UNIT 6

Reflection and Improvement

UNIT OVERVIEW

UNIT NUMBER: 6

DURATION: Approximately 12 in-class hours or iterative until the end of semester or postseason participation

SUMMARY

In this unit, students will complete a process to reflect on and evaluate their accomplishments with the *FIRST* Tech Challenge Game. They will identify a clear, demonstrable goal for improvement on **one** aspect of robot or team performance and develop a plan to execute and test the improvement for impact. Upon completion of this process, students will use the criteria they have outlined to evaluate their success. They will then develop a short Performance Impact presentation to share their experience with another team, class, parent group, sponsor, or other interested group community member.

INSTRUCTIONS

1. As a class reflect on student progress throughout Units 1-5. Ask each student to share their proudest moment or greatest success. Take some time to celebrate and document these achievements! These represent some of the team's strengths and may provide insight into which areas of improvement could have the greatest impact.
2. Present students with the "Second Chance" scenario and Driving Question.
3. Divide the class into small groups of 2-3 students to brainstorm and identify an aspect of robot design, programming, or strategy that could have a significant, positive impact on performance. This may involve correcting a current problem, building upon an existing strength, or trying a completely new approach.
4. In groups, or as a class (depending on the desired improvement and available resources), create a plan to complete and test the redesign. Don't forget to document the current iteration of that aspect before making the change.

LEARNING RESOURCES

Game and Parts Resources

- Archived Game Documentation
- Team Management Resources

Project Based Learning Resources

- Project Based Learning Information, Rubrics, and Resources from the Buck Institute for Education
  - Project Based Teaching Practices
  - Project Based Teaching Rubric
  - Project Design Rubric
  - 6-12 Creativity & Innovation Rubric (CCSS Aligned)

***FIRST* Tech Challenge Mentor Resources**

- https://www.firstinspires.org/resource-library/ftc/team-management-resources

5. Complete and test the redesign. This can be completed in small groups if several kits are available to modify and test, but may need to be completed as a class if everyone is working on the same robot or process for improvement.
6. In groups or as a class, determine the impact of the redesign and complete a Performance Impact summary to share the results and experience with other groups or with the community.

ASSESSMENTS:

1. Make a Decision
    1. Templates
    2. Rubric
2. Make a Plan Templates
    1. Templates
    2. Rubric
3. Performance Impact Templates
    1. Templates
    2. Rubric
4. Weekly Engineering Notebook
5. Weekly Self & Peer Evaluation

TOOLS & MATERIALS

1. Tetrix Kit of Parts or Rev Kit of Parts
2. Electronics parts
3. Soldering iron
4. Saws
5. Wrenches
6. Drill
7. Allen wrenches
8. Any and all power tools available

STANDARDS ADDRESSED:

Full course standards alignments can be found here.

ENTRY EVENT & DRIVING QUESTION

Second Chance Scenario

What would you do if you had more time? Imagine that a prestigious postseason bonus tournament will be taking place in your area: the "Second Chance Championship." The competition is open and the game challenge is the same, but not just anyone can participate.

To gain entrance into the tournament, your team must demonstrate a documented attempt to improve your robot, programming, or team play. The overall goal is to generate an **observable, positive impact** on performance. You have one month to select an area for improvement, implement the change, and prepare your team for a "Second Chance Championship."

Driving Question

How can we, as a team of engineers, generate a significant, positive impact on our performance in the *FIRST* Tech Challenge and earn a place in the Second Chance Championship?

HINT:
The goal of this challenge is not to guarantee a win, but to make a well-conceived and well-documented effort to make the robot, programming, or team play **observably better** than it was before. Progress in the real world of engineering doesn't always happen with a grand slam or a win. It comes one small improvement (and several setbacks) at a time. Teams may choose to build upon an existing strength, correct an existing problem, or try a new approach they didn't have time for or simply didn't think of before.

Understanding Impact
Select a simply constructed object in the room, such as a chair, a table, or a bookshelf. Discuss its function and how well it performs that function.

As a class, talk about what a significant improvement might look like for this object. Remember that the improvement must be observable and must have an impact on that item's performance.

For example, a chair in the classroom could be improved visually by changing its color, or the material it's made of. If the chair's performance task is to be supportive and comfortable, would these improvements have a significant impact on its performance of that task? Maybe, but modifying the shape of the seat, or its height, or the placement of the backrest, might have a more significant impact on that performance.

Guiding Questions:

- How is the chair performing now?
- What works well and what doesn't?
- What could be improved? (e.g., style, color, shape, height, material, durability)
- How big a difference would that improvement make on the chair's actual function?
- Would there be any negative consequences to that improvement? (e.g., weight, too big for space, expensive, don't have the material or know how to do it)

HINT:
When discussing the current performance or condition of a given item, it's a good idea to include some discussion about the cost of making, fixing, or purchasing that item. There are usually reasons, beyond basic design, that something may not work as well as it could (e.g., cost of materials or manufacturing). For this activity, these reasons can be discussed as important considerations in the real world of engineering, and then removed

	as limitations for the brainstorming process to encourage broader thinking about the problem.

Facilitator's Tips

Q: What kinds of improvements can be made?

A: As a facilitator, it's important to support students as they generate their own ideas for improvements, based on their experience with the *FIRST* TECH Challenge Game. Listed below are some guiding questions and suggestions for students to investigate in their Engineering Notebooks and discuss as a class.

Guiding Questions for Technical Improvement Goals:

- How can we make the robot more reliable?
- How can we make the robot faster?
- How can we make the robot more accurate?
- How can we make the robot easier to control/maneuver?
- How can we make the robot more powerful?
- How can we make the robot more stable?
- How can we make the robot more resilient?

Guiding Questions for Non-Technical Improvement Goals:

- How can we improve our game strategy?
- How can we improve our time management?
- How can we improve our workflow or process of development?
- How can we improve our tracking or documentation of results?
- How can we work together more effectively?
- How can we distribute work more effectively?
- How can we improve access to different opportunities within the team?

Q: Must the improvement involve technical changes?

A: Yes and no. Because the improvement will ultimately be assessed based on the performance of the robot and team in the challenge, the robot and programming will be involved. However, it may be the case that the robot and programming stay largely the same, but the way in which the team works together, or the development of a stronger, more diverse team would result in new ideas or untapped talents being integrated into game play. Encourage team players to take on new roles. Try switching the presentation crew and the drivers, or give the programmers a chance to revise the game strategy. Mix up teams between classes or give one group the chance to experiment with or play with another group's robot. Every team has untapped talent. This unit in the postseason period is a great opportunity to identify that potential and Unit 7: Skill Building is a great place to develop it.

To learn more about identifying biases and how they affect equitable participant engagement, *FIRST* Tech Challenge has developed a Schoology module called FTC Volunteer Training: Invisible Inequities Course. Teachers and mentors can join the course by searching the course title and using the access Code: BRXDP-2ND8V.

REDESIGN CHALLENGE

Focused Improvement

Have students work in small groups to identify three specific aspects of robot design, programming, or team performance that they feel could be improved. If possible, encourage students to work in mixed groups that include individuals who participated in different aspects of robot design or team play (e.g., a builder, a programmer, a driver, a manager).

Consider reviewing:

1. Content of Engineering Notebooks
2. Robot development process
3. Videos of games or competitions with the robot

4. Robot performance or statistics
5. Team performance and roles on the team

HINT:
Encourage students to review video footage of competition, notes, and ideas from their team's Engineering Notebook. Make sure to include discussion about personal experience and frustrations as the game was executed.

Use or adapt the Make a Decision resource to have students brainstorm and evaluate ideas for **focused** robot performance or team improvement. The end goal is to focus on **one** aspect of robot design, programming, or team play that could have a significant and observable impact on overall performance in the *FIRST* Tech Challenge game.

Encourage students to consider the **value** of the improvement as well as any negative consequences or ripple effects on other aspects of design or team play.

Two different templates have been provided in the form of a mind map and an organization chart template in the Make a Decision resource. Students may choose the template that best supports their own brainstorming style. The headers provided on the templates have been selected to support students as they consider the kinds of Guiding Questions below, but teachers should feel free to encourage students to generate their own headers or to modify the word doc templates to include specific key questions for students who need more defined direction.

Guiding Questions:

1. What will it solve?
2. Is this problem a big problem or a small problem?
3. Will this improvement correct a problem or further develop and enhance an existing capability?
4. What kind of impact will it have on performance?
5. Will the impact be observable? How?
6. Are there any negative consequences to making this kind of change?
7. Is the improvement permitted in the rules for this year's game?
8. Has the improvement been permitted in the rules of previous games?
9. Is it likely to be permitted or useful in future games?
10. Do you have enough time to do it?
11. Do you have the resources you need to do it?
12. What do you have to learn or know to do it?
13. What other aspects of the robot design or team performance will this impact?

Answering these questions will help students to decide which aspect of robot design, programming, or team performance they would like to improve.
Let students know that they will be creating a short presentation on the impact of their attempted improvement at the end of this unit. They will need to include details about their robot or team performance **before** and **after** the improvement was attempted, so it's important to make sure their anticipated outcomes are **measurable** and **observable**.

A rubric for this activity has been provided in the Unit 6 Rubric resource.

Redesign Facilitator's Tips:

Q: Do we have to choose just **one** aspect to redesign?

A: There is no limit to how many improvements can be suggested or made, but **how** they are completed will depend on resources, class time, and the kinds of improvements students are driven to attempt.

If more than one improvement is selected, it may be a good idea to complete one change at a time so that the impact of the improvement can be clearly observed before moving on to the next.

If resources or the number of kits are limited, it may be a good idea to have small groups each think through and plan a different solution and then revisit the "Critical Friends" protocol from Unit 4: Initial Design to come to a class or group consensus about which focused improvement idea should be executed and tested.

If resources (specifically the number of kits) and time allow, students may wish to divide into groups and each attempt a different improvement or aspect of design to improve. A culminating activity could then be completed to test and select the improvement that has the greatest impact. In this case, it would be important to make sure that the starting point for each group rests on the same strategy, design and programming.

Q: What resources exist to assess the value of the improvement for future game play or challenges?

A: It may be a good idea to review the games from previous years to see if the improvement being proposed would have been useful for those challenges. Some aspects of design or programming, such as gripping extensions or object-oriented programming, will appear frequently. Other aspects, such as improved connectivity with mobile devices, may have appeared more recently in competition needs and are likely to continue to be useful.

Past season games can be found in the Archived Game Documentation on the *FIRST* Tech Challenge website.

Information regarding the legality of parts or approaches can be found in the Game Manual for each year, and in the Team Management Resources in the *FIRST* Tech Challenge Resource Library.

Note that the legality of parts and software will vary from year to year.

PLANNING

Create a Timeline

Think about the steps and resources needed to complete the improvement. Use one of the Make a Plan templates or have students create their own timeline of tasks, resources and responsibilities to make the improvement. Depending on the improvement selected, there may be a clear, linear path to follow, or there may be several tasks that will overlap and flow between each other.

Use the planning tool or tools that best suits your students' needs.

HINT:
You may want to revisit some of the steps and tasks involved in "Creating a Project Timeline" from Unit 5: Building and Programming. Remember that the task in Unit 6 is much more focused (**one** aspect of design or performance). The order of operations and tasks may be very similar to Unit 5, but the templates for Unit 6 have been created to abbreviate this process slightly.

Ongoing Review

How will you know if the improvement is being completed in line with your original goals for impact?

1. Document the "before" state of your robot, programming or performance.
    - Take a video
    - Take pictures
    - Take screen shots of programming or current CAD designs
2. Create a checklist of observable outcomes (Performance Impact Criteria) to assess whether the improvement is having the desired impact on performance.

    Use the template provided in the Performance Impact resource or have students create their own. The templates have been created to add picture or text details as needed.

Guiding Questions for the Creation of Checklist Criteria:

- Does the robot/extension/program run/move/execute X% faster?
- Does the robot/extension/program/team process complete its function reliably X times out of X?
- Does the robot/extension/program reach X% further?

- Is the robot/extension more stable or resilient? Can it complete its task X times out of X without tipping over or coming apart?
- Do we make more, the same number, or fewer errors this way?
- Does the robot/extension/program/team process/strategy operate X% more precisely or effectively? Do we have fewer collisions or driving errors?

Before making the changes, use the template provided or make your own checklist of markers of success on the Performance Impact resource. Decide, as a class, how many of these markers should be achieved for an observable impact to be demonstrated.

A rubric for this activity has been provided in the Unit 6 Rubric resource.

Planning Facilitator's Tip:

Q: Is it important to stick to the plan?

A: The development of organization and time management skills is a critical part of the *FIRST* Tech Challenge experience and it's important to work towards those goals. It's also important to give students the opportunity to learn to think and work flexibly when the situation calls for it. During the redesign process, it's possible that students will change paths on the redesign they've planned. Depending on the significance of the change, it may be necessary to pause, regroup, and revisit the timeline and plan for completion.

REDESIGN

Make the Change

Have students execute the redesign and the plan they've created. Make sure to revisit the plan, timeline and performance impact criteria frequently. The plan may change, but it's important to revisit the overall goals to keep on track.
Add notes, pictures, or links to the plan and checklist. These can all be included in your Engineering Notebook to demonstrate team progress and growth. They will also become an important resource for the Performance Impact presentation at the end of this unit.

Redesign Facilitator's Tip:

Q: How can focus be maintained over the course of the Unit?

A: It is typical for a design to evolve as it is developed and ideas are fleshed out and tested. However, it's important to return to the overall goals and desired impact of the improvement frequently. It's a good idea to begin each class or session with a review of the desired impact of the improvement and the criteria that have been selected to indicate that the changes are having the desired impact.
Templates for checklists and documentation of impact criteria have been provided in the Performance Impact resource for this unit.

IMPACT

Have students test the improvement and revisit the Performance Impact checklist that they created in the Planning phase of this unit. An important piece of Project-Based Learning is for students to share their learning in some way. This can be done in many ways; limited only by resources, time, and student interest. The key pieces to include are an explanation of the desired improvement, a representation of the anticipated impact, and a representation of the actual impact, as well as documentation of any unexpected or surprising learning.

The desired outcome is an engaging, visual, or interactive presentation that allows students to share their latest success. Presentations should be brief and light-hearted.

Some suggestions for impact presentations include:

- Before and after Impact Summary (provided in the Performance Impact resource with this unit) can be shared in *FIRST* Inspire forums or with other teams to demonstrate a problem solved by the team, that others may be interested in.
- Before and after videos of performance shared on a team or school website.
- Info-graphics created using online tools or graphic design software.
- Visual representations of statistics or graphs of results formatted to be easily interpreted by community members.
- Live demonstrations and oral presentation of achievements with others in the school, parents, or the *FIRST* Inspire community.

Guiding Questions:

- How many markers of impact were achieved?
- Were there any negative impacts in other areas of design or performance that resulted from the improvement?
- Did the plan or the intended improvement change?
- Did you learn anything that surprised you?
- Were there any surprising results?

Return to the original "Second Chance Competition" scenario and Driving Question. Invite school staff or other classes to take part in student presentations and weigh in on whether the improvement completed has made a significant and observable impact on performance.

If time and resources allow, organize a "Second Chance" scrimmage or mini-tournament with another team or between groups within a class to redo the *FIRST* Tech Challenge game with their new and improved robot, program, or team play.

A rubric for this activity has been provided in the Unit 6 Rubric resource.

Impact Facilitator's Tips:

Q: How can the impact be documented?

A: Make sure to document the **before** state of your improvement, as well as the **after** state.

- Throughout the process, schedule documentation dates so that smaller developments, ideas and errors aren't missed.
- Make a video, take pictures and screenshots.
- Have students complete a video journal entry each session using a smart phone.
- Use the templates provided with this unit. They can be modified to suit your students' learning or presentation styles and allow for text information or pictures to be added. Use them "as is" or as a starting point for students who are learning to organize their ideas visually and present information in a variety of ways.
- Add documentation to the Engineering Notebook to demonstrate and document team growth and development.

Q: How can this presentation be used to reach long term team goals?

A: Effective documentation and presentation of progress are valuable skills for students personally, and the overall experience of the *FIRST* Tech Challenge emphasizes these real world, non-technical skills as part of the competition. Striving towards and demonstration of sincere efforts to improve and develop new skills can help teams in their search for sponsors, in recruitment efforts, and potentially, in efforts to earn *FIRST* Tech Challenge awards outside of game play.

FIRST Tech Challenge celebrates efforts outside of game play with a number of awards. Efforts in this year's postseason may help teams attain these awards in the future.

Make a Plan

Unit 6: Reflection and Improvement

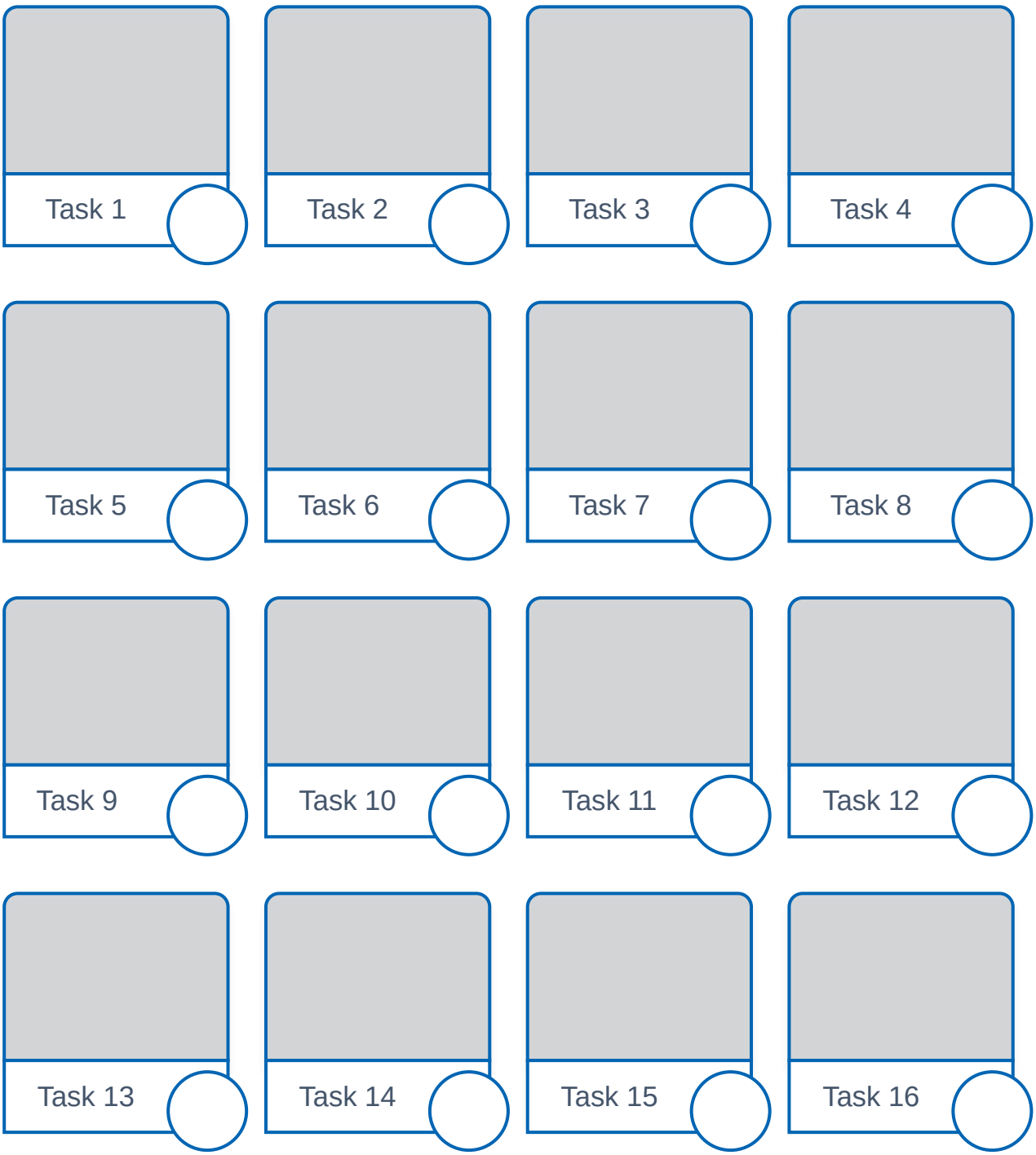
Use the template below or make your own timeline or checklist to complete the improvement you and your team have selected to impact your performance.

Task	Resources Needed	Estimated Completion Date	Team Members Responsible

Make a Plan

Unit 6: Reflection and Improvement

Use the template below or make your own timeline or checklist to complete the improvement you and your team have selected to impact your performance.



Make a Plan

Unit 6: Reflection and Improvement

Use the template below or make your own timeline or checklist to complete the improvement you and your team have selected to impact your performance.

Task 1

- [ ] Subtask 1
- [ ] Subtask 2
- [ ] Subtask 3
- [ ] Subtask 4
- [ ] Subtask 5
- [ ] Subtask 6
- [ ] Subtask 7
- [ ] Subtask 8

Task 2

- [ ] Subtask 1
- [ ] Subtask 2
- [ ] Subtask 3
- [ ] Subtask 4
- [ ] Subtask 5
- [ ] Subtask 6
- [ ] Subtask 7
- [ ] Subtask 8

Task 3

- [ ] Subtask 1
- [ ] Subtask 2
- [ ] Subtask 3
- [ ] Subtask 4
- [ ] Subtask 5
- [ ] Subtask 6
- [ ] Subtask 7
- [ ] Subtask 8

Task 4

- [ ] Subtask 1
- [ ] Subtask 2
- [ ] Subtask 3
- [ ] Subtask 4
- [ ] Subtask 5
- [ ] Subtask 6
- [ ] Subtask 7
- [ ] Subtask 8

Make a Decision

Unit 6: Reflection and Improvement

Make a list of things your robot or team does well. Write or draw as many ideas as you can fit in each box.

Robot Design	Programming	Strategy or Team Performance

Make a list of things your robot or team does **not** do well. Write or draw as many ideas as you can fit in each box.

Robot Design	Programming	Strategy or Team Performance

Choose **three** areas of improvement from these ideas that you think would make your team or robot perform **better**.

Circle them.

Now think about the **impact** these improvements would have.

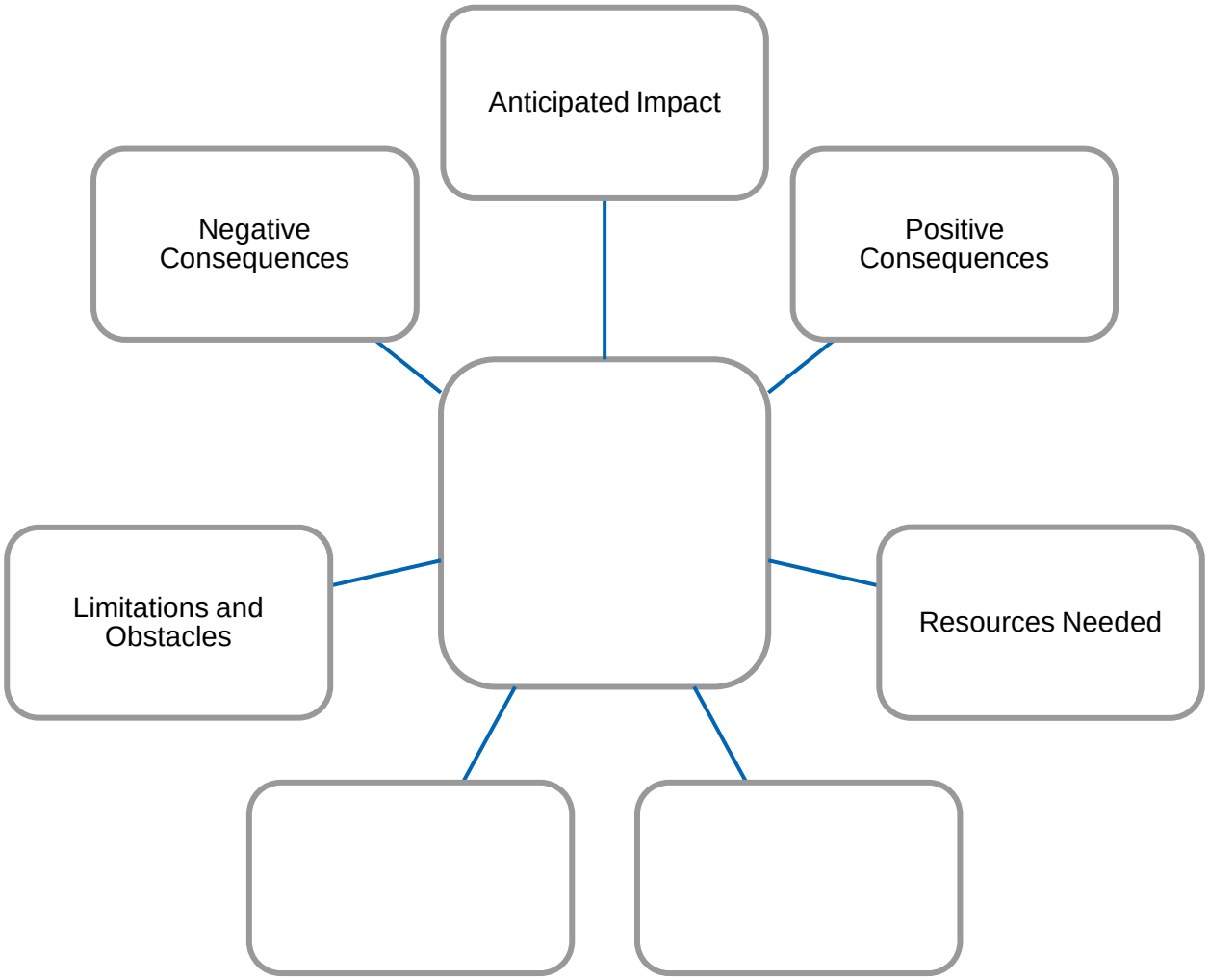
- Which idea would have an **observable** impact on your robot or team performance?
- Which idea would have a **valuable** impact on your robot or team performance?

Choose **one** of these ideas. How would you make the improvement?

Draw your idea, write your idea, or copy and paste images or links of solutions you've seen and would like to try.

How might the improvement impact your robot or team performance?

Choose one of the mapping templates or create your own to brainstorm the possible impact of the improvement, as well as any obstacles, limitations, or consequences that you might encounter.


Anticipated Impact
Negative Consequences
Positive Consequences
Limitations and Obstacles
Resources Needed

Performance Impact

Unit 6: Reflection and Improvement

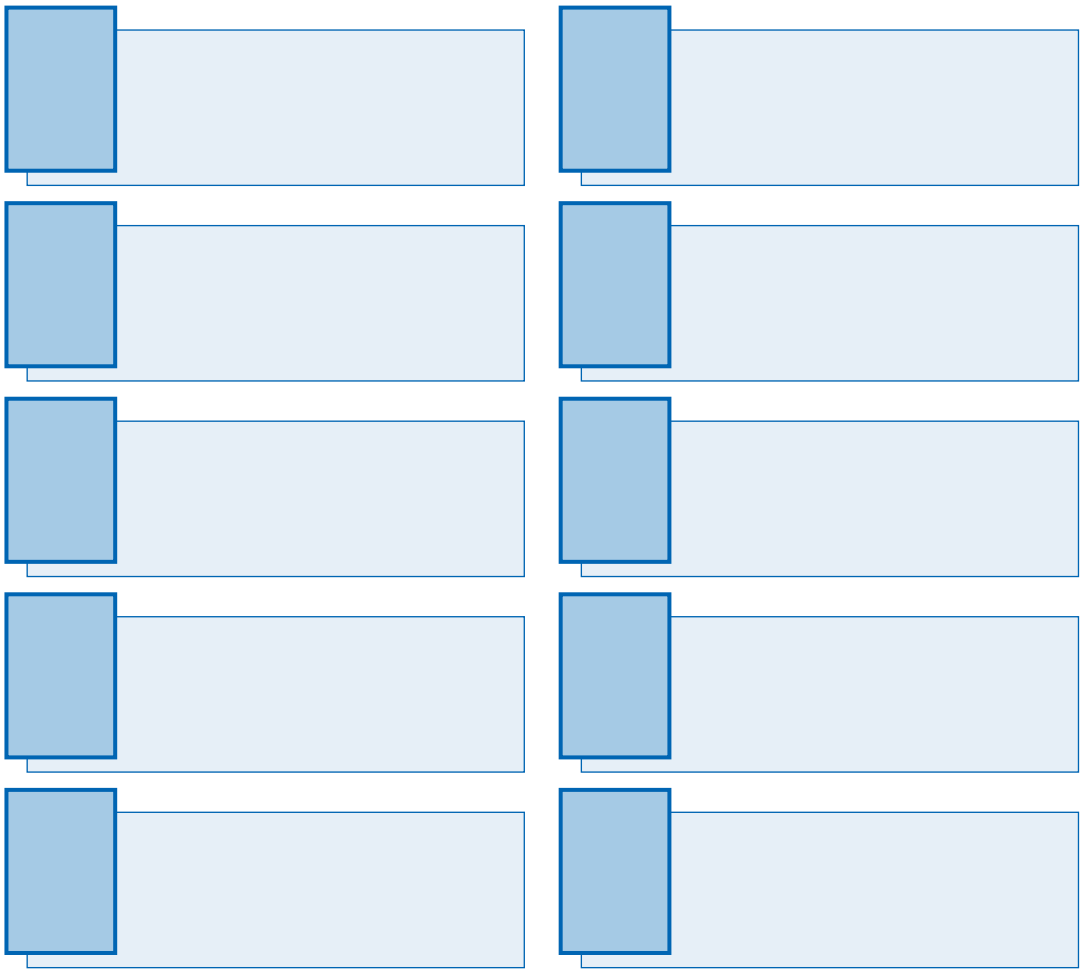
Impact Criteria Checklist:

Unexpected impact on performance:

Performance Impact

Unit 6: Reflection and Improvement

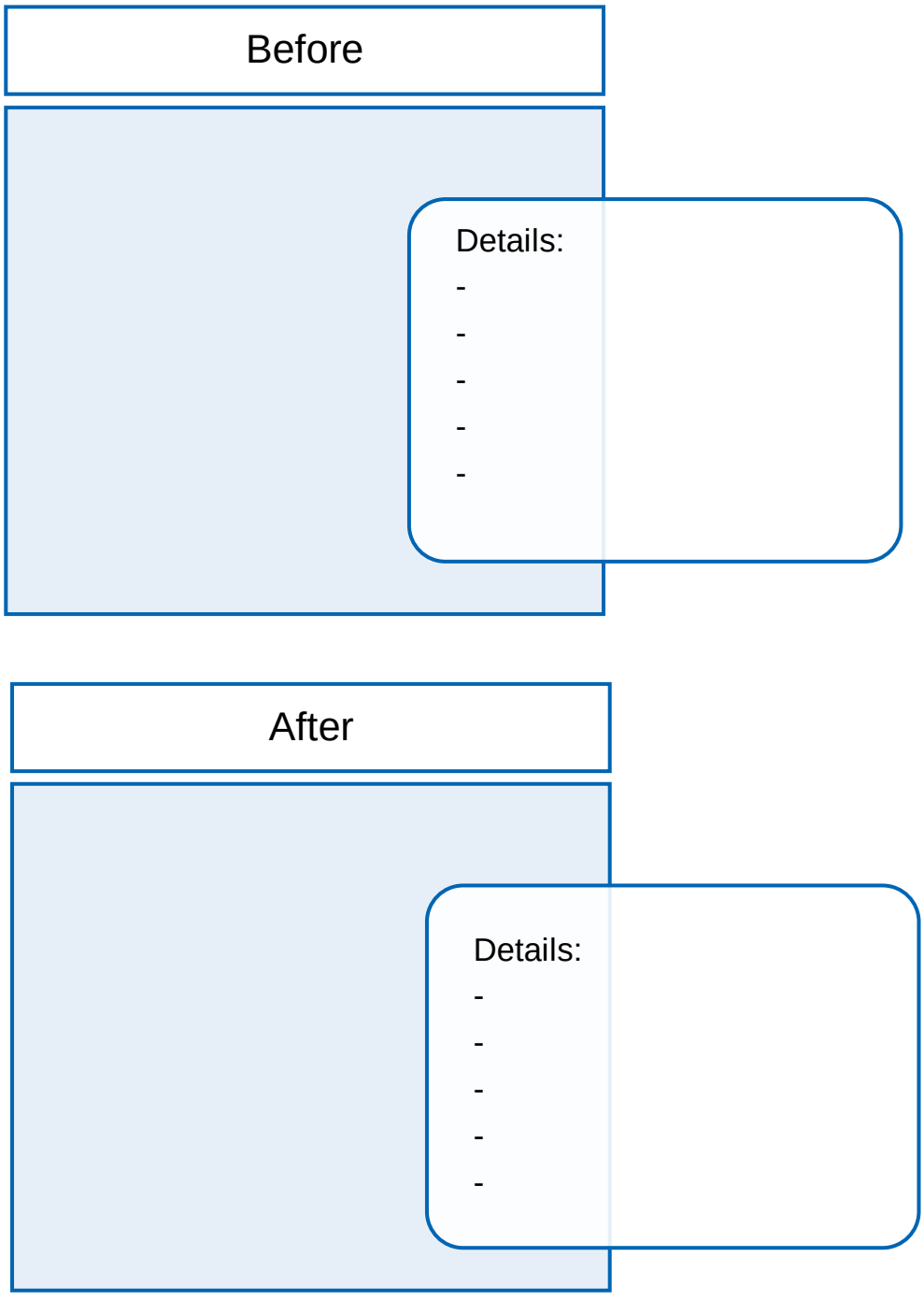
Impact Criteria Checklist:



Unexpected impact on performance:

Before and After Impact Summary

Unit 6: Reflection and Improvement



Before and After Impact Summary

Unit 6: Reflection and Improvement

Before	After
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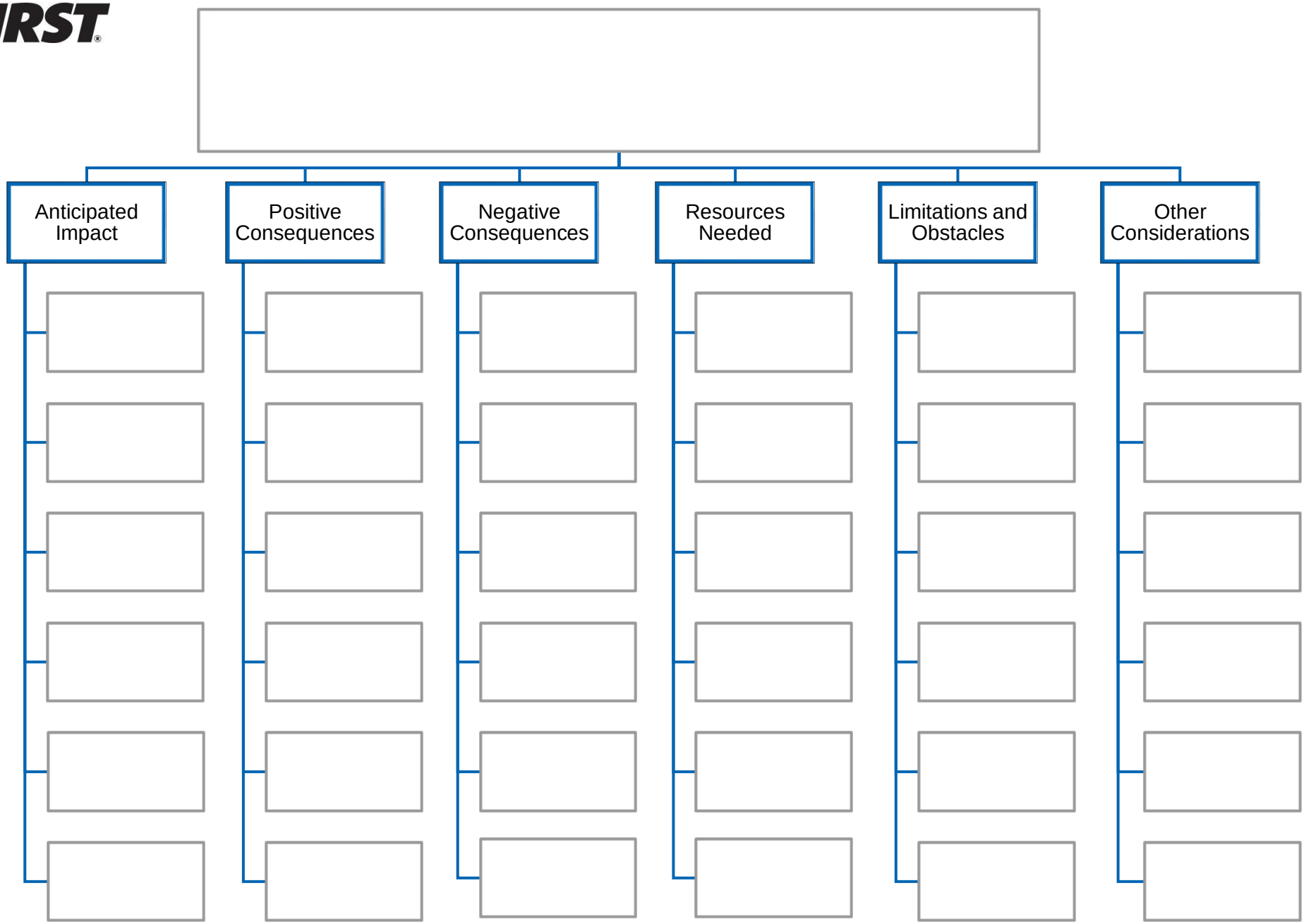
Lessons learned:


Anticipated Impact
Positive Consequences
Negative Consequences
Resources Needed
Limitations and Obstacles
Other Considerations

Make a Decision - Rubric

Unit 6: Reflection and Improvement

	Emerging	Developing	Proficient	Advanced
Investigates and analyzes existing robot design and team performance for areas of strength.	Provides limited or superficial ideas about areas of strength.	Provides limited but evidence-based ideas about areas of strength.	Provides several evidence-based ideas about areas of strength.	Provides several evidence-based, insightful ideas about areas of strength.
Investigates and analyzes existing robot design and team performance for areas of improvement.	Provides limited or superficial ideas about areas of improvement.	Provides limited but evidence-based ideas about areas of improvement.	Provides several evidence-based ideas about areas of improvement.	Provides several evidence-based, insightful ideas about areas of improvement.
Analyzes how parts of a whole interact with each other to produce overall outcomes in a complex, collaborative system.	Demonstrates limited or no appreciation of the relationship between the parts of the robot or team.	Demonstrates a superficial appreciation of the relationship between the parts of the robot or team.	Demonstrates a clear appreciation of the relationship between the parts of the robot or team.	Demonstrates an in-depth and insightful appreciation of the relationship between the parts of the robot or team.
Considers constraints, consequences, costs and benefits of adopting new ideas.	Identifies up to three constraints but does not comment on how they will affect the adoption of new ideas.	Identifies up to three constraints and provides broad, general comments on how they will affect the adoption of new ideas.	Identifies more than three constraints and provides specific examples of how they will affect the adoption of new ideas.	Identifies more than three constraints, provides specific examples of how they will affect the adoption of new ideas, and proposes realistic solutions to the described constraints.

Make a Plan - Rubric

Unit 6: Reflection and Improvement

	Emerging	Developing	Proficient	Advanced
Effectively identifies tasks and subtasks required to complete an objective.	Identifies general tasks required to complete an objective.	Identifies specific tasks required to complete an objective.	Identifies specific tasks and subtasks required to complete an objective and demonstrates an effort to communicate the relationship between them.	Identifies specific tasks and subtasks required to complete an objective and effectively communicates the relationship between them.
Identifies resources to help complete an objective and evaluates their use.	Identifies up to three available resources but does not comment on their value or use.	Identifies up to three available resources and comments on how they will be used.	Identifies three or more available resources and comments on how they will be used to achieve specific objectives.	Identifies three or more available resources and comments on how they will be used to achieve specific objectives. Identifies alternatives where resources are limited or ineffective.
Prioritizes tasks and subtasks and manages work flow to achieve an objective.	Demonstrates an effort to prioritize tasks or estimate completion time to achieve an objective.	Prioritizes some tasks effectively and provides an estimate of completion time for some of them.	Prioritizes most tasks effectively and provides an estimate of completion time for all of them.	Prioritizes tasks effectively and provides substantiated estimates of completion time.

Performance Impact - Rubric

Unit 6: Reflection and Improvement

	Emerging	Developing	Proficient	Advanced
References relevant evidence when assessing the impact of the improvement.	Assesses the impact of the improvement with limited reference to criteria for evaluation.	Assesses the impact of the improvement and refers to some specific criteria for evaluation.	Assesses the impact of the improvement and refers to specific, relevant criteria for evaluation.	Assesses the impact of the improvement, refers to specific, relevant criteria for evaluation, and notes potential areas for further investigation or testing.
Compares the outcome of results with initial expectations.	Provides information about the outcome of results and initial expectations.	Provides some detailed information about the outcome of results and initial expectations.	Provides detailed information about the outcome of results and illustrates their relationship to or difference from initial expectations.	Provides detailed information about the outcome of results, illustrates their relationship to or difference from initial expectations, and describes why they may or may not align.
Draws conclusions about their improvement experience.	Inferences drawn from results are limited or superficial.	Inferences drawn from results are supported with evidence.	Inferences drawn from results are supported with evidence and include lessons learned from the experience.	Inferences drawn from results are supported with evidence, include lessons learned, and how they will be applied in the future.