S+P — Hooks For Hands

AN EXPLORATION OF HANDLES AND EXTREMITIES

NARRATIVE

You are part of an intergalactic product design firm that focuses on biomechatronics— making prosthetics for amputees. You have a license to practice in multiple galaxies, and you get clients from the most unimaginable places.

Your newest client walked into the office this morning: it is Captain Hook. Pirating is not paying what it used to and he's been forced to seek more gainful employment. He needs to know- what's the most difficult part of re-entering the workforce? You will set out on a day-long exploration of what can be done in this world with a pirate hook for a hand. In the end, you will make recommendations of the kinds of employment that are feasible for your client, continuing as Captain Hook.

STAGING

At each student's seat:

- Place one hook, alternating the different types of hooks.
- Put one rubber band next to each hook.

On the pedestal:

- Place one of each hook. If possible, use rolled up tape to stand each hook.

RULES

1. You must try to do all regular activities using your hooked hand. If you need help, use another hook (not your other hand) to complete the task wherever possible.
2. You must record observations from your interactions and create a display of information of the things that your hook interacted with.

MATERIALS

- 2 types of wooden hooks (one round, one square)- 1 hook per student
- 5-10 sheets of paper per student
- 1 rubber band per student

TOOLS

N/A

LEARNING OBJECTIVES

- To build awareness of the ways in which the world is designed for able-bodied humans
- To experience how having hands informs the design of everything.

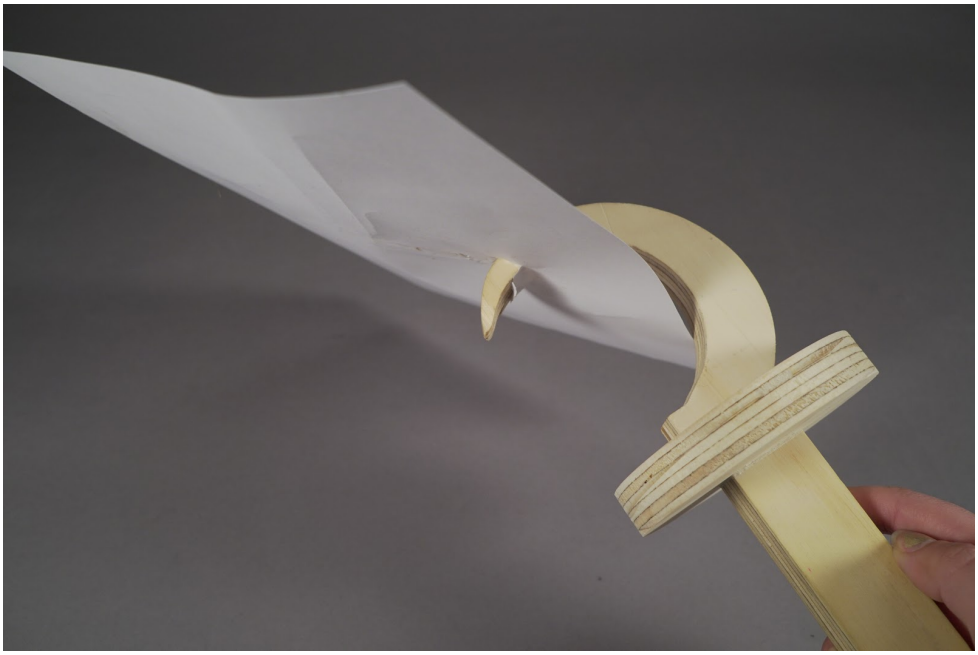
SKILL OBJECTIVES

- To identify and deconstruct handles in the real world.
- To conduct a test and collect real-world data.
- To display information in a readable and coherent way.

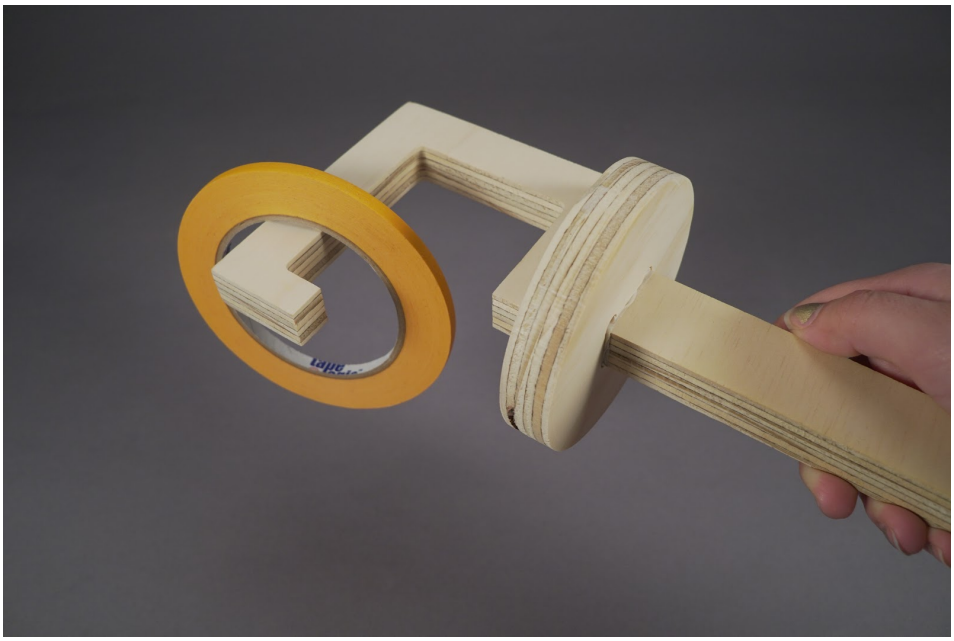
Reference Photos

Materials

Tools needed for exploration: one of two hooks (square or round), paper for their Field Guide, a writing instrument, and a rubber band for a makeshift writing adaptation.

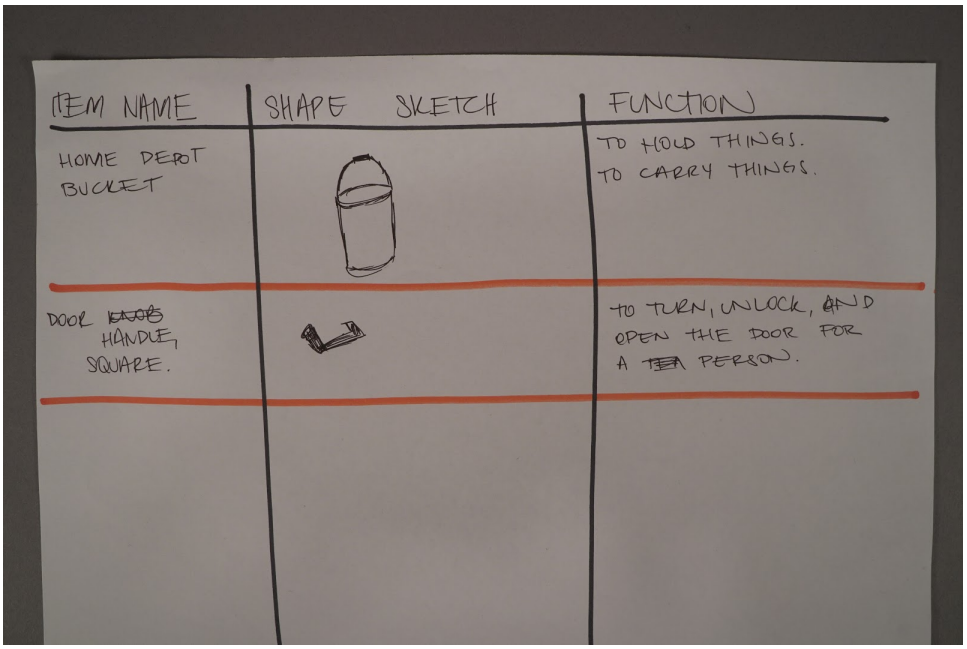


Example attempt of the round hook in picking up a sheet of paper by hooking through it in order to grab at it.



Example of the square hook picking up objects, in this case, a roll of tape that rests inside of the hook.

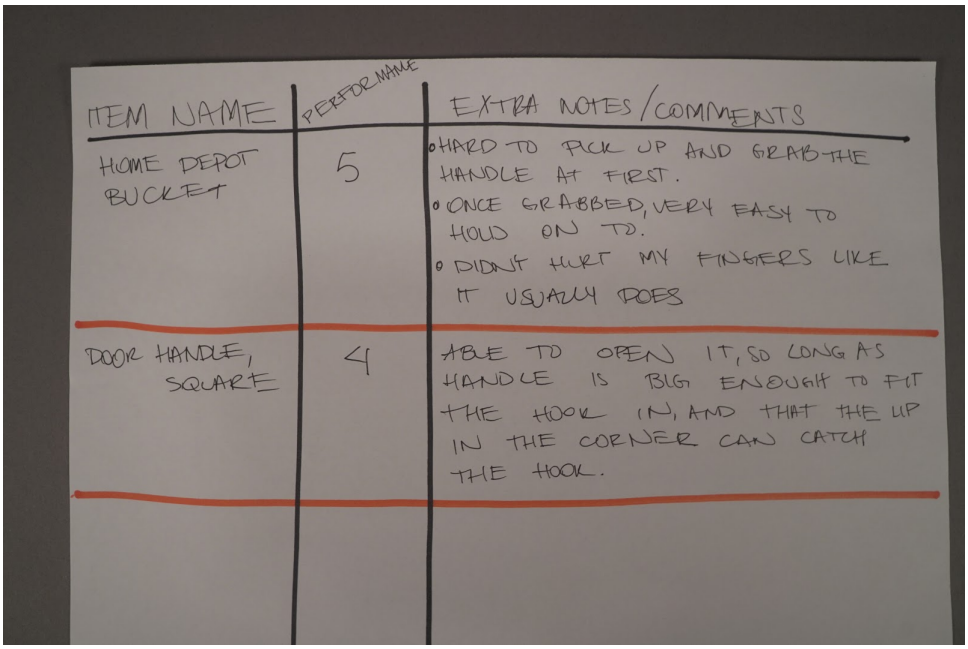
Example of the round hook finding a good fit: picking up a conical disposable coffee cup thanks to the tapering of its sides that give the hook something to grab onto.



ITEM NAME	SHAPE SKETCH	FUNCTION
HOME DEPOT BUCKET		TO HOLD THINGS. TO CARRY THINGS.
DOOR ~~KNOB~~ HANDLE, SQUARE.		TO TURN, UNLOCK, AND OPEN THE DOOR FOR A ~~TEA~~ PERSON.

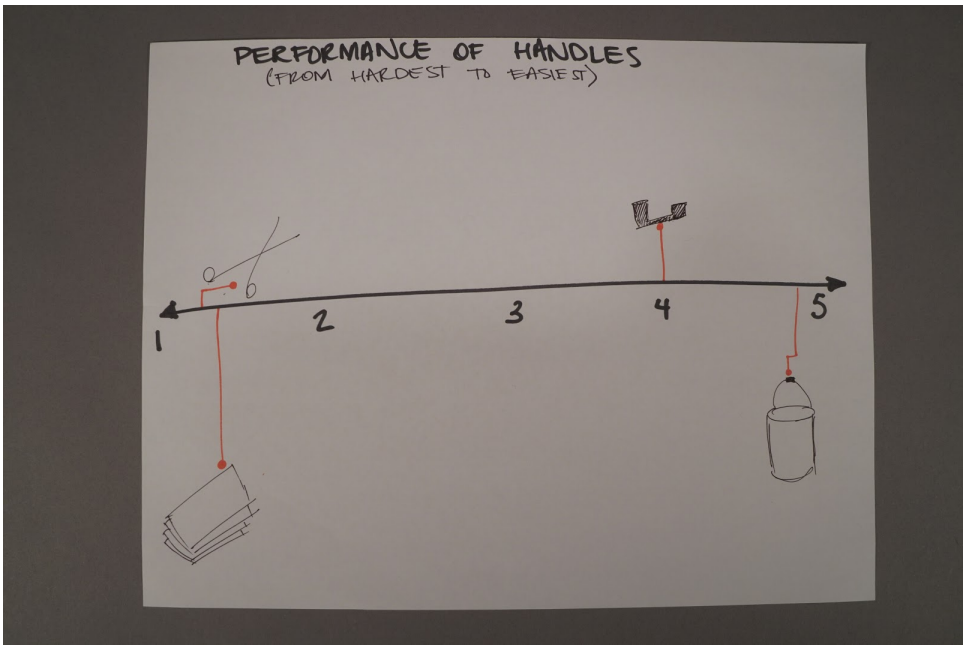
Field Guide, page 1 of 2

This sheet is used for recording notes on the performance of the hook as an appendage trying to interact with objects in the real world. This page records the Item Name, the Shape Sketch, and Function of the object being explored.



ITEM NAME	PERFORMANCE	EXTRA NOTES/COMMENTS
HOME DEPOT BUCKET	5	• HARD TO PICK UP AND GRAB THE HANDLE AT FIRST. • ONCE GRABBED, VERY EASY TO HOLD ON TO. • DIDN'T HURT MY FINGERS LIKE IT USUALLY DOES
DOOR HANDLE, SQUARE	4	ABLE TO OPEN IT, SO LONG AS HANDLE IS BIG ENOUGH TO FIT THE HOOK IN, AND THAT THE LIP IN THE CORNER CAN CATCH THE HOOK.

This sheet is used for recording notes on the performance of the hook as an appendage trying to interact with objects in the real world. This page records the Item Name, the Performance Rating, and Extra Notes or Comments about the object being explored.



Spectrum Chart

This example asks students to place the objects on a number line that represents their ease of use relative to other objects, creating a spectrum of difficulty of use.

Procedures

Hooks for Hands

Snapshot

- Give out one hook per student
- Explore doing activities with a hook inside the classroom
- De-brief initial experience and reactions
- Design a Field Guide to capture notes
- Explore the same activities with a hook inside the classroom
- De-brief to normalize the data
- Take the hook with you and explore living with the hook:
    - What can you do with just one hook (no extra hand) or with the help of a second person's hook?
    - What types of handles are there?
- Collect and display the data

Overarching questions that can help frame the discussions include:

- What is a handle?
- What are handles designed for?
- What could it be that makes hooks, the leading prosthetic in medicine today, designed the way they are?
- What makes it so hard to have a hook for a hand?
- What makes some data plots better than others?

Discuss and Explore

1. Set up the room as described, with items atop the pedestal.
2. Read the challenge paragraph to the group.

Teacher Tip: You are welcome to dive deeper into the narrative and encourage their world-building. Here are sayings that you may have learned from Captain Hook that you can teach the kids and use in the classroom: "Shiver me Timbers!" = When in shock or disbelief; "All hands hoay" = Everyone get on the deck (get back to work); "Avast ye" = Pay attention.

3. Discuss with the students to get them thinking:
    - Have the students take a few minutes to think/write to themselves:
        - What would happen if you had a hook for a hand? How do your interactions with the world change? What are you still able to do? What's more difficult? What's impossible?
        - Pick 3 typical activities in your day and predict if they would be harder/impossible, etc.
    - After a few minutes ask the students to share in their small groups:

        - Did anyone come up with anything that would be easier to do with a hook?
    - Have them share out loud with the rest of the class; press them for details:
        - What exactly about the task would be more challenging? (i.e. Holding the toothbrush in place while moving it back and forth? Not getting the hook wet while stirring your chocolate milk? Fitting your hook into your t-shirt sleeve?
4. Read the Rules (above) aloud to the class.
5. Explore this new appendage by having students use the hook to pick up objects around them, inside the classroom. Prompt the students:
    - Now, for the remainder of this class, you are Captain Hook. Any time that you would have used your dominant hand, you should use your hook.
    - As Captain Hook, if you had to go to school, what would you have to do? Before going off into the world and performing tasks with a hook, we will explore this idea here in the classroom by trying to use the things around you with your hook.
    - Before you begin, let's brainstorm: what are some of the things you can try to do right around your area?
        - Write something on paper
        - Open your book bag and take something out
        - Pick up papers and put them in a folder
        - Open a book and flip to a page
        - Tie your shoe
        - Drink some water
        - Push your chair in and out
    - Remember, you must try your hardest to complete the task by just using your hook. If you need help, ask for help from someone else's hook; don't use your non-dominant hand.
    - And remember- these hooks are for exploring a serious question. Do not let us catch you misusing the hook, or playing with it in an inappropriate way.
6. Give students 5-10 minutes to attempt some tasks. Debrief with the students:
    - Which items were harder to use?
    - Easiest to use? What about those items made them easy to use?
    - How does the shape of the hook influence how it can be used?
    - What are our hooks able to do that our hand can't and vice versa?
    - What do you call what your hand touches and uses to use the object or complete the task?
    - Did you ever wish you had more than one point of contact with the object?
    - Of everything you grabbed- are all these types of handles?
    - What did you miss about not being able to use your hand?
    - What surprised you about the experience/what was frustrating?

This is a good stopping point for the day.

Field Guide Preparation

7. Welcome the students by informing them that they will be expanding their exploration of what it means to be Captain Hook:

- Today we're going to expand our exploration of what it means to have a hook for a hand. For the next 24 hours until we meet again, you are Captain Hook, everywhere— in this classroom, in your next classes, at home, and wherever. Any time that you would have used your dominant hand, you should use your hook.

Teacher's Note: Make sure to talk to other teachers in your school in an effort to get them to tolerate the students using a hook for a hand in their class, too. The follow-through and consistency of carrying the project through to every class will help with their engagement, consistency, and with the legitimacy of the project. Mention to the students that try as they must to use only the hook, if their hook impedes their learning in their other classes, or other essential functions like going to the bathroom, they should use common sense to put down the hook and do what they need to do.

8. Explain that every exploration needs an accompanying Field Guide to take notes in. See the Referenced Materials for an example of these worksheets.
9. Prime the students:
    - Now, we're going to make a Field Guide— every exploration needs an accompanying Field Guide to take notes in. This field guide will help you record data, a place for your observations, so you can later display this data and compare it with your classmates' data later. This data will help inform you of what tasks were harder than others, and this will help you make a recommendation to Captain Hook of what jobs he might be able to work in with his hook.
    - Now, from this moment until tomorrow's class, you are Captain Hook— in this classroom, in your next classes, at home, and wherever. Any time that you would have used your dominant hand, you should use your hook. So, if you have to write some things down, you are going to have to attach your pen or pencil to your hook.
    - Let's start. Use your rubber band to attach a pen or pencil to your hook.
10. Ask students to think of what kinds of things they would record during their exploration. After a chance to think, guide them:
    - Tell the students to make columns on their paper with the following headers. Ask them to consider the spacing they should leave in each column to fill it out.

        - Item Name
        - Shape Sketch
        - Function
        - Performance
            - Objects that are easier to use with the hook
            - Objects that are harder to use with the hook
            - Objects that work with the hook but are unnecessary.
        - Comments
            - Did you use your non-dominant hand?
            - Did anything stand out?
            - Anything else worth remembering?
    - Pause to reflect on their first writing experience
        - How much longer did that take?
        - How much harder was that?
        - Is your handwriting with your hook more or less legible than your usual handwriting?
    - Go through each column and elaborate on how they should be used. Ask them:
        - What details are important in a shape sketch? (Form of the object)
        - What details are important in Function?
        - How can you rate the performance of each handle? How can you accommodate all the objects that are in between one category and the next?
            - Get students to understand the value in a scale rating system. For example, you could use the following:
                a. 1 is for objects that are easier to use with the hook
                b. 3 is for objects that are just the same with the hook as with the hand
                c. 5 is for objects that are harder to use with the hook than with the hand
                d. 2 and 4 are for objects that are right in the middle of two categories.

Teacher Tip: We want to give the students a benchmark for rating the performance of their hook with each handle. Talk with them about setting a minimum mark, a maximum mark, and a reference in between. A minimum performance mark can be something that is impossible to handle with the hook, such as paper, and receive a 1. A maximum performance mark can be something that is just as easy to handle with the hook as it is with your hand, such as a bucket, and receive a 5.

Data Collection and Analysis

11. Have a conversation with the students around the importance of normalizing data:

- Remember the arc of our work: We're going to experience the world as a person with a hook for a hand, we'll record our experience by rating the difficulty from 1-5, we'll compare to our peers' findings and then we'll make a recommendation to Captain Hook for what kinds of tasks he might pursue in his new job.
- When it's time to compare our 1-5 ratings with our peers' ratings, what could go wrong? What happens if the same experience of pushing a chair in is rated a 1 for one person and a 5 for another? Will we be able to compare across the rating? How are ratings a personal, relative, and subjective reporting of data?
- Today, we'll attempt to normalize the data you will collect by doing converging on an agreed upon rating for similar experiences. Using your field guide, you will repeat the classroom exercises you've already completed and practice rating them between a 1 and a 5. Then, we will come together and try to agree on similar rating systems.

12. Prompt the students to explore the classroom the same way they did the day before.
    - Let's brainstorm, again: what are some of the things you can try to do right around your area?
        - Write something on paper
        - Open your book bag and take something out
        - Pick up papers and put them in a folder
        - Open a book and flip to a page
        - Tie your shoe
        - Drink some water
        - Push your chair in and out
    - Remember, you must try your hardest to complete the task by just using your hook. If you need help, ask for help from someone else's hook; don't use your non-dominant hand.
    - Sit back down at your chair when you've recorded and rated 5 different actions.
13. Make a table on the board with space for 5 different activities and their ratings from 1 to 5. Tally the number of students that rated each activity a 1,2,3,4 and 5. Have conversation with the outliers— if the majority rated pushing in a char a 4 or 5, but there are a few 1's, have a conversation about what made that activity so hard for them and try for the majority group to convince them of meeting them on that majority rating. Do this for all 5 activities to normalize the data you'll be getting.
14. Prompt the student go out in the world and make their tests and observations. Let the students take home their hook and charge them with recording observations throughout their journey from school to home, and then at home.

- Now you are ready to go be explorers in the real world.
- Remember, you must try your hardest to complete the task by just using your hook. If you need help, ask for help from someone else's hook; don't use your non-dominant hand. (but, please, use common sense).
- Your goal is to record at least 30 interactions before next class.
- Your challenge is to:
  - **Find something that is made easier by using your hook. Remember- we're trying to find make recommendations for the kinds of things we can do in a new job.**
- What are some of the things you might have to do when you get up from your seat? (To do these things, they can remove their pen/pencil from their hook.)
  - Open a book
  - Write something down
  - Put your things away in your bookbag
  - Push in your chair
  - Open a door
  - Open your locker
  - Eat your lunch
  - Get in the car
  - Put your seatbelt on, etc.

This is a good stopping point for the day. The students should start the next class with their data collected from their exploration.

15. Analyze the Data. When the students come back with their observations, have them sort their items into 5 lists:
    - Each a list of items that were ranked on a difficulty level of 1, 2, 3, 4,and 5.
16. Have students circle 3 tasks that surprised them. Share out with the rest of the class.
17. Display the Data. Ask students to make a Spectrum Chart, as referenced above. Introduce how to use the chart and then, with the students, decide what would make good labels for the axes of the chart. Ask them:
    - What kind of information would it be useful to see when making a decision of where to work or what to do for the rest of Captain Hook's life?
    - What kind of things could you chart to make that be portrayed in your chart?
18. Have the students populate the table. Challenge them to be as visual, not verbal, as possible. As they make decisions of what to display, have them write down all the list of assumptions they make.

Teacher Tip: Students can make charts with all kinds of categories. To organize their data and see what stands out to them, have them make intermediate lists of objects and their attributes, first. Then, with this list, they'll have a starting point to make an even more clear display of information. An example of some assumptions students might make are: the handle of a speaker is not part of a speaker, therefore it is part of the interface to the object; a cup is an interface to coffee; but a backpack is the object being handled, not the paper inside; etc. All reasonable assumptions are allowed, they should just be recognized and noted.

19. Discuss the emerging charts once the students are done populating them.
    - Tape the student graphs around the classroom and have a walk around tour. You can give each student 2-3 colored stickers for them to put on items that they would like to discuss. (If time doesn't allow, just trade charts with a partner at your table.)
    - Prompt the students that after some walking around, they will have to answer some questions based on their observations:
        - What stood out to you?
        - Were there any ratings that you strongly agree with or disagree with?
            - Ask the author to defend the rating they gave that experience.
        - Where do these all differ and where are they the same?
        - What could account for their differences?
        - What kind of information can a person get from just viewing these charts?
        - What else could you have recorded during your explorations?
        - So, what recommendations would you make for where Captain Hook would be able to strive with his hook for a hand?
            - What evidence (in your data charts) can you use to back that up?

Final Reflection

20. Have students take out a piece of paper and first write down their thoughts individually. Select some of these questions to write on the board for them to respond to:
    - What did you learn makes a handle ideal, or ergonomic for human use? For hook use?
        - How did that help you create categories for the different types of handles?
    - What are characteristics of a good display chart?
    - What is one takeaway...
        - from this project in regards to people's abilities and motions?
        - About the power of data representation and observation?

21. Take turns sharing a few selected responses within groups.

Break-Outs/Extensions

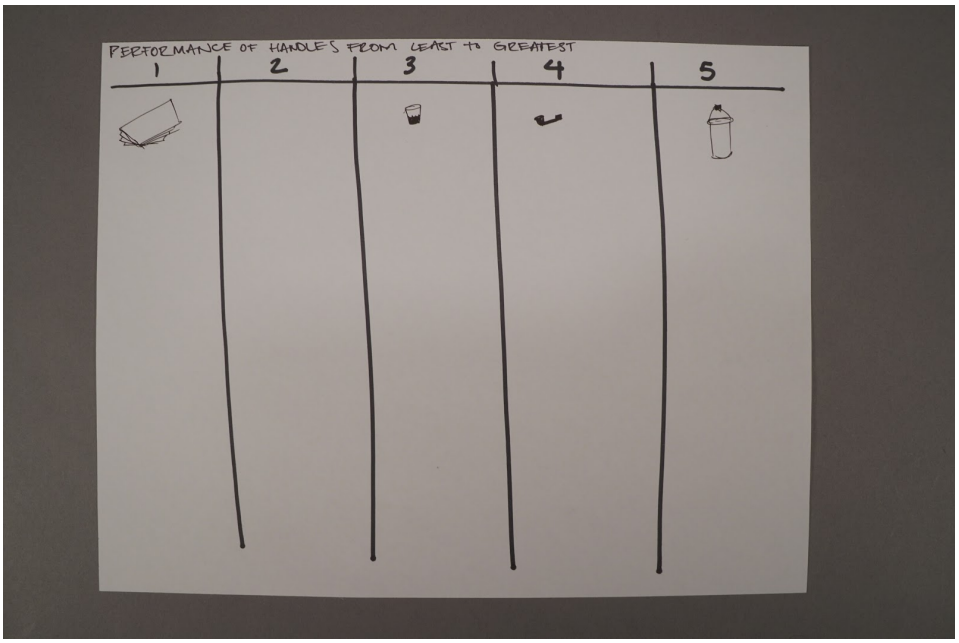
Use these activities to extend the project or increase the challenge.

Connecting Concepts
The following are concepts inherent to this lesson. Have the students write down the most interesting thing they learned or any lingering questions they still have about each concept as relates to each concept:

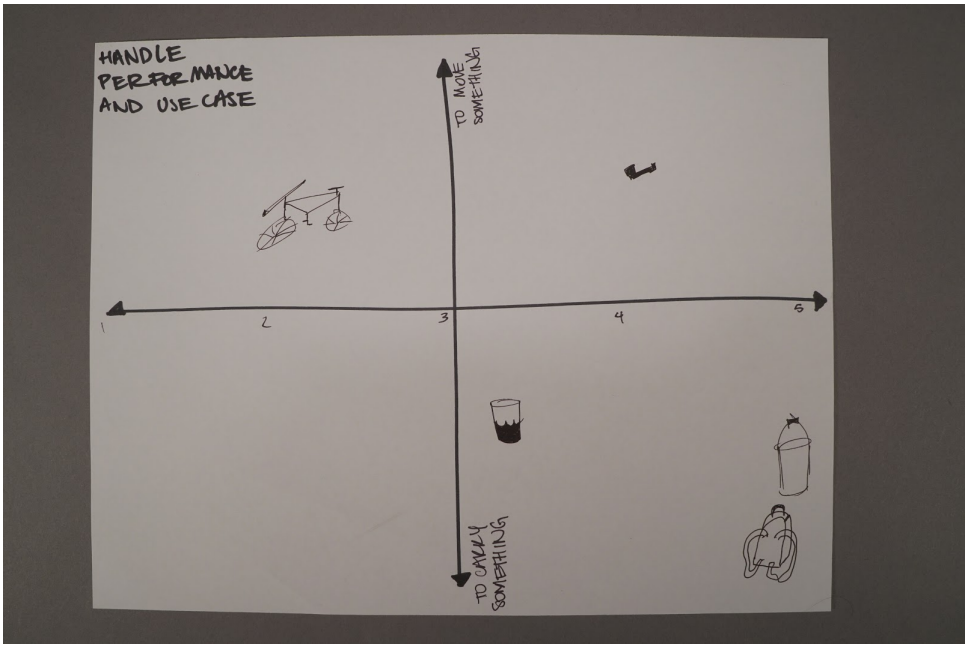
- Design
    - Purpose, planning, or intention that exists or is thought to exist behind an action, fact, or material object.
- Handles
    - An interface for your hand to manipulate, hold, carry, or control an object.
- Ergonomics
    - The study of how objects are designed for maximum comfort during use; an object is more or less ergonomic depending on how well it has been designed to fit for use with the human body.
- Data collection
    - The process of acquiring and recording data in a way that will make it useful for future attempts at communicating or portraying information related to that data. Certain practices have been developed that can make data collection more or less fruitful.

Building a hand out of Lego
(https://www.greatbigstory.com/stories/building-diy-prosthesis-from-lego?playall=1680)
This is a video from Great Big Story that tells of David Aguilar, an 18-year old that made a prosthetic out of Lego.

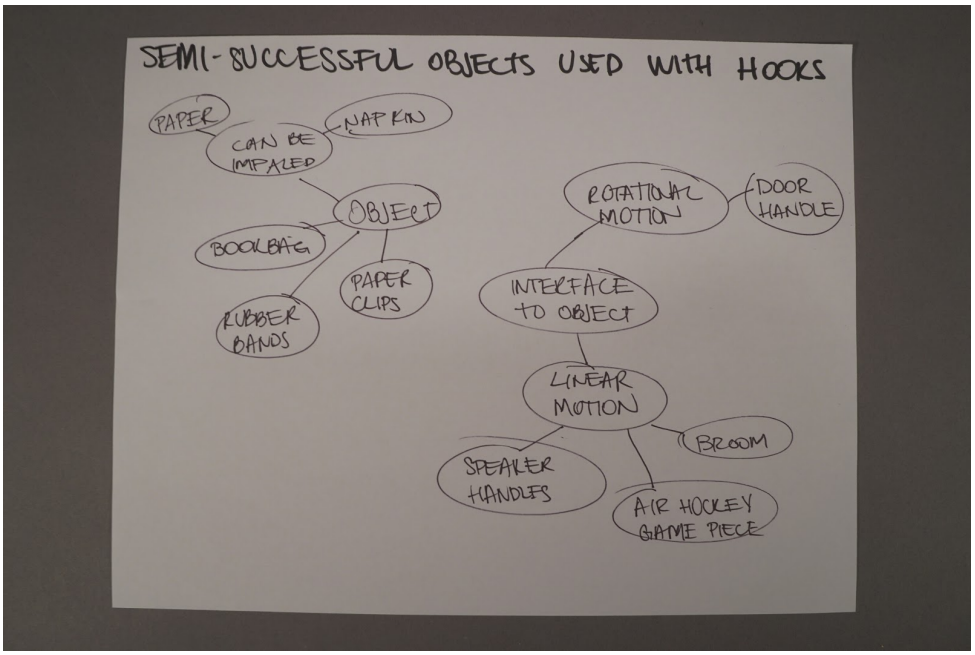
Data Display
Challenge your students to use other data display methods to portray information about their exploration. What extra information can be shown through different displays (tables, webs, scatter plots) and what information is compromised? What does it mean to be as visual as possible rather than verbal? Below are examples of some types of data visualizations.



Example data table listing the different objects by their performance. This is one of the simplest forms to display this data.



Example two-axes spectrum chart mapping the performance of the objects against a second piece of information, in this case, their function- whether to carry something or to move something.



Example web plot displaying hierarchies of categorizations for the types of objects the hook interfaced with.

Comments

Use this space to provide feedback and comment on this lesson

S+P — Hook Adaptation

AN EXPLORATION OF EGGS AND EXTREMITIES

CHALLENGE

It's breakfast time!
Thanks to your suggestion, Captain Hook is waiting to hear back for a job offer.
After spending so much time on land, Captain Hook has taken a liking to fancy meals, like fried eggs in the morning. But, he's learning how hard it is to enjoy a meal with his hook so he's asking for your help.

We will help Captain Hook by building him a prosthetic to help him season his eggs. This hook adaptation that you build him must be able to grab, pick-up, and shake the Salt and Pepper shakers over his eggs, without using an extra hand.

STAGING

- Arrange tables in groups of about 4 students.
- At each group's table: Lay a mat down to position the Salt and Pepper shakers (located ~ 8" apart) and the plate with cardboard eggs on them.
- On the pedestal: Place one of each hook. If possible, use rolled up tape to stand each hook.

RULES

- You must pick up the salt shaker, shake it 2 times over the eggs, and put it back down.
- You must pick up the pepper shaker, shake it 3 times over the eggs, and put it back down.
- You may only use your hook with adaptations, without your extra hand, to complete this challenge.
- Your adaptations may not be permanent to the hooks. They must be removable.
- If you drop your salt and pepper shakers, you must pick them up with your hook.
- You must time your trials and be able to compare across multiple adaptation designs.

MATERIALS

Per student:

- Cardboard, 2- 1'x1' sheets
- Cardstock, 2- 8.5"x11" sheets
- Paper, 2- 8.5"x11" sheets
- Rubber Bands, 5

TOOLS

- Hot Glue
- X-Acto Knife
- Cardboard Cutter
- Ruler

On each table of 4:

- Mat with marks to position props
- Salt and Pepper Shakers
- Cardboard eggs
- Plate for the eggs

LEARNING OBJECTIVES

- To defend design decisions around the properties of the materials.
- To predict the success of a design based on its features.
- To conduct consistent timed tests.
- To identify ways to include a control in a

SKILL OBJECTIVES

- To choose materials based on their properties matching design needs.
- To design and build tools for a multi-purpose challenge (grab, pick-up, shake).
- To create a data table and a display of

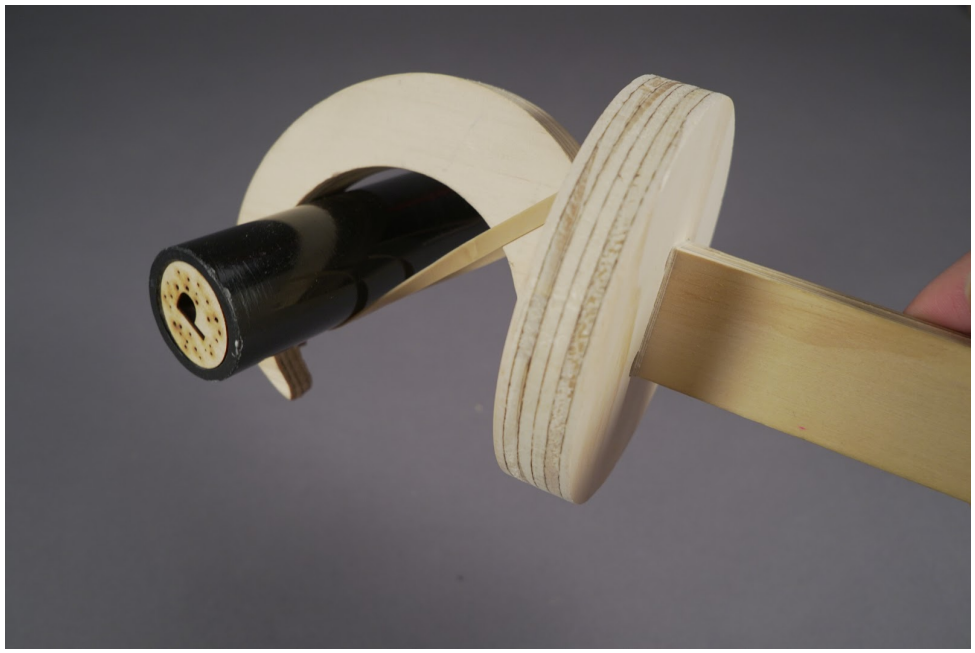
test.	information.

Reference Photos

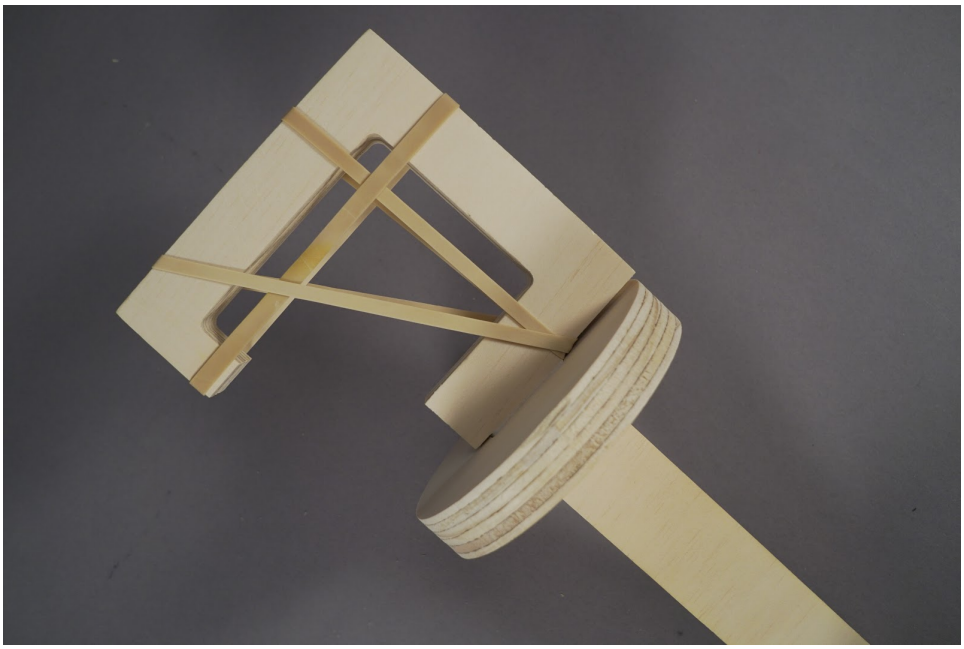
Materials & Tools

All Materials and Tools needed to make hook adaptations: cardboard, paper, cardstock, one of each hook, Salt and Pepper shakers, eggs on a plate, a place mat, rubber bands, cardboard cutter, X-acto knife, ruler, and a hot glue gun.

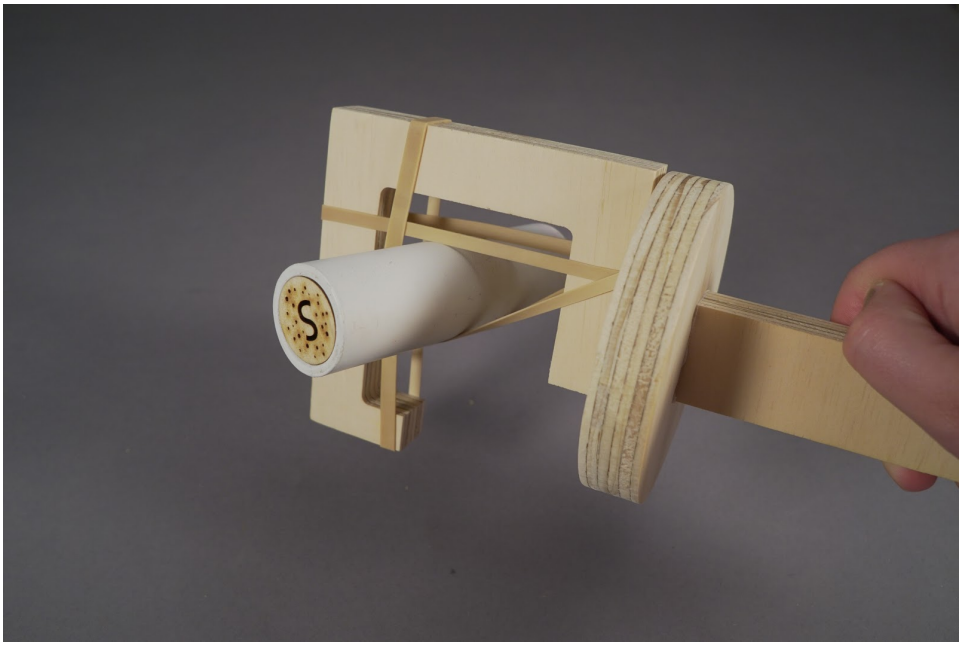
Example 1- A round hook adaptation where the rubber band is stretched to create a pocket the size of the Pepper shaker.



Example 1 being used in action.

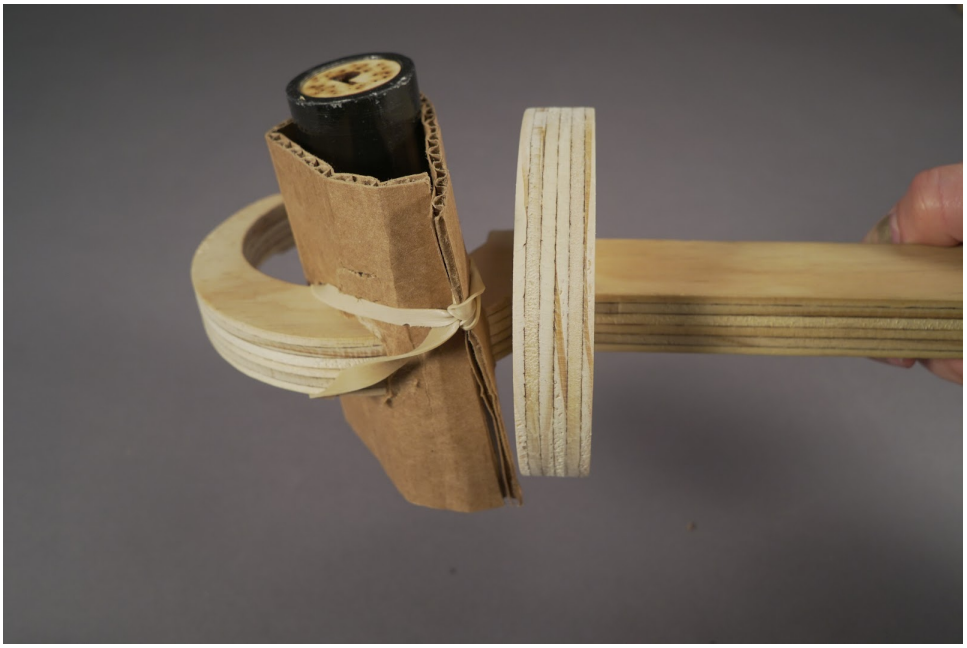


Example 2- A square hook adaptation made by stretching rubber bands to triangulate a space where the Salt shaker fits nearly perfectly.



Example 2 used in action.

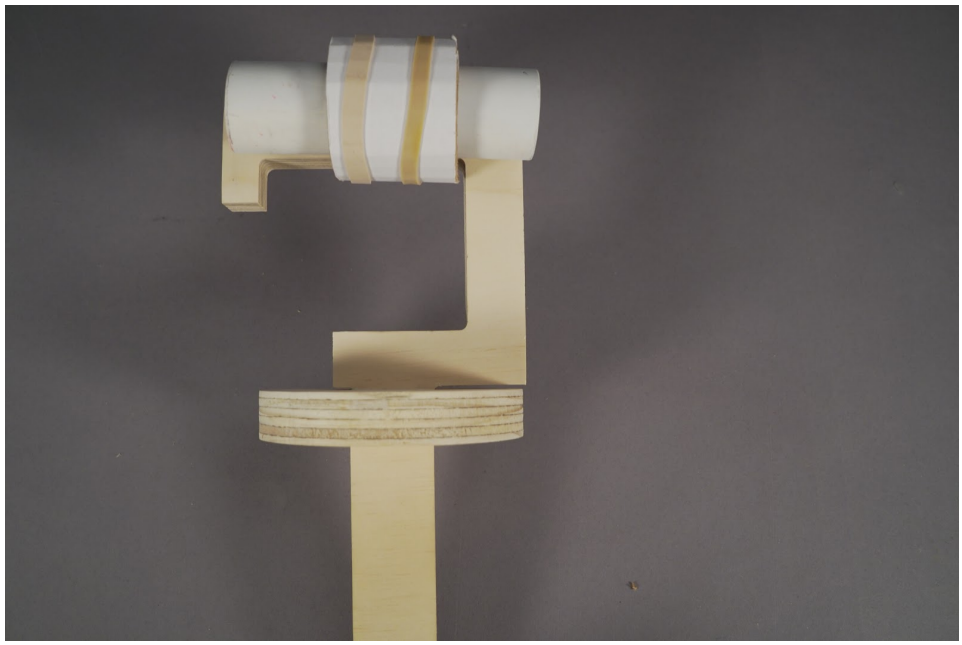
Example 3- Cardboard is used to make a catch that hugs the Pepper shaker into its opening.



A side view of Example 3.

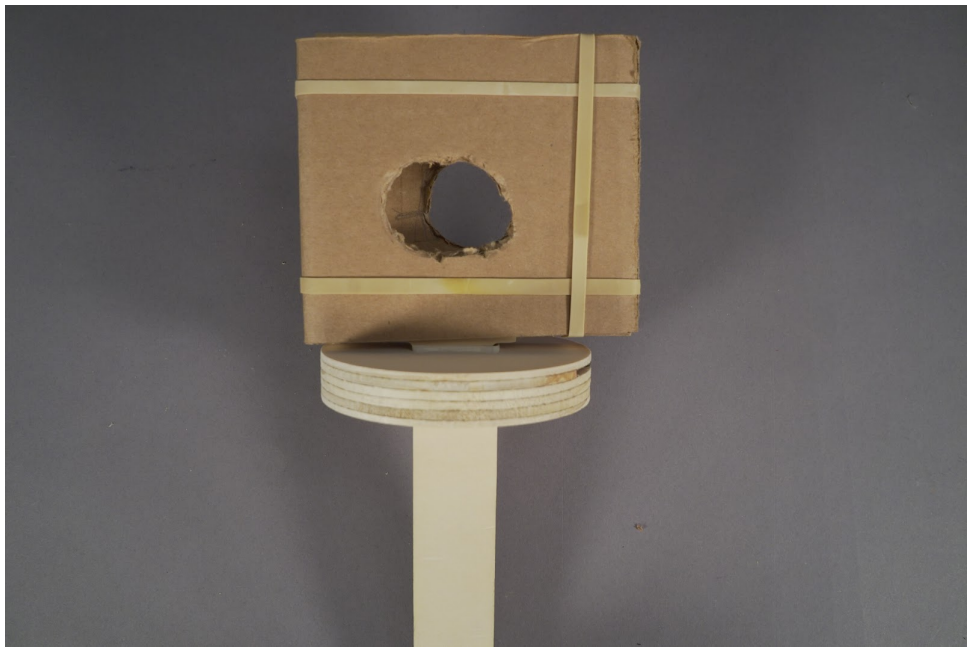
Example 4- An opening is designed to grip the salt shaker in the middle of the cardboard slab.

Example 4 placed on its side, with the frayed flexured circle (cut to flex around the object) seen grabbing the salt shaker.

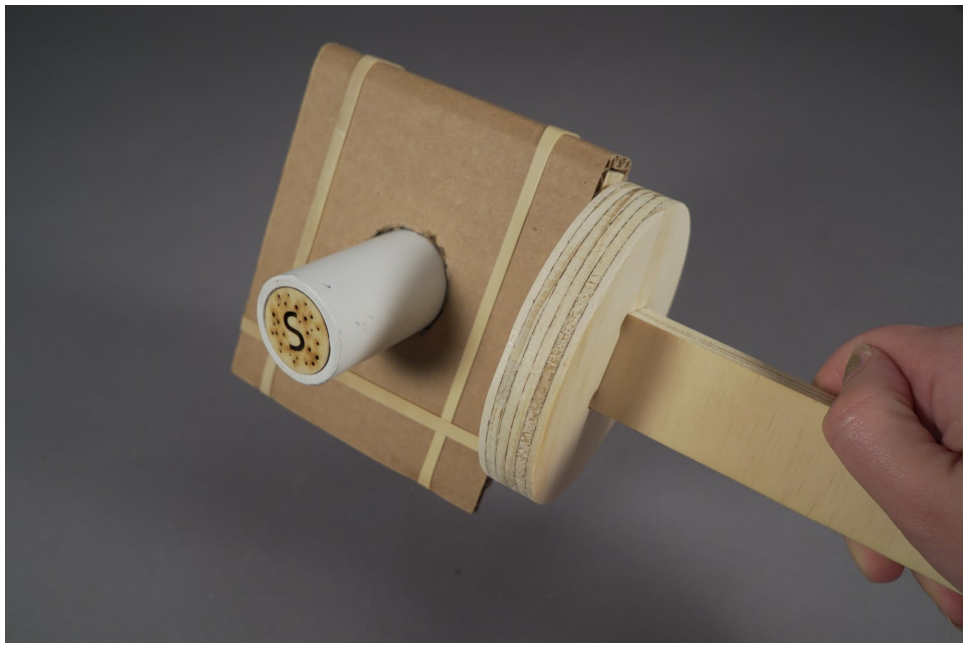


Example 5- A rolled up piece of cardboard creates a spring-loaded catch for the Salt shaker to fit into.

Example 5 caught mid-action.



Example 6- Two circles are placed off-center to accommodate the salt shaker as it enters at a diagonal.



Example 6 being used mid-action.

Procedures

Hook Adaptation: Mating a Hook with a Shaker

In this procedure, students will build adaptations to go on their wooden hooks that will help them in picking up the salt and pepper shakers in order to season their eggs. They will critique each other's designs and discuss the strengths and weaknesses of each. They will take timed trials of their design to determine a reliable estimate of their design's performance.

1. Setup the room as described above.
2. Read the challenge to the students. Provoke them:
    a. How will you know if your solution is better than his current solution of just a bare hook?
        i. (Get them to want a point of comparison from which they can measure improvement. Get them to see the need for timing the trials before and after the hook adaptation.)
3. Deliver the rules.
4. Select a student at random and have that student repeat the challenge to you.
    a. "You are allowed two clarifying questions."
    b. Answer their two questions.
    c. Ask students to define as a group the vocab from the challenge such as "adaptation" and "prosthetic".
    d. Talk about the concept of having a tool, a task, and an adaptation for that tool to complete the task. Where else does this happen? (drill bits for a drill, tires changed on your bike or car, cell phone cases for water diving, GoPro cases, etc.)
5. Explain to the students that every test needs a control in order to have a base for comparison. Since they will be testing their design solutions and conducting timed trials of their shaking procedure, they will need a control trial, first. Prompt the class on what a good control might be.

Teacher Tip: A good control is something that sets the base for what is being measured. In this case, we need to know how long it takes to season the eggs (salt twice, pepper three times) before the hook is altered in any way. Two timed trials should be taken: seasoning the eggs just with their hands, then season the eggs with the hook alone (no adaptation).

6. Have the students take turns conducting their two control trials at their tables. Prompt them:

    a. Each student should make a table to record their findings.
        i. What are some things the table should say to record these findings ?
    b. Every student should complete a timed trial of both controls: using their hands, and using just the hook (when it's too hard or impossible to do with the hook, end the test and record the time you stopped trying (i.e. "Incomplete after 3:00")).
    c. Choose a student to be the timer.
    d. How many times should you repeat a test to have certainty in your results? Three to four students, or 3-4 trials, is about right.
7. Share amongst each other:
    a. How long did each table take to complete the challenge? What calculation can you do to report one number that represents the entire table's performance?
        i. Have students calculate the average of their trials. For any hook trials that were impossible or incomplete, these would be N/A and not be averaged, just noted.
8. Prepare for designing the hook adaptations. With the class, discuss the hook and its design opportunities:
    a. What are the basic needs of this hook adaptation? What does it need to do? (what did you have trouble with during your control tests?)
        i. Grip the shaker.
        ii. Pick up and put down the shaker.
        iii. Shake the shaker.
        iv. Release the shaker.
    b. What are some things in the world that grip?
        i. If they need inspiration: construction claws, binder clips, velcro (small hooks going into small loops), paper clips, drawstring bags).
    c. What are some factors to a successful gripping mechanism?
        i. Grip strength, material strength, gripper surface texture for friction, ability to engage and disengage, load-bearing capacity, etc.
    d. What are the different parts of the hook? How might they be used in making an adaptation?
        i. Piercing point on hook, base shield, thickness in the hook, tapering, right angles, etc.
    e. What is the hook already good at? What have we learned from our explorations that it can do well?
    f. How can you use our classroom materials to make something inspired by the real world?

Design & Critique

Teacher Tip: If students do not have familiarity with working with cardboard, a few basics should be covered, for instance: using the grain direction for maximum rigidity, scoring the cardboard to make it curved, cutting in two depths of cut, and the variety of ways to make cardboard attachments. You might have to cover other tips and techniques for using the other tools, too (i.e. the X-Acto knife, the Canary Cardboard Cutter, the dremel saw, etc.).

9. Have the students prepare to make their designs.
    a. Pick a design that you're going to pursue for your hook adaptation. Then, turn to a partner and describe to them your design and why you chose it. Take turns asking each other clarifying questions on the design and how you'll make it. This will help you think through making your design come to life. Then, you may begin making your hook adaptation.
10. Let the students begin to work on their hook adaptations. As you go around, some prompting questions may include:
    a. What is the main function of your design? What makes it work? Tension in holding the shaker in place? A tapered form that press fits?
    b. What does your design depend on for success? The size of the enclosure to be exact? The cardboard's grain aligning for structure? A quick, agile manipulation of the hook?
    c. What would you predict might be some failure points?

Teacher Tip: If students are struggling, you can show them the Referenced Solutions provided above and have them build off of them. Even copying the solution will still result in their understanding of how the design was made, and therefore, why it works.

11. Once the students have made significant progress on their designs, pause for an all-class discussion. Select a few student works and model a design critique:
    a. How are these solutions similar?
    b. How are these solutions different?
    c. In what ways do the materials used inform the function of the design?
    d. How does the approach of the student inform the design of the adaptation?
    e. What does it remind you of? Where else have you seen something work like this in the world?
    f. Where are the expected failure points for the design? How might those be improved upon?

Testing

12. Once the students are done with their solutions, move them towards conducting timed trials of their designs.
    a. Discuss with the students:

        i. What columns headers should you have on your data table? (Person conducting test, design being tested, time to complete, trial number)
        ii. How many trials do you need to conduct in order to be confident in your prediction?
        iii. How many people do you need to conduct each trial?
        iv. What do you expect? Which solutions do you think will do best? Why?
    b. Conduct the trials and have students record their data in a data table.
    c. Compare results amongst students:
        i. Who has the design with the shortest timed trial?
        ii. How far apart are the results?
        iii. What parts of the design accounts for the biggest differences?
        iv. Are any solutions as enabling as a human hand? (is the timed trial near what it was to the bare, human hand?)
        v. Can the data inform any general trends of successful designs?
        vi. What are the failure points of the designs? (wear and tear, getting it wet, rubber band might loosen off, etc.)

Final Discussion

13. Discuss details of the work with the students to wrap up their design exercise. Let the students jump in and participate in the full-group discussion.
    a. What was your process in designing and making your adaptation?
        i. How did you decide upon this process? (defend your choices)
    b. If you could do it again, would you change anything about your process?
    c. If you had more time, what would you do next?
    d. If you could have other materials, what would you have liked to have? What would you make out of different materials?
    e. In what ways did the testing and trials inform changes to your design?
    f. What other features or functionalities would you want in a gripping mechanism that picks up a shaker?
        i. Hint: Would it be advantageous to have two separate entities come together?
    g. As a united product design firm— what's the best prosthetic design we can make for Captain Hook?

Break-Outs/Extensions

Use these activities to extend the project or increase the challenge.

Function + Form

In this challenge, we move past the basic function of using the salt and pepper shaker, into the form of the product. We consider how the design of the hook adaptation would hold up in other use cases, like being carried around, having to fit in a pocket, or being banged around. We can also consider an aesthetic angle: is this something that you want to be proud of? How might this make Captain Hook feel? Is it worth to take to a formal brunch at the Langham Hotel, for example?

Have students render various form factors for their hook, understanding that it might require a change in their function design, too.

Comments

Use this space to provide feedback and comment on this lesson

S+P— More Than Just Sticks

AN EXPLORATION OF PINCHING AND GIANT CHOPSTICKS

NARRATIVE

The alien looked human. Two legs, a torso, a head, and two arms. But the arms were long and straight and very thin and, where hands would be, there was only two holes at the end of the arm.
He was moving towards me. I was frozen in fear. Did he want me or....my cup of coffee?
Finally, we talked.
I learned that these aliens did, in fact, come in peace. They were on their way to the Andromeda Galaxy when their space ship broke and they just needed to make a pit stop where they could fix their ship. So, I invited them to stay for a few days while they make adjustments and go on their way.
I noticed their long stick arms again and wondered— how hard will it be for these new friends to live on this earth with these long sticks as hands? Then I realized, you might be able to help.

Today, I enlist help from you, a highly skilled intergalactic product design firm. Lucky for you, you have a license to practice on clients from all across our galaxy.

In order to help our new friends, you need to better understand them by performing common Earthly tasks with their alien limbs and see how well they fare.

STAGING

- Arrange tables in groups of about four students, though students will work in teams of two.
- Pass out two dowels per team of two students.
- Place a rubber band next to each pair of dowels.
- Set a pair of dowels on the pedestal.

RULES

You will explore the possibilities of your pair of dowels by attempting regular tasks with these dowels as hands.

1. Hold your dowels at their halfway point.
2. Try to do everything regularly possible but with your dowels as hands.
3. You can only use your dowels or another person's dowels to help you with any task.
4. Record observations from your interactions and analyze your data in a presentable way by locating each in one of three buckets: tasks for which dowels are better than hand, worse than hand, and work but are unnecessary.

MATERIALS

Per team of 2 students:

- 2 wooden dowels, ¾" thick, 2' long
- 5-10 sheets of paper,
- 1 writing instrument
- 1 rubber band per team

TOOLS

N/A

LEARNING OBJECTIVES

- To create further awareness of the ways in

SKILL OBJECTIVES

- To be able to identify and deconstruct

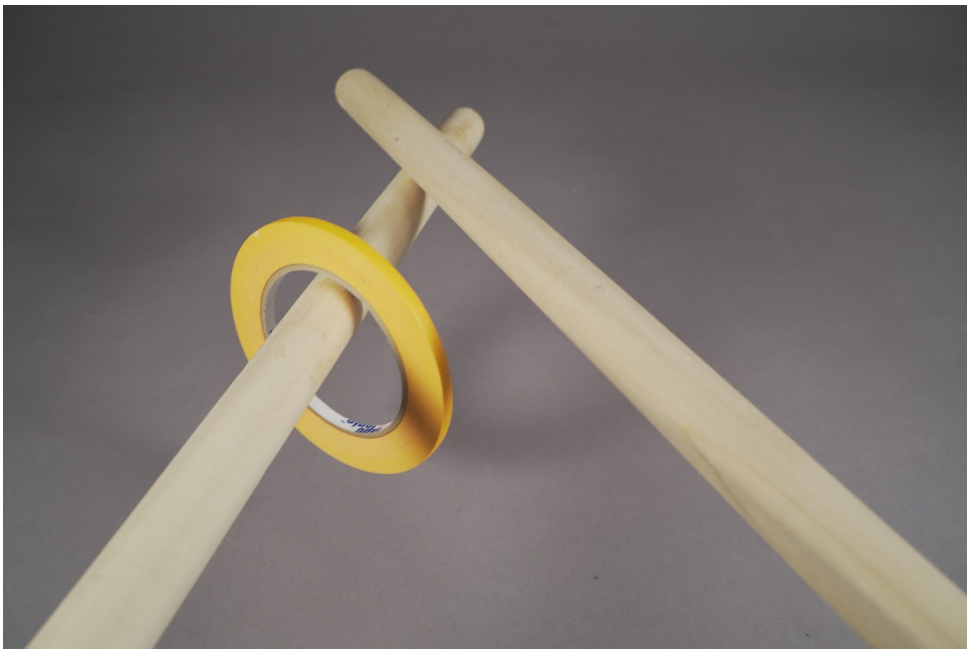
which the world is designed for human appendages and not prosthetics. • To develop an appreciation for what adding a pinch function opens up in terms of skills.	handles in the real world. • To be able to deconstruct and tell the functional difference between hooks and dowels. • To collect real-world data and conduct a test.

Reference Photos

Materials

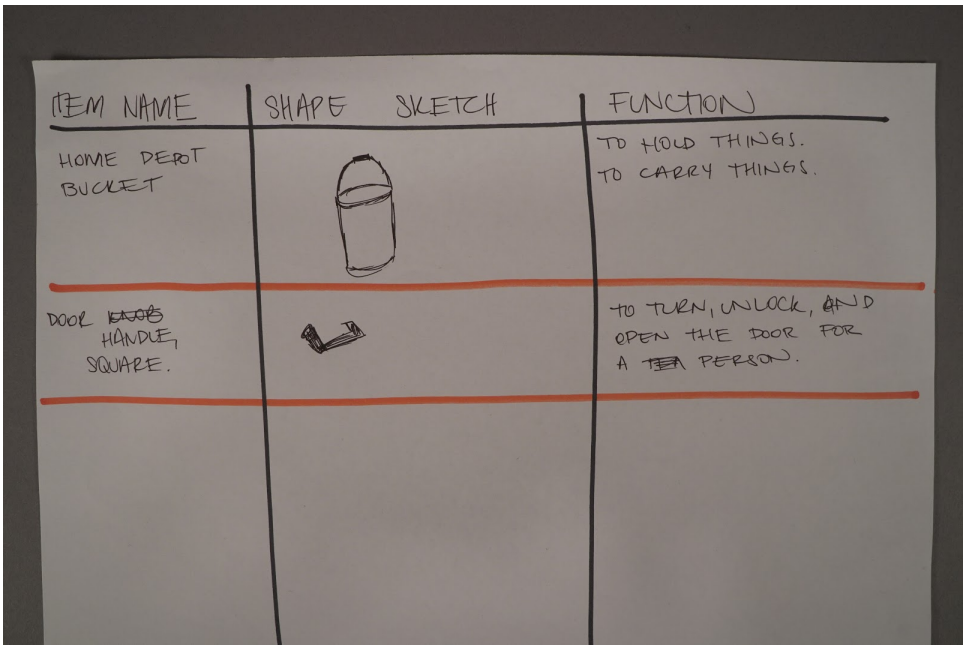
All tools necessary for conducting their explorations: Paper for their Field Guide, a writing instrument, and dowels as appendages.

The dowels attempt to pick up a sheet of paper and are fairly successful, even if they might not be able to do this to a stack of paper.



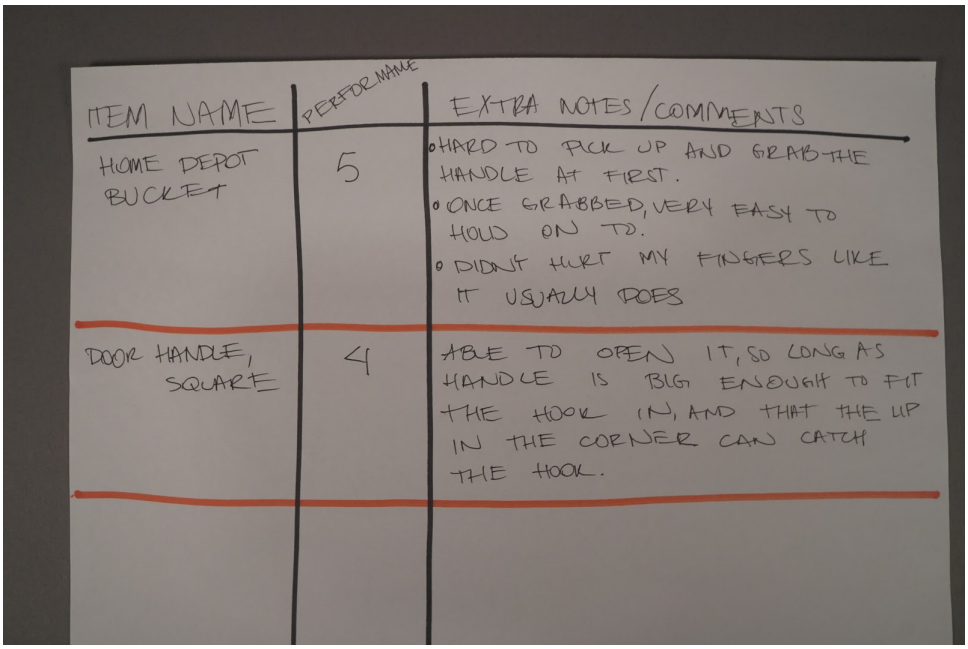
Example of dowels trying to pick up classroom supplies near the students, in this case, a roll of tape. In this case, for example, it should be noted in their Field Guide that an edge off a table is needed in order to get a grab on the tape.

Example of dowels trying to pick up a disposable coffee cup. While the pick-up strategy works for this motion thanks the lip of the cup, the hold is not strong enough to tilt the cup and drink out of it.



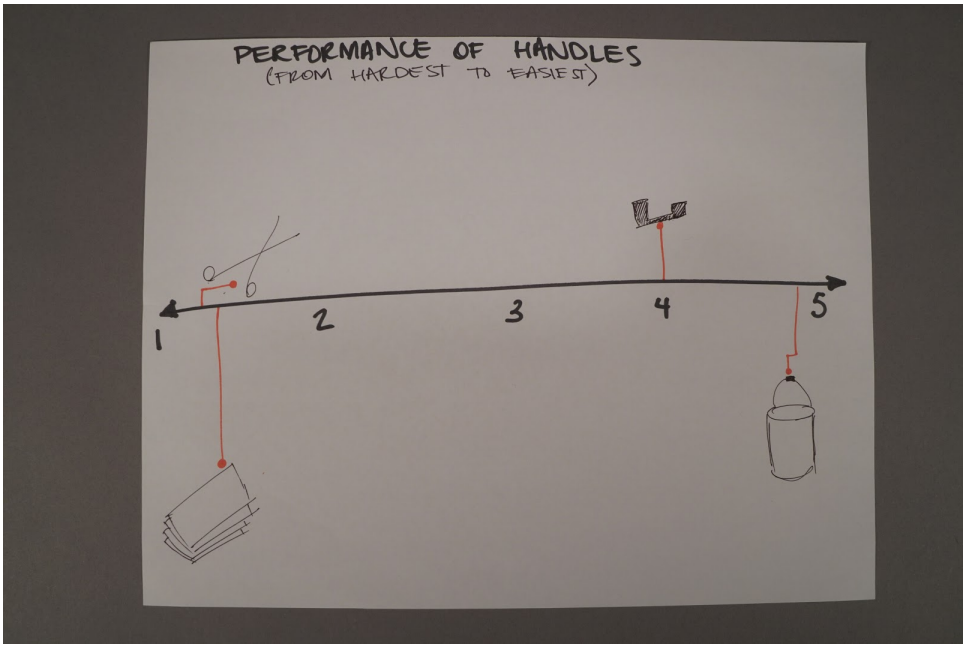
Field Guide, page 1 of 2

This is used for recording notes on the performance of the dowels as appendages trying to interact with objects in the real world. This page records the Item Name, the Shape Sketch, and Function of the object being explored.



Field Guide, page 2 of 2

This is used for recording notes on the performance of the dowels as appendages trying to interact with objects in the real world. This page records the Item Name, the Performance Rating, and Extra Notes or Comments about the object being explored.



Spectrum Chart

This example asks students to place the objects in a location that represents their ease of use relative to other objects, creating a spectrum of difficulty of use.

Procedures

More Than Just Sticks

In this challenge, students will test how their dowels work as hands in the real world. They will gather data and analyze it by creating a data table of the performance of different types of handles they interact with.
Overarching questions that can help frame the discussions include:

- What is a handle?
- What is tricky about the dowels?
- How are dowels similar to human arms and hands?
- What is the biggest difference between the dowels and the hook? If you had to choose just one, which do you want? What are the benefits of having two dowels over having one hook?

Discuss and Plan

1. Set up the room as described, with items atop the pedestal.
2. Read the challenge paragraph to the group.
3. Discuss with the students:
    - What would happen if you had a two dowels as a hand? How do your interactions with the world change? What are you still able to do? What's more difficult? What's impossible?
    - What can you do that you couldn't do with a hook previously? How is this similar or different from the functions your hand can do?
4. Read the rules to their challenge.
5. Explain that before they go off and complete their challenge, first they will just do some getting used to the dowels. Prompt the students to take turns picking up the objects on their table using their dowels. Remind them:
    - Now, for the remainder of this class, you are to study our alien friends. You have to believe and act like it, with sticks for hands. Any time that you would have used your dominant hand, you should use your dowels.
    - So, imagine you are an alien. As an alien, if you had to go to school, how would it go? Explore this by trying to use the things around you with your dowels.
    - Before you begin, let's brainstorm: what are some of the things you can try to do right around your area?
        - Write something on a paper
        - Open your book bag and take something out
        - Pick up papers and put them in a folder
        - Open a book and flip to a page
        - Tie your shoe
        - Drink some water
        - Push your chair in and out

Safety Check: Dowels are not swords. If they become swords, you become in trouble.

6. After some trying, debrief with the students:

    - Which items were harder to use?
    - What do we know about these items?
    - In regards to how they're used with our hands, how are each of these different?
    - What do you call what your hand touches and uses to use the object or complete the task?
    - Are all these types of handles?
7. Explain that every exploration needs an accompanying Field Guide to take notes in. See the Referenced Materials for an example of these worksheets.
8. Prime the students:
    - Now, we're going to make a Field Guide— every exploration needs an accompanying Field Guide to take notes in. *(skip intro if you already did Lesson 1)*. This field guide will help you record data, a place for your observations, so you can later display this data and compare it with your classmates' data. This data will help inform you of what tasks were harder than others, and this will help you build empathy towards what what it's like to live with alien limbs.
    - Since you are working in pairs, you can take turns using the dowels and recording the experience.
9. Ask students to think of what kinds of things they would record during their exploration.
    - As a group, discuss: what was the previous format for writing down data during an exploration? Is there anything we want to change about that format?
10. After a chance to think, guide them:
    - Tell the students to make columns on their paper with the following headers. Ask them to consider the spacing they should leave in each column to fill it out.
        - Item Name
        - Shape Sketch
        - Function
        - Performance
            - Objects that are easier to use with the dowels,
            - Objects that are worse to use with the dowels,
            - Objects that work with the dowels but are unnecessary.
        - Comments
            - Did you use your non-dominant hand?
            - Did anything stand out?
            - Anything else worth remembering?
    - Go through each column and elaborate on how they should be used. Ask them:

- What details are important in a shape sketch? (Form of the object)
- What details are important in Function?
- How can you rate the performance of each handle? How can you accommodate all the objects that are in between one category and the next?
    - Get students to understand the value in a scale rating system. For example, you could use the following:
        a. 1 is for objects that are worse to use with the dowels
        b. 3 is for objects that are just the same with the dowels as with the hand
        c. 5 is for objects that are easier to use with the dowels than with the hand
        d. 2 and 4 are for objects that are right in the middle of two categories.

Teacher Tip: We want to give the students a benchmark for rating the performance of their dowels with each handle. Talk with them about setting a minimum mark, a maximum mark, and a reference in between. A minimum performance mark can be something that is impossible to handle with the dowels, such as a remote control, and receive a 1. A maximum performance mark can be something that is just as easy to handle with the dowels as it is with your hand, such as a bucket, and receive a 5.

Data Collection and Analysis

11. Prompt the students to go out in the world and make their tests and observations. If there is class time, have them begin by going around the classroom and the school. Because these sticks are a greater potential danger, we do not recommend you task them with taking them home. Instead, consider giving them one to two class periods to do some exploring in and around the classroom.
    - Challenge the students:
        - Find an object that is easier to use with the dowels than with hands.
        - Find the object that is the hardest to use with the dowels.
    - If you do the same activities as you did with the hook, then you can compare your findings from them to now. Let's brainstorm, again: what are some of the things you did right around your area?
        - Write something on paper
        - Open your book bag and take something out
        - Pick up papers and put them in a folder
        - Open a book and flip to a page
        - Tie your shoe
        - Drink some water
        - Push your chair in and out
12. Analyze the Data. When the students come back with their observations, have them sort their items into three lists:
    - Objects that are easier to use with the dowels,
    - Objects that are worse to use with the dowels,

- Objects that work with the dowels but are unnecessary.

13. Discuss the resulting lists once the students are done populating them.
    - Where do they differ and where are they the same?
    - What could account for the differences in reporting?
    - What kind of information can a person get from just viewing these charts?

Teacher Tip: If time allows, you may decide to graph these findings in a similar way you did in the first hook exploration. This would make it easier for the students to be able to compare both side by side, and to draw parallels between the two explorations.

Final Reflection

14. Have students take out a piece of paper and first write down their thoughts individually. Select some of these questions to write on the board for them to respond to:
    - What did you learn makes a handle ergonomic for human use? For dowel use?
        - How did that help you create categories for the different types of handles?
    - What functionalities do dowels afford you that hooks do not?
    - What other contraptions or forms can you imagine would use handles well?

15. Take turns sharing a few selected responses within groups.

Break-Outs/Extensions

Use these activities to extend the project or increase the challenge.

Pick it up, too

There is plenty to do with just two sticks for hands! If you feel they haven't explored enough, challenge the students to the following:

- Find the sport that is the easiest to play with the sticks.
- Find the instrument that is the easiest to play with the sticks.
- Find the classroom task that is the easiest to do with the sticks.

Connecting Concepts

The following are concepts relating to this Procedure. Have students use each word in an expository set of sentences to tell how each concept relates to the work they've done:

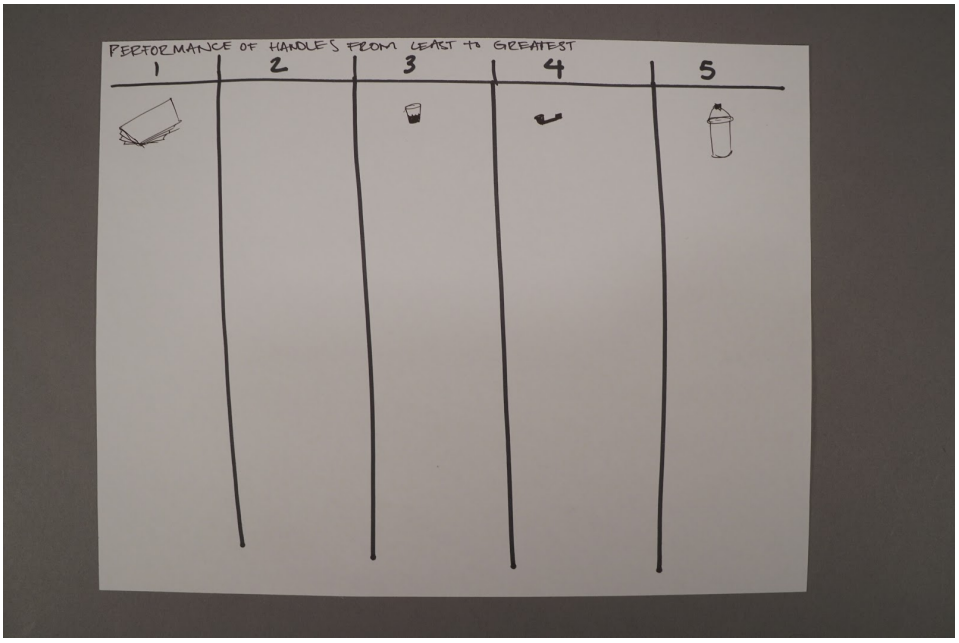
- Design intention
    - Every designer or creator sets out with a certain purpose in mind when designing an object. Every feature is intended, or, at times, a serendipitous surprise. Either way, everything should be considered intentional. What, then, was the intention of the designer in the objects we've explored?
- Adaptability
    - Some objects are multi-use or multi-faceted, meaning they have multiple ways they can be used, whether by design or by use case. These objects that can switch in between states are adaptable. Which of the objects that we've explored show adaptability to how they can be used?
- Equal exerted effort
    - When using an object, one has to exert some level of effort to get the object to perform the way it was intended. This effort can often be quantified, though a qualitative measure of this effort is also useful. In our explorations, what objects are used with the equal effort when used with hands than when used with dowels?
- Quantification vs. qualification
    - When we quantify something, we evaluate it with numerical metrics that help us to understand that object, it's performance, or whatever is being evaluated. When we qualify something, we evaluate it in a subjective manner that helps us understand that object in more analog terms. Where in this project did we use quantitative or qualitative evaluation methods?

Compare and Contrast

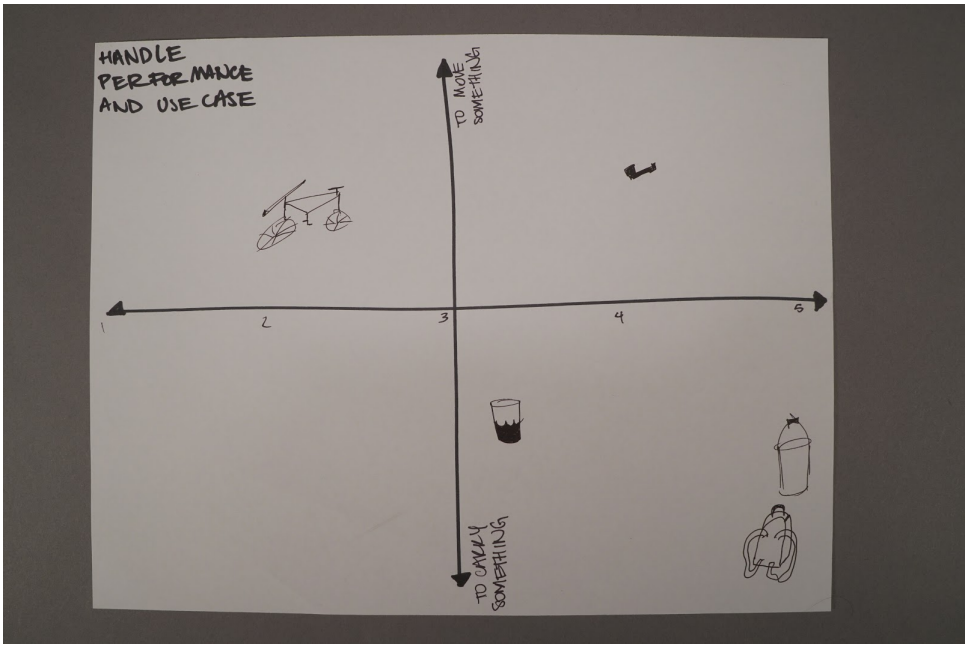
Have students compare their data tables of this dowels exercise with their data tables generated during their hook exercise. Which objects overlap in the three categories? Which objects changed columns drastically? Is there a pattern in the form or the function of these objects that changed or stayed similar? What might be some optimal handle designs that could accommodate use by both the hook and the dowels, if these aliens ever hung out with Captain Hook?

Data Display

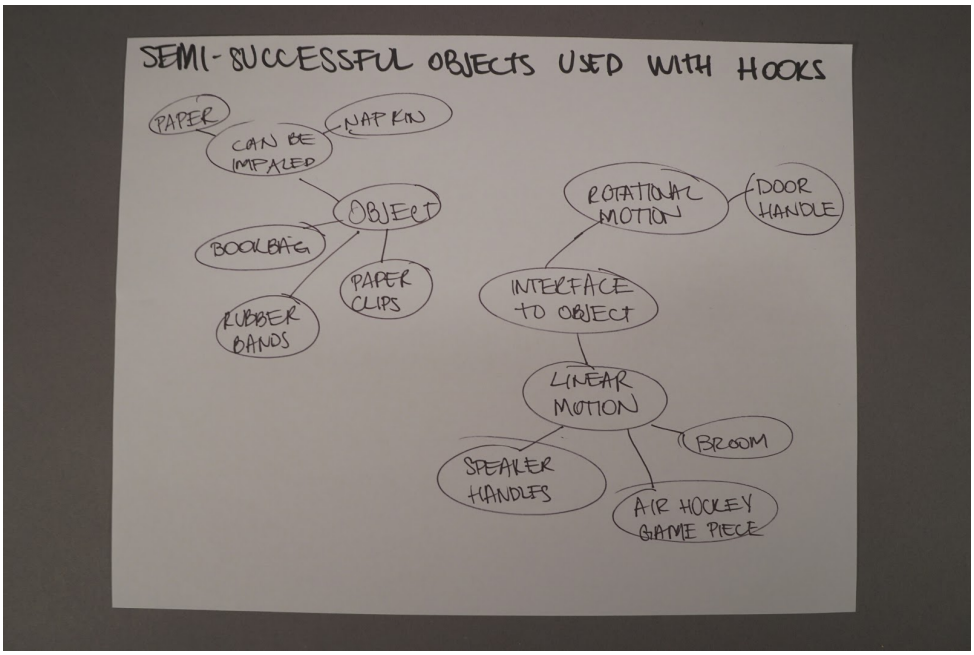
Challenge your students to use other data display methods to portray information about their exploration. What extra information can be shown through different displays (tables, webs, scatter plots) and what information is compromised? What does it mean to be as visual as possible rather than verbal? Below are examples of some types of data visualizations.



Example data table listing the different objects by their performance. This is one of the simplest forms to display this data.



Example two-axes spectrum chart mapping the performance of the objects against a second piece of information, in this case, their function- whether to carry something or to move something.



Example web plot displaying hierarchies of categorizations for the types of objects the hooks interfaced with. Can just as easily be made for objects used with the dowels.

Comments

Use this space to provide feedback and comment on this lesson

S+P— Dowel Adaptation

AN EXPLORATION OF EGGS AND ALIEN APPENDAGES

CHALLENGE

It's breakfast time!
Our alien friends must have stayed at the same hotel as Captain Hook, because they too have taken a liking to fancy meals.
During their time on Earth, our intergalactic friends have come to like the concept of breakfast, particularly when there are fried eggs available.
However, they've learned how hard it is to do a simple task like season their eggs with their long appendages and have asked for our help since you are, after all, a licensed intergalactic prosthetic design firm.
Today, it's your job to design an adaptation to be able to salt and pepper the eggs with your dowels.

STAGING

- Arrange tables in groups of about four students, though students will work in teams of two.
- Lay down a mat on each table and on the pedestal to position the salt and pepper shakers (located ~ 8" apart) and the plate with cardboard eggs on them.

RULES

- Holding your dowels at their halfway point:
  - You must pick up the salt shaker, shake it 2 times over the eggs, and put it back down.
  - You must pick up the pepper shaker, shake it 3 times over the eggs, and put it back down.
- You may only use your dowels with adaptations to season the eggs, no human hands. Of course, you may use your hands to make the adaptation.
- You may not make permanent adaptations to your dowels- your solutions must be removable.
- If you drop your salt and pepper shaker while in Test Trial mode, you can pick it up with your hands. But if you drop your salt and pepper shaker while in Time Trial mode,, you must pick it up with your dowels.
- You must time your trials and be able to compare across multiple adaptation designs.

MATERIALS

Per team of 2 students:

- Wooden dowels, 2, ¾" thick, 2' long
- Cardboard, 2- 1'x1' sheets
- Cardstock, 2- 8.5"x11" sheets
- Paper, 2- 8.5"x11" sheets
- Rubber Bands, 5

TOOLS

Per team of 2 students:

- Hot Glue
- X-Acto Knife
- Cardboard Cutter
- Ruler

For staging, on pedestal and on each table of 4:

- Salt and Pepper Shakers
- Cardboard eggs
- Plate for the eggs
- Mat to position props

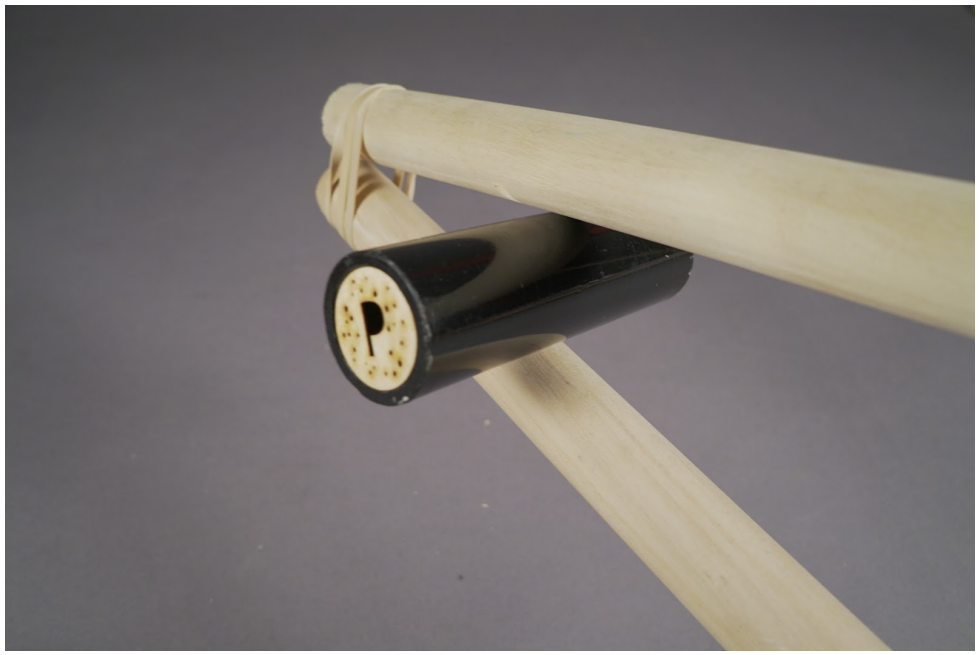
LEARNING OBJECTIVES	SKILL OBJECTIVES
• To defend design decisions around the properties of the materials. • To predict the success of a design based on its features. • To conduct consistent timed tests. • To identify ways to include a control in a test.	• To choose materials based on their properties matching design needs. • To design and build tools for a multi-purpose challenge (grab, pick-up, shake). • To create a data table and a display of information.

Reference Photos

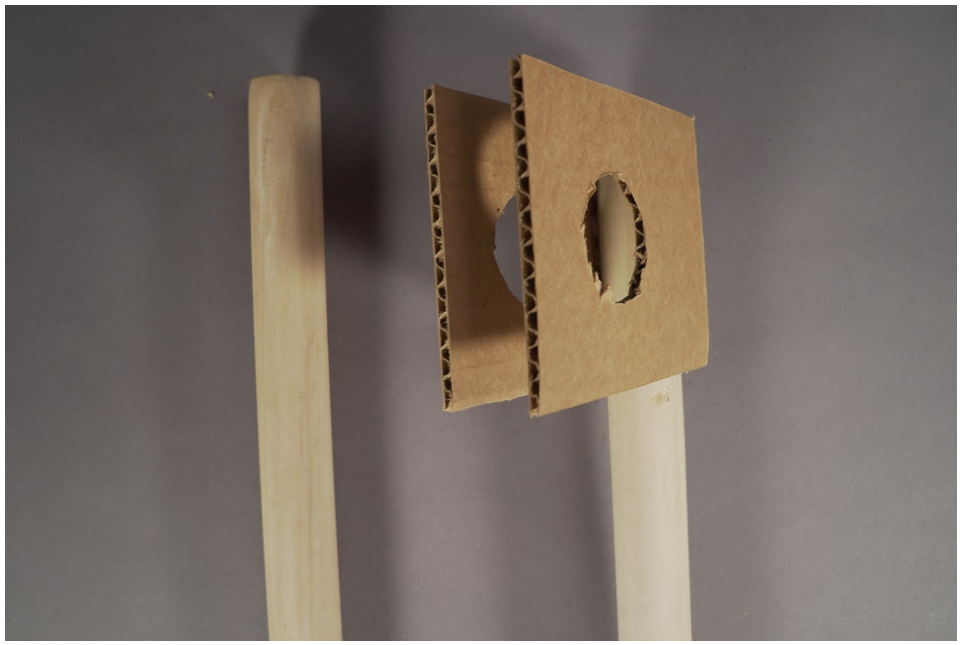
Materials & Tools

All materials and tools needed to design and make dowel adaptations: cardboard, paper, cardstock, 2 dowels, Salt and Pepper shakers, a plate with eggs, a placemat, cardboard cutter, X-acto knife, ruler, rubber bands, and a hot glue gun.

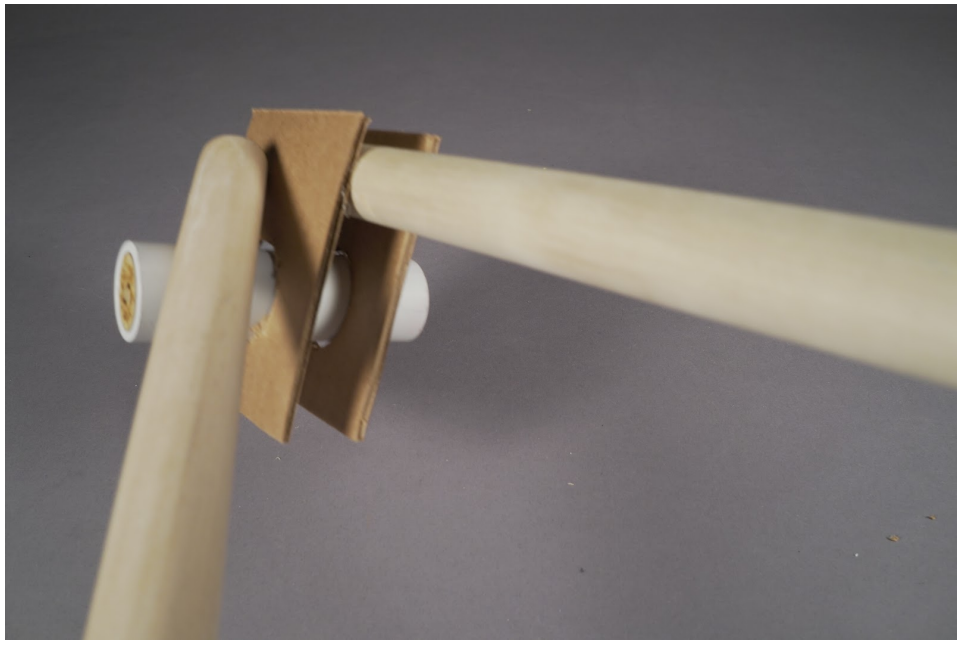
Example 1- Rubber bands tied to the end of two sticks, imitating a lobster claw, to create a fulcrum, or pivot point, at the end of the dowels.



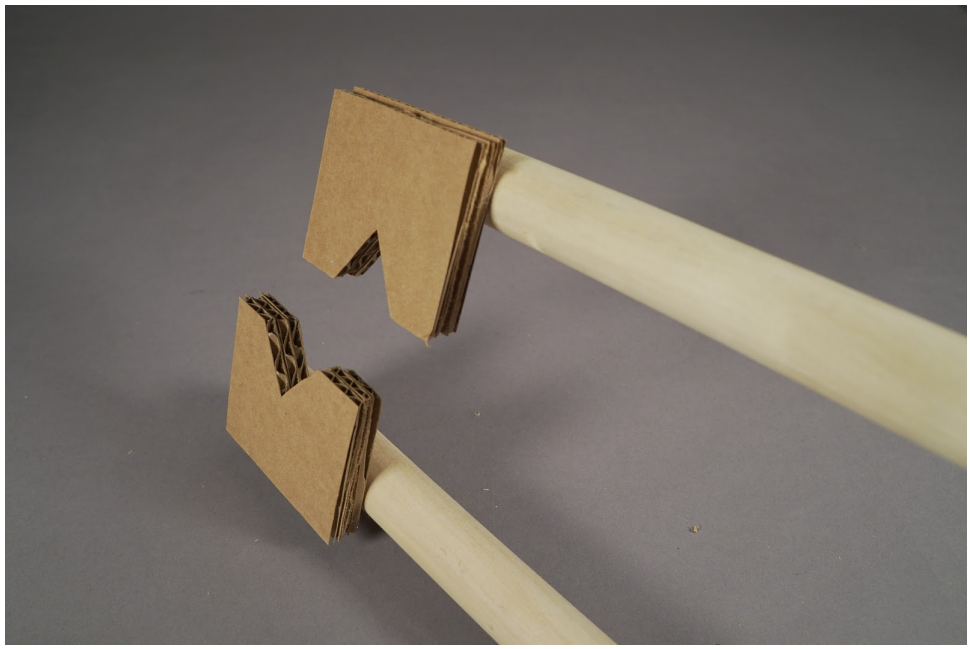
Example 1 being used in example.



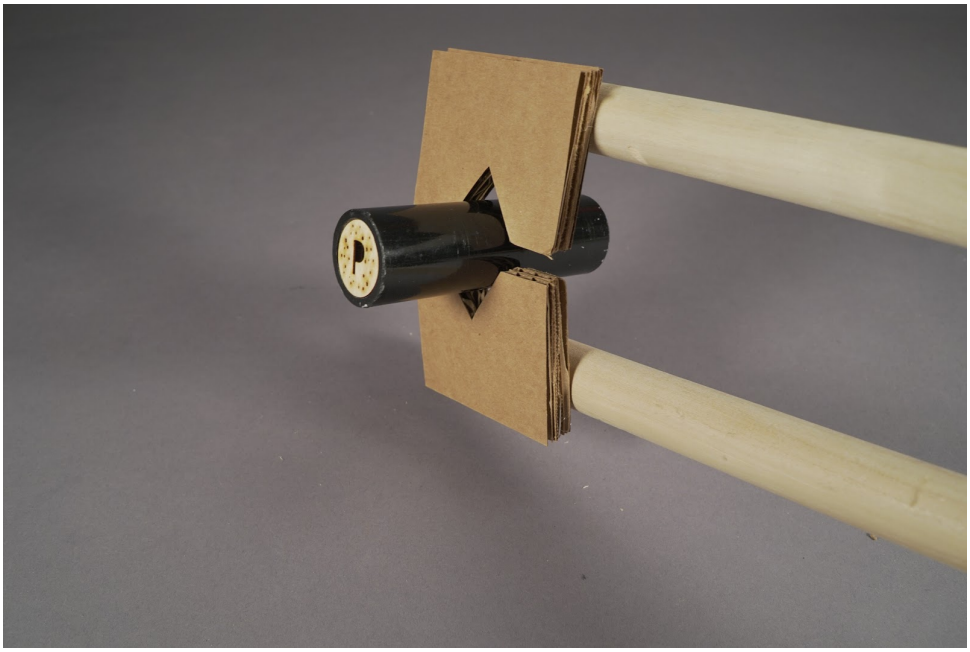
Example 2- Two holes in the cardboard provide a four-point hold for the Salt shaker, while the left dowel is used to push against the cardboard, thus securing it in place.



Example 2 pictured in use with the left dowel pushing against the shaker to keep it from sliding out of the cardboard sleeve.



Example 3- Cardboard is stacked to make a 3-ply square of cardboard. The angled cutouts create two points of contact on each side.



Example 3 in use, with the Pepper shaker caught between both cardboard pieces. As cardboard is stacked, the salt shaker has many more points of contact, instead of only 2 points of contact, holding it more securely in place.

Procedures

Dowel Adaptation

In this procedure, student teams will build adaptations for their wooden dowels that will help them in picking up the salt and pepper shakers in order to season their eggs. They will critique each other's designs and discuss the strengths and weaknesses of each. They will take timed trials of their design to determine a reliable estimate of their design's performance.

1. Set up the room as described above.
2. Read the challenge to the students and deliver the rules.
3. Select a student at random and have that student repeat the challenge to you.
    a. "You are allowed two clarifying questions."
    b. Answer their two questions.

Teacher Tip: Here, we allow the students to make permanent adaptations to their dowels, that is, they can hot glue onto the wood to keep their adaptation in place. Your students may be astute to notice that this would translate to hot gluing an adaptation to the alien's long stick-arms. You can be ready to explain that their alien skin is quite different from our sensitive hot glue skin. Temperatures on their planet have made them quite heat-resistant. Hot glue on their skin feels like Elmer's glue feels to us.

4. Explain to the students that every test needs a control in order to have a base for comparison. Since they will be testing their design solutions and conducting timed trials of their shaking procedure, they will need a control trial, first. Prompt the class on what a good control might be.
    a. What do you remember we used as a control when making hook adaptations for Captain Hook? And what was its purpose?

Teacher Tip: A good control is something that sets the base for what is being measured. In this case, we need to know how long it takes to season the eggs (salt twice, pepper three times) before experiments are done with any dowel adaptations. Two timed trials should be taken: seasoning the eggs just with their hands, then seasoning the eggs with the dowels alone (no adaptation).

5. Have the students take turns conducting their two control trials at their tables. Prompt them:

    a. Each student should make a table to record their findings.
        i. What are some things the table should say to record these findings ?
    b. Every student should complete a timed trial of both controls: using their hands, and using just the dowels (when it's too hard or impossible to do with the dowels, end the test and record the time you stopped trying (i.e. "Incomplete after 3:00")).
    c. Choose a student to be the timer.
    d. How many times should you repeat a test to have certainty in your results? Three to four students, or 3-4 trials, is about right.
6. Share amongst each other:
    a. How long did each table take? What calculation can you do to report one number that represents the entire table's performance?
        i. Have students calculate the average of their trials. For any dowel trials that were impossible or incomplete, these would be N/A and not be averaged, just noted.
7. Prepare for designing the dowel adaptations. With the class, discuss the dowels and their design opportunities:
    a. What are the basic needs of this dowel adaptation? What does it need to do?
        i. Grip the shaker.
        ii. Pick up the shaker.
    b. You did that once already, with the hook adaptation. Is it possible to repeat your exact hook adaptation for the dowels? Would you want to do that? Why or why not?
    c. What are some things in the world that grip?
    d. What are some factors to a successful gripping mechanism?
        i. Grip strength, material strength, gripper surface texture for friction, ability to engage and disengage, load-bearing capacity, etc.
    e. What are the different parts of the dowels? How might they be used in making an adaptation?
        i. Length, even thickness, flat edge at endpoint, wood (adheres hot glue), etc.
    f. What are the dowels already good at? What have we learned from our explorations that it can do well?
    g. What can you do with the dowels that you couldn't do with the hook? (Clamping, Pinching, Move in two different directions, etc.)

Teacher Tip: Breakdown that in the evolutionary spectrum, one hook only allows one limb or appendage to manipulate an object. A pair of dowels, however, allows two limbs, or two independently moving appendages to be able to control an object. This means control of movement by two different features, control of pressure, control of stability, and more.

Design & Critique

8. Have the students prepare to make their designs.

    a. Pick a design that you're going to pursue for your dowel adaptation. Then, turn to a partner and describe to them your design and why you chose it. Take turns asking each other clarifying questions on the design and how you'll make it. This will help you think through making your design come to life. Then, you may begin making your dowel adaptation.
    b. What are some of the questions you could ask your partner to help them think through their idea?
        i. What materials will you use?
        ii. What's going to hold it together?
        iii. What will you need help with?
        iv. How do you know this will work?
9. Let the students begin to work on their dowel adaptations.
10. After the students get going, model the kind of observation and design breakdown that you will have with them by showing them the Referenced Solutions (above) as Stuff that Might be Useful. Even copying the solution will still result in their understanding of how the design was made, and therefore, why it works. Point at each solution and ask them:
    a. "What is the main function of the design?
    b. What makes it work?
    c. What does it depend on for success?"
11. Give the students more time to work. Then, do rounds to engage with their work. As you go around, some prompting questions may include:
    a. What is the main function of your design? What makes it work? Tension in holding the shaker in place? A tapered form that press fits?
    b. What does it depend on for success? The size of the enclosure to be exact? The exact manipulation of the dowels at the right angle?
    c. What would you predict might be some failure points?
12. Once the students have made significant progress on their designs, pause for an all-class discussion. Select a few student works to model a design critique:
    a. How are these solutions similar?
    b. How are these solutions different?
    c. In what ways do the materials used inform the function of the design?
    d. How does the approach of the student inform the design of the adaptation?
    e. What other mechanisms are similar to this design's function? Form?
    f. Where are the expected failure points for the design? How might those be mitigated?
    g. What other problems are you still encountering with your design that you haven't been able to solve?

Testing

13. Once the students are done with their solutions, move them towards conducting timed trials of their designs.
    a. Review with the students the data collection process from Hook 2 project and ask them:

i. What columns headers should you have on your data table? (Person conducting test, design being tested, time to complete, trial number)
ii. How many trials do you need to conduct in order to be confident in your prediction?
iii. How many people do you need to conduct each trial?
iv. What do you expect? Which solutions do you think will do best? Why?

b. Conduct the trials and have students record their data in a data table. When they're done averaging their results, have them come up to the board and report their findings.
c. Compare results amongst students:
    i. Who has the design with the shortest timed trial?
    ii. How far apart are the results?
    iii. What parts of the design accounts for the biggest differences?
    iv. Are any solutions as enabling as a human hand? (is the timed trial near what it was to the bare, human hand?)
    v. Can the data inform any general trends of successful designs?
    vi. What are the failure points of the designs? (wear and tear, getting it wet, rubber band might loosen off, etc.)

Teacher Tip: When students see each other's time stamps they will hopefully be motivated to edit their design and work towards a faster solution. If time allows, let them go back to the drawing board and be able to work with materials to iterate on their designs, even if it's copying a peer's solution.

Final Discussion

14. Discuss details of the work with the students to wrap up their design exercise. Let the students jump in and participate in the full-group discussion.

a. What was your process in designing and making your adaptation?
    i. How did you decide upon this process? (defend your choices)
b. If you could do it again, would you change anything about your process?
c. If you had more time, what would you do next?
d. If you could have other materials, what would you have liked to have? What would you make out of different materials?
e. In what ways did the testing and trials inform changes to your design?
f. How many of you think your hook adaptation is more effective than your dowel? Vice versa?(If you could only have one, which would you choose?) What is your evidence?
g. What other features or functionalities would you want in a gripping mechanism that picks up a shaker? What is the basic dynamic that the hand does when picking up and shaking the salt and pepper shakers?
    i. Hint: Would it be helpful to have the two limbs or appendages anchored to a point, together, and pivoting? Look at how the thumb allows us to pivot with our other fingers.
    ii. Connecting those two limbs, while still maintaining that one can move in an opposing direction (like an opposable thumb) is another next step.
h. As a united product design firm— what's the best prosthetic design we can pursue for our alien clients?

Break-Outs/Extensions

Use these activities to extend the project or increase the challenge.

Connecting Concepts

The following are core concepts embedded into this Procedure. Have students write an expository piece connecting where they identified these concepts throughout the project and any questions they may still have about them.

- Lever
    - a rigid bar resting on a pivot, used to help move a heavy or firmly fixed load with one end when pressure is applied to the other.
- Fulcrum
    - the point on which a lever rests or is supported and on which it pivots.
- Friction
    - the resistance that one surface or object encounters when moving over another
- Force
    - strength or energy as an attribute of physical action or movement

Comments

Use this space to provide feedback and comment on this lesson

S+P— Environment Adaptation

AN EXPLORATION OF EGGS AND ENVIRONMENTS

CHALLENGE

It's breakfast time!

Our alien friends are still waiting for some parts to finish fixing their spaceship (their home is very far away). With all this time on earth, they are eager to be more independent. They have bought their own objects to make breakfast and have asked for our help in adapting them so they can use them with their long, stick arms. Now that you know how it feels to have sticks for arms, it is your job to design an adaptation for each of these objects so our alien friends can use them.

STAGING

- Tables are arranged in groups of about 4 students, though students will work in teams of 2.
- On the pedestal and at each group's table:
    - A mat is laid down to position the Salt and Pepper shakers (located ~ 8" apart) and the plate with cardboard eggs on them.
    - Around them are the frying pan, the coffee cup, and the large spoon.

RULES

Holding your dowels at their halfway point, you must:

- Salt and Pepper the eggs:
    - You must pick up the salt shaker, shake it 2 times over the eggs, and put it back down.
    - You must pick up the pepper shaker, shake it 3 times over the eggs, and put it back down.
- Fry an egg:
    - You must pick up the frying pan and flip the egg inside, twice: once upside down, then back around. Then put the frying pan down.
- Drink out of a coffee cup:
    - You must pick up a coffee cup and have your partner (pretend) drink out of it . Then put it down.
- Stir with a large spoon:
    - You must pick up the large spoon and stir a (pretend) pot with it. Then put it down.
- You may not make permanent adaptations to the objects- they must be removable.
- If you drop any object, you must pick them up with your dowels.

MATERIALS

Per team of students:

- Wooden dowels, 2: ¾" thick, 2' long
- Cardboard, 4- 1'x1' sheets
- Cardstock, 4- 8.5"x11" sheets
- Paper, 2- 8.5"x11" sheets
- Rubber Bands, 5

TOOLS

Per team of two students:

- Hot Glue
- X-Acto Knife
- Cardboard Cutter
- Ruler

For staging, on pedestal and on each table of 4:

- Salt and Pepper Shakers
- Cardboard eggs
- Plate for the eggs
- Mat to position props
- Small frying pan
- Disposable Coffee Cup
- Large spoon

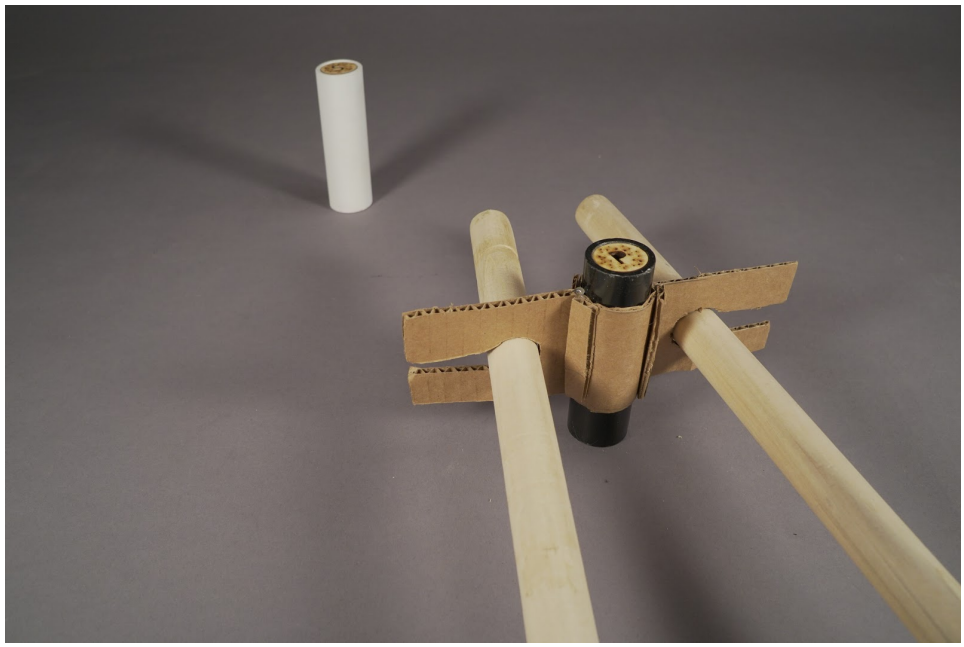
• You must time your trials and be able to compare across other teams' adaptation designs.	

LEARNING OBJECTIVES	SKILL OBJECTIVES
• To consider the role of ergonomics when designing a solution. • To defend design decisions around the properties of the materials. • To predict the success of a design based on its features. • To conduct consistent timed tests. • To display data collected.	• To build a functional adaptation by working within the constraints of an object • To choose materials based on their properties matching design needs.

Reference Photos

Materials & Tools

All materials and tools needed for adapting the aliens' environment: cardboard, paper, cardstock, frying pan, disposable coffee cup, large spoon, salt and pepper shakers, eggs on a plate, a placemat, cardboard cutter, x-acto knife, ruler, rubber bands, 2 dowels, hot glue gun.



Example adaptation for the dowels to grab the pepper shaker.

Example adaptation for the dowel to grab the large spoon and stir.

Example adaptation for the dowels to pick up the frying pan and flip the egg.

Example adaptation for the dowels to pick up the disposable coffee cup and tilt the beverage into a mouth, and then set it back down.

Procedures

Environment Adaptation

In this procedure, student teams will build adaptations around their environment— a series of kitchen objects— so they can be handled with their dowels. They will critique each other's designs and discuss the strengths and weaknesses of each. They will take timed trials of their design to determine a reliable estimate of their design's performance.

1. Set up the room as described above.
2. Read the challenge to the students and deliver the rules.

Teacher's Note: The challenges given to the students here (frying pan, disposable drinking cup, large spoon) can all be replaced with other daily task-related things that the kids would have to adapt for use with the dowels. They should be objects that require only one task, i.e. not holding and twisting open a lid.

3. Select a student at random and have that student repeat the challenge to you.
    a. "You are allowed two clarifying questions."
    b. Answer their two questions.
    c. Discuss the word "ergonomics" and what it means to this project:
        i. Who knows what the word "ergonomics" means?
        ii. "ergon" is greek for "work". "nomos" is greek for "laws". Today, it is used to describe the science of designing the job to fit the worker, not forcing the worker to fit the job.
        iii. Every object around you has a layer of ergonomics consideration baked into its design. What are some examples from this classroom?
            1. Rubber grip on pencils and pens
            2. Curvature of plastic drink bottles
            3. Padding on the back-facing inside of a backpack
4. Explain to the students that every test needs a control in order to have a base for comparison. Since they will be testing their design solutions and conducting timed trials of their various challenges, they will need a control trial, first. Prompt the class on what a good control might be.
    a. What do you remember we used as a control when we made the dowel adaptations? And what was its purpose?

Teacher Tip: A good control is something that sets the base for what is being measured. In this case, we need to know how long it takes to season the eggs (salt twice, pepper three times) before experiments are done with any dowel adaptations. Two timed trials should be taken: completing all the tasks just with their hands, then completing all the tasks with the dowels alone (no adaptation).

5. Have the students take turns conducting their two control trials at their tables. Prompt them:

    a. Each student should make a table to record their findings.
        i. What are some things the table should say to record these findings ?
    b. Every student should complete a timed trial of both controls: using their hands, and using just the dowels (when it's too hard or impossible to do with the dowels, end the test and record the time you stopped trying (i.e. "Incomplete after 3:00")).
    c. How many times should you repeat a test to have certainty in your results? Three to four students, or 3-4 trials, is about right.
6. Share amongst each other:
    a. How long did each table take to complete each challenge? What calculation can you do to report one number that represents the entire table's performance?
        i. Have students calculate the average of their trials. For any dowel trials that were impossible or incomplete, these would be N/A and not be averaged, just noted.
7. Prepare for designing the object adaptations. With the class, discuss each object and its design opportunities:
    a. What are the basic needs of this object's adaptation? What does it need to do?
        i. The shakers:
            1. Grip the shaker.
            2. Pick up the shaker.
        ii. The frying pan:
            1. Grip by the handle.
            2. Pick up the pan.
            3. Joust forward and then in a vertical circle to flip the egg.
        iii. The large spoon:
            1. Grip the spoon.
            2. Pick up the spoon.
            3. Rotate the spoon and move in a circular motion.
        iv. The disposable coffee cup:
            1. Grip around the cup.
            2. Pick up the cup up your partner's mouth.
            3. Tilt the cup to drink from it.
    b. What are some things in the world that grip?
    c. What are some factors to a successful gripping mechanism?
        i. Grip strength, material strength, gripper surface texture for friction, ability to engage and disengage, load-bearing capacity, etc.
    d. What are the different parts of the dowels? How might they be used in making an adaptation?
        i. Length, even thickness, flat edge at endpoint, wood (adheres hot glue), etc.
    e. What are the dowels already good at? What have we learned from our explorations that it can do well?

Design & Critique

8. Have the students prepare to make their designs.

    a. Pick a design that you're going to pursue for your dowel adaptations. Then, turn to a partner and describe to them your design and why you chose it. Take turns asking each other clarifying questions on the design and how you'll make it. This will help you think through making your design come to life. Then, you may begin making your dowel adaptations.
    b. What are some of the questions you could ask your partner to help them think through their idea?
        i. What materials will you use?
        ii. What's going to hold it together?
        iii. What will you need help with?
        iv. How do you know this will work?
9. Let the students begin to work on their environment adaptations. As you go around, some prompting questions may include:
    a. What is the main function of your design? What makes it work? Tension in holding the shaker in place? A tapered form that press fits?
    b. What does your design depend on for success? The size of the enclosure to be exact? The cardboard's grain aligning for structure? A quick, agile manipulation of the dowels?
    c. What would you predict might be some failure points?

Teacher Tip: If students are struggling, you can show them the Referenced Solutions provided above and have them build off of them. Even copying the solution will still result in their understanding of how the design was made, and therefore, why it works. Break down each solution you point to and ask them:

"What is the main function of the design? What makes it work? What does it depend on for success?"

10. Once the students have made significant progress on their designs, pause for an all-class discussion. Select a few student works to model a design critique:
    a. How are these solutions similar?
    b. How are these solutions different?
    c. If you had to categorize the solutions, how might they be grouped?
    d. How does the approach of the student inform the design of the adaptation?
    e. What other problems are you still encountering with your design that you haven't been able to solve?
    f. What other mechanisms are similar to this design's function? Form?
    g. Where are the expected failure points for the design? How might those be mitigated?

Testing

11. Once the students are done with their solutions, move them towards conducting timed trials of their designs.
    a. Discuss with the students:

i. What columns should be reported? (Person conducting test, design being tested, time to complete, trial number)
ii. How many trials do you need to conduct in order to be confident in your prediction?
iii. How many people do you need to conduct each trial?
iv. What do you expect? Which solutions do you think will do best? Why?

b. Conduct the trials and have students record their data in a data table.
c. Compare results amongst students:
    i. Who has the design with the shortest timed trial?
    ii. How far apart are the results?
    iii. What parts of the design accounts for the biggest differences?
    iv. Are any solutions as enabling as a human hand? (is the timed trial near what it was to the bare, human hand?)
    v. Can the data inform any general trends of successful designs?
    vi. What are the failure points of the designs? (wear and tear, getting it wet, rubber band might loosen off, etc.)

Final Discussion

12. Discuss details of the work with the students to wrap up their design exercise. Let the students jump in and participate in the full-group discussion.
    a. What was your process in designing and making your adaptations?
        i. How did you decide upon this process? (defend your choices)
    b. If you could do it again, would you change anything about your process?
    c. If you had more time, what would you do next?
    d. If you could have other materials, what would you have liked to have? What would you make out of different materials?
    e. In what ways did the testing and trials inform changes to your design?
    f. Look at your adaptations- which of these are handles?
    g. What other features or functionalities would you want in a mechanism that picks up a shaker? What is the basic dynamic that the hand does when picking up and shaking the salt and pepper shakers?
        i. Hint: Would it be helpful to have the two limbs or appendages anchored to a point, together, and pivoting? Look at how the thumb allows us to pivot with our other fingers.
        ii. Connecting those two limbs, while still maintaining that one can move in an opposing direction (like an opposable thumb) is another next step.
    h. As a united product design firm— what's the best prosthetic design for each product that we can pursue for our alien clients?

Break-Outs/Extensions

Use these activities to extend the project or increase the challenge.

Connecting Concepts

The following are core concepts embedded into this Procedure. Have students write an expository piece connecting where they identified these concepts throughout the project and any questions they may still have about them.

- Design
  - Purpose, planning, or intention that exists or is thought to exist behind an action, fact, or material object.
- Ergonomics
  - The study of how objects are designed for maximum comfort during use; an object is more or less ergonomic depending on how well it has been designed to fit for use with the human body.
- Intended Use Case
  - This is the moment for which this product was designed, the way the user would interact with it and manipulate the object, with the intention coming from the designer or creator of the object.
- Press Fit
  - An interference fit between two parts in which one is forced under pressure into a slightly smaller hole in the other.
- Leverage
  - The exertion of force by means of a lever or an object used in the manner of a lever
- Fulcrum
  - The point on which a lever rests or is supported and on which it pivots
- Friction
  - The resistance that one surface or object encounters when moving over another
- Force
  - Strength or energy as an attribute of physical action or movement
- Universal design
  - Something created to be used with a number of applications but still through one same, universal design interface for it to be used with.

Comments

Use this space to provide feedback and comment on this lesson

S+P— The Awe in the Claw

AN EXPLORATION OF PINCHERS AND ROBUSTNESS

CHALLENGE

It's breakfast time!
We have eggs that need to be seasoned. It's your job to salt and pepper the eggs....but you can't use your hands. You can, however, build a claw out of the kit before you. Your job is to use this kit to build a claw that can help you salt and pepper your eggs.

STAGING

On the pedestal:

- Salt and pepper shakers are located ~ 8" apart, next to a plate that has cardboard eggs on them.
- One built out claw is positioned on the side.

RULES

- You must pick up the salt shaker, shake it 2 times over the eggs, and put it back down.
- You must pick up the pepper shaker, shake it 3 times over the eggs, and put it back down.
- You must use the kit materials to build a claw that grabs the S+P shakers.
- No rubber bands or other materials can obstruct the center of the claw.
- You may look at the display claw while building, but challenge yourself not to!
- You can build it like the display claw or differently. Just make sure to note and be able to defend the differences.
- You must time your trials and compare them against others' data.
- You must create your own beam to which to attach your claw.

MATERIALS

One Claw Kit per team of two students:

- 2 Wooden claws
- 1 peg board
- 5 rubber bands
- 4 ft of String
- 6 Carriage bolts, Wing Nuts, and Washers
- 1- 8.5"x11" sheet of cardboard

TOOLS

- Hot glue
- X-Acto Knife
- Cardboard Cutter

LEARNING OBJECTIVES

- To make sense and use of found objects to meet your goal.
- To identify fulcrum points and how different designs pertain to different leverage points.

SKILL OBJECTIVES

- To build and assemble a kit of parts into a functional claw.
- To use nuts and bolts as fasteners.

Procedures

Assembling a claw.

In this procedure, students will use a kit to assemble a claw that will grab and pick up the salt and pepper shaker. They will study the differences between a claw and the other appendages they've explored: a hook and dowels.

1. Setup the room as described above.
2. Read the challenge to the students and deliver the rules.
3. Select a student at random and have that student repeat the challenge to you.
    a. "You are allowed two clarifying questions."
    b. Answer their two questions.
4. Explain to the students that every test needs a control in order to have a base for comparison. Since they will be testing their design solutions and conducting timed trials of their shaking procedure, they will need a control trial, first. Prompt the class on what a good control might be.
5. Select a volunteer to come up to the pedestal to conduct a control trial.
    a. Have them do a timed trial of the shaking procedure by picking it up with just their hands. Record this information for later.
    b. "Do you expect the claw to be faster or slower than the fastest hook adaptation? Than the fastest dowels adaptation?"
    c. Have them try to use the assembled claw to complete the challenge. Record the time it takes. Compare this to other recorded times you have for the same task.
        i. Ask the students to attempt to explain the results.
6. Discuss altogether the claw and its design opportunities:
    a. What are the different parts of the claw? Can we agree on naming conventions for the parts?
    b. In what ways is the claw different from the dowels? From the hook?
    c. What are some of the strengths and ergonomic benefits of the claw that you don't have with the hook or dowels?
    d. What else in the world behaves like a claw?
    e. What are some areas of improvement for the claw design?

Design & Critique

7. Let the students begin to work on assembling their claws. As you go around, some prompting questions may include:
    a. What is the main improvement of your design?
    b. What does it depend on for success?
    c. What would you predict might be some failure points?
8. Once the students have made significant progress on their designs, pause for an all-class discussion. Select a few student works to model a design critique:

a. How are these solutions similar?
b. How are these solutions different from each other? From the display claw?
c. What other mechanisms are similar to this design's function? Form?
d. Where are the expected failure points for the design? How might those be mitigated?

Testing

9. Once the students are done with their solutions, move them towards conducting timed trials of their designs.
    a. Discuss with the students:
        i. What columns should be reported?
        ii. How many trials do you need to conduct in order to be confident in your prediction?
        iii. How many people do you need to conduct each trial?
        iv. What do you expect? Which claws do you think will do best? Why?
    b. Conduct the trials and have students record their data in a data table.
    c. Compare results amongst students:
        i. How far apart are the results from each other?
        ii. How do the results compare to measured trials by the hook and dowels?
        iii. What parts of the design accounts for the biggest differences?
        iv. Can the data inform any general trends of successful designs?
        v. What are the failure points of the designs and what are they attributed to?
        vi. Are there edits and improvements you could make to your claw to make it stronger?

Final Discussion

10. Discuss details of the work with the students to wrap up their design exercise. Let the students jump in and participate in the full-group discussion.
    a. What was your process in designing and making your adaptation?
    b. If you could do it again, would you change anything about your process?
    c. If you had more time, what would you do next?
    d. If you could have other materials, what would you like to have?
    e. What other features or functionalities would you want in a pick-up-and-shake mechanism? What is the basic work that the hand does when picking up and shaking the salt and pepper shakers? (hint: grabbing from two appendages as contact points)

Procedures

Optimizing the design of a claw.

In this procedure, students will use their kit and spare parts to optimize the design of their claw to make it stronger. Students also design a test to measure and compare this strength across different designs.

1. Setup the room as described above.
2. Read the challenge to the students and deliver the rules.
3. Select a student at random and have that student repeat the challenge to you.
    a. "You are allowed two clarifying questions."
    b. Answer their two questions.
4. Explain to the students that every test needs a control in order to have a base for comparison. Since they will be testing their design solutions and conducting timed trials of their shaking procedure, they will need a control trial, first. Prompt the class on what a good control might be.
5. Select a volunteer to come up to the pedestal to conduct a control trial.
    a. Have them do a timed trial of the shaking procedure by picking it up with just their hands. Record this information for later.
    b. Have them try to use the hook, by itself, to complete the challenge. When it's too hard or impossible to do with the hook, end the test.
6. Discuss altogether the hook and its design opportunities:
    a. What pick-up-and-shake strategies could your hook help you achieve?
    b. What is the hook already good at?
7.

8. Design & Critique

9. Let the students begin to work on their hook adaptations. As you go around, some prompting questions may include:
    a. What is the main mechanism of your design?
    b. What does it depend on for success?
    c. What would you predict might be some failure points?
10. Once the students have made significant progress on their designs, pause for an all-class discussion. Select a few student works to model a design critique:
    a. How are these solutions similar?
    b. How are these solutions different?
    c. How does the approach of the student inform the design of the adaptation?
    d. What other mechanisms are similar to this design's function? Form?
    e. Where are the expected failure points for the design? How might those be mitigated?
11.

12. Testing

13. Once the students are done with their solutions, move them towards conducting timed trials of their designs.
    a. Discuss with the students:

i. What columns should be reported?
ii. How many trials do you need to conduct in order to be confident in your prediction?
iii. How many people do you need to conduct each trial?

b. Conduct the trials and have students record their data in a data table.
c. Compare results amongst students:
    i. How far apart are the results?
    ii. What parts of the design accounts for the biggest differences?
    iii. Can the data inform any general trends of successful designs?
    iv. What are the failure points of the designs and what are they attributed to?

14.

15. Final Discussion

16. Discuss details of the work with the students to wrap up their design exercise. Let the students jump in and participate in the full-group discussion.
    a. What was your process in designing and making your adaptation?
    b. If you could do it again, would you change anything about your process?
    c. If you had more time, what would you do next?
    d. If you could have other materials, what would you like to have?
    e. What other features or functionalities would you want in a pick-up-and-shake mechanism? What is the basic work that the hand does when picking up and shaking the salt and pepper shakers? (hint: grabbing from two appendages as contact points)

Break-Outs/Extensions

Use these activities to extend the project or increase the challenge.

This is basic body type. Now this is what I'm wondering. Don't we need to consider whatever it is that's going on here? Or can we just assume that what is going on is only for here and now. It doesn't require more thinking than that.

Comments

Use this space to provide feedback and comment on this lesson