UNIT 7

Skill Building

UNIT OVERVIEW

UNIT NUMBER: 7

DURATION: Up to 20 in-class hours depending on mini-challenge selection and adaptations for interest or experience level

SUMMARY

This unit will focus on the development of one or two new or interesting skills for individual students or groups within a team. The process defined will guide individuals or small groups of individuals with similar goals, in the selection of a key skill area for development. Students will select one or more mini-challenge scenarios to be completed or adapted as an independent project (with support from team/classmates, teachers/mentors, and *FIRST*-vetted resources), and then present evidence of their new skill development to classmates in peer-to-peer presentations or a small group mentoring session.

INSTRUCTIONS

1. As a class, speak in general terms about the value of setting goals for personal development.
2. Provide students with the Individual Engineering Notebook. Have them complete the Personal Goals section to help them identify an area of skill development that they would like to explore.
3. Divide students into pairs or small groups and have them discuss their goals for personal development with their partner or group. Encourage students to provide each other with constructive input and ideas about their goals and how they can accomplish them. (e.g., resources, ideas, tools, etc.)
4. Review the mini-challenge scenarios with students and have them select one or more mini-challenges to complete or adapt to suit their personal goals or current level of ability. Students may work together in small groups or work to complete their challenge individually. Let students know that this unit will end with a peer-to-peer presentation to demonstrate the experience and skills they have gained.

LEARNING RESOURCES

***FIRST* Tech Challenge Self-Reflection and Planning Resources**

- Individual Engineering Notebook
- Skill Development Reflection

Programming Resources

- Java4Robotics curriculum

CAD Resources

- PTC for FIRST Teams

5. Provide students with time to complete their challenge. Encourage them to assist each other where possible, and to document their experience, as well as effective resources they've used throughout the process. This is similar to what they would do during the competition season in their Engineering Notebook.
6. Have students assemble evidence of their skill development in the Demonstrate your Experience section of the Individual Engineering Notebook. They will use this to share their learning with classmates in peer-to-peer presentations. Presentations can be completed informally in small groups with similar interests, or more formally to the class.

- 3D Printing for FIRST Teams Blog Series by PTC

ASSESSMENTS:

1. Weekly Engineering Notebook
2. Weekly Self & Peer Evaluation
3. Individual Engineering Notebook
4. Skill Development Reflection
5. Skill Development Checklist
6. Mini-Challenge Scenarios

TOOLS & MATERIALS

1. Tetrix Kit of Parts or Rev Kit of Parts
2. Programming Software (based on availability and interest)
3. CAD Software (based on availability and interest)
4. Graphic Design Software (based on availability and interest)
5. Collaboration Software (based on availability and interest)

STANDARDS ADDRESSED:

Full course standards alignments can be found here.

PERSONAL GOALS

The mission of *FIRST* is to inspire young people to be science and technology leaders and well-rounded contributors to society. While the *FIRST* Tech Challenge itself is a team-oriented competition, the personal growth and development of individual students and their skill sets both within and around the STEM field are integral to the experience. Students gain valuable life and work skills they can take beyond the competition or classroom.

As a class, talk about the value of goal setting in terms of personal development. As a warm up activity, it may be a good idea to have students share a goal they have set and achieved in the past. Students can draw from experiences outside the context of *FIRST* or the classroom (e.g., learning to change a tire, getting a driving permit, making a new friend, baking a cake, earning enough money at a part-time job to buy a laptop).

After speaking generally about personal goals, have students consider their experience with the *FIRST* Tech Challenge.

Divide students into small groups and provide them with the Individual Engineering Notebook resource.

The Individual Engineering Notebook is a **personal** resource to help students identify and document their own goals, ideas, progress and achievements, just as the Engineering Notebook for the *FIRST* Tech challenge chronicles the process of problem solving, engineering design, and **team** development. The goal of the Individual Engineering notebook is to guide students through a process of self-assessment and practical goal setting. The process results in documented evidence of skill development in engineering and related fields, that can be demonstrated to peers, parents, teachers, on post-secondary applications, or to potential employers.

Have them complete the section on PERSONAL GOALS individually and then share their ideas with a neighbor.

Guiding Questions:

1. What were some of the goals you had when you started the *FIRST* Tech Challenge?
2. How do you see those goals being useful to you in your social, academic, or professional lives?
3. Have you achieved any of those goals through your experience with the *FIRST* Tech Challenge? If so, which ones?
4. Are there any goals you had at the beginning of this experience that you have not yet achieved?
5. What roles, tasks, or responsibilities did you take on throughout the *FIRST* Tech Challenge?
6. Where there any roles, tasks, or responsibilities you would like to have tried, that you didn't have a chance to try?

HINT:
It may be a good idea to have students speak with classmates or team members who have been involved with roles that are different from their own, to discuss tasks, benefits, and challenges involved in taking on those responsibilities. These students may also prove valuable later in the activity, as resources to support individuals as they complete their selected challenges.

Personal Goals Facilitator's Tips:

Q: How can I encourage students to share their goals and ambitions?

A: It's important to set a tone and expectation of open-mindedness and inclusivity in the classroom. Teachers may wish to revisit the *FIRST* Values to encourage Gracious Professionalism® and Coopertition®.

Students should be reminded that an individual's goals and motivations may be surprising to you, but are deeply personal and fundamentally important to them. This unit presents an opportunity for students to branch out and take a supported risk. Assumptions or biases about what a person or group should or shouldn't be interested in can have a significant effect on student engagement.

You may also share a goal that you have worked on currently or in the past, and how you pursued it. What did you do? What went well? What didn't go well?

SELECT A CHALLENGE

After completing the Personal Goals section of the Individual Engineering Notebook, review the eight mini-challenge scenarios with the class.

The mini-challenge scenarios and Driving Questions can be provided to students from the Mini-Challenge Scenarios resource document. The resource also includes a template for students to map out initial and formative questions they will need to ask themselves and others to complete the objective of their mini-challenge.

While the mini-challenges have been developed as shorter, self-contained activities, teachers or students may wish to combine or integrate challenges, or have students work together to create more complex, interdisciplinary challenges.

Additional (Optional) Challenges have been provided in the instructor's notes for each mini-challenge to encourage adaptation and expansion of the activities to suit the individual needs of a student working independently, or to meet the integrated needs of a small group of students with complimentary goals.

Guiding Questions and Suggested Resources have also been included.

Select a Challenge Facilitator's Tips:

Q: How should the mini-challenges be introduced to students?

A: The mini-challenges can be introduced and discussed by the class together or students may review them in small groups of individuals with similar goals. In some situations, teachers may wish to discuss student goals individually and then offer suggestions about challenges or adaptations that may be suitable.
Regardless of how the mini-challenge scenarios are introduced, the selection of an area for skill development should be student-driven and connected to the goals students have outlined in the Personal Goals section of the Individual Engineering Notebook.

Q: How can I encourage students to try something new?

A: Some students may be interested in a different area of development, but hesitant to try something outside their comfort zone. Some students may become frustrated, intimidated, or feel as if they have failed if they cannot easily accomplish the objective they have set for themselves.
Students should be encouraged to adapt mini-challenges to suit their level and interest, but not to shy away from the "challenge" part. It's important, at this point in the process, to emphasize that valuable lessons can be learned from attempts that are less than successful. Setting realistic but challenging objectives is a skill, in itself, that has to be developed. It's ok to modify the objectives of the mini-challenge (before or during the challenge), or to isolate one component of it as a more manageable task for skill development.

Q: How can students be assessed when they are completing customized challenges?

A: Challenge scenarios are intended to be open-ended, student-directed, and adaptable. Assessment will be based on student self-evaluation and their ability to provide and explain evidence of their learning.

A Skill Development Checklist has been provided for teachers to document and track student progress through the process outlined in the Individual Engineering Notebook.

A Skill Development Reflection resource has also been provided for students to evaluate and think critically about their own experience with the challenge.

Q: How many mini-challenges should students complete?

A: The mini-challenges have been created as independent projects for completion, but may also be combined or completed one after the other if students have broader goals or more experience with the required skill set.

Suggestions have also been provided with each scenario to add additional challenge or complexity. Students should be encouraged to modify the challenge or increase its level of complexity to suit their needs and ambition.

Space has been provided to develop and make note of adaptations to the challenge, both in the Select a Challenge section of the Individual Engineering Notebook, and on the individual Mini-Challenge Scenarios document, where students can modify the Driving Question.

Teachers may wish to guide students in this process by suggesting an Additional (Optional) Challenge or by having students with complimentary goals work together to complete different aspects of an expanded challenge.

MAKE A PLAN AND COMPLETE THE CHALLENGE(S)

Think about the steps and resources needed to complete the challenge.

HINT:
In an open-ended challenge, expect that the tasks will change as the project evolves and students gain a better understanding of what is required to meet their objectives, or the time and resources available to them.

Use the template provided in the Individual Engineering Notebook, select one of the Make a Plan templates from Unit 6, or have students create their own timeline of tasks, resources, and learning that will need to take place to accomplish the challenge.

Have students complete the challenge they have selected or adapted, using the Make a Plan section as a living document to track, not just the tasks they are completing, but how they are adapting to the challenge and how they are adapting the challenge to their needs or goals.

As they learn and work to complete the challenge, they should gather evidence of their progress in the form of notes in the Individual Engineering Notebook, images, links to videos they have created and posted, or screen shots of programming progress. The Notes and Observations section of the Individual Engineering Notebook can be copy and pasted in word doc format, or reproduced in hard copy to document progress, observations, and notes as students complete each work session. There is also a section for Steps for Next Session to help students target and document priorities and prepare for the next work session.

It's important at this point, to also draw student attention to the Demonstrate your Experience section of the Individual Engineering Notebook.

Make sure that students understand that they will need to provide evidence of their skills (even if they are different from their original goals) in the final step of this unit, where they will share their learning with classmates.

Make a Plan Facilitator's Tips:

Q: How can the Make a Plan section in the Individual Engineering Notebook be used?

A: The Make a Plan section is intended to function as a living document, where students can identify tasks and subtasks and create a general timeline to complete them. Additional steps may be added or steps may be removed as students work to complete their challenge, or modify it to better suit their level or timeframe.

Changes can be documented in the Notes section, or the whole Make a Plan section of the document may be copied and pasted repeatedly with version numbers to show how the plan evolves as the student starts to think more critically about which tasks really matter and which tasks may not be as relevant as they had initially planned.

Students should be encouraged to adapt the section to their needs and documentation style. This is an area to work through the steps and track valuable resources or developments. Teachers can periodically review this section with students as a formative assessment to identify challenges or areas where they may need more direction.

DEMONSTRATE YOUR EXPERIENCE

Have students complete the Demonstrate your Experience section of the Individual Engineering Notebook.

The desired outcome is a list of proven skills gained by completing the challenge(s) they selected or adapted.

Students can use this evidence for the creation of academic or professional portfolios, with skills described and presented as they would in a judging session for the *FIRST* Tech Challenge, on an application for post-secondary education, or as they would be included for employment on a CV or in a job interview.

For this presentation, divide students into small groups to share the skill(s) they have developed.

Encourage students to assume the role of a mentor, who is sharing their experience and examples of their expertise. Partners or other students in the group may be provided with suggested questions to ask the student who is presenting as a mentor, or prompted to take 5 minutes after the "mentor" has presented to think of their own to generate discussion.

Students should approach these peer-to-peer sessions with an eye, not just for the efforts of their classmates, but for new ideas and areas of skill development they might like to investigate in the future.

Sample Questions for Students to ask Each Other:

- Why did you choose to develop this skill?
- Tell me about the problem you had to solve for this challenge.
- Tell me about how you worked through the problem.
- What resources did you use to learn about this?
- What obstacles did you face while completing this challenge?
- Tell me about how you overcame these challenges.
- What skills have you developed through this experience?
- Show me examples of your work or ability in this area.
- Tell me about your future goals or next steps in this area.

Demonstrate your Experience Facilitator's Tips:

Q: How should groups be determined for the peer-to-peer presentations?

A: Students may find it worthwhile to discuss their learning experience and to share ideas and solutions with a few other students who share their interests or some of their personal goals. This may, however, prove difficult to organize in small classes or in classes where individuals have very different personal goals from their peers.

Creating mixed groups of individuals with diverse interests or experience can be a good way to promote communication across team members and fields of interest. Sometimes, truly inspiring ideas and solutions come from fresh eyes and an open mind. Students with different interests or goals may view things from a unique perspective or ask questions that might not occur to someone who is already skilled in that area.

Q: How can we ensure that feedback is critical but respectfully given?

A: Before peer-to-peer presentations begin, it may be a good idea to review the "Critical Friends Protocol" from Unit 4. This process may already be familiar to students, but reviewing it briefly can also act as a friendly reminder, not just about the process, but about some of the language that can be used when questioning and collaborating with peers.

Skill Development Reflection

Unit 7: Skill Development

Name: Date:

In your own words, describe the challenge you completed.

Note: The challenge you completed may differ from the challenge you originally planned to complete.

Select the phrase below that best describes how close you have come to achieving the personal goal(s) you set for yourself at the beginning of this unit.

Provide more details in the “Comments” section.

I did not work towards my goal.	I made some progress toward achieving my goal(s).	I achieved one or more of my goal(s).	I exceeded my goal(s).
Comments:			

Identify and comment on at least three skills you feel you have developed through this experience.

Skill Description:	

Skill level when you started the challenge:	Beginner	Intermediate	Advanced	Expert
Description of how the skill was developed:				
Skill level when you completed the challenge:	Beginner	Intermediate	Advanced	Expert
Comments:				

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Skill level when you completed the challenge:	Beginner	Intermediate	Advanced	Expert
Comments:				

Problem Solving and Communication Scenario

Unit 7: Skill Development

SCENARIO:

Imagine that you are an engineer collaborating with another engineer in a completely different location. You are in Location A and your partner is in a remote location (Location B), out of sight, and out of range for direct verbal communication.

You have been asked to design a simple model made from the Tetrix Kit of Parts, Matrix Kit of Parts, or another set of pre-determined components provided by your teacher.

You will be designing the model at your location (Location A), but the final product will need to be reproduced by your colleague at a different location (Location B).

Your colleague, located in Room B, has the required components, but does not have the design specifications for the model. They will need recreate the model you've designed, based on communication from you, the individual in Room A.

- What will you need to consider when designing your model?
- What will you need to consider when communicating how to build it?

Note: You may not take a picture of the design or show the individual (in Location B) a photo of the model you have developed.

DRIVING QUESTION:

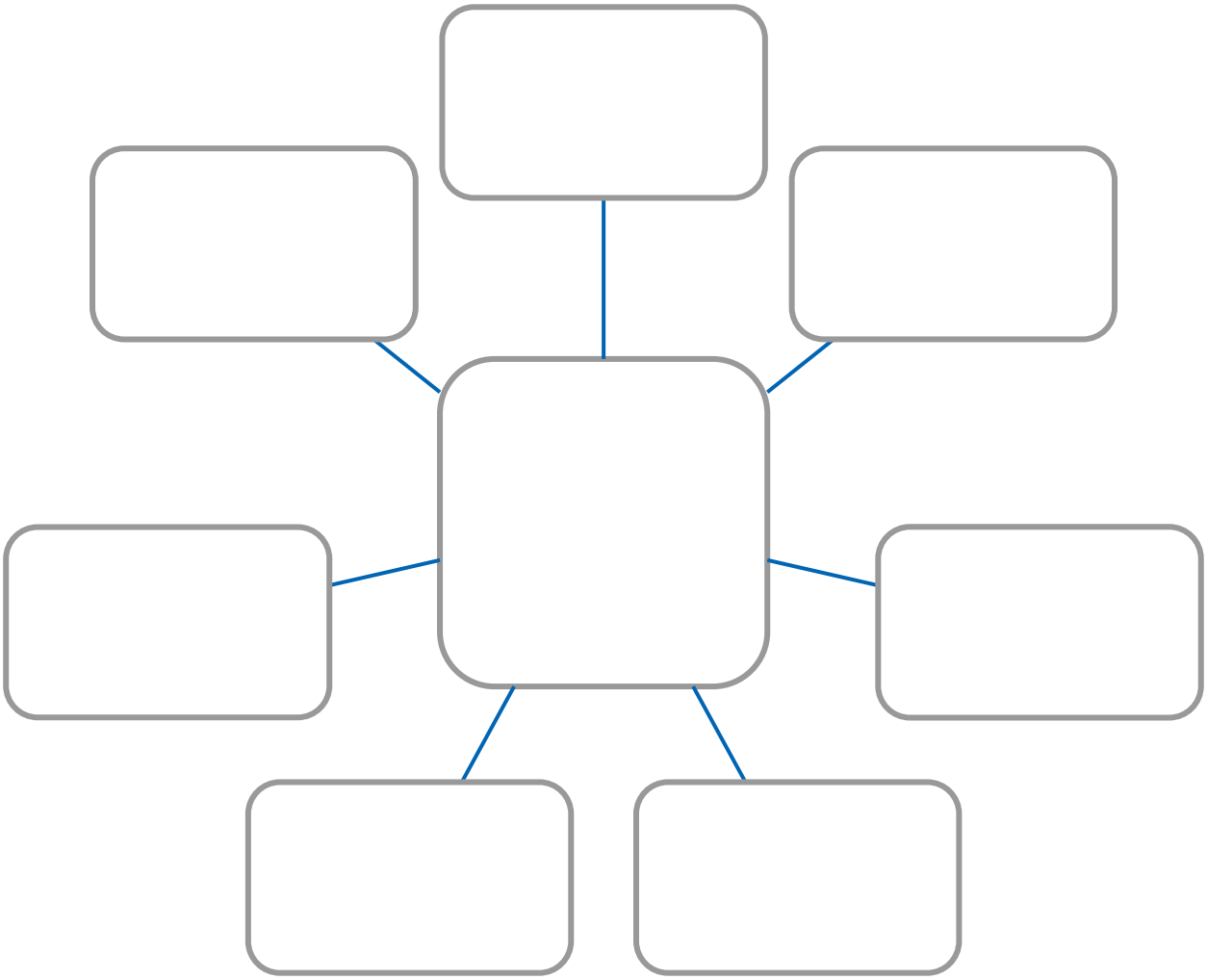
	How can available resources and components be used to design an original model in one location and to have someone build it in another location?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

Write your Driving Question for this scenario in the center square below and brainstorm the questions you will need to ask yourself or others to address it.

Use the template below or created your own mind map to document your ideas.



CAD Design Basics Scenario

Unit 7: Reflection and Improvement

SCENARIO:

You have entered a competition where the playing field is flat, but there are some fixed obstacles that cannot be easily avoided by driving around them.

Since you can't go around them, and you can't go under them, your team has decided that the best approach is to try to pass clearly over them.

To accomplish this objective, you need to raise the chassis on the existing robot and increase the clearance between the playing field and the robot so it doesn't get caught on the obstacles as it passes over them.

The new chassis needs to be 20% further from the ground than your current competition robot.

To have your team build the new chassis, you will need a detailed design that includes:

- A detailed visual model of the chassis, including labelled dimensions
- A precise list of resources and materials you need that are currently available to you (e.g., kits of parts, classroom resources, 3D printed or manufactured materials)
- A precise list of any components you need to borrow, buy, or make if they are not currently available for you to use
- A completed CAD model that shows how the components fit together and to confirm that they meet the necessary requirements for size and clearance

DRIVING QUESTION:

	How can you use CAD software to design a new chassis with a 20% greater clearance from the ground?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

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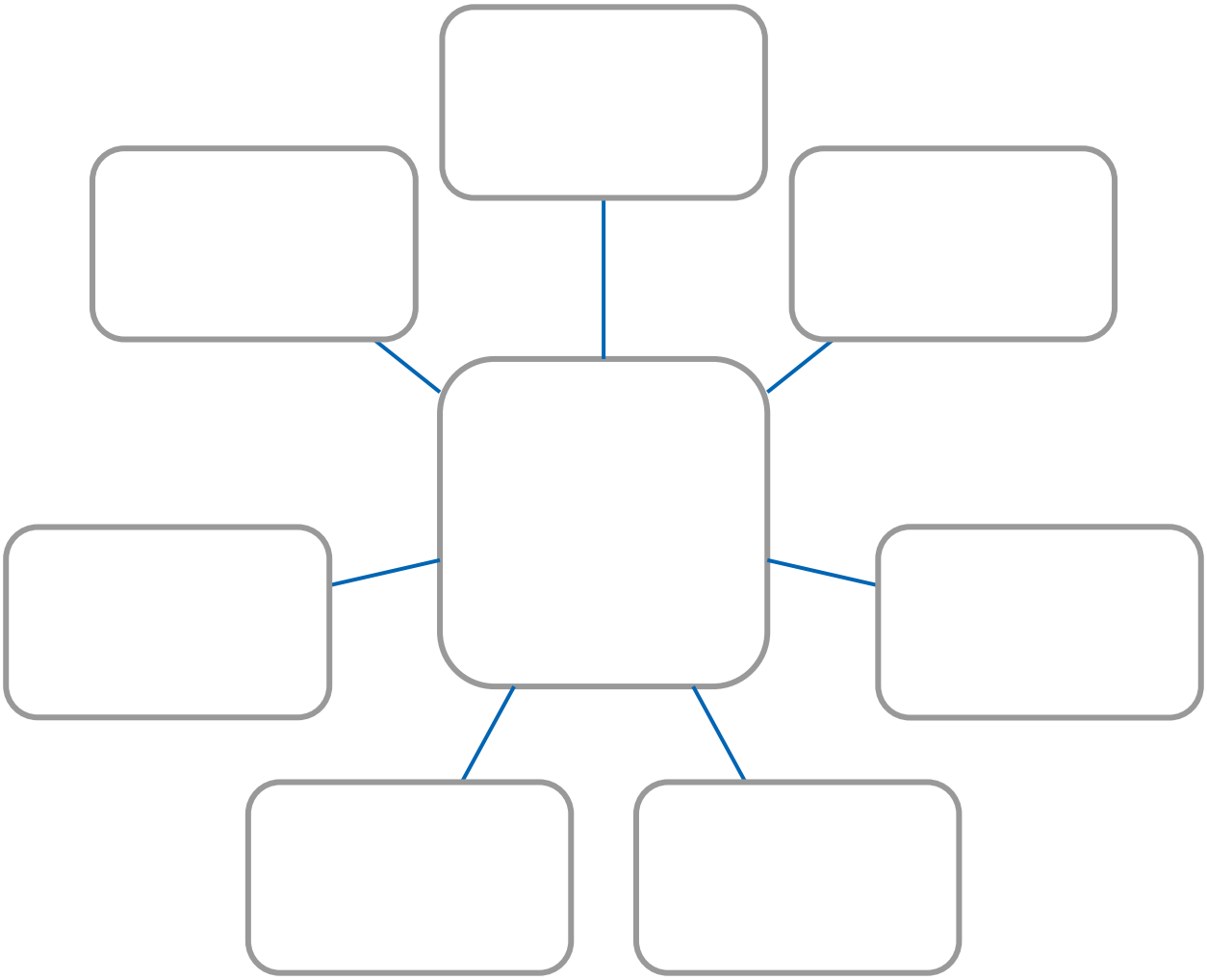

CAD Design Advanced Scenario

Unit 7: Skill Development

SCENARIO:

You need to design a new gripping end effector for your robot, but will not have access to your team's physical robot or components to do so.

You have access to a CAD model of the robot (if already created) and some CAD files of components, as well as whatever you can make.

The end effector will need to articulate or swivel to pick up a small, spherical object located 24 inches away from the robot, on a platform that is elevated 12 inches off the ground.

You need to use CAD software to confirm that the gripping end effector will swivel along the axes defined and reach the object in question.

You will also need to provide your team with:

- A detailed visual model of the end effector, including labelled dimensions
- A precise list of resources and materials that are currently available to you (e.g., kits of parts, classroom resources, 3D printed or manufactured materials)
- A precise list of any components you need to borrow, buy, or make if they are not currently available for you to use
- A completed CAD model that shows how the components fit together and to confirm that they meet the necessary requirements for size and functionality

DRIVING QUESTION:

	How can you use CAD software to design and confirm the functionality of a new gripping end effector?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

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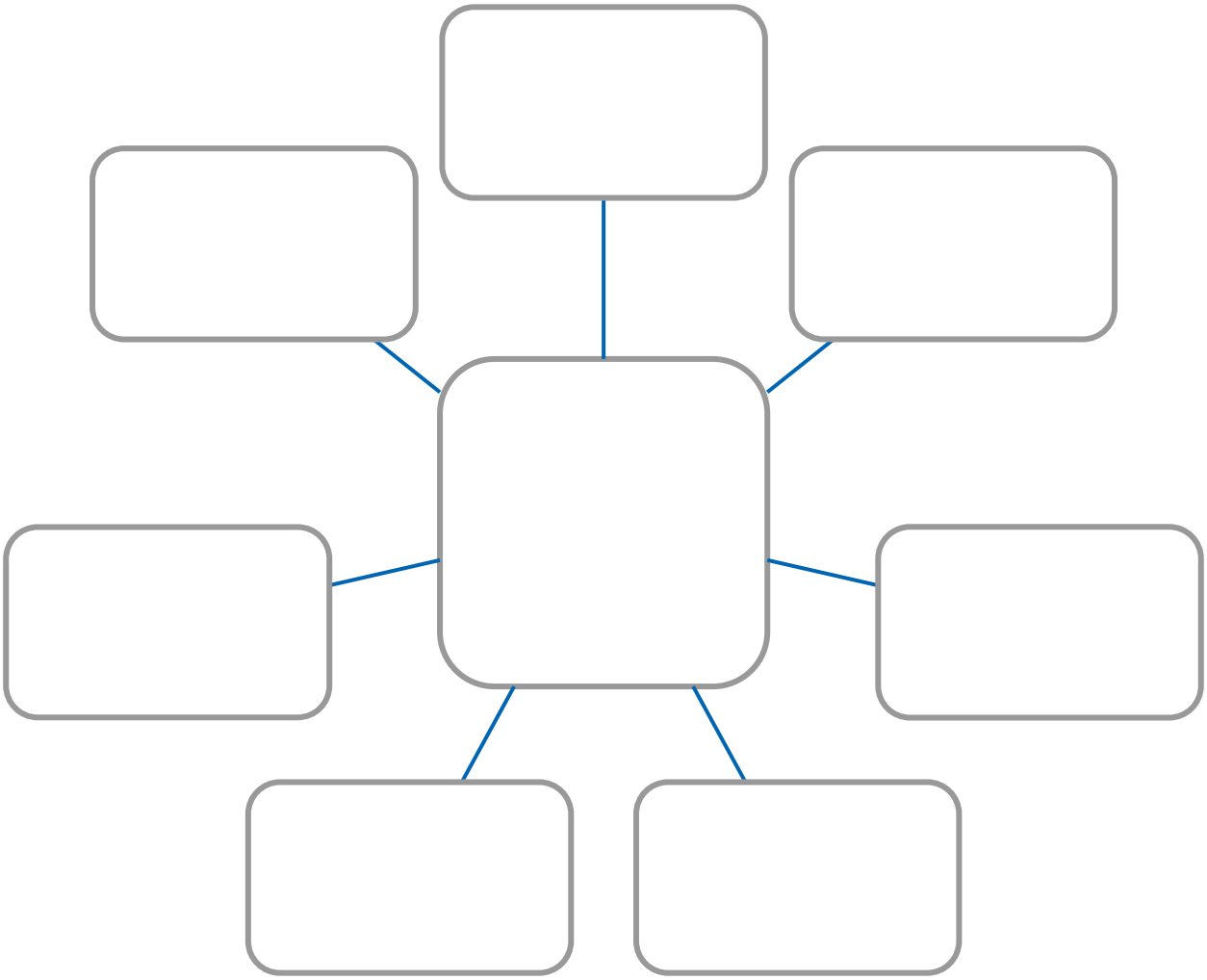

Programming Basics Scenario

Unit 7: Skill Development

SCENARIO:

You are looking forward to working with the Pushbot (or your own robot) and don't want to waste a minute of class time when you arrive at your work station.

You need to program the robot to wait on standby for your arrival, and to respond to a "Let's get started!" command with an enthusiastic display.

Challenge Criteria:

- Use the Pushbot or a robot of your own design to complete this challenge.
- You may use a Reflected Light sensor, an Analog Touch sensor, or another sensor of your choosing to gather data.
- Program the robot to use data from one sensor to exist in a "sleep" mode and "wait" for your arrival. The robot should use sensor data to tell it when to sleep and when to "Wake up!"
- The robot should "Wake up!" if a user is detected approaching the work station and prepare for action.
- Once the robot is "awake," the robot should respond to data from a second sensor to "Get Started" with an interesting display (e.g., text, sound, movement pattern).

DRIVING QUESTION:

	How can you use Java or MIT App Inventor to automate the activation of a robot from a sleep mode, to standby, to an active state?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

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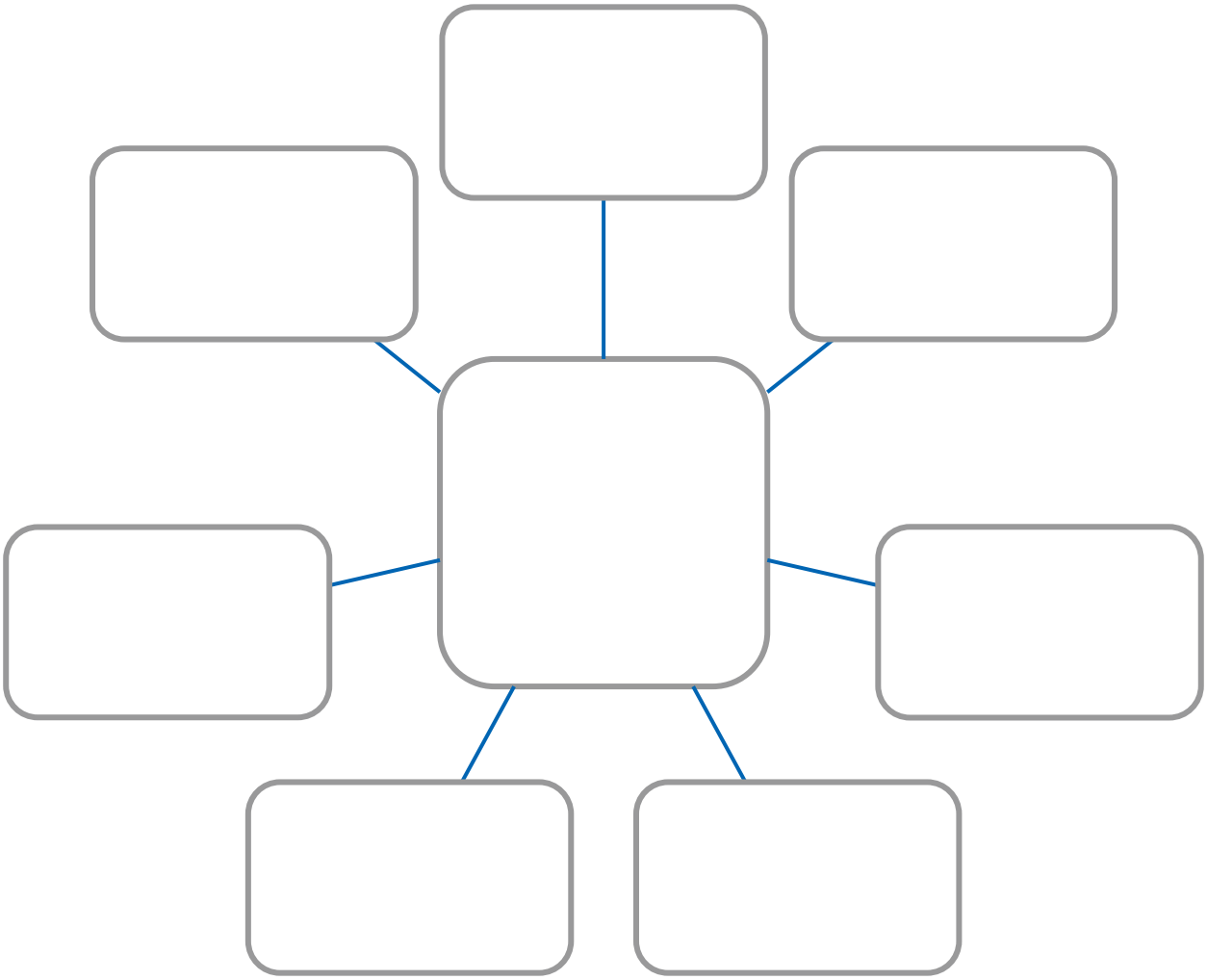

Programming Advanced Scenario

Unit 7: Skill Development

SCENARIO:

You have been asked to create a text-based game for a classmate to play.

Your classmate has asked for a game of Tic Tac Toe, or similar game of your own design.

You may need to define:

- The goal of the game.
- How the game will be played.
- Who will play the game? (E.g., two players or one player against the computer)
- The positions of game squares.
- The “winning” state for the game.

What will your game look like and how will it work?

DRIVING QUESTION:

	How can you use Java or MIT App Inventor to create a playable, text-based game?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

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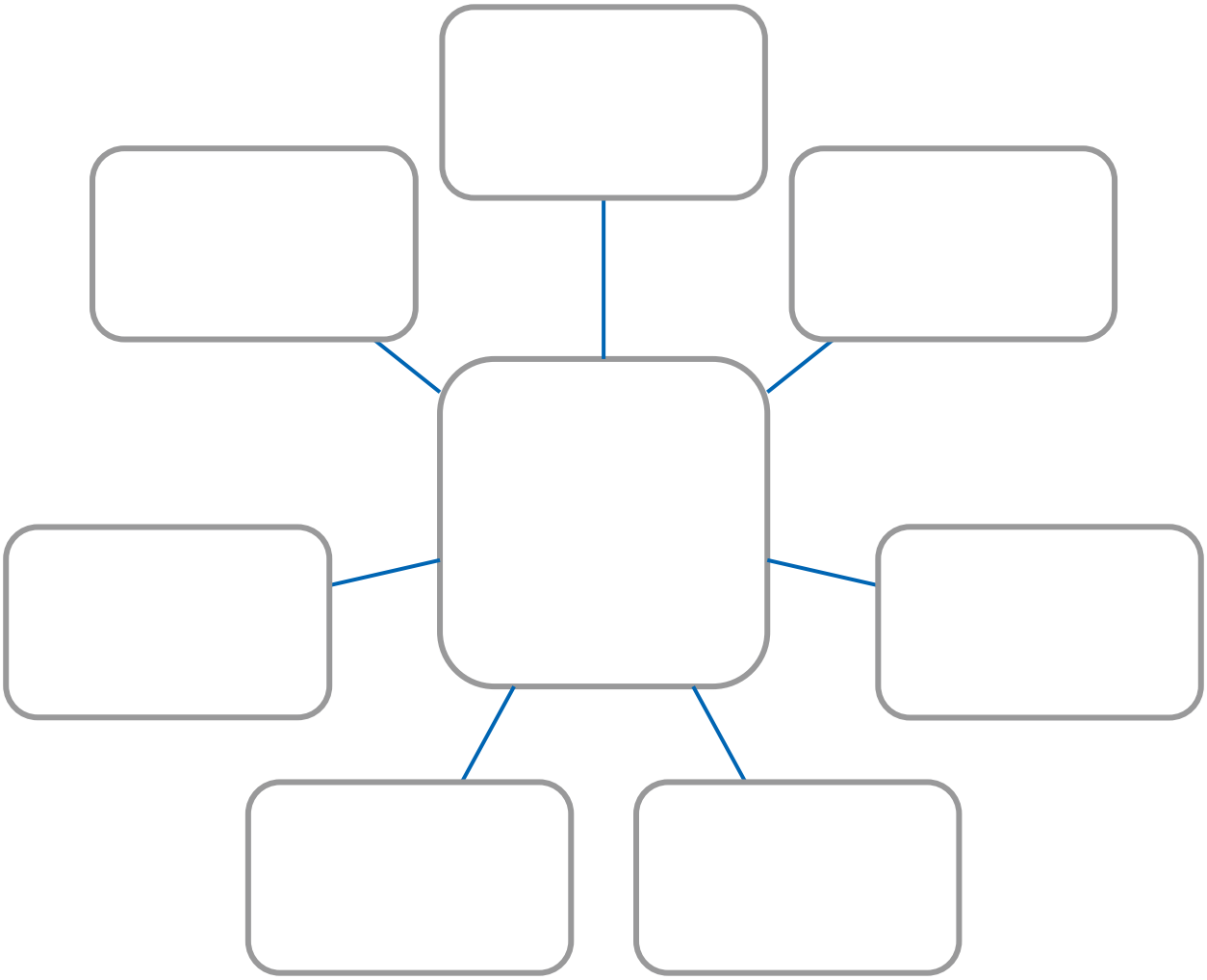


Programming Basic Path Scenario

Unit 7: Skill Development

SCENARIO:

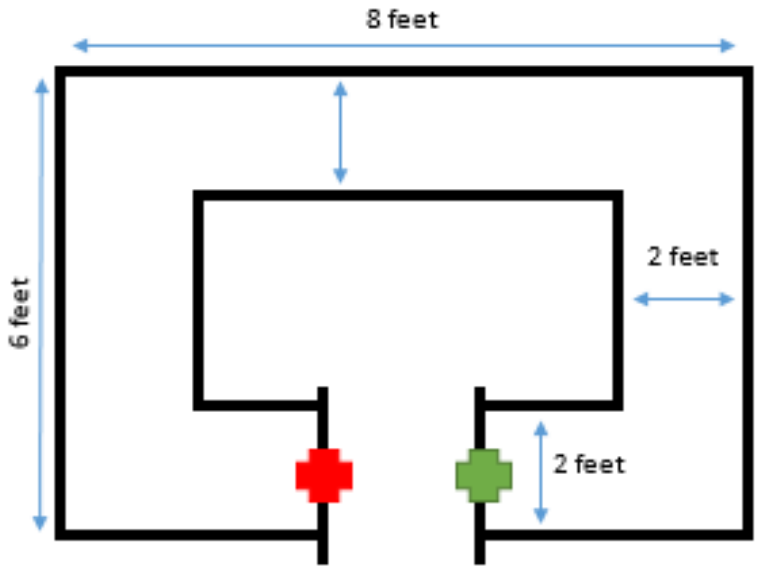
Your team has been challenged to program a robot to navigate along a defined path that has been taped to the floor. Your robot must accomplish this task without a driver to control it.

Your robot should:

- Stay within the confines of the tape.
- Not be controlled by a driver.

Sample Basic Path Configuration:

- The tape should be black and at least 1 inch in width.
- Working on a light-colored surface should produce better results.



DRIVING QUESTION:

	How can we program a robot to navigate a defined path, without being controlled by a driver?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

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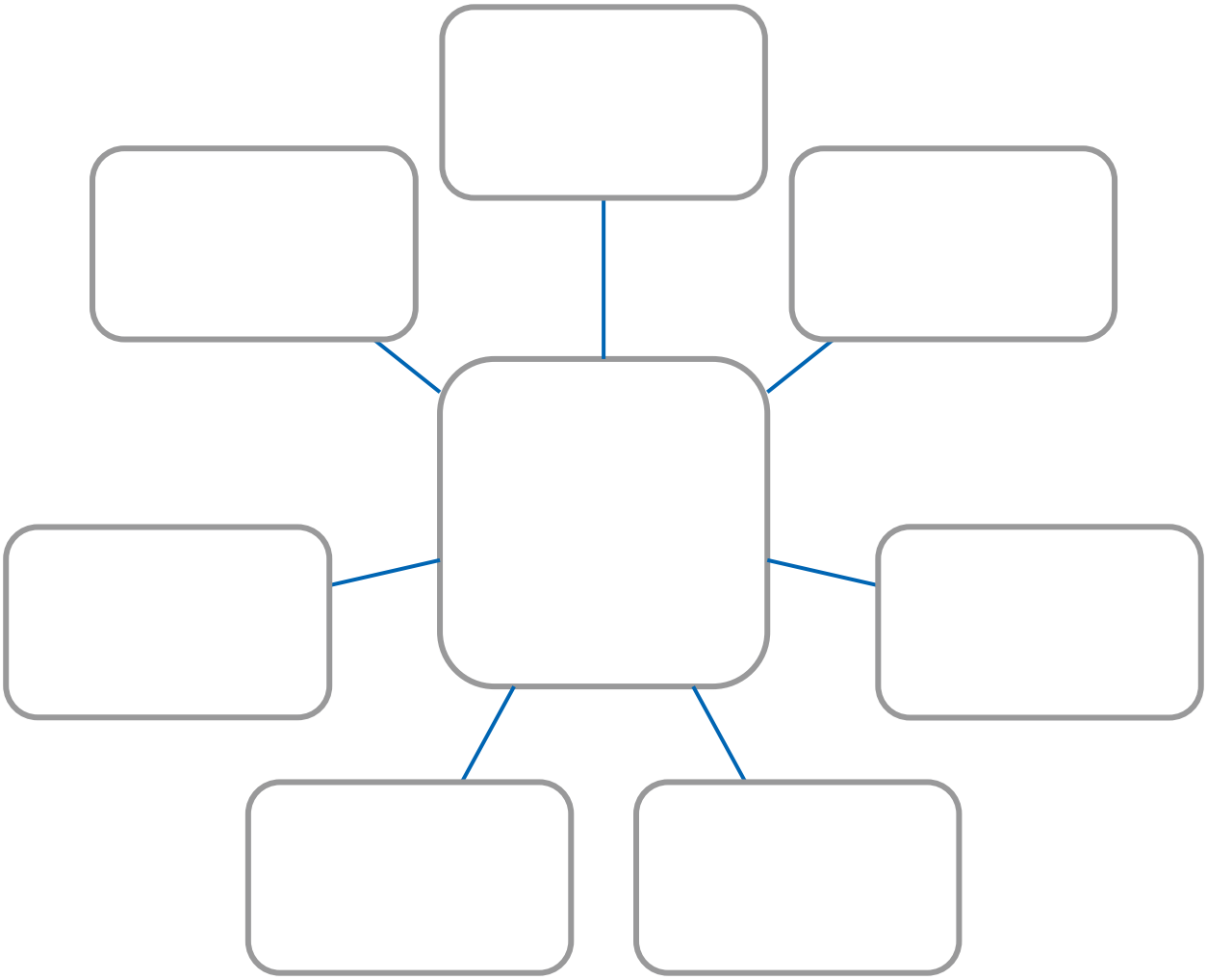


Programming Advanced Path Scenario

Unit 7: Skill Development

SCENARIO:

After completing the Programming Path Challenge, your team has been asked to program a robot that can navigate not just a particular path, but **any** path.

The path your robot must follow will be taped to the floor.

Your robot will need to navigate the path in one direction, and then turn around and complete the same path in the opposite direction, without a driver to control it.

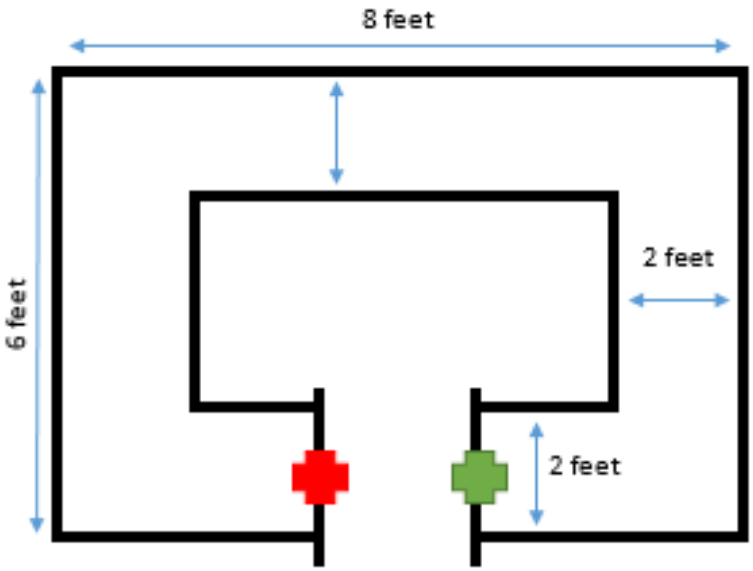
It should also be able to complete a second, different path configuration in the same way.

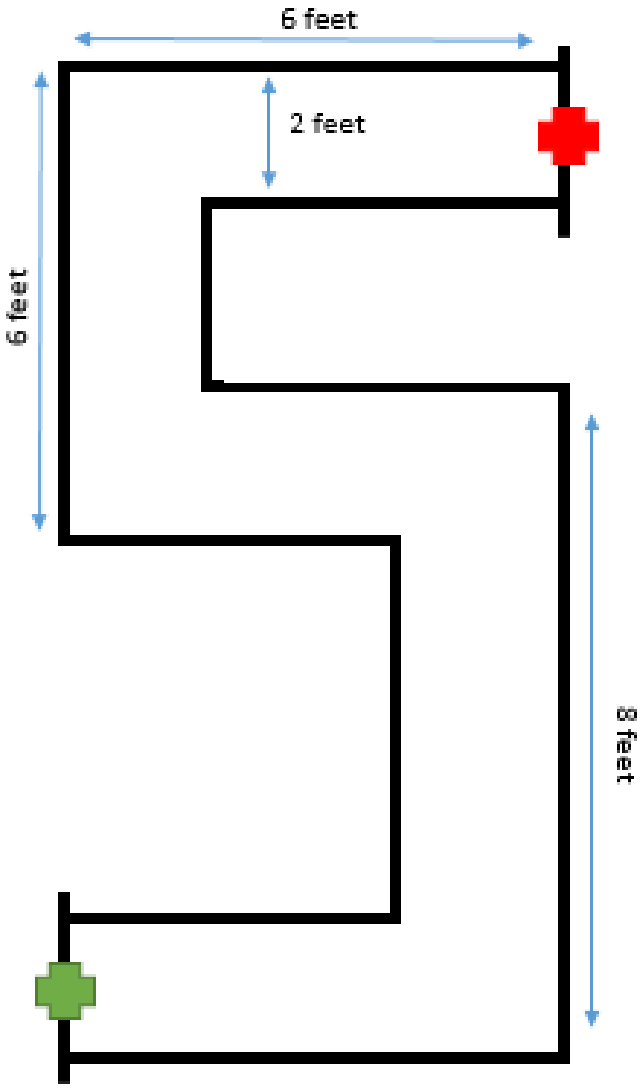
Your robot should:

- Stay within the confines of the tape.
- Not be controlled by a driver.
- Be able to follow the path (or any marked path), in both directions, with **one** program.

Sample Advanced Path Configurations:

- The tape should be black and at least 1 inch in width.
- Working on a light-colored surface should produce better results.





DRIVING QUESTION:

	How can we program a robot to navigate **any** path, without being controlled by a driver?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

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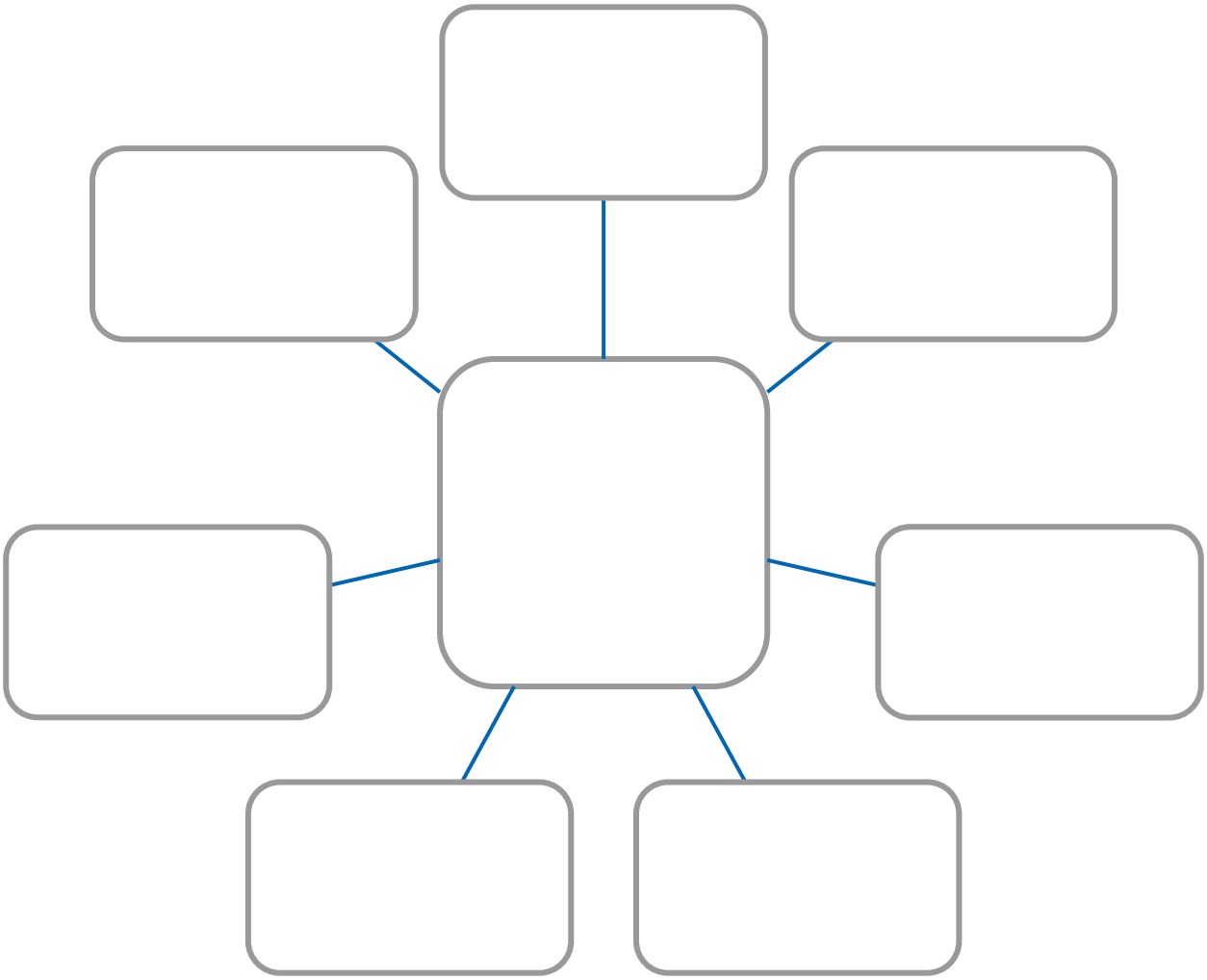
Use the template below or created your own mind map to document your ideas



Building Design Scenario

Unit 7: Skill Development

SCENARIO:

You need to transport a vessel of water vertically, from one location (floor level) to another location that is at least 24 inches above floor level.

You need to design and build a device to accomplish this task using classroom resources and/or components from the Tetrix Kit of Parts or Matrix Kit of Parts.

- The device you design and build must be powered **without** the use of motors or electricity.
- It should effectively lower an empty vessel to the ground to be filled with water, and then lift the same vessel after it has been filled with a small quantity of water (at least 3 oz. or approximately 90 ml.).
- The device should sit on a chair or low table.
- The device should lift the vessel containing the water up from the floor level, to a height of at least 24 inches above floor level.
- The amount of water spilled from the vessel as it is raised, should not exceed 5% of the total amount when the vessel was filled.

Note: You will be using actual water for this challenge, so make sure the area and the device are clear of any electrical outlets or components.

DRIVING QUESTION:

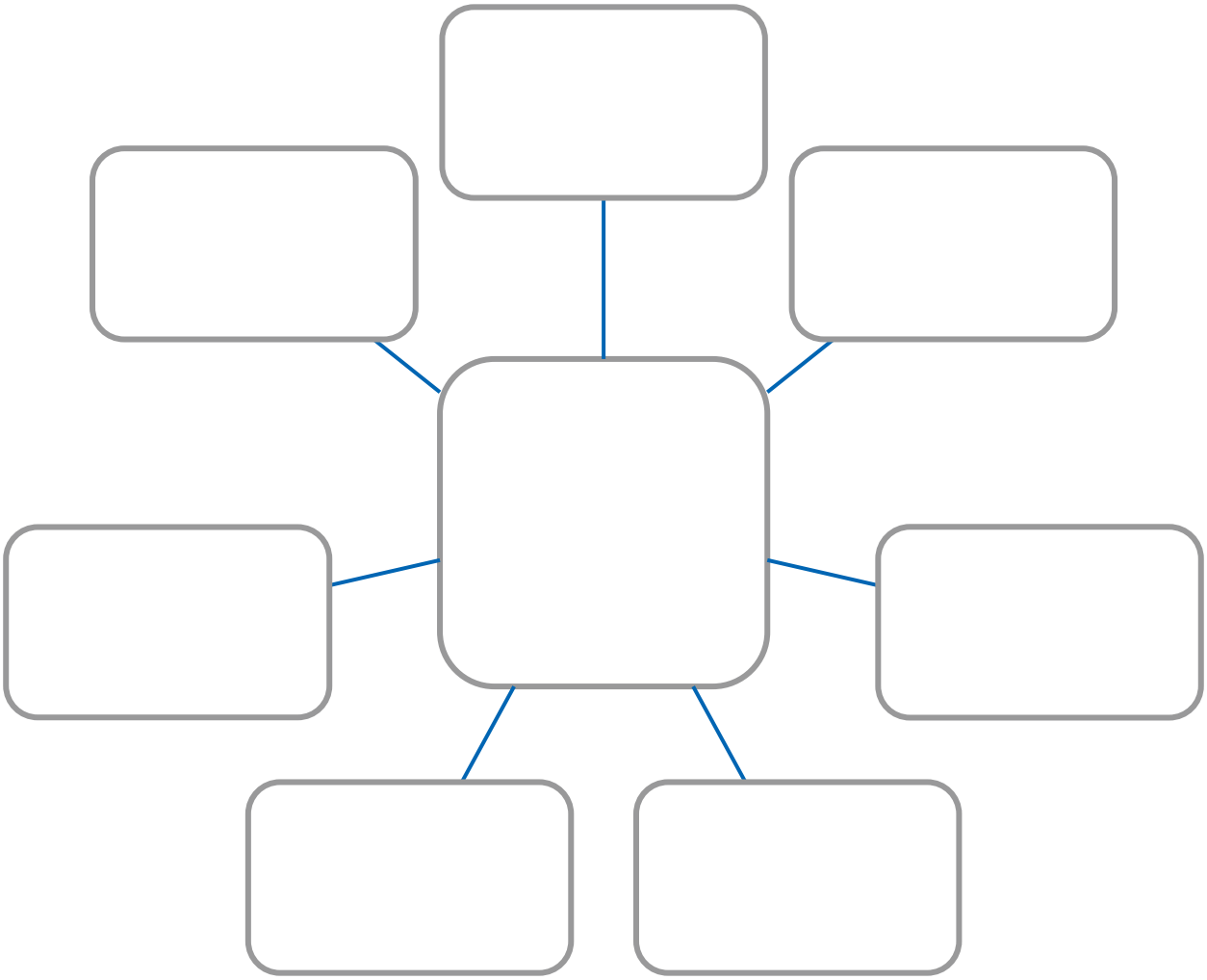
	How can available components be used to create a device that can lower an empty vessel and lift a vessel containing water?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

Write your Driving Question for this scenario in the center square below and brainstorm the questions you will need to ask yourself or others to address it.

Use the template below or created your own mind map to document your ideas.



Integrated Building Scenario

Unit 7: Skill Development

SCENARIO:

You need to safely transport a container of tiny objects that can easily spill (e.g., plastic beads, marbles, pebbles, dried rice or beans) from (floor level) to another location that is at least 24 inches above floor level.

You need to design and build a device to accomplish this task using classroom resources and/or components from the Tetrix Kit of Parts or Matrix Kit of Parts.

- The device you design and build must be motorized and operated using a remote control.
- It should effectively lower an empty vessel to collect the objects and then lift the same vessel after it has been filled to at least ¾ of the container's capacity, with the tiny objects.
- The device should sit on a chair or low table, and bring the vessel containing the objects up from the floor level.
- The device should lift the vessel containing the objects from the floor level, to a height of at least 24 inches above floor level.
- The weight of the contents in the vessel should be the same before and after it has been lifted (0%) loss.

DRIVING QUESTION:

	How can classroom resources and/or components from the Tetrix Kit of Parts or Matrix Kit of Parts used to create a remote-controlled mechanism that can lower an empty vessel and lift a vessel containing contents that could easily spill?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

Write your Driving Question for this scenario in the center square below and brainstorm the questions you will need to ask yourself or others to address it.

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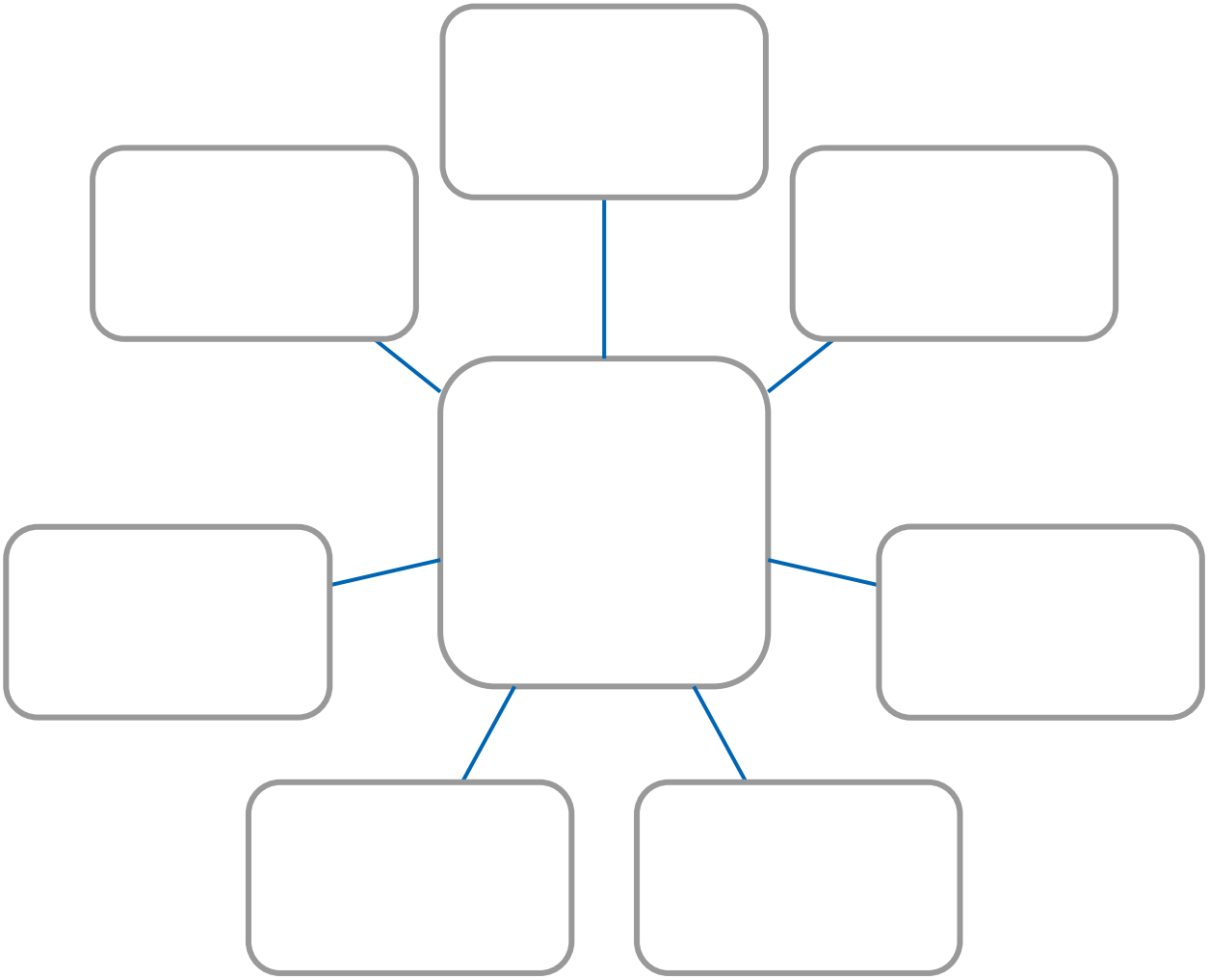

Engineering Notebook Scenario

Unit 7: Skill Development

SCENARIO:

Your team has asked you to improve the Engineering Notebook used for the *FIRST* Tech Challenge.

You have a few options to consider as you complete this challenge.

The overall goal is to update and enhance the format of the engineering notebook, but it's important to focus improvements with a clear, demonstrable objective.

Make the Engineering Notebook more usable in one of the following ways:

a) as a working document for collaboration.
b) as a searchable reference document.
c) as an esthetically enhanced presentation document.

DRIVING QUESTION:

	How can you make your Engineering Notebook a more effective document and tool?

Is this the Driving Question you would like to answer? If not, make rough notes about any changes you would like to make to the Scenario or the Driving Question here.

What evidence will you provide to show that you have addressed this Driving Question?

Write your Driving Question for this scenario in the center square below and brainstorm the questions you will need to ask yourself or others to address it.

Use the template below or created your own mind map to document your ideas.