning

Handout: Session 14, Activity A

Now that you have a model made, it's time to move on to the next step: building a prototype. Remember the differences between a prototype and a model. Plan your prototype in your design notebook.

> **Model:** A visual representation of a total design (or some aspect of the design) that is nonfunctional.
> **Prototype:** A working model used to demonstrate and test some aspect of the design or the design as a whole. A prototype is produced before the final version.

1. What ideas do you have for developing your prototype?

2. What suggestions do your peers have for you?

3. In *11B Handout: The Perfect Fit: Meeting Needs Through Design*, you should have come up with your design requirements. You are going to use those to develop design specifications. Requirements are general ways that the designer-engineer will meet the needs of the users. Specifications are more specific and identify measurable needs for the product design—they serve as guidelines for designing and engineering the product. Using the chart from *11B Handout* add specifications to the chart.

Name of Product: _____ Brief Description: _____

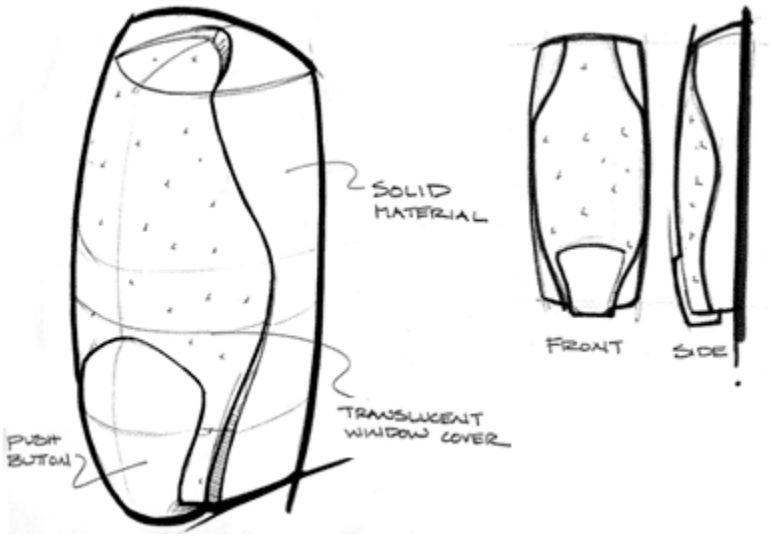
User Needs	Design Requirements	Design Specifications

ZIBA Designs a Soap Dispenser

Reading: Session 14, Activity A

ZIBA Design designed a new Dial* soap dispenser for commercial use in restrooms. Follow the process that ZIBA engineers and product designers used to develop this product.

Sketch of Dial Soap Dispenser



A new Dial soap dispenser needed to meet the following requirements:

- Dispenser has a semi-translucent cover for viewing soap levels.
- Dispenser uses a rounded push button for easy interaction.
- Spout needs to indicate where soap comes out.
- Space should be available on the inside of the cover for distributor label.
- The Dial brand should be recognizable.

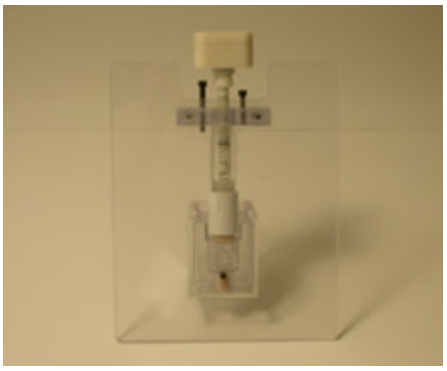
14A Reading: ZIBA Designs a Soap Dispenser (continued)

This first sketch shows the initial concept from a front, and side view.

Computer Model

This shows a computer model of the soap dispenser. A computer model is used to help product designers plan the design and dimensions more accurately than a hand-drawn sketch. This computer rendering is used to guide the development of the soap dispenser model.

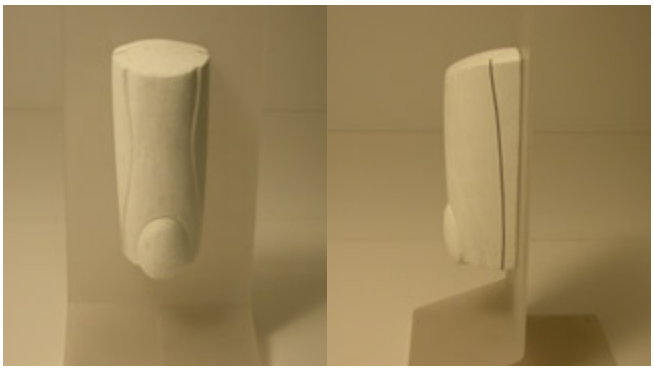
Mechanical Model



The next step is figuring out how the parts of the dispenser will work. In this case, a model was made of the mechanical component, the soap-dispensing mechanism. With this model, engineers can trial and test how the mechanism will work.

14A Reading: ZIBA Designs a Soap Dispenser (continued)

White Foam Visual Model

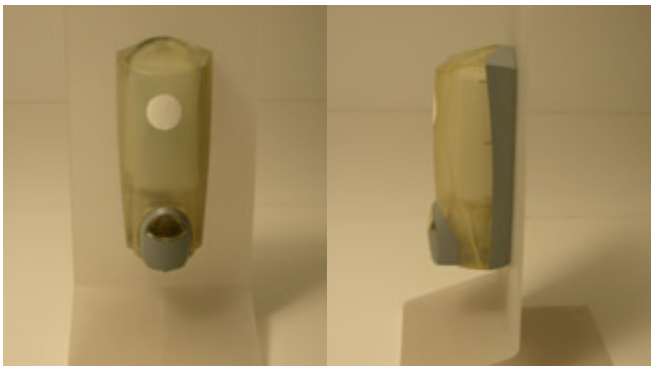


A white foam visual model is a quickly built model to evaluate early visual concepts and different product configurations. A white foam model is used for non-detailed, configuration explanation in the early phase of a design project. A front and side view are shown here.

Urethane Functional Model

A urethane foam model is a more detailed model used to evaluate a refined visual design. Details such as parting lines for manufacturing, and button details can be shown.

Mechanical Functional Prototype



14A Reading: ZIBA Designs a Soap Dispenser (continued)

A mechanical functional prototype is a complete mechanical and visual model used to evaluate all aspects of a product before proceeding to the manufacturing stage.

Production Product

The production product is the final design that rolls off the manufacturing line and is sold to customers.

Session 14, Activity B

Prototype Materials

Goal
Consider the materials for developing a prototype.

Outcome
Students decide what materials they will use for their projects.

Description
In this activity, students explore possible materials for developing their prototypes. Ideally, this will involve a visit to a local hardware store where they can get a sense of the materials available to them.

Supplies
Materials to demonstrate what may be used in prototypes:

- Wood
- Foam
- Plexiglass
- Metal
- Canvas fabric
- Bubble packing
- Cotton balls
- Duct tape
- Tubing
- Sandpaper
- Sponges
- Steel wool pads
- String or twine
- Glue
- Masking tape

Materials to demonstrate what may be used in prototypes: wood, foam, plexiglass, fiberglass, metal, canvas fabric, bubble packing, cotton balls, tubing, sandpaper, sponges, steel wool pads, string or twine, glue, masking tape, and duct tape.

Preparation
Invite a guest who is knowledgeable about materials, such as a machinist, a product designer, material engineer, handy person, and so forth.

Plan a visit to a hardware store in advance.

Bring in sample materials to show possible materials for prototypes.

14B: Prototype Materials (continued)

Procedures
Consider Materials

1. If possible, show sample prototypes and ask students what types of materials they see used. Remember that the goal of a prototype is to test and ultimately demonstrate how the final product will work.

2. Explain that material choice should be based on property characteristics of the design. For example, do they need a material that bends? Do they need something to be strong? It makes sense when choosing materials to think of it this way:

   Function → desired property → material selected

3. Have students sketch the prototypes that they are planning. In doing so, they should label the properties that each part of their prototypes requires. Then, have them refer to the properties' test results from *3A: Properties of Materials* and decide which class of material makes sense for each application. They may want to run material property tests to compare materials.

4. If possible, hold a feedback session with a guest expert on materials. In a whole-group discussion, have students share their ideas for their prototypes and the materials they are considering. They should also refer to their specifications to see what materials will meet these specifications. Ask for advice from peers and the experts.

5. Remind them that when selecting materials, it is important to consider the following:

   - How much does the material cost?
   - How big will the prototype be? How much of each material will they need to buy?
   - Where can they find the materials?

6. Explain that deciding what materials to use and where to find them will take some exploration. This exploration may include:

   - Taking a trip to a hardware store to get ideas
   - Looking at parts catalogs to get an idea of what's available
   - Talking to a variety of people about different options for materials

Wrap Up
Review students' material choices to be sure their selections are realistic.

Follow With
The next activity, *14C: Budget*, gets students planning their materials budgets.

Prototype Materials

Handout: Session 14, Activity B

Building a prototype can be fun and challenging. Here are a few tips to keep in mind:

1. Make it large enough. Remember that others will want to see the detail, and you will want to make sure all the parts work.
2. Pay attention to detail. Be sure that you show all the parts and components.
3. Make it strong. Use durable materials.
4. Make it "green." Use recyclable materials when possible.
5. Make it realistic. The prototype should be as close to the real product as possible.

Answer the following question to plan your prototype:

1. What materials are you considering using for your prototype?

2. Now, in your design notebook, draw a sketch of your prototype and label the materials.

Session 14, Activity C

Budget

Goal
Consider the budget for developing a prototype.

Outcome
Students create a budget for their materials using a spreadsheet.

Description
In this activity, students begin to develop a budget for their materials using a spreadsheet.

Supplies
Spreadsheet software program, computers

Preparation

1. Be sure, if you are going to have students develop budgets on a spreadsheet program, that you have enough computers with the appropriate software for students to do so.

2. You may want to set up a basic template that will help novice spreadsheet-users get started.

3. Decide what students' budgets will be (if you are providing the resources).

Procedures
Make a Budget

1. Get students started on a spreadsheet to prepare a materials budget for their project. Use an electronic spreadsheet program to do this. If students are not familiar with spreadsheets, this may take some time to explain how to set up a spreadsheet.

2. Include the following in the budget: material, quantity, and price. Students should list the materials that they selected in the previous activity, figure out how much they will need of each material, and the price for that quantity.

3. Depending on who is doing the shopping for the material (the facilitator or the student), students either give their budgets and materials lists to the facilitator or take them home to serve as a shopping list.

Wrap Up
Review students' budgets to be sure they are realistic. Discuss the Home Improvement activity, *Your Work Schedule*, which helps students plan their work time outside of class.

Follow With
In Session 15, *Develop It!* Students work on their prototypes.

Budget

Handout: Session 14, Activity C

Using a spreadsheet program, prepare a budget for your project. Include the materials, how much you will need of each material, the cost for each material, and the total cost.

Materials	Quantity	Cost
		Total Cost =

Your Work Schedule

Home Improvement: Session 14

Goal
Help students to structure concentrated work time for developing their prototypes.

Description
Students develop a method for structuring their time. This chart that shows progress of a project may be done electronically or on paper. The calendar should include their work sessions, class meetings, mentor meetings, science and engineering fair deadlines, and so forth.

Preparation
Bring in examples of calendars and other schedule organizers.

Procedures

1. Decide how you would like students to develop a calendar: Will you leave it up to them to choose or will you choose for them?
2. Provide examples of calendars and other schedule organizers.
3. Have periodic check-ins with students to see if they are on track. This may be done face-to-face or by email.
4. Suggest that students pair up with a partner for frequent check-ins to make sure they are both on track.

Next Day
Review students' calendars. Be sure to schedule regular meetings with them to check on their progress.

Your Work Schedule

Handout: Session 14, Home Improvement

By now, you will have set goals for yourself such as participating in a science fair. Because you will probably be doing much of the work for the remainder of the project at home, it is important to pace yourself and budget your time wisely. Creating a work calendar can help with this. Here are some suggestions for your calendar.

- Get a Yahoo personal account and use the Yahoo Calendar. http://calendar.yahoo.com/*
- If you use Microsoft Outlook* for email, you can use the calendar there.
- Make your own calendar.
- Use a store-bought calendar to plan your work schedule.

Things to include in your calendar:

- Work time and specific deadlines
- Personal dates such as vacations, family trips, and school events
- Class meetings
- Mentor meetings
- Partner check-ins
- Leader check-ins
- Science and engineering fair deadlines

Review your calendar and ask yourself:

- Do you have all fixed deadlines on the calendar?
- Do you have projected completion dates for goals and subgoals?
- Did you include research and information gathering time?
- Did you allot realistic time blocks to allow for setbacks?