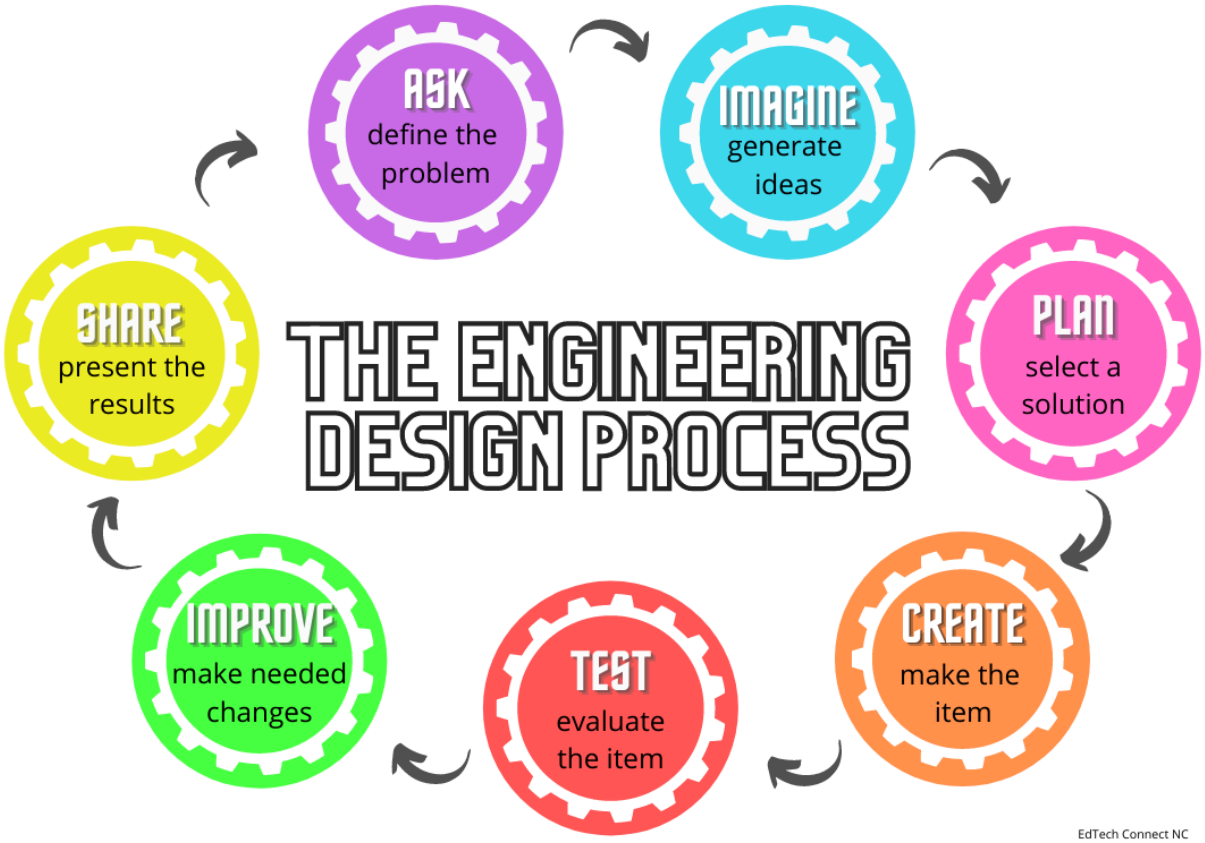

The engineering design process is a step-by-step way to solve problems and build solutions, just like the process your team uses in the FIRST Robotics Competition (FRC). It helps you take an idea and turn it into a functioning robot capable of tackling the season's unique challenges. Here's how it works, tailored to FRC:

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1. Ask (Understand the Challenge)

- Every FRC season starts with the **Kickoff Event**, where you're introduced to the game challenge.
- What tasks does your robot need to complete? Scoring points, moving game pieces, climbing, or defending?
- Study the **rules**, **game manual**, and **field layout** to fully understand the problem.

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2. Research (Learn and Gather Ideas)

- Dive deeper into the game requirements and look for inspiration.
- Watch kickoff analysis videos and review strategies or designs from past competitions.
- Research different mechanisms (e.g., arms, conveyors, or swerve drives) and understand their pros and cons.

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3. Imagine (Brainstorm and Strategize)

- With your team, brainstorm solutions for the challenge.
- What's the best overall **strategy** for your robot? Will it focus on scoring, assisting, or defense?
- Generate ideas for specific parts, like how your robot will pick up, hold, and deliver game pieces.

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4. Plan (Select and Design Your Robot)

- Evaluate your ideas and choose the ones that best fit your strategy and constraints like time, budget, and resources.
- Use tools like CAD (computer-aided design) to sketch and model your robot.
- Break the project into tasks, assigning roles for building, programming, and testing.

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5. Create (Build a Prototype)

- Build prototypes of key mechanisms, like a claw for gripping or a shooter for launching game pieces.
- Use materials like wood, 3D-printed parts, or spare components to quickly test your ideas.

- This step is all about experimenting—don't worry if it doesn't work perfectly at first!

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6. Test (Evaluate Your Design)

- Test your prototypes and finished components. Do they perform the tasks as expected?
- Simulate real gameplay scenarios to see how your robot functions under pressure.
- Identify problems, like a mechanism being too slow or inaccurate, and collect feedback.

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7. Improve (Refine and Finalize)

- Use what you learned during testing to tweak and improve your robot.
- Modify designs, improve programming, and strengthen weak points.
- This iteration is key to creating a reliable and competitive robot.

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8. Share (Compete and Present)

- Bring your robot to competitions and showcase your hard work on the field!
- Explain your design decisions to judges during the **Engineering Inspiration Award** or **Design Award** presentations.
- Learn from other teams and share ideas to improve together.

Why Is This Process Important in FRC?

- It gives your team a clear path to follow, even when the challenge seems overwhelming.
- It mimics what real engineers do, teaching skills like teamwork, problem-solving, and innovation.
- It's okay to fail! Each mistake is a chance to learn and build a better solution.

By following the engineering design process, your team can create a robot that's not just functional but also represents your creativity, collaboration, and commitment to excellence—core values of **FIRST Robotics**!

Ask: This step ensures you fully understand the problem and establish a clear direction for your project.

Ask Step Template: Understanding the Problem

1. Define the Problem

- What is the game challenge for this season?
  (Summarize the primary tasks your robot needs to accomplish based on the game manual.)
  Answer:
  Example: The robot needs to pick up cubes, place them on high platforms, and climb a bar in the endgame.

---

2. Set Goals

- What are the key objectives for our robot?
  (List the tasks or actions that will help your team score points or support your strategy.)
  Goals:
    - Example: Deliver game pieces to scoring zones.
    - Example: Climb during the endgame for bonus points.
    - Example: Play effective defense when needed.

---

3. Identify Constraints

- What limitations or restrictions do we need to consider?
  (Examples: size, weight, budget, time, or rules from the game manual.)
  Constraints:
    - Example: The robot must fit within starting dimensions.
    - Example: Stay under the maximum weight limit.
    - Example: Use only approved materials.

---

4. Understand the Field

- What are the important features of the game field?
  (Sketch or describe key zones, obstacles, or scoring areas.)
  Answer:
  Example: The field has scoring platforms of different heights and obstacles like ramps.

---

5. Define the End-User

- Who will interact with our solution?
  (Think about your drivers, operators, and alliance partners.)
  Answer:
  Example: Drivers and operators need intuitive controls to score efficiently. Alliance partners may depend on us to assist in defense or endgame.

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6. Identify Team Resources

- What tools, materials, and skills do we have?
  (List the strengths and resources available to your team.)
  Answer:
    - Example: A skilled programming team for autonomous modes.
    - Example: Access to a 3D printer for custom parts.
    - Example: Mentors with mechanical design expertise.

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7. Ask Questions

- What additional questions do we need to answer before moving forward?
  (List unknowns or areas requiring further research.)
  Questions:
    - Example: How many points are awarded for each type of scoring?
    - Example: What is the fastest way to traverse the field?
    - Example: What mechanisms have worked well in past seasons?

Summary:

- **Problem Statement:** (Summarize in one sentence.)
- **Main Objectives:** (List your top goals.)
- **Key Constraints:** (Highlight the most critical limitations.)

This template will guide your team to clearly define the problem, align on goals, and identify any gaps before brainstorming solutions.

Research: This step is all about gathering information to make informed decisions for your robot design.

Research Step Template: Gathering Information

1. Understand the Game Challenge

- **What are the game objectives?**
  (List specific tasks your robot needs to complete, based on the game manual.)
  Example: Score game pieces, navigate obstacles, climb a bar.
- **What are the scoring opportunities?**
  (Describe the actions that earn points and their values.)
  Example: Delivering a game piece to the scoring zone = 5 points. Climbing the bar during the endgame = 15 points.

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2. Study the Game Field

- **What are the key features of the field?**
  (Describe field zones, obstacles, and scoring areas.)
  Example: The field includes a low platform, a high scoring area, and an obstacle ramp.
- **What challenges or hazards might affect robot performance?**
  Example: Robots may need to cross uneven surfaces or avoid collision with other robots.

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3. Review Past Solutions

- **What strategies or mechanisms have teams used in similar games?**
  (Search for videos, photos, or CAD models from previous competitions.)
  Example: Conveyor belts for delivering game pieces or swerve drives for high mobility.
- **What lessons can we learn from past designs?**
  Example: Lightweight materials improve speed, but durability is essential for defensive play.

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4. Analyze Team Strengths and Weaknesses

- **What are our team's strengths?**
  (Consider skills, tools, and expertise available.)
  Example: Strong programming skills for autonomous routines. Access to advanced fabrication tools.

- **What are our weaknesses or limitations?**
  (Identify areas where you may need additional support or resources.)
  Example: Limited time for prototyping. Few team members with electrical expertise.

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5. Research Technologies and Components

- **What types of mechanisms might help us achieve our goals?**
  (List potential options, like elevators, arms, or drivetrain systems.)
  Example: Spring-loaded claws for grabbing game pieces.
- **What materials, sensors, or motors could be useful?**
  (Research options and list the pros and cons of each.)
  Example: Using a brushless motor for faster and more efficient movement.

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6. Learn from Experts

- **What can we learn from mentors, engineers, or experienced teams?**
  (Write down their advice or tips.)
  Example: A mentor suggests testing mechanisms in stages to identify weak points early.
- **What do official resources say?**
  (Include insights from the FIRST website, Q&A forums, or rule updates.)
  Example: Clarifications about game piece handling in the official Q&A.

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7. Summarize Your Findings

- **Key Insights:**
  (Summarize what you've learned in a few bullet points.)
  Example: A claw is better than a vacuum for handling this year's game pieces. A tank drive may be more reliable than swerve for crossing obstacles.
- **Unanswered Questions:**
  (List any areas where more research or testing is needed.)
  Example: How will a specific material hold up under stress?

Actionable Steps:

1. Prioritize mechanisms to prototype based on research findings.
2. Assign team members to continue exploring unanswered questions.
3. Use insights to guide brainstorming and design in the next phase.

This template will help your team gather and organize the information needed to make smart, informed decisions during the **Imagine** and **Plan** steps.

Plan: This step focuses on selecting the best solution, creating a detailed design, and organizing tasks for building your robot.

Plan Step Template: Choosing and Designing the Solution

1. Define Your Strategy

- **What is our team's overall strategy for the game?**
  (Summarize how your robot will prioritize tasks to maximize points and support your alliance.)
  Example: Focus on scoring game pieces in the high goal and climbing during the endgame.
- **Which game objectives will we focus on?**
  (List the key tasks your robot will perform.)
  Example: Delivering game pieces to the high goal, defending against opponents, climbing in the endgame.

---

2. Select the Best Design Concepts

- **What design solutions did we brainstorm?**
  (List the top ideas from the Imagine step.)
  Example: A claw for gripping game pieces, a shooter for high goal scoring, a tank drivetrain for stability.
- **Which solution best meets our goals and constraints? Why?**
  (Explain why you chose specific designs.)
  Example: The claw was chosen for its simplicity and reliability during testing.

---

3. Break Down the Robot Design

- **What are the major subsystems of the robot?**
  (List key components, like the drivetrain, manipulator, or climbing mechanism.)
  Example:
    - Drivetrain: Tank drive for stability.
    - Manipulator: Claw for picking up game pieces.
    - Endgame Mechanism: Hook and winch for climbing.

- **How will these subsystems work together?**
  (Describe how the robot's components will integrate.)
  Example: The claw will pick up game pieces and pass them to the shooter for scoring.

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4. Create a Detailed Design Plan

- **Sketch or model the robot design.**
  (Attach drawings or screenshots of CAD models if available.)
  Example: Include a diagram of the drivetrain, claw, and climbing mechanism.
- **Specify materials and parts.**
  (List what you'll need for each subsystem, including motors, sensors, and structural components.)
  Example:
    - Aluminum frame for the chassis.
    - Brushless motors for drivetrain.
    - Pneumatic system for claw actuation.

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5. Set a Timeline

- **What is our schedule for building and testing the robot?**
  (Break the timeline into phases with deadlines.)
  Example:
    - Week 1: Build drivetrain.
    - Week 2: Prototype claw mechanism.
    - Week 3: Integrate and test subsystems.
    - Week 4: Debug and refine.

---

6. Assign Roles

- **Who will work on each part of the robot?**
  (Assign tasks to team members based on skills and interests.)
  Example:
    - Drivetrain: Alex and Jordan.
    - Manipulator: Taylor and Priya.
    - Programming: Chris and Sam.

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7. Prepare for Contingencies

- **What risks or challenges might we face?**
  (Identify potential problems and how you'll address them.)
  Example:
    - Risk: The claw may not grip game pieces reliably.
    - Contingency: Prototype a backup mechanism, such as a roller intake.
- **How will we track progress and adapt?**
  (Describe how you'll review progress and make changes if needed.)
  Example: Weekly team check-ins to assess progress and adjust priorities.

Summary:

- **Chosen Design:** (Brief description of the overall design.)
- **Key Subsystems:** (List and describe each subsystem.)
- **Timeline and Roles:** (Summarize deadlines and team assignments.)

This template helps ensure your team has a clear and organized plan for building a competitive and functional robot while staying on track with time and resources.

Here's a template to help your team during the Create step of the engineering design process in the FIRST Robotics Competition (FRC). This step focuses on building prototypes, assembling components, and creating a functional robot.

Create Step Template: Building Prototypes and Assembling the Robot

1. Review the Plan

- **What are we building in this phase?**
  (Summarize the specific part, mechanism, or subsystem you're focusing on.)
  Example: Prototype the claw mechanism for picking up game pieces.
- **What are the key goals for this phase?**
  (List what the subsystem or robot should accomplish once built.)
  Example:
    - The claw should securely grip game pieces of various sizes.
    - The drivetrain should be operational for basic field movement.

---

2. Gather Materials and Tools

- **What materials do we need?**
  (List the parts and materials required for this build.)
  Example: Aluminum tubing, brushless motors, pneumatic actuators.
- **What tools are required?**
  (Specify tools needed for assembly and fabrication.)
  Example: Drill press, 3D printer, soldering iron.

---

3. Build Prototypes

- **Which parts are we prototyping first?**
  (Focus on testing critical subsystems before final assembly.)
  Example: Test a claw mechanism with different grip designs.
- **What are the results of the prototype tests?**
  (Describe what works, what doesn't, and any improvements needed.)
  Example: The claw grips well but struggles to release game pieces consistently.

---

4. Assemble the Robot

- **What subsystems are ready to integrate?**
  (List the subsystems completed and prepared for assembly.)
  Example: Drivetrain and basic manipulator are ready for integration.
- **How will we ensure proper assembly?**
  (Describe methods to align and connect parts, ensuring functionality.)
  Example: Use alignment jigs and verify connections with testing procedures.

---

5. Incorporate Programming

- **What programming tasks are needed at this stage?**
  (Describe any basic coding or testing needed for the robot to function.)
  Example: Test drivetrain responsiveness to controller inputs.
- **What sensors or controls need integration?**
  (List any electronics that need installation and configuration.)
  Example: Install encoders on the drivetrain for precise movement.

---

6. Test and Refine

- **What are the initial tests for this phase?**
  (List specific tests to ensure each subsystem works correctly.)
  Example:
    - Test claw gripping and releasing game pieces.
    - Test drivetrain movement across the field.
- **What issues were discovered, and how can we fix them?**
  (Record any problems and proposed solutions.)
  Example: The claw lacks grip strength—adjust pneumatic pressure.

---

7. Document the Build

- **What have we built so far?**
  (Summarize the progress made in this step.)
  Example: The drivetrain is operational, and the claw prototype is ready for refinement.
- **What needs to be improved or completed next?**
  (List next steps for refinement or further building.)
  Example: Refine claw mechanism for smoother release, integrate climbing mechanism.

Summary:

- **What We Built:** (Briefly describe the components completed in this phase.)
- **What Worked:** (Highlight successes during building and testing.)
- **What Needs Improvement:** (List unresolved issues or areas for refinement.)

This template will help your team stay organized during the build process and ensure each part of the robot is tested and functional before moving to the next step.

Test: This step is crucial for ensuring your robot's systems and mechanisms perform as expected in real-world conditions.

Test Step Template: Evaluating and Validating the Robot

1. Define Testing Goals

- **What are we testing?**
  (Specify the subsystem or functionality being tested.)
  Example: Test the claw mechanism's ability to pick up, hold, and release game pieces.
- **What are the success criteria?**
  (List measurable outcomes or benchmarks the system must meet.)
  Example:
    - The claw must securely hold game pieces of varying sizes.
    - The drivetrain should reach a speed of at least 10 ft/s.

---

2. Set Up the Test Environment

- **Where will the tests take place?**
  (Describe the location or setup, including any simulated game elements.)
  Example: Use the practice field with game pieces and obstacles.
- **What equipment or tools are needed?**
  (List tools like sensors, cameras, or measurement devices.)
  Example: Stopwatch for timing, scale for weight testing, voltage monitor for battery levels.

---

3. Run the Tests

- **What specific tests will we perform?**
  (Describe the scenarios or actions for testing.)
  Example:
    - Test the claw by picking up and releasing game pieces 10 times in a row.
    - Drive the robot across the field and measure stopping distance.
- **Record results:**
  (Log performance metrics for each test.)
  Example:
    - Test 1: The claw successfully picked up game pieces 8 out of 10 times.
    - Test 2: Drivetrain stopped within 2 feet of the target.

---

4. Analyze Results

- **What worked well?**
  (List aspects that met or exceeded expectations.)
  Example: The claw successfully gripped game pieces without dropping them.
- **What issues were discovered?**
  (Identify problems or inconsistencies during testing.)
  Example: The claw mechanism occasionally struggled to release game pieces.

---

5. Propose Improvements

- **What changes could improve performance?**
  (List adjustments or refinements based on test results.)
  Example: Increase pneumatic pressure to improve claw release speed.
- **What additional tests are needed after improvements?**
  (Plan follow-up tests to verify fixes.)
  Example: Retest the claw after adjusting pressure to ensure consistency.

---

6. Evaluate Overall Performance

- **How does the subsystem or robot perform as a whole?**
  (Summarize the system's readiness for competition.)
  Example: The drivetrain meets speed and control requirements, but the claw needs further optimization.
- **Are there any risks or concerns moving forward?**
  (Identify potential issues that may need monitoring.)
  Example: Monitor battery voltage during prolonged use to prevent power drops.

---

7. Document Findings

- **Test Summary:**
  (Summarize the key findings from this round of testing.)
  Example:
    - The drivetrain exceeded speed expectations.
    - The claw mechanism needs refinements for consistent performance.
- **Next Steps:**
  (List tasks based on test outcomes.)
  Example: Refine claw design, integrate autonomous mode, and conduct full-system testing.

Summary:

- **What Was Tested:** (Briefly describe the subsystem or feature tested.)
- **Results:** (Summarize outcomes, both successes and failures.)
- **Next Steps:** (Highlight the actions needed to improve or validate further.)

This template helps ensure your team systematically tests and evaluates your robot, addressing weaknesses and building confidence in its performance before competition.

Improve: This step focuses on refining and optimizing your robot based on feedback and testing results to ensure peak performance.

Improve Step Template: Refining and Optimizing the Robot

1. Review Testing Results

- **What worked well?**
  (Summarize the successes from the testing phase.)
  Example: The drivetrain is reliable and meets speed requirements.
- **What issues or failures were identified?**
  (List specific problems discovered during testing.)
  Example: The claw struggles to release game pieces consistently.
- **What feedback did we receive?**
  (Include input from team members, mentors, or alliance partners.)
  Example: Improve the robot's alignment system for placing game pieces accurately.

---

2. Define Improvement Goals

- **What specific aspects need improvement?**
  (Identify the key areas to focus on.)
  Example: Optimize the claw mechanism and enhance autonomous accuracy.
- **What are the success criteria for improvements?**
  (List measurable outcomes or benchmarks for success.)
  Example:

    - The claw should release game pieces 10 out of 10 times.
    - Autonomous mode should consistently score during the opening period.

---

3. Brainstorm Solutions

- **What ideas could address the issues?**
  (Generate multiple options to solve each problem.)
  Example:
    - Adjust pneumatic pressure in the claw.
    - Redesign the gripping surface with better materials.
- **Which solution is the most feasible? Why?**
  (Evaluate and select the best solution based on constraints like time, budget, and complexity.)
  Example: Add rubber padding to the claw for better grip.

---

4. Make Improvements

- **What changes will we implement?**
  (List specific actions to address the identified issues.)
  Example:
    - Modify the claw mechanism for smoother operation.
    - Reprogram autonomous mode for better alignment.
- **What resources do we need?**
  (List materials, tools, or expertise required.)
  Example: Additional rubber padding, pneumatic fittings, and mentor assistance with coding.

---

5. Retest the Improvements

- **How will we test the changes?**
  (Describe specific tests to evaluate the effectiveness of improvements.)
  Example: Run 10 trials of the claw releasing game pieces.
- **What are the results of retesting?**
  (Summarize the performance after modifications.)
  Example: The claw now releases game pieces 9 out of 10 times, an improvement from 7 out of 10.

---

6. Evaluate Overall Performance

- **How do the improvements impact the robot's overall functionality?**
  (Summarize whether the changes meet the improvement goals.)
  Example: The improved claw mechanism increases scoring reliability, and autonomous alignment is now consistent.
- **Are there any remaining issues or risks?**
  (Identify areas that may still need attention.)
  Example: The claw still struggles with oversized game pieces under certain conditions.

---

7. Document Changes and Lessons Learned

- **What changes were made?**
  (Record all modifications to the design or programming.)
  Example: Added rubber padding to the claw and adjusted pneumatic pressure.
- **What lessons did we learn during this process?**
  (Reflect on insights gained for future improvements.)
  Example: Testing early prototypes with different materials can save time later.

Summary:

- **What Was Improved:** (Briefly describe the systems or functions that were refined.)
- **Results of Changes:** (Summarize the outcomes of retesting and how they align with goals.)
- **Next Steps:** (Highlight any remaining tasks or future improvements.)

This template ensures your team approaches improvements systematically, making data-driven decisions and continuously enhancing the robot's performance.

Share: This step focuses on communicating your design journey, sharing your results, and reflecting on lessons learned to benefit both your team and the wider FRC community.

Share Step Template: Communicating and Reflecting on the Design Process

1. Define Your Audience

- **Who are we sharing with?**
  (List your intended audience, such as judges, sponsors, other teams, or the community.)
  Example: FRC judges, school administration, local sponsors, and younger teams.
- **What is the purpose of sharing?**
  (Clarify the goals, such as inspiring others, attracting sponsors, or documenting progress.)
  Example: Showcase our robot's capabilities and highlight teamwork and problem-solving.

---

2. Summarize Your Design Journey

- **What problem did we solve?**
  (Briefly explain the challenge your team addressed.)
  Example: Develop a robot capable of scoring game pieces and climbing in the endgame.
- **How did we solve it?**
  (Highlight the key steps of your process and major design decisions.)
  Example: Used a claw mechanism for game piece manipulation and a winch system for climbing.
- **What were our key successes?**
  (Summarize what worked well during the season.)
  Example: Our autonomous mode consistently scores points in the opening period.
- **What challenges did we face, and how did we overcome them?**
  (Describe problems encountered and solutions implemented.)
  Example: Adjusted our claw design multiple times to improve grip and reliability.

---

3. Showcase Results

- **What are the robot's capabilities?**
  (List the key features and functions of your robot.)
  Example:
    - Tank drivetrain for stability.
    - Pneumatic claw for secure gripping of game pieces.
    - Endgame climbing mechanism for consistent scoring.

- **What data or achievements demonstrate success?**
  (Include metrics, competition results, or testing outcomes.)
  Example:
    - The robot scored 95% of game pieces in testing.
    - Our team ranked 5th in regional competition.

---

4. Create Presentation Materials

- **What format will we use to share?**
  (Choose formats such as a presentation, video, technical binder, or social media posts.)
  Example: Create a team video, build a pit display, and prepare a technical binder for judges.
- **What content should we include?**
  (Outline key points and visuals to include in your materials.)
  Example:
    - Diagrams of the robot's design.
    - Photos of the build process and team activities.
    - Graphs of testing performance metrics.

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5. Engage Your Audience

- **What's our story?**
  (Tell a compelling story about your team's journey.)
  Example: Share how teamwork and persistence helped us overcome setbacks.
- **How will we involve our audience?**
  (Plan interactive elements, such as demos or Q&A sessions.)
  Example: Let sponsors drive the robot during a demo and answer their questions about the design.

---

6. Gather Feedback

- **What feedback did we receive?**
  (Record comments and suggestions from your audience.)
  Example: Judges appreciated the innovation in our claw design but suggested refining our technical documentation.
- **How can we use this feedback?**
  (List ways to improve based on feedback.)
  Example: Improve CAD documentation for next season and prepare a more detailed explanation of our strategy.

---

7. Reflect and Share Lessons Learned

- **What did we learn from this season?**
  (Highlight takeaways about teamwork, engineering, or problem-solving.)
  Example: Early prototyping and consistent communication were crucial to our success.
- **How can we share this knowledge with others?**
  (Identify ways to pass on your insights to other teams or future members.)
  Example: Host a workshop for rookie teams on building effective prototypes.

---

8. Document and Archive

- **How will we preserve our work for future use?**
  (Plan how to store documentation, photos, and designs for future seasons.)
  Example: Save CAD files, team videos, and testing data in a shared cloud folder.

Summary:

- **Audience:** (Who you shared with and why.)
- **Key Messages:** (What you communicated about your robot and process.)
- **Feedback and Next Steps:** (What you learned from sharing and how you'll improve.)

This template ensures your team effectively communicates your efforts and achievements, inspires others, and reflects on lessons learned for continuous improvement.