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2019-2020 *FIRST*® Tech Challenge

Engineering Notebook Guide

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Introduction

What is FIRST® Tech Challenge?

FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. To learn more about *FIRST*® Tech Challenge and other *FIRST*® Programs, visit www.firstinspires.org.

FIRST Core Values

We express the *FIRST*® philosophies of *Gracious Professionalism*® and *Coopertition*® through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

Gracious Professionalism®

FIRST® uses this term to describe our programs' intent.

Gracious Professionalism® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

Watch Dr. Woodie Flowers explain *Gracious Professionalism* in this short video.

What is the *FIRST*® Tech Challenge Engineering Notebook Guide?

The purpose of the *FIRST* Tech Challenge Engineering Notebook Guide is to:

- Give teams a tool to help them create successful and effective engineering notebooks to be used throughout the *FIRST* Tech Challenge season.
- Expand on the guidelines provided in the Game Manual Part 1.
- Providing award winning notebook examples.

This Guide focuses on the skills and ideas needed for developing the following general goals:

- Creating a successful and effective engineering notebook
- Provide tips for mentors and coaches to guide students to best use the engineering notebook.

This Guide would not be possible without the contributions of time and ideas provided by the following people:

- Jill Wilker, *FIRST* Tech Challenge Judge Advisor
- Kevin Ross, *FIRST* Tech Challenge Judge Advisor
- Chris Rake, *FIRST* VP of Programs
- Anika Greene, *FIRST* Tech Challenge Judge Advisor

- Eric Cheek, *FIRST* Tech Challenge Judge Advisor
- And the hundreds of other dedicated coaches, students, and volunteers who have sent us suggestions.

Engineering Notebook Overview

What is an Engineering Notebook?

One of the goals of *FIRST* and *FIRST* Tech Challenge is to recognize the engineering design process, the journey that a team makes in the phases of the creating their robot, and the business aspects of running a team including

- Problem Definition
- Information Gathering
- Brainstorming Solutions
- Concept Design
- System Level Design
- Testing
- Design Improvement
- Production
- Promotion
- Budgeting
- Planning
- Outreach

Throughout the process of building and designing a robot, teams will draw ideas on paper, encounter obstacles, and learn valuable lessons. This is where teams will use an engineering notebook. These notebooks follow the team from kickoff throughout the competitions. Judges review a team's engineering notebook to better understand the journey, design, and team.

The engineering notebook is a documentation of the team, outreach and fund-raising efforts, team plans, and the robot design. This documentation should include sketches, discussions and team meetings, design evolution, processes, obstacles, and each team member's thoughts throughout the journey for the entire season. Teams must create a new notebook for each season.

In the *FIRST* Tech Challenge, engineering notebooks also include business planning, outreach goals and achievement, and a team's insights into what it is to be a *FIRST* Tech Challenge team.

A new notebook must be created for each new season.

Engineering Notebook Questions

This journey goes beyond recording the day-to-day "here's what we did" or just listing "we met today". It explores questions like:

- What is the agenda today and what are our goals? These often come from the next steps from the previous meeting.
- What decisions did your team make in forming the team, creating the robot, writing the program, the outreach projects, etc.?
- How did your team make those decisions?
- Why did you make that choice when building your robot, coded the software that way, picked that group of individuals to outreach to, etc.?
- What was the impact on your team, robot, or community when you made that decision?
- What is the next step?

Engineering Notebook Formats

Teams may record their season with either handwritten, electronic, or online documents. There is no distinction made between handwritten and typed engineering notebooks during Judging; each format is equally acceptable. Only one copy is needed per team.

Electronic or Typed: Teams may use electronic or online programs to create their engineering notebook. For Judging, teams must print out their engineering notebooks and place them in a binder, with a ring diameter of no more than 3 inch (7.62 cm) and no more than 2 binders.

Handwritten: Teams can choose from spiral-bound, laboratory, or documentation notebooks available through their school or local office supply store. Teams can also use loose-leaf paper and place them in a three-ring binder with a ring diameter no larger than 3 inch (7.62 cm).

Teams may submit up to 2 binders or notebooks. Additional notebooks will not be accepted or considered.

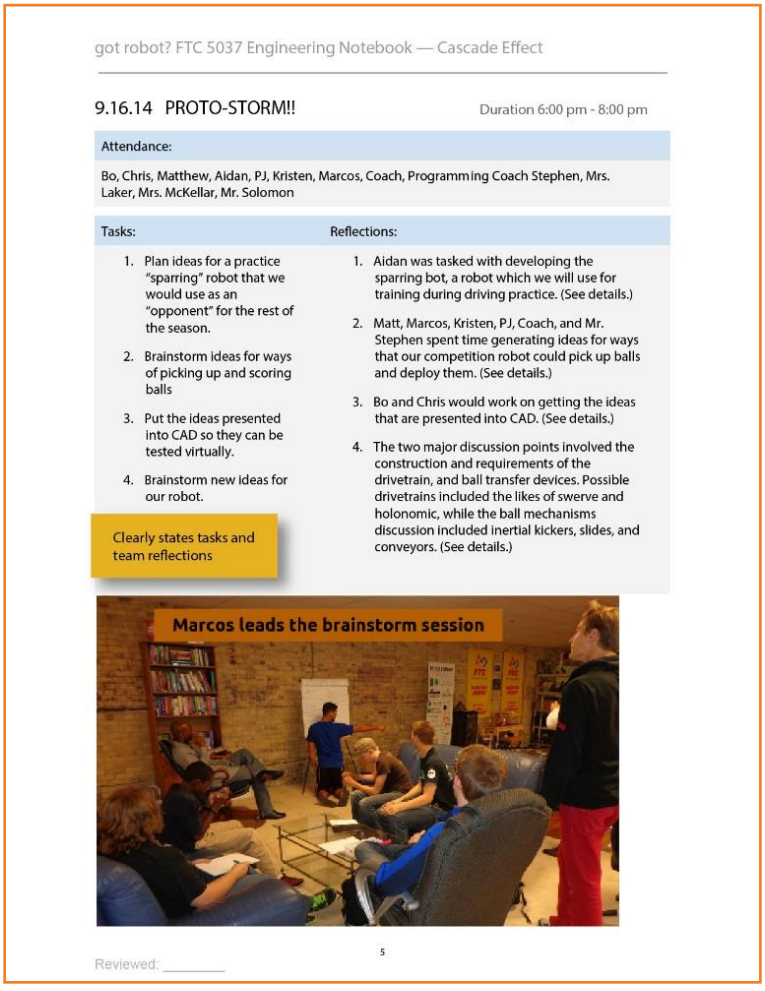
Engineering Notebook Requirements

1. Teams may not present more than two notebooks at a competition.
2. The team number must appear on the outside cover of the engineering notebook. **Engineering notebooks will not be considered without this information. This is important because Judges can't connect your engineering notebook to your team without this information.**
3. Teams should attach a summary page to the front cover of the engineering notebook. The summary should be between one and three pages long and include a concise narrative about the team, school, or organization with bulleted highlights of the team's season. The team summary page should also include the team number and a list of pages in the engineering notebook the team would most like the Judges to consider. Teams should list either the page number for those entries, or tab the pages they would like judges to pay extra attention to. Judges have many notebooks to look at. A summary page in your notebook helps them to focus on the work you are most proud of. Help them get to know your team better by adding a summary page.
4. The engineering notebook should include:
    a. Engineering content that includes the robot design processes.
    b. Team information that includes information about the team and outreach activities.
    c. A team plan. The team plan could include any of the following:
        i. A business plan to show the Judges how you plan to manage your team, what your fund-raising goals or outreach goals are, and identify areas of responsibility of your team members.
        ii. A strategic plan to show the Judges the specifics about how to meet your goals. This could include a timeline with milestones, for example.
        iii. A sustainability plan to show the Judges how you plan to recruit new members to keep the team alive as students graduate. This could also include how you train new members and pass the leadership of the team on to new members.

Engineering Notebook Tips to Help your Team Stand Out

1. Every notebook is a work in progress, forever changing and developing. Judges do not want to see a "final copy" notebook; they want the notebook to be real, even if that means there are misspellings, stains, worn edges and wrinkled pages.
2. Document EVERYTHING.
    a. Include the time after you finish your build and all the way up to competition, as well as between competitions. If your team plans to compete in multiple events for the season, what are you doing to improve your performance? How are your outreach efforts? How is your team investing its time between the competitions? ***Do not stop using the engineering notebook once the robot is complete.***
    b. Ask yourself questions like:
        i. What worked, what didn't? Do not be afraid to include your failures. This is about your journey toward success. When something didn't work, how did you problem-solve?
        ii. What changes are you planning on making?
        iii. How has your robot changed over the season?
        iv. How do you plan to fund your way to each event?
    c. The documentation should include enough detail for another person to look at your notebook and be able to build your robot from it, or at least follow the steps your team took to get to your final robot design.

    The summary page should be used to impress the Judges without the team being in the room.
    d. When writing your summary, make sure you highlight what makes your team stand out. Remember to keep this short. You want Judges to have more time diving into the pages of your notebook that you have identified for them.
    e. Remember, Judges only have a limited amount of time with each notebook. When you think about your team highlights, keep in mind that more pages to review mean that they will have less time to spend on each page. Think, ***quality over quantity*.**
3. Engineering notebooks should be organized enough that someone unfamiliar with your team (for example a potential sponsor) can understand your team and your journey.
4. In your notebook, introduce each team member and mentor with a brief biography of their first name, age (or school year), role on the team, interests, and reasons for joining a *FIRST* Tech Challenge team. Please don't include last names in the engineering notebook.
    a. The engineering notebook is also a good place to discuss and show team activities that are done throughout the team's season. These can include what your team outreach efforts include, team building activities, or more.


got robot? FTC 5037 Engineering Notebook — Cascade Effect

9.16.14 PROTO-STORM!! Duration 6:00 pm - 8:00 pm

Attendance:

Bo, Chris, Matthew, Aidan, PJ, Kristen, Marcos, Coach, Programming Coach Stephen, Mrs. Laker, Mrs. McKellar, Mr. Solomon

Tasks:

1. Plan ideas for a practice "sparring" robot that we would use as an "opponent" for the rest of the season.
2. Brainstorm ideas for ways of picking up and scoring balls
3. Put the ideas presented into CAD so they can be tested virtually.
4. Brainstorm new ideas for our robot.

Reflections:

1. Aidan was tasked with developing the sparring bot, a robot which we will use for training during driving practice. (See details.)
2. Matt, Marcos, Kristen, PJ, Coach, and Mr. Stephen spent time generating ideas for ways that our competition robot could pick up balls and deploy them. (See details.)
3. Bo and Chris would work on getting the ideas that are presented into CAD. (See details.)
4. The two major discussion points involved the construction and requirements of the drivetrain, and ball transfer devices. Possible drivetrains included the likes of swerve and holonomic, while the ball mechanisms discussion included inertial kickers, slides, and conveyors. (See details.)

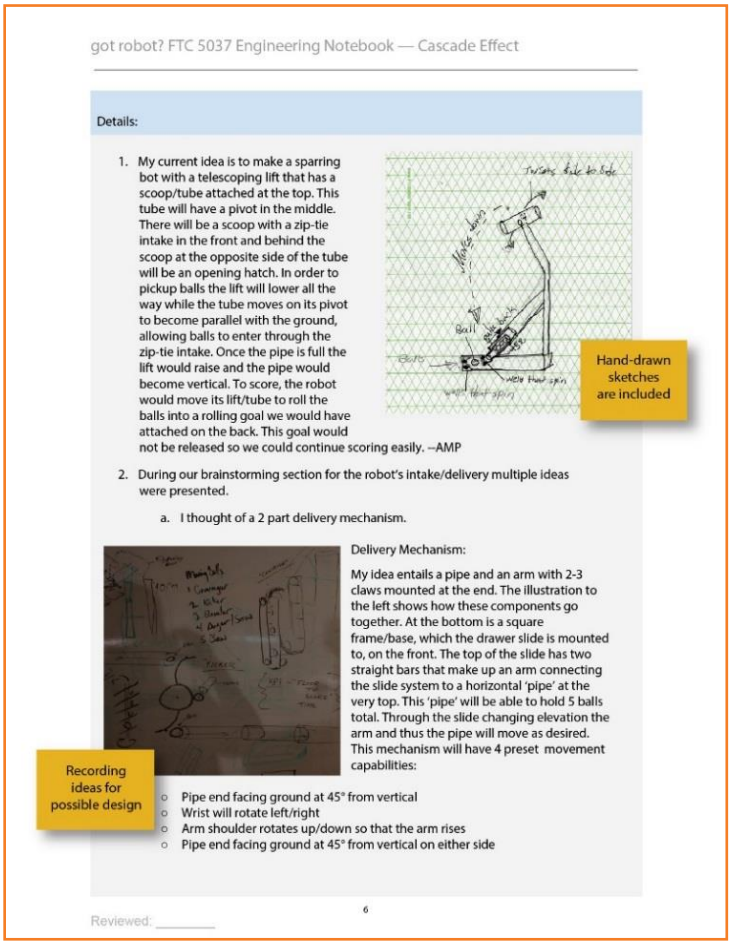
Clearly states tasks and team reflections

Marcos leads the brainstorm session

5

Reviewed: _____

   b. Pictures with the bios would serve as a great visual for the Judges to get to know each member of the team.
5. The date, start and stop times for meetings should be recorded. Teams should identify the start of a new meeting in the notebook, either with a line that separates meeting, or by starting a new page for each meeting.
   a. Include highlights from the meeting. What did you talk about? What did you do? What did you plan and carry out during your time together?
6. All designs and changes to the robot should be recorded directly into the engineering notebook. Try to include all details and sketches. Notes and calculations should be done in the notebook. Make sure that they are a part of the notebook. Extra pages added to the notebook are sometimes misplaced.
   a. A Judging panel is always interested to see a unique design or playing strategy. On the other hand, a design without the substance to support its reasoning is not viewed as highly. Remember to explain the *underlying science, math, and strategies your team is using as well as why you are doing what you are doing*.
   b. Pictures or sketches of the robot designs, electrical wiring diagrams, or even software development are recommended as part of a thorough documentation, although we do not recommend that students add copies of their code to the notebook.
7. Think about including your software development. This does not mean including the entire code, rather we encourage you to describe your code.
8. Written entries should be in permanent ink – not pencil.
9. Entries should be made by every team member, initialed, and dated. Judges like to see entries from more than one team member. It is not against the rules for one student to own the engineering notebook. However, showing that your team has multiple members sharing the responsibility showcases how your team is thinking about the sustainability of your team.
10. To insert pictures or outside information into the notebook, tape the picture into the notebook and outline with permanent ink, to note that it was there in case it falls out. Put your team number on the back of the picture.
11. If there is an error, draw a single line through the incorrect data. Do NOT erase or use correction fluid. All corrections should be initialed and dated.



Team Plan

Identify the purpose for a plan for your team. This is unique for every team and may touch on one or more of the following needs:

- Direction the team wants to take.
- Outlining team goals.
- Type of outreach team wants to focus on.
- Creating a team budget.

- Fund-raising needs.
- Seeking out sponsors.

The team plan can act as the backbone and guiding force for your team. By mapping out where you plan to go during the season, the goals you want to achieve and what you need to do to reach them, your team will be able to stay on track throughout the season. This is a living document and may change based on challenges that may arise through the season, lessons learned, or new opportunities. Plan to revisit this document a few times throughout the season to see if your team is on track of if a new direction is being taken and adapt your business plan.

Your strategic plan may also include milestones. Some examples could be:

- A short-term goal such as competing in at least two events this season
- A longer-term goal such as making it to a Regional Championship and fund-raising the costs
- A very long-term goal such a plan to create and foster additional *FIRST* Tech Challenge teams

Ask yourself:

- What are your team goals?
- Are you planning to use the business plan to plan your funding strategies?
    - How much money does your team need to get started and for what? (such as a budget)
    - How much money does your team need to sustain it for multiple years?
    - How much money does your team plan to raise through fund-raising efforts?
    - How much money does your team expect raising through grant opportunities?
    - How much money or in-kind donations do your team plan to raise through sponsorship?
    - How will you promote a business or organization if you receive a sponsorship? (Logo on team t-shirts and flare, or some other way?)
- Are you planning to use the business plan to seek out sponsors?

A strategic plan or business plan is a document that describes how an organization will define, set priorities, and develop the ways that it will achieve its goals. It helps the organization (in this case, your team) choose a course of action and a measure by which to decide about how they will gather and use resources. That information can be shared within the team to keep everyone focused. It can also be shared with parents, school administrators, sponsors, and other groups to describe the team's purpose and impact.

Make sure to identify what must be purchased, such as tools and major parts, not only simple categories like parts, travel lodging, and other things. It should include the budget, the fund-raising plan, and a contingency plan, if the team does not reach their fund-raising plan, and what they will do if they have excess. For multiple team organizations, show who is doing what and how the money raised is divided.

A Sustainability Plan

This plan can be integrated into the business or strategic plan. This plan explains how the team plans to grow and stay competitive when students graduate from the program. This may include plans to recruit sponsors, new mentors, or team members.

When considering including a sustainability plan, ask yourself:

- How does your team plan to continue past this season?
- Are you training younger team members in key roles as members graduate out?
- Are there plans for recruiting new members? What are they?
- Does your team have a plan to recruit more mentors?
- How are you fund-raising the costs of next season? Registration? New parts?
- How are you and your team leaving a legacy that will last beyond just this season?

See an example in our Appendix D: Sample Business or Strategic Plan – Sustainability.

Notebook Examples

Scanned copies of award-winning engineering notebook (both electronic and handwritten) examples are posted on the *FIRST* Tech Challenge Team Management Resources website under engineering notebook Resources. We recommend teams to look over these great examples of what the Judges will be looking for when reading through the engineering notebooks. Please remember, each engineering notebook reflects the team creating it. Although these samples are great references, the method and format used for these teams may not fit your team. These are examples that may *inspire* your team when starting your engineering notebook but should not be used as the sole template for your notebook.

Award Categories that Require the Engineering Notebook

The chart below provides a quick overview of the engineering notebook requirements by award:

Engineering Notebook Requirements by Award *Important: To be considered for any of the following awards, a team MUST submit an engineering notebook!*	
Inspire Award	• The engineering notebook must include information about the robot design, information about the team, and a team plan. The entire engineering notebook must be high quality, thoughtful, thorough, detailed and well organized.
Think Award	• Engineering notebook must have engineering content. The engineering content should include entries describing underlying science, mathematics, and game strategies. • The engineering notebook must show the team has a clear understanding of the engineering design process, with pictures or drawings and details documenting all stages of robot design. • Notebook must recount the team's journey, experience and lessons learned throughout the season. • Engineering notebook should be organized, and should include a summary page. Note: Teams should review the engineering notebook resources published in the Team Management section of the *FIRST* website.
Connect Award	• Team must submit an engineering notebook. The engineering notebook must include a team plan that covers the team's goals and plans for the season, which could include robot game strategies, outreach to science, engineering, and math communities, and team finances.
Collins Aerospace Innovate Award	• Team must submit an engineering notebook. The engineering notebook must include engineering content that documents a specific design challenge and how the team arrived at their design solution.
Design Award	• Team must submit an engineering notebook that includes robot CAD images or detailed robot design drawings. Design, and construction documentation.
Motivate Award	• Team must submit an engineering notebook. The engineering notebook must include a team plan that covers the team's goals and plans for the season. This could include robot game strategies, outreach to individuals outside of the science, engineering and math communities, and team finances.
Control Award, sponsored by Arm, Inc.	• The team must submit an engineering notebook. The engineering notebook must include engineering content that documents the control components.

Read the full Awards Descriptions in the Game Manual Part 1.

Engineering Notebook Self-Assessment

Engineering Notebook Self-Assessment

Notebook Formatting		
This section describes the minimum requirements a team must meet for their engineering notebook to be considered at any competition.		
Item Description	**Present?**	**Comments**
Required: Minimum of one notebook, not to exceed two. *Judges won't look at more than 2 notebooks.*		
Required: Team number on the outside front cover. *Judges need to know who the notebook belongs to*.		
Recommended: Summary Page - Either attached to front cover or in first 3 pages of the notebook. 1. Team Number. *If your summary page falls out of the notebook, judges know who it belongs to.* 2. Brief, one-page narrative about the Team, the School/Organization, and overview of highlights of the team's season. **3.** References to page numbers or tabbed pages for judges to pages in the notebook the team would like the Judges to consider. *This is an easy way to direct the judges to what you want them to see!*		
Recommended: Notebook is divided into sections, including: 1. A section that describes the engineering process 2. A section that describes the team, outreach activities, and individual goals 3. Team Plan		
Notebook Sections		
This section provides teams with guidance on what type of content should be included in each of the sections of the engineering notebook.		
Item Description	**Present?**	**Comments**
Engineering Content 1. Engineering content that outlines the design, build, & testing stages of the robot 2. Includes code development process. You don't need to add the code itself.		
Team Information 1. Team member coach and mentor biographies. *Please don't use last names.* 2. Team sponsor information 3. Team outreach activities, including fundraisers, demos, community connections, etc.		
Team Plan can include the following. 1. Business Plan: a. Goal Setting b. Team Funding/Budgeting 2. Strategic Plan a. How to execute goals 3. Sustainability Plan a. Where does you team hope to be in 1 year, 2 years, etc.? How will you get there?		
Notebook Suggestions – Content and Quality		
This section provides additional suggestions on how teams can create a stand out engineering notebook.		
Item Description	**Present?**	**Comments**
Formatting Suggestions • Creative cover, team photo, etc. • Table of contents and section dividers • Neat organization, neat presentation of information • Important pages are tabbed, or pages are numbered so your summary can point to them. • Entries made on both sides of the paper		
Content Suggestions • Team growth and development is documented • Team leadership and organization is documented • Team failures and struggles are documented • Every team member contributes to the notebook		

• Every meeting has at least one notebook entry • Entries include pictures, drawings, and text as applicable • Notebook is an accurate representation of the team and journey • Notebook documents changes in the robot plan, including ***WHY*** the change was made		

Additional Engineering Notebook Resources

For more information and suggestions, check out the following resources:

Engineering Notebook Self-Assessment – A checklist that walks a team through each engineering notebook requirement, what to include in each section, and suggestions for content and quality notebooks.

Mentor Manual – there is a section on the engineering notebook, as well as Appendices that include: engineering notebook samples (with tips on why they were successful), information on writing a business or strategic plan, and more.

FIRST Tech Challenge Example Engineering Notebooks – under the training resources section of the *FIRST* Tech Challenge Team Resources webpage there are four full engineering notebooks from teams. Check them out for ideas.

FIRST Tech Challenge Fund-raising Resources – Fund-raising Guide, budgets, sponsor presentations, etc.

Fund-raising Toolkit – lots of information and example business, strategic, and sustainability plans, including sample budgets.

Judges Manual – review for information on how Judges evaluate the engineering notebook.

Appendix A – Resources

Game Forum Q&A

http://ftcforum.usfirst.org/forum.php
Anyone may view questions and answers within the *FIRST*® Tech Challenge Game Q&A forum without a password. To submit a new question, you must have a unique Q&A System User Name and Password for your team.

FIRST Tech Challenge Game Manuals

Part 1 and 2 - https://www.firstinspires.org/resource-library/ftc/game-and-season-info

FIRST Headquarters Pre-Event Support

Phone: 603-666-3906
Mon – Fri
8:30am – 5:00pm
Email: Firsttechchallenge@firstinspires.org

FIRST Websites

FIRST homepage – www.firstinspires.org

FIRST Tech Challenge Page – For everything *FIRST* Tech Challenge.

FIRST Tech Challenge Event Schedule – Find *FIRST* Tech Challenge events in your area.

FIRST Tech Challenge Social Media

FIRST Tech Challenge Twitter Feed - If you are on Twitter, follow the *FIRST* Tech Challenge Twitter feed for news updates.

FIRST Tech Challenge Facebook page - If you are on Facebook, follow the *FIRST* Tech Challenge page for news updates.

FIRST Tech Challenge YouTube Channel – Contains training videos, Game animations, news clips, and more.

FIRST Tech Challenge Blog – Weekly articles for the *FIRST* Tech Challenge community, including Outstanding Volunteer Recognition!

FIRST Tech Challenge Team Email Blasts – contain the most recent *FIRST* Tech Challenge news for Teams.

Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email firsttechchallenge@firstinspires.org. Thank you!