



# Activity C – Clipmobile Design Team

## Performance Task For Youth

You will plan and design a vehicle to maximize its ability to coast, based on considering the effects of friction. You also will consider constraints of capacity, efficiency, complexity, and costs in the design.

## Success Indicator

Youth will be able to design a vehicle that will roll easily and meet the constraints listed.

### List of Materials Needed

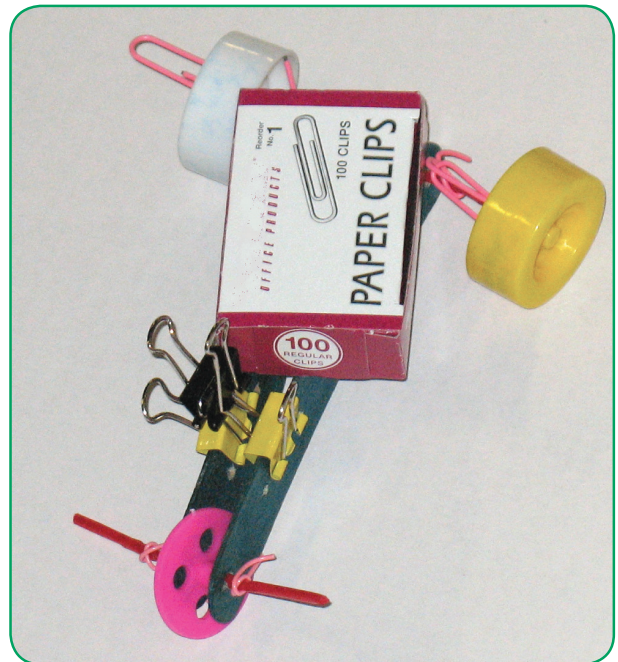
- Robotics Notebook
- Activity Supplies
  - A bag of “start-up” sample supplies for each Design Team. One each of the following is suggested:
    - One regular craft stick, one jumbo craft stick, one craft stick with holes
    - One regular paper clip, one large paper clip
    - One 1-inch paper brad, one 1 ½-inch paper brad
    - One binder clip
    - One drinking straw
    - One coffee stirrer (straw type)
    - One rubber band
    - One toy wheel
    - One wood skewer (dull or remove the sharp, pointed end; may cut or break in half for packing in bag)
- Copies of play money on page 26
- Optional materials could include whiteboard, poster pad, or newsprint.
- Optional: Poster/Handout of Clipmobile Challenge on page 24
- Optional: Copies of Junk Drawer Supply Company Materials Order Form on page 25

### Activity Timeline and Getting Ready

- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.
- Assemble packs of start-up materials for each group.
  - Fill a resealable bag with some materials that can be used in building the Clipmobile — one bag for each group.
  - Each bag should include some of each type of supplies available to the groups, but the bag should not include enough supplies to complete a full Clipmobile.

## Experiencing

1. Explain to youth about the budget. They will have \$45.00 to spend on materials that they will “purchase” from the materials supplier (you). Youth must learn the importance of staying on budget. For every dollar (\$1) under budget, they get an extra point. For every dollar (\$1) over budget, they must subtract two points. In determining budget, youth cannot return any materials purchased, but get dollar points for supplies in inventory at half the value of new ones. Materials broken or unusable will not have any credit value.
2. Review with the groups the concepts of design and manufacturing elements, and of form and function (from module 1 in *Give Robots a Hand*).
3. Highlight that engineers work at solving problems based on constraints in the task’s requirements. Some of those constraints will be listed in the Clipmobile activity.
4. Give limited instructions on the design task and customer requirements (constraints).
  - a. Provide each team with their start-up funds (\$45.00 play money).
  - b. Ask each team to review the Clipmobile Challenge and the Junk Drawer Supply Company procedures (found in the Robotics Notebook or on page 24).
  - c. Clipmobile Challenge (customer requirements):
    - i. Design a vehicle that will roll freely down a ramp and will travel (coast) a long distance (overcome friction).
    - ii. It must be able to hold (carry) a box of paper clips (capacity).
    - iii. It must contain at least five different types of parts (complexity).
    - iv. But it must use the least total number of all parts (efficiency).
    - v. Cost target: under \$35 of play money for all the parts and materials used to build one of their clipmobiles as designed.
5. Design Teams may purchase a sample bag of materials at the reduced cost of \$10.00 for planning and design.
6. Allow Design Team discussion and design on how to make the vehicle. Teams may use start-up supplies during design, but this is not a build time so no tools or building during this time.
7. Have each Design Team use the Robotics Notebook to plan and draw their ideas. Groups should make sketches of their plans.
8. Based on their design plan, each team will create a Materials Order Form (MOF) of all the supplies they wish to order (purchase) for building their Clipmobile.



## Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth reflect on the activity in their Robotics Notebook. Use more targeted questions as prompts to get to particular points. There is no one right answer.

- Ask Design Teams to discuss the vehicles they have designed with the entire group.
- How do you think friction will affect this vehicle?
- How did you use axles or bearings in the vehicle?
- Based on the design criteria, which part of the vehicle design is most important?
- What design criteria has to be included?
- How did you address all of the constraints of the customer requirements?
- What other parts or supplies might make it easier to design this vehicle?

## Generalizing and Applying

- Where might manufacturers have to be concerned about friction when they design a car?
- How about in designing a farm tractor or plow?
- Select an item either in the room or one commonly found and discuss constraints that might have been used during its design.
- Youth can apply what they have designed in Activity D.



# CAREER CONNECTIONS

## Career Connection 3: Constraints

There are many elements for engineers to consider when approaching a problem. Oftentimes, there are constraints that impact the engineering design process, especially in the type of design that can realistically be built. Engineers use their creativity and resources to overcome these obstacles.

Engineers must take time into account when devising a solution, because they often work on a deadline. “Time to market” is used to describe the time needed to plan, create, test, produce, and release a new product. The timely delivery of products to people is critical for companies to profit. To minimize their “time to market,” engineers work in teams, sometimes assigned to specialized components of the overall product.

Money is another constraint that engineers face. Engineers constantly search for less expensive materials that perform similarly to their expensive counterparts. Along with the expense of resources, engineers also must consider the availability of these materials. Certain supplies are sometimes unavailable, so engineers must find replacements and alternative equipment.

The physical elements of components also pose a challenge. Engineers must use physics and mathematics to ensure that the dimensions of their device will allow it to function correctly. They must find materials with properties that best suit the design.

- What are some constraints that you face in daily life? What are some ways you have found to work within those constraints?
- What do you think are some of the constraints in building a robot? Why?

## Clipmobile Challenge

Using what you have learned by exploring friction and movement, see how you can apply your knowledge for this design challenge.

### Customer Requirements for a Clipmobile

- Design a vehicle that will overcome friction and roll freely down a ramp, and travel a long distance (performance).
- It must be able to hold (carry) a box of paper clips (capacity).
- It must contain at least five different types of parts (complexity).
- But it must use the least total number of all parts (efficiency).
- Cost target is to be no more than \$35.00 of play money, including start-up supplies in inventory bag (budget).

### Manufacturing Selection Criteria

Criteria to select the team that will be chosen to mass produce the Clipmobile:

#### Meeting Design Criteria (constraints)

<b>Capacity</b> – carry a box of paper clips:	(Yes) 10 points; (No) 0 points	_____
<b>Performance</b> – roll down ramp and coast:	+1 point per inch – maximum 24 points	_____
<b>Complexity</b> – various types of parts used:	+2 points for each type of part	_____
<b>Efficiency</b> – least overall number of parts:	-1 point for each part used	_____
<b>Budget/cost</b> – cost of production:	+1 point for each dollar under \$35.00	_____
	-2 points for each dollar over \$35.00	_____

#### Team Business Strength

<b>Capital</b> – dollars left from \$45.00	+1 point for each dollar still in cash	_____
<b>Inventory value</b> – value of supplies in inventory	+1 point for each dollar of value	_____
	Overall Team Score	_____

## Junk Drawer Supply Company

JDSC is the official supplier of all materials for Clipmobile design, development, and manufacturing. Thank you for using JDSC.

How to get parts and supplies:

1. The Junk Drawer Supply Company will provide each Design Team with a Materials Order Form (MOF) and a sample of the different items for sale. This sample pack of supplies will only cost \$10.00 for the whole bag of supplies (Over a \$25.00 value of supplies — what a bargain!). These items can be used in your design process and in your building activity.
2. During the *Design*, complete the MOF, listing the total number of each part or item you plan to use.
3. Calculate the cost for each type of part you have ordered.
4. Add up all the costs for parts to get the total dollar amount needed to purchase all the items.
5. During the *Build activity*, have one of your team members take the completed MOF to the Junk Drawer Supply Company area to pay for and pick up the materials ordered.
6. The Junk Drawer Supply Company has limited operating hours and will close after all the teams have filled their orders. Make sure to order enough to build your Clipmobile, but try not to have too many extras as leftover inventory is only worth half of its cost new.
7. The Junk Drawer Supply Company is very picky and will not accept any returned parts or items.

Junk Drawer Supply Company Clipmobile Materials Order Form (MOF)				
	Sold to: _____			Order Date _____
Item Code #	Item/Part Description	Price per Item	Number Ordered	Total Cost (Price X Number)
101	Craft Stick – Large or small	\$3.00		
102	Craft Stick w/ holes – Large or small	\$4.00		
203	Paper Clip – Large or small	\$1.00		
304	Brass Paper Brad – Various sizes	\$1.00		
405	Binder Clip – Various sizes	\$2.00		
506	Drinking Straw – Various sizes	\$2.00		
507	Coffee Stirrer Straw	\$1.00		
608	Rubber Band – Various sizes	\$1.00		
709	Wheel – Various sizes	\$3.00		
810	Wood Skewer – Various sizes	\$2.00		
Thanks for using Junk Draw Supply Company. See us first for all your robot supplies!		Grand Total:		







# Activity D – Clipmobile Build Team

## Performance Task For Youth

You will build or assemble a complex Clipmobile, considering and addressing effects of friction and design constraints.

### Success Indicator

Youth will be able to build a vehicle to overcome friction and other constraints to roll freely down a ramp.

### List of Materials Needed

- Robotics Notebook
- Activity Supplies
  - Collection of parts or materials that can be used in creating the Clipmobile
  - Different sizes of paper clips, binder clips, paper brads, and clothespins
  - Craft, paint, or wood sticks
  - Various sizes of coffee stirrers and drinking straws (axles and bearings)
  - Variety of other items, including toy wheels or disks, at least four per group
  - Cardboard for ramp – about 12 inches by 36 inches in size; one or more ramps can be shared for test runs.
  - Optional: Copies of Cost of Production and Materials Inventory sheets on page 30
- Toolbox
  - No tape or glue to be used in making the Clipmobile
  - Hand drill and bits
  - Hacksaw
  - Pliers, scissors, punches, if needed

### Activity Timeline and Getting Ready

- Activity will take approximately 30 minutes.
- Use the same teams from Activity C.

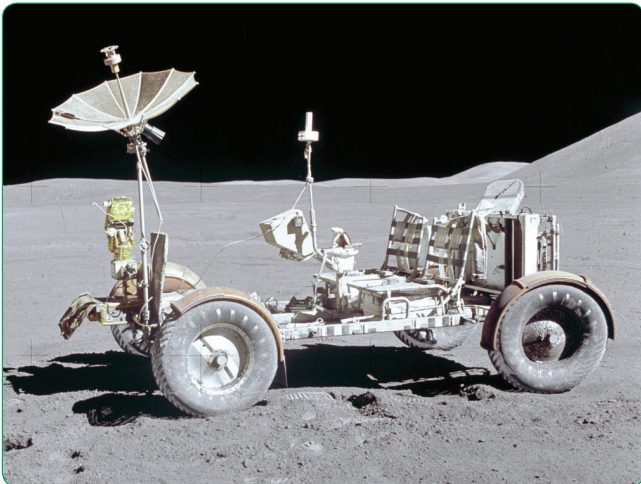


### Experiencing

1. Review design challenge and customer requirements for the Build Teams.
  - a. Build a vehicle that will roll freely down a ramp and will travel (coast) a long distance (overcome friction).
  - b. It must be able to hold (carry) a box of paper clips (capacity).
  - c. It must contain at least five different types of parts (complexity).
  - d. But it must use the least total number of all parts (efficiency).
  - e. Cost target is to be less than \$35.00 of play money, including start-up supplies in inventory bag (budget).
2. Build Teams will start with the following from the Design Team activity:
  - a. Start-up bag of sample supplies used in design activity
  - b. \$35.00 of play money start-up funds (dollars left after purchase of start-up supply bag)
  - c. Materials Order Form completed in the design activity
  - d. Clipmobile plans created in the design activity
3. Allow each team to go to the Junk Drawer Supply Company (JDSC) with their MOF (Materials Order Form) and play money to purchase supplies.
  - a. The materials for the Build Teams will need to be organized for “sale” to the teams.



- b. The parts may be sorted and stored in plastic bags or other containers for easy distribution.
  - c. The JDSC will need play money for change when selling items.
  - d. The JDSC will be open at the beginning of the build activity and parts will be distributed based on each Design Team's Materials Order Form.
  - e. The Build Teams will pay for all the items ordered and picked up.
  - f. The JDSC will close after filling the Materials Order Forms; no additional parts can be purchased or used.
4. Build Teams are to construct, test, and modify their Clipmobile designs.
  5. When vehicles are complete, have the Build Teams complete their budget cost sheet and leftover supplies (inventory).
  6. The teams are to present their vehicles, cost sheets, and inventory sheets, and demonstrate how their Clipmobile can hold the weight of a box of paper clips and roll down a ramp.
  7. Youth should make notes in their Robotics Notebook to record actions and modifications (what worked, what didn't work, how it was modified).



## Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth reflect on the activity in their Robotics Notebook. Use more targeted questions as prompts to get to particular points. There is no one right answer.

- What design shapes worked well?
- What design shapes did not work well?
- What are some ways these vehicles overcame or used friction to help in their design?
- What seemed to work well for axles?
- What would have to be changed to haul heavier loads?
- How did the customer constraints affect the building of the Clipmobiles?

## Generalizing and Applying

- How would you get a bicycle to coast farther without peddling?
- Where on a bicycle would you want to have friction? Or less friction?
- Have groups review the data they have gathered in their Robotics Notebook from the previous activities. Ask them to develop a hypothesis about friction – what are the properties of friction?
- What are some additional constraints that you think could be placed on this build?
- Youth can apply what they have learned in Module 2, Watt's Up.

## Build Team

# Clipmobile Reports

How to figure **Cost of Production** of a Clipmobile:

1. Take your completed Clipmobile and evaluate all the components and parts used.
2. Use the COP (Cost of Production) sheet and fill in the information.
  - List the number of each type of part used; how many wheels, how many brads, etc.
  - Calculate the cost of each type of part used in the Clipmobile.
  - Check the last column for the types of parts you used in building the Clipmobile.
3. At the bottom of the COP, calculate the totals for:
  - The total number of parts
  - The total cost of the parts used to build your Clipmobile
  - The total of the different types of parts used

You may have some parts that you did not use or parts that you cut or bent, or that broke when working on them. Sort these extra leftover parts into two stacks: one stack is good parts that could be used on a different activity, and a second stack is the broken, bent, or used parts that are not like new. Since the first stack is good as new, take an inventory (count) of them and record it on the Materials Inventory Sheet (MIS).

How to determine **Supply Inventory** on hand after building the Clipmobile:

1. Take the stack of good unused parts:
  - Group them by their type of part.
  - Count how many of each type and record the number on the MIS (Materials Inventory Sheet) in the “number on hand” column.
  - Calculate the value of each type of part. (Notice that those which are “used” have a value less than “new” parts.)
2. On the bottom, add up the totals for:
  - Total number of parts on hand (in inventory)
  - Total value of parts in inventory
3. Have a representative of JDSC (facilitator or leader) verify your inventory stock and your MIS sheet.

## Clipmobile Report – Cost of Production (COP)

Clipmobile Report					
Cost of Production (COP)					
Date of Production:		Location of Mfg.:		Manufactured by:	
Item Code #	Item/Part Description	Price Per Item	Number Used in Vehicle*	Total Cost (Price X Number)	Check Items Used in This Build
101	Craft Stick – Large or small	\$3.00			
102	Craft Stick w/ holes – Large or small	\$4.00			
203	Paper Clip – Large or small	\$0.50			
304	Brass Paper Brad – Various sizes	\$1.00			
405	Binder Clip – Various sizes	\$1.00			
506	Drinking Straw – Various sizes	\$2.00			
507	Coffee Stirrer Straw	\$1.00			
608	Rubber Band Various sizes	\$1.00			
709	Wheel – Various sizes	\$3.00			
810	Wood Skewer – Various sizes	\$2.00			
*include full value even if only part of an item was used, cut in half, taken apart, etc.		<b>Totals</b>			
			<b>Total Parts Used</b>	<b>Total Cost of Production</b>	<b>Total Parts Used</b>

## Clipmobile Report – Materials Inventory Sheet

Clipmobile Report				For office use only	
Materials Inventory Sheet (MIS)					
List of supplies left over and in good condition					
Date of Inventory:		Location of Mfg.:		Name of Manufacturer:	
Item Code #	Item/Part Description	Used Value Per Item	Number of Good Items Still on Hand*	Total Value (Price X Number)	Verification of Inventory on Hand
101	Craft Stick – Large or small	\$1.50			
102	Craft Stick w/ holes – Large or small	\$2.00			
203	Paper Clip – Large or small	\$0.50			
304	Brass Paper Brad – Various sizes	\$0.50			
405	Binder Clip – Various sizes	\$1.00			
506	Drinking Straw – Various sizes	\$1.00			
507	Coffee Stirrer Straw	\$0.50			
608	Rubber Band Various sizes	\$0.50			
709	Wheel – Various sizes	\$1.50			
810	Wood Skewer – Various sizes	\$1.00			
*only include complete items in good usable condition; not those cut, drilled, bent, taken apart, etc.		<b>Totals</b>			
			<b>Total Parts Not Used</b>	<b>Total Value of Parts on Hand (Inventory)</b>	