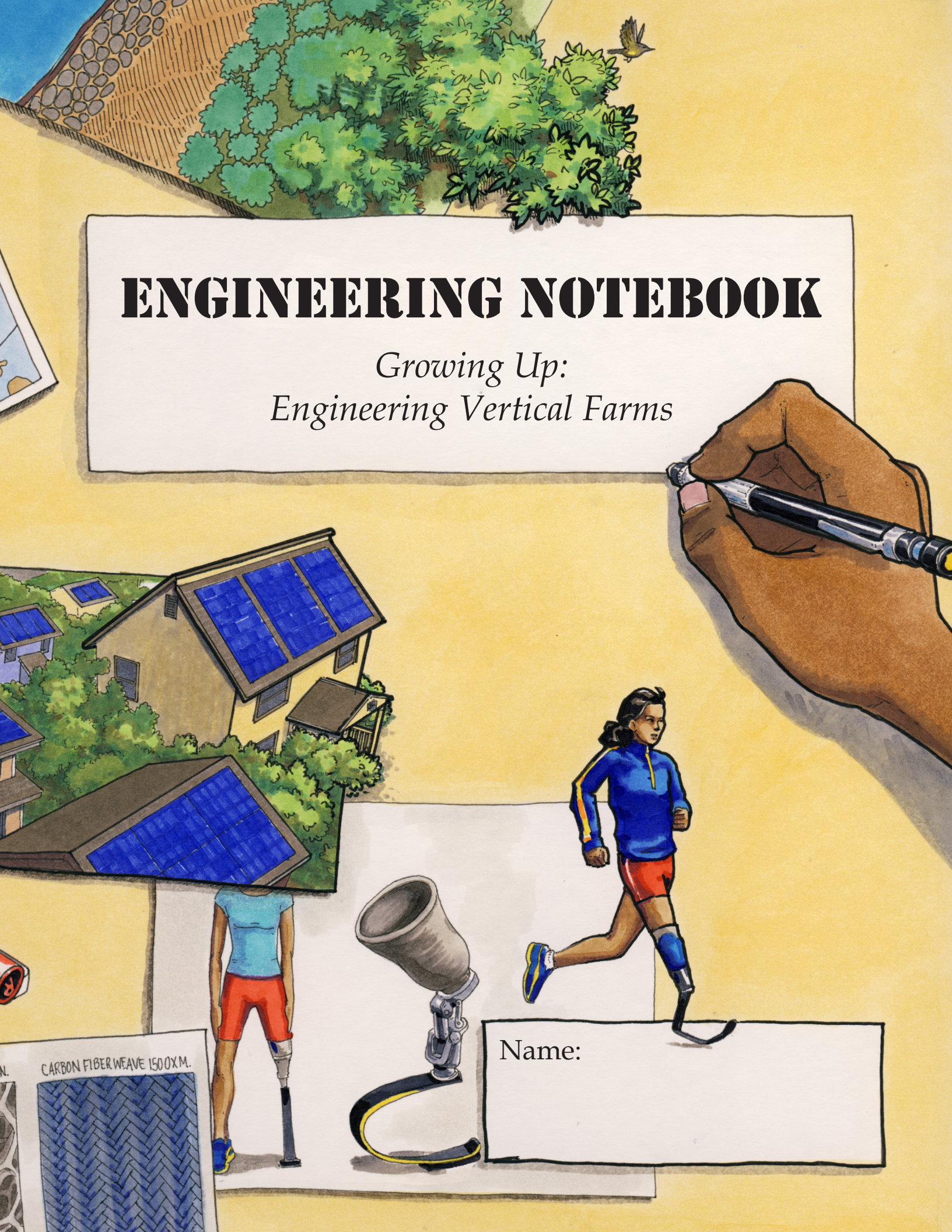


ENGINEERING NOTEBOOK

Growing Up:
Engineering Vertical Farms

Name:

Understand the engineering problem

- Define the problem in your own words

Gather details

- Learn about what others have done
- Explore possible materials or processes you could use for your design
- Conduct science experiments to gather data

Come up with different ways to solve the problem

- Use your creativity to think of lots of ideas that could work
- Evaluate the pros and cons of each idea
- Pick one idea that is a good starting point

Figure out the details of your design

- Discuss how it will work
- Draw diagrams and list materials
- Decide how you will test and evaluate

Build your design

- Follow your plan
- Fix small problems
- Record any changes to your plan

Evaluate how well your design works

- Test multiple times
- Record your observations and findings
- Figure out which parts are working well and which parts are not

Make changes to your design based on testing

- Decide what to change
- Put your changes into a new plan
- Build your improved design and test again

Share your solution with others

- Explain strengths and weaknesses of your solution
- Share how you used the Engineering Design Process
- Ask people for feedback

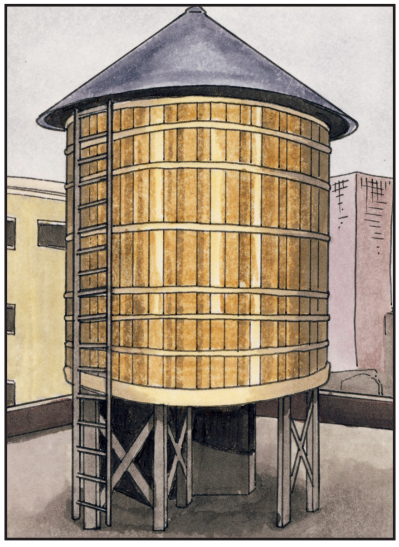
Criteria and Constraints

In engineering, guidelines for your design are called criteria and constraints.

GOAL: Engineer a model tower that can support a water collection tank.

CRITERIA **Things you or your design needs to do**
You will work in groups to engineer your tower.
Your tower must be at least 1 foot tall, not including the water container.
Your tower must hold the deli container filled with water for at least 10 seconds.

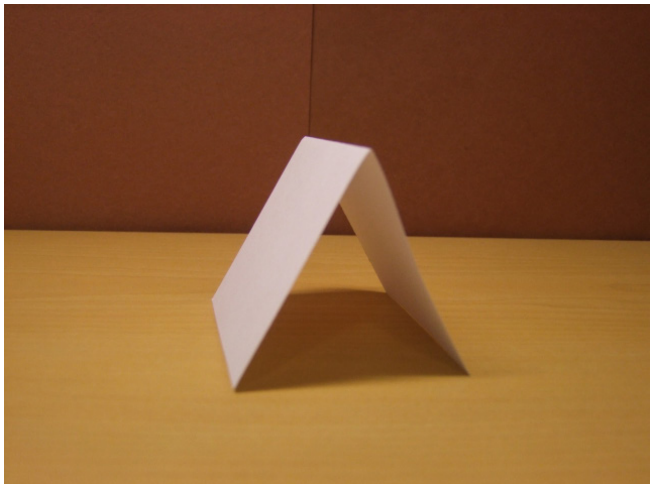
CONSTRAINTS **Ways you and your design is limited**
You will have 100 index cards, masking tape, a measuring tape, and a pair of scissors.
The scissors and measuring tape cannot be used as a part of the tower.
You only have 20 minutes to *create* on your tower.
You can hold the deli container filled with water as you build, but you cannot *test* with it until the official testing time begins.



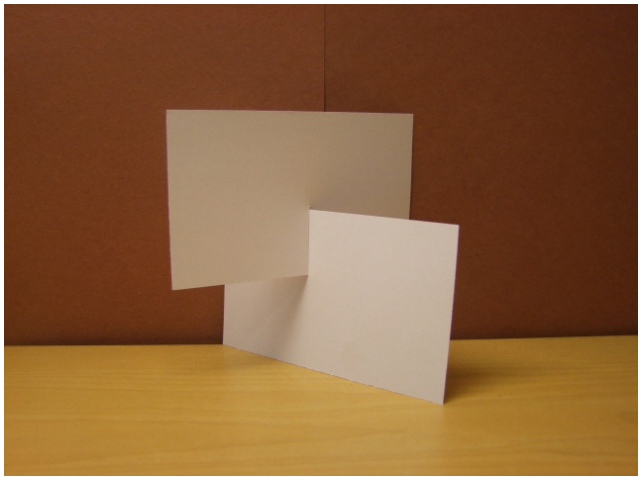
Building With Cards

Here are three ways to build with index cards:

Roll it



Fold it



Cut it

Will any of these ideas help your group build a tower?

What other ideas do you have?

Talk with your group to figure it out!

Greentown: Request for Proposals

To: Engineering Everywhere Engineers
From: Greentown City Council
Subject: Request for Vertical Farm Proposals

Dear Engineers,

The City of Greentown is an American coastal city with 500,000 residents. Greentown is not located near any major agricultural centers, so nearly all of the fresh food found in Greentown grocery stores is shipped from other locations. The citizens of Greentown are interested in ways to create local, sustainable sources of fresh fruits and vegetables. The Greentown City Council is requesting proposals from agricultural engineers interested in creating a vertical farm in our city. We are requesting that engineers make models first. If a successful model is engineered, the council would then consider *creating* a real vertical farm.

In order to be considered, engineers must create a model vertical farm of at least three levels and each level must contain and support at least one model plant. Engineers must *create* and *test* working water and light systems for this model to ensure the plants will have the resources they need to flourish.

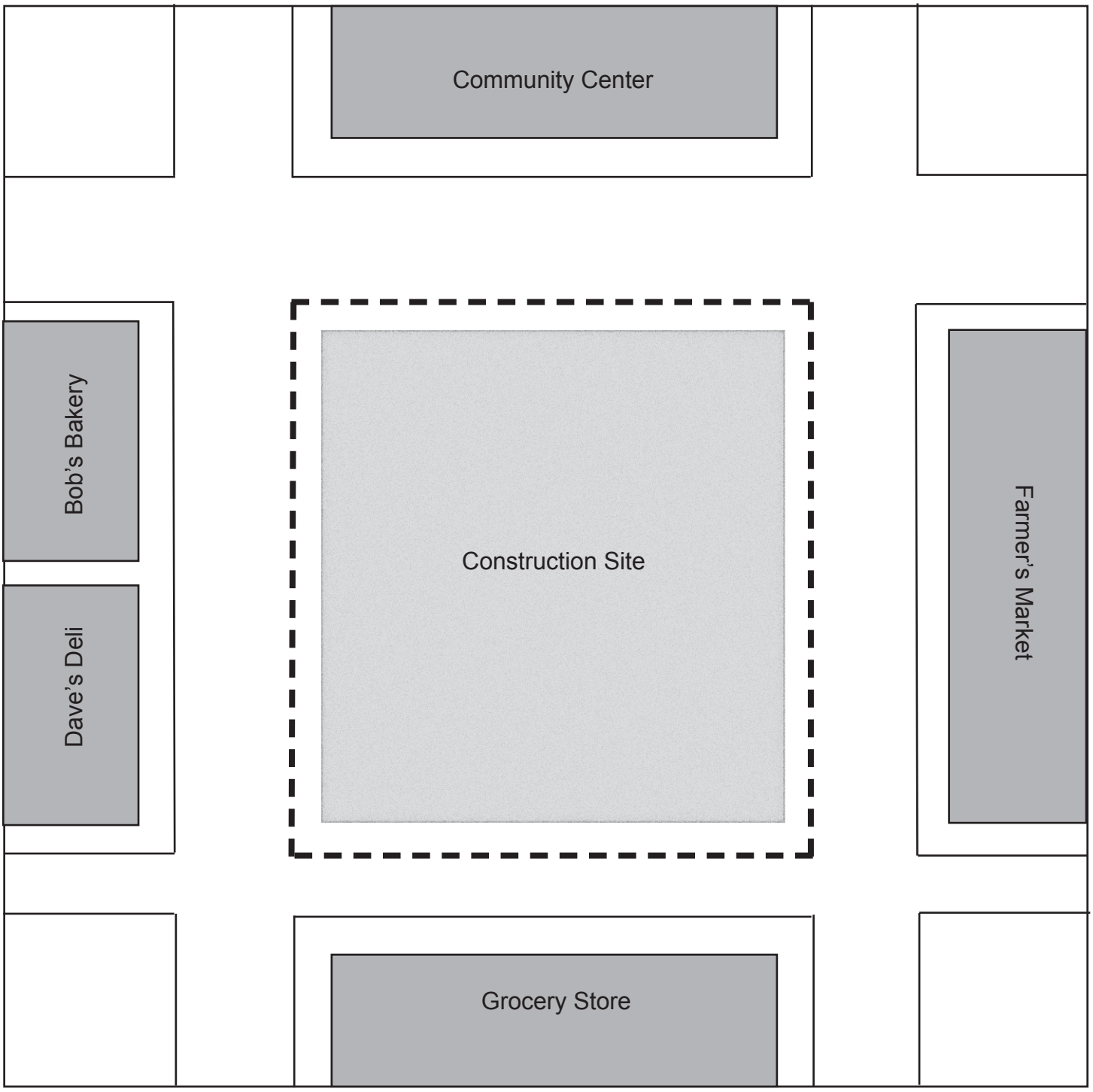
Engineers must create a visual presentation to present to the Greentown City Council at the conclusion of their engineering challenge.

Sincerely,

Chairman Berman

Greentown Request for Proposals: Building Site

Greentown Population: 500,000



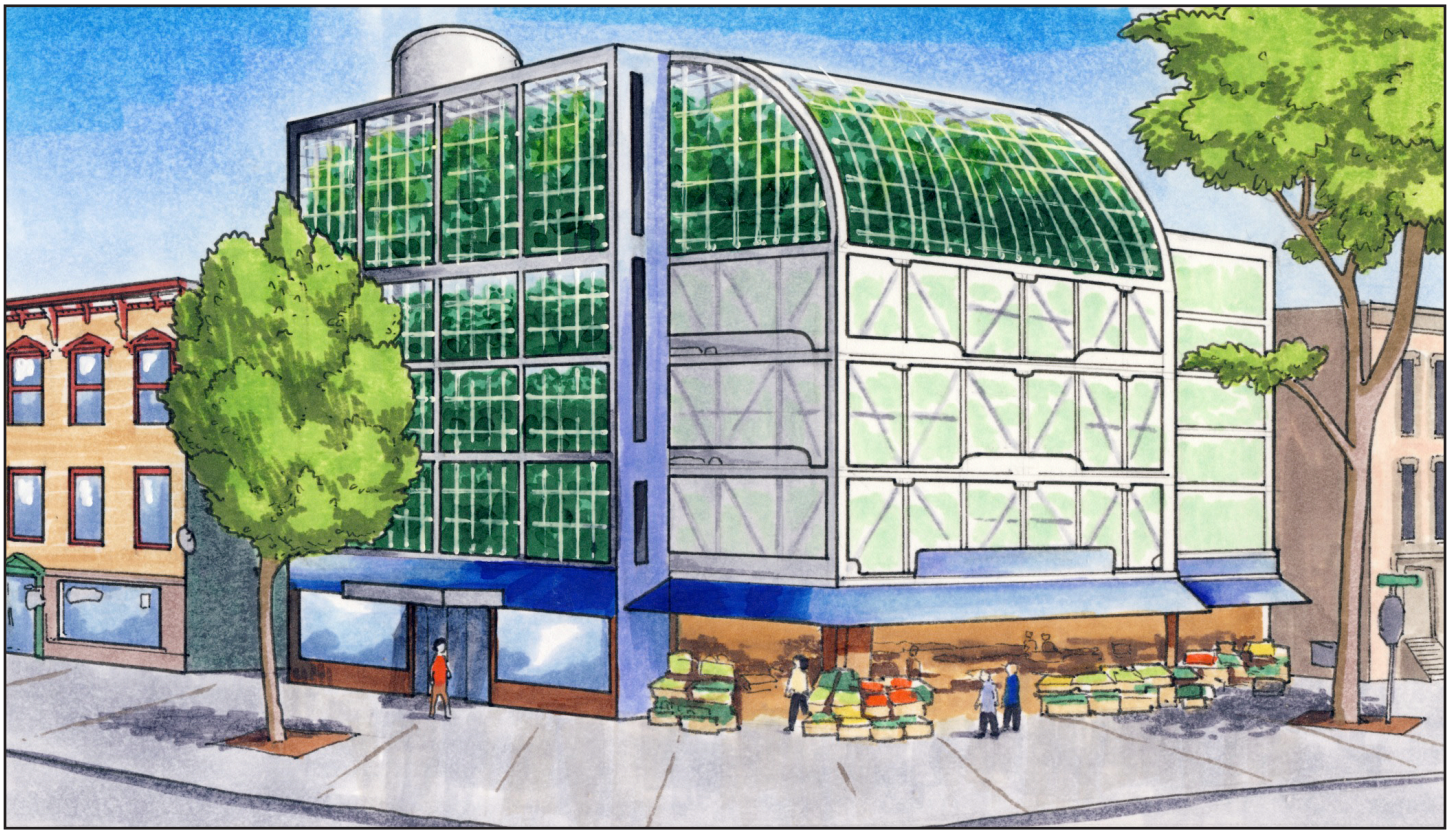
Vertical Farm Prototypes

Look at the two vertical farm prototypes. Consider the following questions:

What are the functions of these buildings?

How are the designs of the vertical farms the same?

How are the designs of the vertical farms different?



Record Your Observations:

Vertical Farm Prototypes

What surprises you about these designs?

What are some potential benefits of building a vertical farm near where you live?

What are some potential drawbacks of building a vertical farm near where you live?

What elements of these designs could you incorporate into your own vertical farm design?

Engineer Profile

Think about yourself as an engineer.

✓ Check off your engineering strengths.
◯ Circle any engineering skills you'd like to practice getting better at throughout the rest of this engineering unit.

- ☐ communicating
- ☐ building things
- ☐ imagining
- ☐ being creative
- ☐ drawing
- ☐ working on a team
- ☐ leading a team
- ☐ analyzing data
- ☐ making a plan
- ☐ offering critical feedback on others work
- ☐ receiving feedback on your own work
- ☐ moving forward after something doesn't work
- ☐ thinking of different ways to do something
- ☐ solving problems
- ☐ troubleshooting problems

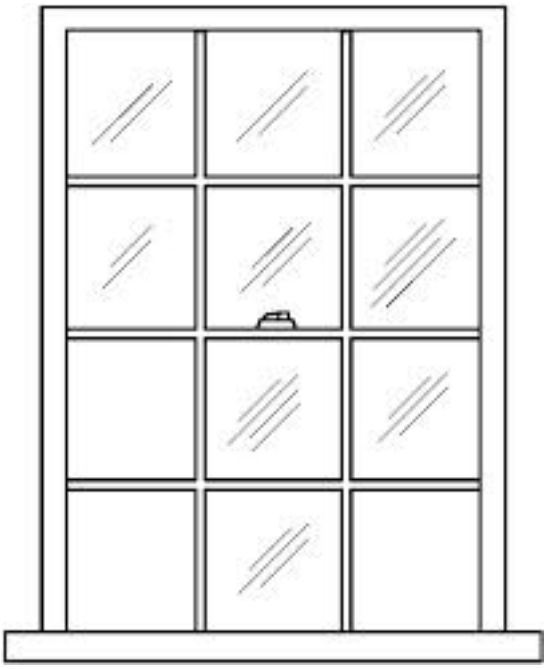
Are there other engineering skills that you feel are strengths or things you hope to get better at? List ideas here and add to your list as you move through the unit.

Can you think of a technology you use everyday that you could use engineering to improve? How would you improve it?

Window Garden Challenge

GOAL: Engineer a window garden that supports 3 plants using as little horizontal space as possible.

CRITERIA **Things you or your design needs to do**
You will work in groups to engineer your garden.
Your garden must support 3 plants.
Your garden should take up as little horizontal space as possible.
You garden must be able to hang on a sturdy hook or using suction cups on a pane of glass.
Your garden should be able to deliver all resources necessary for plant growth, including light and water.



CONSTRAINTS **Ways you or your design are limited**
You will have 3 recycled bottles and can only use the materials available.
The scissors and measuring tape can be used as tools but cannot be used as a part of the structure.
You have 30 minutes to *create* your garden structure and 10 minutes to plant your plants.

Window Garden Examples

Window Garden: Plan

Draw Your Window Garden

Use the space below to draw your group's window garden plan.

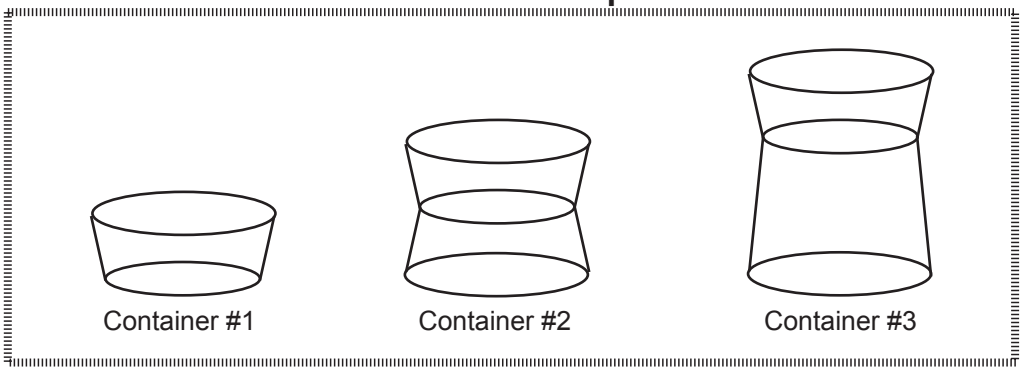
Designing a Water System

Engineering Challenge: Engineer a water system that delivers water to 3 levels.

Here are the criteria and constraints for your closed water system:

CRITERIA Things you or your system needs to do	CONSTRAINTS Ways that you or your system is limited
You will work in groups to engineer a water system.	You may only use the available materials.
Water must be delivered to 3 separate containers at 3 different heights, representing the levels of a vertical farm.	You will have 25 minutes to create your design.

Container Setup



Container #1: 8 oz. container placed on table top.

Container #2: 8 oz. container placed on top of an upsidedown 8 oz. container. Tape 2 containers together.

Container #3: 8 oz. container placed on top of an upsidedown 16 oz. container. Tape 2 containers together.

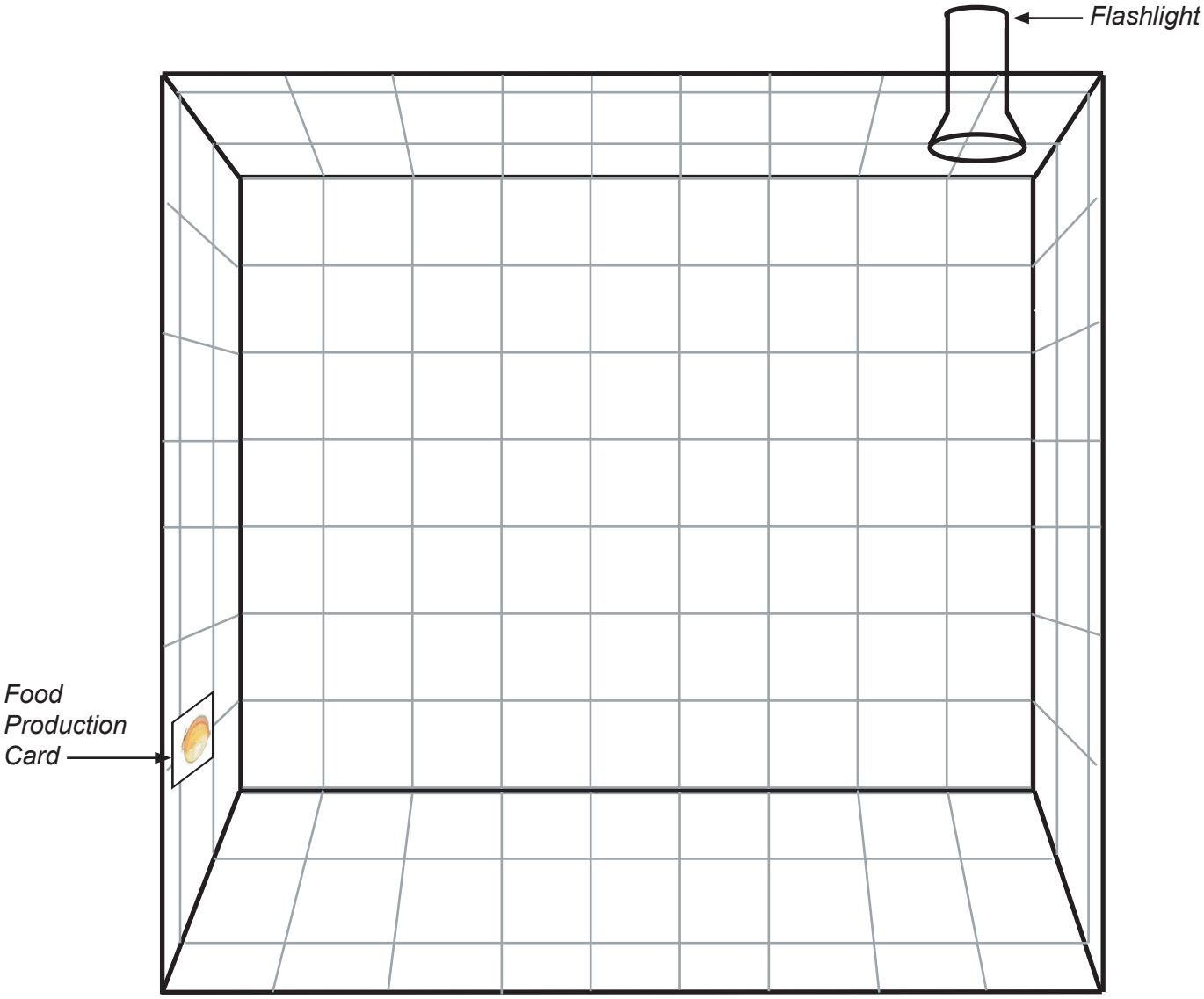
Water System Design

Sketch a plan for your water system in the space below. After you *test*, mark areas of your design that need improvement.

Lighting System Design

CRITERIA	CONSTRAINTS
Your lighting system should direct light onto the *Food Production Card.*	You can use up to 3 mirrors. You can use parabolic or flat mirrors. Other items available include modeling clay, craft sticks, pipe cleaners, and masking tape.
	You will have 20 minutes to engineer.

Draw a plan for your lighting system design below. Mark the path you expect the light to take.



Test your lighting system by turning the flashlight on and off. How much does the needle on the light meter change? Record your results below.

- ☐ A little
- ☐ A lot
- ☐ Not at all

The Challenge

CHALLENGE: Engineer a model vertical farm to meet the needs of the city of Greentown.

CRITERIA Things you or your design needs to do	CONSTRAINTS Ways you or your design is limited
Each group will engineer one room of the vertical farm. The rooms will then be connected to make the full structure.	Building materials must be gathered from the Materials Table.
Each room must support at least one model plant.	
Plants must be watered by an engineered pump system.	The entire structure cannot be less than 3 levels high.
Plants must receive light by an engineered lighting system.	

MATERIALS TABLE	
□ aluminum foil	□ model plant
□ aluminum tray	□ pipe cleaner
□ craft stick	□ pump
□ deli container, 16 oz.	□ soil
□ mirror, flat	□ tubing connector
□ mirror, parabolic	□ tubing splitter
□ modeling clay	□ vinyl tubing

Plan

Draw a detailed plan for your group's model vertical farm in the space below. Choose colors and add them to the key to distinguish between the systems and the structure. Make sure to label your drawing and keep track of your materials.

Test

Follow the testing procedures below to determine how well your model vertical farm directs water and light to the model plant. Record your data in the table.

Water System Testing Procedure

1. Set the meter to the moisture setting. Place the probe into the soil at the base of the testing plant.
2. Mark the starting position of the water meter needle on the data table.
3. Turn on the water pump and run the system for one minute.
4. Mark the new position of the water meter needle on the data table.
5. Did you observe water reaching the plant? Record your observations on the data table.

Light System Testing Procedure

1. Set the meter to the light setting. Put the sensor at the base of the testing plant. Be sure the side with the sensor is facing in the direction the light is coming from.
2. Cover the first mirror in the lighting system. Turn on the flashlight and mark the starting position of the light meter needle on the data table.
3. Uncover the mirror in the lighting system.
4. Mark the new position of light meter needle on the data table.
5. Did you observe light from the flashlight on the plant? Record your observations on the data table.

Water	1 2 3 4 5 6 7 8 9 10 Did water reach the plant? ☐ Yes ☐ No
Light	A B C D E F G H Did light reach the plant? ☐ Yes ☐ No

Which system will you focus on improving?

☐ **Water** ☐ **Light**

Improve: New Plan

Draw a detailed plan for the improvements your group intends to make to one system of the model vertical farm. Add the colors to the key used in the last activity. Make sure to label your drawing and keep track of new materials you use.

You may want to **continue to test your design** as you *improve* it. Use the tables below to record data from additional trials.

	Test 1	Test 2	Test 3
Water	1 2 3 4 5 6 7 8 9 10 Did water reach the plant? ☐ Yes ☐ No	1 2 3 4 5 6 7 8 9 10 Did water reach the plant? ☐ Yes ☐ No	1 2 3 4 5 6 7 8 9 10 Did water reach the plant? ☐ Yes ☐ No
Light	A B C D E F G H Did light reach the plant? ☐ Yes ☐ No	A B C D E F G H Did light reach the plant? ☐ Yes ☐ No	A B C D E F G H Did light reach the plant? ☐ Yes ☐ No

Communicate

6

During your presentation, you will get to share information about your engineering challenge with the Greentown City Council. What are some things you might want to tell them about engineering a vertical farm in their community?


lines for streamlining and shock absorption
frontal view
lateral view
padding
center of
ventilation hole
20° from top to
PREVAILING WINDS IN HARBOR AREA
Wind Power Turbine
Gear-box
Rotor-blade
Nacelle
Hub
Brake
GERULON MICROFIBER