Mentor Manual

FIRST® is a global robotics community that prepares young people for the future.

Revision History		
Revision	Date	Description
1.0	10/23/24	Initial Release

Contents

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 (AUTO) and teleoperated (TELEOP) robots that must perform a series of tasks.

Participants and alumni of *FIRST* programs gain access to education and career discovery opportunities, connections to exclusive scholarships and employers, and a place in the *FIRST* community for life. To learn more about *FIRST®* Tech Challenge and other *FIRST®* Programs, visit www.firstinspires.org.

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.

Youth Protection

FIRST Youth Protection Program has clear guidelines regarding adult and student interaction. Mentors and team leaders should start with reading the FIRST Youth Protection webpage and FIRST Youth Protection guide.

Make sure everyone on and associated with the team understands the *FIRST* Code of Conduct and Reporting Requirements as well as where to Report a Concern. Safeguarding youth is everyone's responsibility, so if you "See something, Say something!" Anyone that observes something inappropriate or experiences something that makes them uncomfortable should report the behavior to a trusted adult, whether that is a mentor, coach, event volunteer, or *FIRST* Youth Protection. Individuals who fail to adhere to the Code of Conduct or *FIRST* Youth Protection policies may be excluded from working in *FIRST* programs and at *FIRST* events.

Many school districts and organizations that teams are affiliated with also have guidelines and rules for adult and student interaction. The mentor must understand these policies and how to enforce them and communicate them to every adult working with the team.

FIRST Tech Challenge Glossary

As with learning anything new, part of the learning curve is learning the language and terminology. Below are some important *FIRST* Tech Challenge terms that you will encounter in this manual:

Term	Description
Awards	All teams participate in judging interviews that the judges use to determine the winners of *FIRST* Tech Challenge awards. Read the Competition Manual for more details about awards.
Mentor (or Coach)	Anyone assisting the team who is not a student team member and works to help the team achieve their goals. Each team must have a minimum of two adult screened coach/mentors. Coach and mentor are used interchangeably in *FIRST* Tech Challenge.
Competition Season	Teams compete against other teams in tournaments. Tournaments start as early as October in some regions and conclude in the *FIRST* Championship in April. Read more about the season timeline and our events on the Events webpage.
Coopertition	Means that teams support and help one another even as they compete to the best of their ability. Read more on the *FIRST* webpage.

Portfolio	Teams create a concise summary which include details of their season to share with judges to help team win awards. See the Competition Manual for details on award requirements.
Events	*FIRST* Tech Challenge events can happen anytime during the year. These include informal workshops and trainings, scrimmages, or tournament events. Read more about the *FIRST* Tech Challenge Events or visit the Events webpage.
***FIRST* Tech Challenge Official Q&A System**	Teams can ask questions and receive official answers about the current season Competition Manual. All questions and answers are publicly viewable.
Game	In September at Kickoff, *FIRST* Tech Challenge announces the annual game in which teams will compete with their robots. Information on the game is published in the Competition Manual released on Kickoff.
Competition Manual	Read it, know it, love it. The Competition Manual outlines everything teams need to know about building the robot, the game, judging, awards, etc. It is published on the *FIRST* Tech Challenge Game webpage.
Gracious Professionalism®	Means that teams support and help one another even as they compete to the best of their ability. Read more in the *Gracious Professionalism®* section or on the *FIRST* webpage.
Kickoff	The *FIRST* Tech Challenge season commences in early September with the annual Kickoff. Many regions host Kickoff events. The *FIRST* Tech Challenge program releases the Competition Manual and all information about the game on Kickoff Day via the Game & Season Materials Page.
Kit of Parts	Materials teams can purchase to use in building their robots, the Android phones, sensors, and modules. Read more on the Registration and Costs webpage. Read more in the `Purchasing Robot Supplies section.`
Mentor	Anyone assisting the team who is not a student team member and who works to help the team achieve their goals. Each team must have two adults who are screened coaches/mentors. Coach and mentor are terms used interchangeably in *FIRST* Tech Challenge.
Program Delivery Partner (PDP)	Coordinates the event structure, team recruitment and support, and funding for the *FIRST* Tech Challenge program in their region.
Team	An official *FIRST* Tech Challenge Team consists of no less than two and no more than fifteen student team members and is designed for students in grades 7-12. Students cannot be older than high school-aged if they are participating team members. All teams are required to register through the Team Registration System. Read more in the `Building the Team section.`
Team Registration	An online platform where mentors create a profile and complete background screening, set up the team's account, order kits, complete payment, and manage team information. Housed on the dashboard when you log into www.firstinspires.org.
Competition	Teams compete against other teams in competitions. *FIRST* Tech Challenge competitions start as early as October in some regions and wrap up in the *FIRST* Tech Challenge *FIRST* Championship in April. (Event seasons vary by region, but always start with the Kickoff in September.
Volunteer Roles	All of *FIRST* relies on volunteers throughout the season. Both mentors and event volunteers are critical to the program's success. Read more on the *FIRST* Tech Challenge Volunteer Resources webpage.
Youth Registration	An online platform where parents/guardians must complete registration information for their student. Housed on the dashboard when you log into www.firstinspires.org. Check out the Youth Team Member System Overview webpage.

2024-2025 Season Specific Information

FIRST Tech Challenge Event

A *FIRST* Tech Challenge event is typically held in a school or college gymnasium, where teams use robots to compete in the current season's game. Teams participating in events compete with alliance partners in a head-to-head style of competition on the official *FIRST* Tech Challenge field. Teams compete in a series of matches that determine their ranking at a tournament. The size of an event can range anywhere from eight teams to over 50 teams competing in one place. Events are generally scheduled by the local Program Delivery Partner, and are run by many volunteers including referees, judges, scorekeepers, queuers, and other key volunteers. Events consist of robot inspections, robot competitions, judging interviews (for most competitions), and an overall celebration of teams and their accomplishments.

Resources
- [Competition Manual](#)
- [Sign-up](#) for Team Updates or check the [Combined Update](#) document frequently

Season Timeline

FIRST Tech Challenge is a year-long program, starting with registration opening in May and ending with the *FIRST* Tech Challenge *FIRST* Championship in April. The competition season varies from region to region, but it can start as early as October and run through April for teams that advance. The following chart details the different aspects of the season and when they happen:

	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April
Registration Opens	■											
Pre-Season	■	■	■	■								
Kickoff					■							
Build Season					■	■	■	■	■			
Qualifying Events						■	■	■	■	■		
Regional Championships								■	■	■	■	
FIRST Championship												■

The Mentor Role

What is a Mentor?

Mentoring is an important part of the *FIRST* program and contributes to the program's success. Every adult on a *FIRST* team is a mentor, simply because they lead through guidance and example. It is important to remember students need guidance, structure, encouragement, and most of all, a fun experience!

When done correctly, this is an inspiring process which builds and expands team members' self-confidence and knowledge. If the process has a strong foundation and works properly, adult team members come away with as much as students do.

> Each Team must have at least two mentors who are 18 years old or older.
> At least one being 25+ is preferred

Understanding Bias
We strongly encourage our coach and mentor volunteers to complete the Strategies for Inspiring Success for All modules we have made available to develop a better understanding of invisible biases.

A Mentor…
- Requires no special skills, but should have patience, dedication, and a willingness to learn alongside the team.
- Is any person who works with the team in their area of expertise, for as little as one team meeting or as many as all of them.
- Helps provide valuable support and serves as a resource in their own area of specialty.
- Directs the process the team follows to solve the yearly game challenge, without providing the solution themselves.
- Is a coach, teacher, motivator, and facilitator.

There is more than just camaraderie on *FIRST* Tech Challenge teams. Many teams become extended families, with strong, lasting relationships. Students and adults absorb knowledge from each other and grow through a teambuilding and learning process from which everyone benefits. In *FIRST* Tech Challenge, it is important that mentors and students are equal, and that the relationship is a partnership. Each person works collaboratively towards a mutual and beneficial goal. To succeed, all the mentors and team members must commit to this.

Mentors should also be willing to acquire some basic knowledge of programming and robot building. Many teams enlist the support of a technology teacher or technical mentor for additional assistance. *FIRST* strongly encourages teams to invite people with backgrounds in engineering and programming to share their knowledge and experience.

A Mentor's Role Includes…
- Inspiring students in science and technology.
- Actively sharing knowledge and experience with the teams to help foster intellectual growth.
- Motivating and engaging students in meaningful activities.
- Balancing effective work habits with FUN!
- Allowing students to do as much of the work as possible.
- Encouraging the team to welcome and include all members.
- Providing students with opportunities to make choices, both good and bad.
- Encouraging students to take risks and be inventive.
- Allowing and encouraging independent thought.
- Creating, encouraging, and facilitating open, honest communication within the team.
- Fostering a reciprocal environment of trust and respect for every member and their ideas.

- Encouraging accountability within the team.
- Facilitating team activities and discussion.
- Developing roles within the team.
- Maintaining equipment and purchasing supplies.
- Communicating with sponsor organizations.
- Registering for competition(s).
- Planning and scheduling meetings, visits, and trips.
- Acting as a liaison between team members, mentors, parents, and volunteers.
- Informing students and parents about what is expected of them in terms of their commitment to the team each step of the way.
- Being a champion for *Gracious Professionalism* and role modeling the principle within the team.

The Teacher Mentor

Many of our *FIRST* Tech Challenge mentors are also classroom teachers. Some teach *FIRST* Tech Challenge in their robotics class, while others coach the program as an after-school club, and others fall somewhere in-between on the spectrum of possibilities. In this instance, we are speaking specifically about the mentor teaching in the classroom.

While every *FIRST* Tech Challenge mentor needs to know and uphold the policies and values of *FIRST* and *FIRST* Tech Challenge, teachers will need to also know, understand, and follow the policies of their school. *FIRST* Tech Challenge has resources to help teacher mentors on our [Educators webpage.](#)

The Mentor as a Facilitator

As a mentor, it is important to be involved, but it is equally important to make sure the process is directed and completed by students. Mentors differ in the amount of instruction they give their teams. While mentors are often teachers, it is important that the role they play on a team be that of a facilitator. The difference is outlined below:
- Teachers communicate knowledge they have learned on a given subject to one or more people.
- Facilitators enable communication within a group so that everyone contributes knowledge and experience toward the solution.

Students will gain the most from the experience if they are the driving force behind the actual robot planning, building, and programming. Mentors should give enough support for their students to have an inspiring and fun experience. This way, students may become complex problem solvers by finding solutions themselves and developing confidence in their ability to do so.

> In your team's rookie year, focus on enjoying the first year of participation as a survey of the program. The objective should be to fully experience FIRST Tech Challenge. Once a team has a positive experience, based on realistic goals, your students will overflow with ideas next year.

Advice for Mentors

Mentoring a team can be one of the most rewarding experiences in a person's life. Like any great reward, it involves a commitment of time and energy. However, it should not be taken too seriously! The goal of *FIRST* Tech Challenge is to help students have fun with robots while they become comfortable with technology. Whether or not the team is successful at a competition, team members win just by participating.

It is important for every adult to remember that there are responsibilities that come with the adult/student relationship. Young people look up to people they trust and respect and will look to mentors as role models. A mentor's actions will be closely watched, and their behavior will be perceived as appropriate. Be intentional and conscientious in your behavior and language.

Before meeting with students, have a meeting with all mentors to set expectations. This can give adults an opportunity to ask questions they may not want to ask in front of the students, openly discuss topics such as diversity, and discuss ideas and potential problems or concerns about working with young people. If this is a school-affiliated team and the school district has an individual who works with school or business partnerships, they should be invited to this meeting to help answer questions.

Mentor Time Management

As a mentor, additional time will be needed each week, beyond team meetings, to prepare and coordinate the team's tasks.

Effective Mentor Time Management

- Be aware of the `Season Timeline` and keep your team focused on upcoming elements.
- For rookie mentors: visit the Coach's Goal Tracker to help guide you through the season.
- Create a realistic meeting schedule. Consider personal and professional commitments, major holidays, and school events.
  - Keep a team calendar posted in the work area. Note key dates, deadlines, and meetings.
  - Entries in the team's portfolio should coincide with these dates.
- Have the team contribute to the selection of deadlines for certain parts of the project, so that they will feel ownership over the process and support mentors in ensuring all deadlines are met.
- Coach students on time management, including breaking larger tasks into smaller steps with deadlines.
- Ask for help. Work with other mentors, parent volunteers, mentors in training, and team members to accomplish team goals, track progress, and meet requirements on time.

Registering the Team

Registration

Registration for *FIRST* Tech Challenge is required and can be accomplished online through our [*FIRST* webpage](#). New users will be asked to provide contact information for the creation of a new username and password. All youth team members must complete their youth registration in their user profiles. Once logged into the account on [www.firstinspires.org](#), a user can:

- Create a new team.
- Edit team information.
- Pay for the season registration through the Storefront.
- Access the Storefront to order materials (see `Purchasing Robot Supplies` below).
- Once registered in the Team Registration, connect with your local Program Delivery Partner for events (see `Registering for Events` below).
- Obtain team access to the official [*FIRST* forums.](#)
- Ensure that each team member is registered and has obtained parent consent in the online Youth Team Member Registration System. Read [Information on registering Teams](#).
- Complete your team roster, in your team dashboard. A completed roster is required at check-in for events.

> All events (except for the *FIRST* Championship) must be registered for at the local level. You MUST contact your Program Delivery Partner to compete locally.

Purchasing Robot Supplies

Once you have created and registered a team, you will be able to purchase build and electronic supplies through our *FIRST* Tech Challenge Storefront. Registration is automatically placed in your cart upon entry. Season Registration must be paid first; however, you can purchase build and electronic supplies later if necessary. Read about the [*FIRST* Tech Challenge Kit of Parts](#) options.

Registering for Events

Once your team is registered and paid for the season, you can register with the *FIRST* Tech Challenge Program Delivery Partner in your region to compete in events in your area. There are a variety of events for teams to compete in, so be sure to check out the [Events webpage](#) for more information.

To find events in your area, go to the [*FIRST* Event Portal](#) and select the information that meets your region's criteria. Events are added from May until October, and sometimes even later, so be sure to keep checking back.

Each region offers varying numbers of events and has different policies about how many teams each event can have, how many events a team can attend in the region, and whether they will allow teams from outside their region to participate. Be sure to contact your [Program Delivery Partner](#) for more information about the events in your region.

Team Identity and Spirit

FIRST Tech Challenge teams and their members come from a variety of backgrounds. New teams should not expect to be like other teams, and experienced teams should not expect to be the same from year to year. Each team will have a different set of skills, experience, and ways of doing things. Each member of the team impacts the dynamic and capabilities of the team, so each time a new member joins, the team dynamic will change a little. Take time to get to know each other and find an approach and style that suits the team and its goals.

Teams are encouraged to develop and promote team identity. It helps to unite the team and develop a sense of belonging and group pride. It is a great way to help judges, announcers, and audiences to recognize a team at a competition. It can also help teams create a "buzz" about what they are doing in their own communities.

Team Overview

When organizing a team, consider size, diversity, age, skill level, time commitment and scheduling. Remember, teams grow and change as student interests and abilities develop, and as they move through the educational system. Be prepared for roles and responsibilities to shift throughout and between seasons. What a team member was interested in last year might change as they grow confident and look to explore new opportunities.

Teams can be formed in any environment such as schools, Boy Scouts, Girl Scouts, 4-H Clubs, church youth organizations, home school communities, or a group of interested students are excellent starting points to form *FIRST* Tech Challenge teams.

> It is important to ensure that the team dynamic remains positive, supportive engaging, and fun. Throughout the experience, team members will face long hours and days working on the robot and awards submissions. Whenever possible and appropriate, keep the atmosphere friendly and add laughter.

Team Size

Every team is different and there is no "ideal" number of students on a team. For most programs the ideal team size is between 6-12 students. Ultimately, the size of a team is based upon the mentor's preference and the interest of the students. You will also want to ensure that every student has an active role that they love and an opportunity to explore and learn other roles too. A team that is too large may not allow all team members to actively participate while too small of a team may overwhelm the students with too many responsibilities. Keep in mind that some events will have limited space in the pits and may limit the number of students that can be in that area, so larger teams should define team member roles clearly and in advance.

Larger teams should consider splitting into two teams to give more students the opportunity to experience more of the program. These teams can still work together and even build matching robots if they want.

Age Range

A *FIRST* Tech Challenge team is made up of pre-college students and is designed for students in grades 7-12 although students maybe younger at the discretion of the mentor. College students and others who have completed high school are welcome to participate in the role of mentor or coach but may not be an active student team member.

Some mentors find that it is best to stay within a four-year age-span for team members. Depending on the age and maturity level of the team, there may be social and developmental differences with mixed-age teams. This can work as an advantage, but mentors should be prepared to deal with team members from a variety of levels.

Time Commitment

Time commitment for mentors and team members will vary with experience and a team's dynamics. It is important to discuss duties, time commitment, meeting times, and dates up front. If students cannot make a reasonable number of meetings, mentors need to consider this. The level of commitment should be the same among all team members. Mentors should not complete the team's work if the team's commitment is low. It is the students' responsibility to successfully complete their robot for competition.

A meeting schedule should be a team effort and consider the students' ages, school schedules, and their experience in *FIRST* Tech Challenge. For example, a rookie team may require longer, more frequent meetings. Read more in the Mentor Time Management section of this manual.
Time commitment guidelines:
- *FIRST* Tech Challenge recommends starting with two shorter meetings, or one longer meeting per week during the teambuilding stage.
- During the design and build phase, meetings should take place more frequently, as indicated by the team's needs. Depending on the role assignments, not every team member needs to be at every meeting.
- To achieve the mission of inspiring students to pursue STEM (Science Technology Engineering Math), and recognizing the many activities competing for their time, we expect students to spend at a minimum 26 hours per season on *FIRST* Tech Challenge, not including the competitions themselves.
  - That would consist of meeting approximately two times a week, for 1-1.5 hours each meeting, for 9-12 weeks.
  - An average student would spend approximately 37 hours total per season; meeting two times a week, 1.5-2 hours per meeting, over 9-12 weeks.
  - At the more intense end students could spend up to 12 hours per week, over a course of 15 weeks, for a total of 180 hours.
- Sessions lasting 1-2 hours are the most productive.
- If an event is scheduled more than eight weeks from the Kickoff date, a less intensive schedule can be created.

> When planning your recruitment, think about what you can do to attract a wide pool of candidates, such as reaching out to diverse groups in your area.

Finding Team Members

When recruiting students for a team, it is important to understand the population of the school or local community and focus recruiting efforts on attracting a broad range of students. Make sure recruiting efforts reach a cross-section of the school or community. Recruiting new students based on status on the honor roll or membership in the Science Club automatically limits the number of potential applicants. Recruit by targeting the entire school and welcoming individuals with different skills and experience. Include and encourage a diverse range of individuals to help with recruiting. Students are more likely to be interested in participating if they see and hear someone they can identify with.

Suggestions for Recruiting Students
- *FIRST* is committed to equity, diversity, and inclusion, make sure to [check out our resources](#).
- Use [*FIRST* videos](#) that show a diverse population of students having fun.
- Hang posters in the school, at the local library, in businesses, and in sponsor organizations.
- Publish notices in the local paper.
- Include promotional materials in school newsletters or on school websites.
- Hold a student assembly where there is a *FIRST* Tech Challenge video and a demo.
- Have a local or previous year's team put on a demonstration at a school or community event.
- Give an overview of *FIRST* Tech Challenge in a series of classes where a variety of students are enrolled.
- Engage adults from local corporations, university students, and *FIRST* Alumni to speak about the value of participation.
- Enlist *FIRST* Alumni and participants on other *FIRST* teams to spread the word.

Selection Criteria

Sometimes you will have more interested students than spots on your *FIRST* Tech Challenge team. Use a variety of criteria to select them. Make sure that the criteria used for selection will not exclude students who could potentially make valuable contributions to the team.
Effective selection criteria might include:
- Interest in joining *FIRST* Tech Challenge.
- Recommendations from teachers, coaches, supervisors, employers, or community members, etc.
- A strong commitment to the meeting schedule, without conflicting commitments to other teams, clubs, or employers.
- Diversity of backgrounds, skills, or experience will create depth to the team.

When there are more students who meet the minimum criteria for participation than there are spots on the team, it will be necessary to decide which of the students will be invited to participate. Be as objective as possible in the selection of team members. Think about team growth and development over time. Encourage students who may not have been selected this season to participate in upcoming seasons when spots on teams may open or interest levels may prompt the establishment of new teams.

If you have a large pool of interested students, consider starting additional team(s) to accommodate the interest. Many schools have multiple teams, and mentors should consider creating additional teams when possible. Adults can be recruited to act as mentors, or existing mentors may choose to start a second team themselves.

Finding Team Mentors

Anyone can be a *FIRST* Tech Challenge mentor. Time and interest are the only requirements. As with the team, having a diverse pool of mentors only benefits the team. Some mentors bring business expertise, some technical expertise, some are great at marketing, while others have leadership skills with experience in building strong teams. A *FIRST* Tech Challenge team can use all these skills.

Each team will need at least two screened, committed adults to see them through the season from start to finish, but these do not have to be mentors with technical skills. Mentors can recruit other adults to serve a shorter time commitment and act as technical mentors. For example, a team might need help with wiring their robot, so they find an electrician who comes in for two meetings to help them learn wiring skills and perfect their wiring plan.

Lots of adults will want to help the team but be unable to commit to the whole season, so understanding the strengths and weaknesses of the lead mentors and the team's needs will help to identify the areas where additional support will be needed. Target your recruiting efforts to those areas.

FIRST has also worked with NI to create the [*FIRST* Mentor Network](), an interactive platform that allows teams and interested mentors to easily find each other for virtual or in-person mentorship. The community platform provides new and returning teams access to passionate, engaged mentors, while giving mentors the opportunity to use their unique skills and have meaningful involvement with one or more teams.

Recruiting Mentors

Mentors may be parents, teachers, engineers, college students, Scout leaders, *FIRST* Alumni, or members of the local community.

When recruiting a mentor, be sure to consider diversity. Young people may be more comfortable if there are mentors on the team with backgrounds like their own. Students can also learn a great deal from individuals with varied life, work, and learning experiences. Below are just some of the tools that may be used to recruit a diverse group of mentors.

Recruiting New Technical Mentors

Always start by identifying the help you need and the time commitment that assistance will require. Some folks are happy to help if they know it will only require a few hours from them. Truly, a wonderful technical member could be anywhere, just waiting for you to ask them for help! Start by polling your team's parents and families and see if there are any technical mentors in that group. Also, many mentors from *FIRST*® LEGO® League and *FIRST*® Robotics Competition may be happy to support or help with a *FIRST* Tech Challenge team, so reach out to other *FIRST* teams in your area, including other *FIRST* Tech Challenge teams. Teams or mentors who are unable to commit to in-person assistance may be willing to commit to remote assistance through video chat.

If you are still unable to locate the help you need, try these locations:
- High school teachers or college professors
- Leaders of community organizations, such as the International Brotherhood of Electrical Workers (IBEW)
- Leading corporations in local communities, such as RTX or PTC
- Local chapters of the American Society of Mechanical Engineers (ASME)
- Senior Corps
- Society for Women Engineers (SWE)
- National Society of Black Engineers (NSBE)
- Society of Hispanic Professional Engineers (SHPE)

Recruiting New Non-Technical Mentors

Some teams do not need technical help; they need support for printing, stapling, painting, coloring, driving to events, cleaning, fundraising, developing a business plan, learning about college and career preparation, etc. As mentioned earlier, always start by identifying the help you need and the time commitment that assistance will require. Some folks are happy to help if they know it will only require a few hours from them or if they can do the work while watching their favorite TV show at night.

Next, ask the team members and their families, or the other *FIRST* teams in your area, including other *FIRST* Tech Challenge teams. If you are still unable to locate the help you need, try these locations:
- Teachers, coaches, school administrators
- Community organizations, such as Girl Scouts, Boy Scouts, Boys and Girls Club, Elks Club, Kiwanis Club, etc.
- Leading corporations in local communities, whether technical or not. Lots of companies encourage their employees to volunteer.
- Senior Corps.

Team Meetings

It is important to set a regular schedule and procedure for team meetings. Make sure all mentors, team members, and parents are aware of commitments and the procedure to be followed at meetings. For more tips, refer to the Mentor Time Management section and the Time Commitment section of this manual.

Teams can meet anywhere that is appropriate. For a school-based program, the school itself makes an ideal meeting place. Schools usually have the computers and space to set up a field (for more information on setting up a field, refer to the game documents available on The *FIRST* Tech Challenge Game webpage). Depending on the situation, teams may also meet in a private home, a meeting hall, or a company conference room.

Things to consider:
- Be sure that planned activities and work hours do not conflict with the host's use of the space.
- Evening or weekend use of the building may require special authorization. Be sure to ask permission to use the site's computers to program the team's robot. Check with the site's host before installing software.

- Schools may require background checks for any adults working in the school. Ask the site to explain any adult supervision and child safety requirements to team mentors.

Select a workplace that has as many of the following as possible:
- Internet access
- Enough space to host the entire team, the computers, and all supplies.
- A secure place to store the parts and partially assembled robot between team meetings.
- Good lighting, at least in the worktable area.
- Simple sets of tools for working with parts.
- Worktables and chairs.
- Space for at least a partial practice field. Room on the ends will be needed for drivers. **Note**: a full-sized field is 12' X 12' (3.66 m x 3.66 m).

Meetings

At the first team meeting, outline a list of rules and procedures to be followed throughout the coming weeks. Work with students to establish these rules and explain that some are inflexible (such as rules about `safety`, `Gracious Professionalism,` or respect), and other rules may be open to revision as the team evolves and discovers new approaches to problems or procedural challenges (such as who completes documentation tasks in the portfolio and at what point in the meeting this occurs).

General Guidelines for Effective Meetings
- Maintain an accurate email list that includes parents.
- Start and end on time. This helps parents and lets students know that punctuality is important, and that time must be used effectively.
- Keep most meetings in the range of 2-3 hours. This is long enough to get organized and accomplish something but focused enough that students do not lose interest. Aim to meet for about seven to ten hours per week, starting immediately after the new game is announced. Time management is a key factor in a team's success.
- Toward the end of the season, meetings may need to be longer for testing and repairing the robot.
- If a meeting is right after school, have a snack ready at the start. (This also may help ensure students will show up on time). Make clear rules about eating and drinking near the robot, tools, and field.
- Schedule 15 minutes at the start of each meeting for a check-in or teambuilding activity to set the tone for the group and how you will use your time together.
- Schedule 15 minutes at the end of every meeting for clean-up. If some team members are going to stay and work longer, clean-up should still be complete at the end of the normal time. This should include maintenance such as sweeping the floor, cleaning up from snack time, and dumping trash. In terms of clean-up, teams should be encouraged to pick up after themselves. The coach should do nothing more than lock doors when the team is done.
- Take pictures of team meetings and events. Use a checklist of team members so there are a few pictures of each student.

Setting Expectations
- Clearly communicate meeting schedules with students and parents.

- Set clear expectations for participation from the first meeting and follow up with team members who are frequently absent. Not every meeting will involve every student. Some meetings may focus on programming, while others may focus on driver training.
- Keep students aware of deadlines. At the beginning of each meeting, have a brief progress review and set the objectives for the day. Document objectives and progress in the engineering notebook or meeting notes at the end of each meeting.
- Identify what the team is working to accomplish and establish criteria for agreement, as necessary. It is also a good idea to write the objectives for the day on a board, a large piece of paper, or another visually prominent place in the workspace. This will help students stay focused throughout the meeting.
- Review the team's portfolio, team goals, and the team calendar weekly to see if the team is on track.
- Ensure students are sharing tasks.

Working Together

- Have some team-building activities to help all members of the team get to know each other and some of their key interests.
- Teach members how to organize the tools and parts per an established system, or have the team agree on a system of its own. Label the locations for storing different items.
- Use brainstorming techniques to get input from everyone and write down all ideas. Weigh alternatives against the objective criteria that have been previously established. Some common techniques are weighted voting, combining similar ideas, testing the feasibility of an idea, and group consensus.
- Be sure to ask if there is anyone who does not understand the solution/plan.
- Implement the selected solution and make sure what is put into practice meets the original intent.

Building Robots

Safety for *FIRST* Tech Challenge

One of the first things a team should review is safety. Introduce the topic at the first meeting and mention that each person will be responsible for both team and personal safety. Stress safety at each meeting and post a list of safe practices in the meeting area! UL has also put together a [Safety Manual](#) to help promote safety at *FIRST* meetings and events.

Ensure students have at least one partner at the work location, while traveling, and at events. This way, if an accident or problem occurs, there is help nearby. When traveling to events, make sure students also have the mentor's contact information and room numbers.

Supervision
- Adult supervision is always required, especially when using power tools and electrical systems.
- Students should be trained in the proper use of tools and pass a safety test before using them. This includes simple hand tools as well as power tools.
- Mentors cannot be everywhere always. Students should speak to mentors if they observe other students acting unsafely.

Apparel
From the first meeting, make sure all members have the appropriate clothing for working in the workspace and around the robot, including ANSI-approved non-shaded safety glasses. Rose, blue, and amber tints are *FIRST* approved, but reflective lenses are not, because participant's eyes must be clearly visible to others always.

Make sure that each person has safety glasses and:
- Label their glasses with their name and team number and have a place to store them.
- Wear them always when working on the robot or when near someone working on the robot.
- Wear the required side shields.
- Wear safety glasses over corrective eyeglasses if they are not polycarbonate or a similar material.
- Is especially careful when near machining equipment.
- Wear closed-toed and closed-heeled shoes. These are required at all *FIRST* events and should be required at all team meetings.
- Wear appropriate clothing when working. Do not wear loose clothing, dangling jewelry, or other items that could be caught in the machinery. Long hair should be tied back.
- Use earplugs to protect your hearing when using loud equipment or at loud events.

> *FIRST* has strict requirements for safety glasses in the pit area and on or within five feet of the field. Safety glasses are required at all *FIRST* Tech Challenge competitions. Without them, students will not be allowed in these areas.

The Workspace
- Keep a first aid kit in the workspace always, including disinfectants and bandages. Bring it to events. Any accidents should be reported immediately to mentors.
- Have a fire extinguisher in the workspace and ensure that everyone knows where it is and how to use it.
- The workspace should be kept clean and uncluttered. Cords should be kept out of moving paths, and tools and materials should be kept in a designated storage area when not in use.

General Safety Practices
Encourage students to be aware of their surroundings always. Move through and explain hazards in the workspace, and ensure that students understand the necessary precautions for dealing with:
- Stored energy hazards, electrical, mechanical, and pneumatic springs, chains and gears, batteries, pneumatic cylinders, and lines, extended "arms," bound joints, and lifted weights.
- Hazards of the AUTO mode.
- Electrical hazards.

- Pinching and crushing hazards.
- Trips and falls prevention.
- Horseplay of any kind cannot be permitted in the workspace. Even small motors and mechanisms can be dangerous.
- Always turn off the main power switch or unplug the external battery before doing any repair or adjustment to the robot.
- Inappropriate emotional or physical behaviors/actions cannot be permitted. Establish a reporting procedure for this type of harassment and discuss it with the group.

Youth Safety

Start with the *FIRST* Youth Protection webpage and *FIRST* Youth Protection guide. Make sure everyone understands the *FIRST* Code of Conduct and Reporting Requirements as well as where to Report a Concern.

Safeguarding youth is everyone's responsibility, so if you "See something, Say something!" Anyone that observes something inappropriate or experiences something that makes them uncomfortable should report the behavior to a trusted adult, whether that is a mentor, coach, event volunteer, or *FIRST* Youth Protection.

Kit of Parts

Teams can order their robot supplies through the *FIRST* Tech Challenge Storefront, which is accessed through your account on www.firstinspires.org. Registration is automatically added to your cart. You can enter the storefront multiple times and purchase up to one item from each category. Awarded grants will appear in the storefront and automatically be deducted from the final total. If you do not see a grant that you were expecting, please DO NOT check out. Please check again in a few days.

FIRST Tech Challenge has created resources to assist mentors in ordering robot supplies through the Team Registration. Some suppliers that offer component kits via the storefront have created reference designs called "Starter Bots" that utilize their kits to build a basic robot capable of playing some aspects of the game. These reference Starter Bot designs can be found on the Robot Building Resources web page.

Developing Strategy

Developing an effective strategy for game play is part of the *FIRST* Tech Challenge experience and is vital to a team's success. As a team builds and programs its robot, it is important to make decisions about strategy and incorporate them into the design of the robot.

In determining strategy, analyze the point breakdown of the game and identify which tasks yield the most points. Also consider how long tasks will take. Consider the AUTO, tele-op, and end game portions of the games separately at first, and then determine how to integrate the three sections in an overall strategy for your robot design.

Brainstorming

Before moving into approaches for a game strategy, it is important to make sure everyone understands the rules, compliance restrictions, and has read the Competition Manual carefully. Clear up any questions or confusion about these things before moving into the brainstorming process. Although

training in programming, CAD, etc. can come later, these pieces can vastly improve what students know about robots, the kit of parts, and the potential designs.

Effective Brainstorming for *FIRST* Tech Challenge
- Discuss general strategies for achieving different objectives without referencing specific mechanisms.
- Discuss strategies without deliberating on how a robot would achieve that strategy (e.g., shooting the ball through the air, elevating the ball without shooting it).
- There are many different mechanisms to do each of these tasks, but do not talk about them yet. Note any ideas for mechanisms if they come up, but keep the conversation focused on big ideas because talking about the mechanisms too early may lead a team to overlook the best solution.
- Try to be understanding and do not reject ideas unless it is impossible or against game rules.
- For big ideas, try to think of every class of mechanism that could implement that strategy.
- Document all ideas. They may be useful later.
- Evaluate alternative designs and the advantages and disadvantages of each mechanism.
- Think about speed. Will this mechanism be faster or slower than others?
- Consider accuracy. How consistently does the mechanism achieve the desired result?
- Complexity is an important consideration. Will the team be able to build it and keep it working and properly adjusted?
- Think about the size and weight of the robot. Will this design fit in the robot's required dimensions?
- Consider programming requirements. Does this mechanism require sensors and programming that might be difficult to integrate?
- Rank each mechanism per how likely it is to be the best solution. Consider how each mechanism will help to score points in competition.
- Try to solve all the problems. Explore all possibilities.
- There are game time limits, so always consider speed when evaluating different designs.
- Start with a basic, solid design, and then improve it incrementally, using sensors or refinements.
- Start simple, test, and take measurements, identify ways to improve, make those changes, and then test again.
- There is always the option of sticking with it or going back to a simpler design.
- Test thoroughly.
- Avoid single points of failure whenever possible! Always consider what the result would be if one single item on the robot failed. Would this take the robot out of action, or just be a minor irritation? If there is a single point of failure, check it constantly and make sure the pit crew can quickly repair it if necessary.

Designing a robot

It is important to remember that design is an iterative, ever-changing process and that effective design involves making compromises. In general, it is best to keep design simple whenever possible. In the engineering world, simple solutions are much more desirable than complex ones. The complex solution has many more places to fail, is more difficult to repair, costs more, and its operation is less intuitive. Students are sometimes drawn to complex solutions. Keep reinforcing the principle of simplicity. Ask the team to distill its ideas to make the solution as simple as possible. Driving and operating a robot can be challenging with a variety of obstacles on the field. A simple robot is far easier to use than one that requires many complex steps to perform a task.

The What?

Think about what the robot will need to do, what it can do to compete in the game, and what kinds of objects the robot will need to manipulate. These discussions all involve trade-offs and compromises, as it may be impossible to do everything at once. Teams will need to decide what is most important to them.

The How?

Once it has been decided "what" the robot will do, it is necessary to figure out "how" the robot will do it. This is often more difficult. It is easy to decide "We need the robot to pick up a parking-cone," but it is difficult to figure out a feasible way to do it within the *FIRST* Tech Challenge restrictions. This is where experimentation is important. In general, *FIRST* Tech Challenge robot design can be divided into two major categories: drive train and mechanism.

> It is often better to be very good at one thing than mediocre at everything. Once the team has decided what to do, it must figure out how to best accomplish the task.

Robot Drive Train Design

One of the major robot systems is the drive train, which moves it around on the field. There are many different drive train configurations, but they all consist of:
- One or more motors
- Some means of transferring their torque/motion to the floor (a wheel, etc.)
- Some means of steering

The most traditional drive train configuration is called "skid-steer," sometimes called "tank drive." This is a system in which each "side" of the drive train is powered independently; turning is completed by running one side forward and the other side in reverse.

There are many options, and drive train design is often a matter of personal preference. It does not matter what the drive train looks like if it can perform the following specific tasks:
- Moving the robot at a "reasonable" speed without overloading the motors.
- Turning/maneuvering at a "reasonable" rate without overloading the motors.

- Overcoming any required field obstacles. (Climb stairs, etc.).

The team determines what defines an acceptable performance. Experiment and determine what works best. There are ways to tweak the drive train to enhance performance in several areas, but like most aspects of design, trade-offs and compromises will need to be made.

Robot Mechanism Design
In addition to moving around the field, a *FIRST* Tech Challenge robot must manipulate various objects. Manipulation is the hardest aspect of the *FIRST* Tech Challenge, especially for newer teams. What looks simple to humans can be extremely difficult for a robot. Try to create a system that effectively utilizes the available resources to accomplish as many tasks as possible.

Most years, the *FIRST* Tech Challenge game includes several different methods of scoring. Each team must decide which methods of scoring are most important and how they will accomplish them. It is often impossible to design one system to do everything, and this is where every team must make design compromises. It is important to help teams prioritize robot functions, design as many options as possible, and attempt to build mechanisms that perform multiple tasks.

Use real world examples for design inspiration. Take field trips around the community to look at machines and mechanisms that are used to accomplish tasks like those required for the competition, such as forklift trucks or cranes. Look through books or conduct online research into different machines and their functions. Take those ideas that apply to the task, and work to convert them to the challenge. After the team research mechanisms for a while, brainstorm and then prototype the ideas the team selects.

Notes:
- Try to minimize the weight and complexity of manipulators. Large, heavy accessories bog down the robot, waste batteries, and cause navigation to become less predictable and repeatable.
- The more complex a design is, the more likely it is to fail during competition. Encourage the team to look for simple solutions that will work consistently at the event and be better overall.

> Do not waste time trying to get a perfect working model right away. What is learned from the quick and rough prototype may completely change a final approach. Try to get multiple sub-teams working on various solutions simultaneously. Competition and learning can be effective motivators.

3-D Modeling Software
Another option for design and prototyping is the use of 3-D modeling or CAD (computer-aided design) software. This kind of software uses computer technology to design and document design. Elements can be modeled and assembled in the software to test and observe their effectiveness. CAD also allows teams to design their own parts to 3-D print.

While learning to use these types of software can take some extra time, it is a valuable skill for students to learn, is of great benefit when designing and prototyping a robot, and an excellent experience for students interested in drafting and design for future careers.
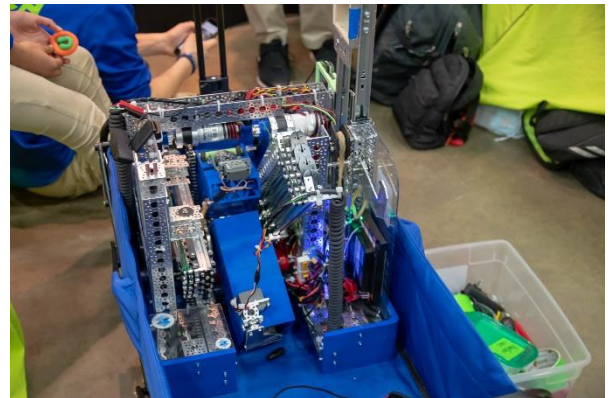
Prototyping

The kit of parts provides for several design possibilities. It is easy to build something, test it, and then rebuild it into something else. Brainstorm many ways to accomplish the team's goals and then test them to see what works best. This is called prototyping.

Once there is a working design, do not be afraid to modify it so it works better - and then do not be afraid to modify it again! Emphasize to students that it is okay to try things repeatedly to improve the machine and increase results.

Students, especially new team members, should spend some time simply playing around with the parts. This can take place before the new season's game is announced, and it is vital for students to develop an understanding of what the parts can and cannot do, how they fit together, etc. After the game is announced, experimenting with parts with the game goals in mind can still be useful for visualizing solutions.

During initial prototyping, do not worry too much about size or material limitations. Focus on getting something that works to solve a game problem. Once a concept has been proven, teams can focus on reducing the size or bringing the design back into materials compliance. Try multiple prototypes for each sub-system and worry about hooking it all together later. Use two-dimensional corrugated cardboard, plastic, or foam models to quickly determine feasibility and dimensions. Cut everything to scale. Once precise dimensions are determined, use the prototype parts to trace for cutting the real material. If new templates are made, be sure to mark the old one "OBSOLETE" to prevent confusion. Objectively evaluate the prototypes before deciding which mechanisms to use. Often students and adults get emotionally invested in ideas or directions. To get the best mechanism, set aside those feelings and use objective evidence as the only criteria for judging one design versus another. Document all prototyping and testing carefully. Even if considerable time is spent and a mechanism is rejected, this provides a valuable real-life engineering experience and demonstrates sound decision-making and innovation to the judges.

Building

Once planning, brainstorming, design, and prototyping are completed, building the robot for the game can begin. Each year, the *FIRST* Tech Challenge game is announced in September. Be sure to check material limits, types of materials, dimensions, and building strategies for compliance with *FIRST* Tech Challenge rules. Ensure that the team is very familiar with these rules, and that they are checked regularly for updates.

Notes:
- From year to year, the allowed parts and compliance standards change, so make sure to consult the most current Competition Manual for specific robot build rules.
- Teams are encouraged to use the robot inspection checklist to ensure their robot follows the rules before arriving at the competition.

> Use colored tape or small labels to identify small hex keys that are not marked clearly with their size. Ensure students know which hex key size or color is used with particular elements.

In addition to the tools provided in the kit of parts, additional tools may be required to assemble the model, customize elements, and modify the robot as required. Remember to review safety practices and safe tool handling with students before anyone gets to work.

Recommended Tools	Additional Power Tools	Helpful Supplies
• SAE Allen Wrenches: 7/64", 1/8" • Metric Allen Wrenches: 1.5mm, 2mm, 2.5mm • SAE Wrench/Nut Driver: 5/16", 1/4" • Metric Wrench/Nut Driver: 5mm • Hacksaw, 32 tooth blade • Hand Files (flat and round) • Wire Strippers • Wire Cutters • Needle Nosed Pliers • Locking Pliers	• Soldering Iron • Jigsaw • Drill • Heat Gun • Drill Press	• Shrink Wire Wrap • Electrical Tape • Black and Red Wire • Wire Loom • Zip Ties • Blue Thread Locker • Gear and Axle Lubricant • Extra Fuses for 12V Battery • Velcro

Teams should not get locked into continually trying to improve a bad design. Sometimes it may be necessary to step back, rethink, tear down, and rebuild a robot. Times like these are great opportunities to return to the brainstorming notes and portfolio to investigate other concepts and strategies that were recorded during the brainstorming, design, and prototyping stages of the development process.

Allowed Materials
In addition to the kit of parts materials, teams may use raw and post processed materials to build their robots. Items such as extruded metals, sheet goods, wood, plastic, rubber, and 3D printed parts are allowed per the rules. This provides some flexibility and creativity when designing the robot. These items also generally come at a lower price point and are budget friendly.
These parts can be drilled, cut, or otherwise modified to create customized elements for each robot. This provides an excellent learning experience for students, but also requires a little extra caution. Try not to cut metal parts unless it is necessary. Remind students that building supplies are limited, so they should always measure twice and cut once. Students who are unsure should have a partner or mentor to help them double-check their measurements and angles until they are confident doing it themselves. When customizing metal parts, it is important to smooth or cover any sharp edges. These precautions should be taken to avoid injury and to prevent damage to wires and other components as robots compete on the field.

General Building Best Practices
- Always ensure the robot's main power switch is easily accessible. This safety rule is paramount in case a robot needs to be shut down in an emergency.
- Batteries must be securely mounted to the robot and should be protected from any sharp edges or protrusions.
- Design to facilitate easy repair. Make sure that every part is accessible and easy to fix for quick and painless pit repair.

- Build the robot for competition. Consider the outcome of different types of collisions and add guards and bumpers in the design to minimize impact. Protect wires and position motors so that the end of the wire is inside the robot body.
- As screws, nuts, and washers are removed from the robot or from early prototypes, check them for damage and discard or mark parts that are no longer perfect.
- Investigate and experiment with gear ratios.
- Investigate and experiment with traction.
- At the end of each build session, unplug all chargers.
- Always double-check to make sure that fuses are matched exactly in type and amperage, and never use anything other than the correct fuse to bridge the connection, because batteries can overheat and catch fire if too much current is drawn.
- Reroute wires through channels where possible, for safety, and to prevent entanglement.

Wiring

Wiring is one of the most important components of a robot. However, wiring often does not receive the same care and attention as the rest of the robot. Even the briefest of power interruptions can cause the communication system to have to reboot. Good wiring allows teams to create tight connections and to better troubleshoot problems as they occur. Good wiring takes a lot of patience and practice, and teams should budget time accordingly.

In addition to building a great robot, there are best practices for general wiring of the robot – good habits to start as soon as possible.

- Make wiring diagrams
- Use the proper tools
- Label the wires
- Keep it neat
- Use proper wire management
- Tie it all down
- Be careful with power switch placement
- Conduct proper maintenance

For more information on wiring best practices, check out our Robot Wiring Guide on our Robot Building Resources webpage.
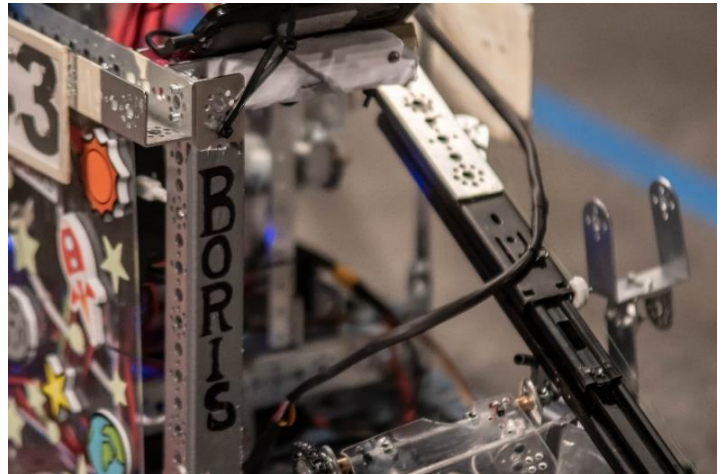
Programming

Programming Tools
Java is the recommended programming language for the *Robot Controller*. The following tools are recommended for use in the *FIRST* Tech Challenge:
   a. FTC Blocks Development tool – a visual, blocks-based programming tool hosted by the *Robot Controller*.
   b. FTC OnBot Java Programming tool – a text-based integrated development environment hosted by the *Robot Controller*.
   c. Android Studio – a text-based integrated development environment.

For those who have some experience with the software but little experience applying it within the context of *FIRST* Tech Challenge, sample programs, programming guides, and video tutorials have been provided with the online activities for teams in the following resources:

- *FIRST* Tech Challenge Community Forum
- Robot Building Resources
- Programming Resources

Programming
It is always a good idea to have more than one team member responsible for the programming and to have all team members familiar with it. An effective way to achieve this is to assign each team member a tutorial to present to the rest of the group.

- Create a flowchart to make the programming more of a team effort; to keep with good programming practices, have the team create this flowchart as a group effort. Keep the flowchart simple, and only outline the major steps of the program as blocks. Leave it to the programming team to fill in the details of each block, with the understanding that if they get stuck on a block, they can, and should, ask the rest of the team for assistance.
- Test and archive once the programming team is ready to test the program. Have them prepare a simple set of instructions and turn the testing over to a testing team. It is better to have team members who are not intimate with the code do the testing, following only a simple set of instructions.

Robot Control System
A *FIRST* Tech Challenge robot is controlled by an Android-based platform. Teams will use two Android devices to control their robot. One Android device is mounted directly onto the robot and acts as a robot controller. The other Android device is connected to one or two gamepads to make up the operator console.
If you need more help, check out these resources:

- *FIRST* Tech Challenge Community Forum
- Robot Building Resources

General Programming Best Practices for *FIRST* Tech Challenge
- Always back up programs before the start of each programming session. A copy of the last working version should always be available, in case of a broken program.
- Create flow charts of code and include them in team notes or the portfolio.
- Create comments on the code, right from the beginning. This helps with debugging and with situations in which another programmer needs to step in and work on the code.
- Avoid cryptic names. Variable names are much more readable and less likely to be forgotten over time. ("MotorLeftFront" is much more descriptive than "mtr_S1_C1.") Use the same prefix for multiple variables that belong to the same physical structure or concept.
- By the time AUTO programming begins, structural changes to the robot hardware should be complete, especially anything involving the wheels and drive train. After any significant hardware change, the AUTO programs must be tested and re-adjusted if necessary. Remember that a simple thing like changing wheel size will change the robot's speed.

- Do not try to accomplish all the tasks for the entire challenge at the same time. This is especially true for the programming team. Working through each step individually may be less exciting for students, but it is a more accurate and efficient approach to the problem overall.
- Allow some settling time after a motion or turn. Allow about 100 milliseconds to let the robot finish all its movement actions before beginning again.
- Design repeatable tests for all major subsystems. Document baseline tests in the **team portfolio**. Compare improvements with the baseline and document them as well. Track how well the AUTO mode works at different battery levels, so there are no surprises. Test sensors under different conditions (e.g., test light and color sensors under different lighting conditions).
- Make small changes and test frequently. If several things are changed all at once and something does not work, it can be hard to figure out where the problem is.
- Make sure to practice using the same version that will be used at the competition. The final practice before any competition should be run using the latest software, so there is time to address any new problems that the changes may introduce.
- Think about all the ways a system could fail and conduct trials to determine them. Figure out which failure modes are the most prevalent and concentrate on fixing them first.

Iteration

It takes a lot of planning and trial and error to build a successful robot. One of the advantages to the `Season Timeline` is the opportunity for teams to continue to work on their robot before, during, and after competitions – and again before the next level of competition. Teams are constantly seeing what other teams are doing, learning new skills, and identifying strategies that might require changes to the robot. Do not be afraid to change your robot! The engineering process depends on the willingness to try something new, scrap it, and then try something else.

The Portfolio

What is a Portfolio?

A team portfolio is a short and concise summary of the team's engineering journey throughout their season. The portfolio should include sketches, discussions and team meetings, design evolution, processes, obstacles, goals and plans to learn new skills, and each team member's concise thoughts throughout the journey for the season, the portfolio is like the team's CV or resume.

One of the goals of *FIRST* and *FIRST* Tech Challenge is to recognize the engineering design process and the journey that a team makes. This journey encompasses the phases of the problem definition, concept design, system-level design, detailed design, test and verification, and production of the robot.

> A team number on the top of every page makes it easy for judges to know who created the portfolio they are reviewing. The team number on the front page is a <u>required</u> component of the portfolio.

Portfolio Formats

Teams may choose to document their summary portfolio with either handwritten or electronic documents. There is no distinction made between handwritten and electronic portfolios during judging; each format is equally acceptable.

- Electronic: Teams may choose to use any electronic programs to create their portfolio.
    - For REMOTE event judging, teams must create a single PDF file of their portfolio.
    - For traditional events, teams must print their portfolio.

- Handwritten: Teams can choose to create a handwritten version.
    - For REMOTE judging events, this is discouraged due to difficulties in scanning into a readable, sharable, online version.

Portfolio Requirements

A portfolio is required for some awards but is helpful for all awards. A good portfolio is also a great way to record your team's season and share it with future team members or sponsors.

Please read Section 6 – Awards of the competition manual for the specific rules regarding awards and portfolio specific requirements.

Outreach Activities for Teams

Community Outreach

A vital component of *FIRST* Tech Challenge is helping to build the *FIRST* community by introducing more young people to the experience, and by celebrating science, technology, and engineering. Outreach events include activities to encourage students and mentors to join existing robotics teams or to start new teams, as well as to raise awareness of robotics in education in general. While it may seem counterintuitive for teams to try to create new competitors, the bigger picture is that *FIRST* is not about the competition, but about changing the culture by inspiring students. The more teams there are, the more students there are to inspire.

FIRST stresses community involvement in several ways, including recognition via *FIRST* Tech Challenge awards, such as the Inspire, Motivate, and Connect Awards.

Suggestions for Community Outreach
- Contact regional *FIRST* organizations and volunteer to support their activities.
- Connect with other teams online, and reach out to others in the community, both near and far. This can be done through social media (*FIRST* Tech Challenge social media accounts, Facebook groups, LinkedIn, etc.) or via unofficial groups designed just for this purpose.
- Get parents involved. Parents are their children's greatest supporters. They are incredibly valuable as volunteers, cheerleaders, and advocates for the benefits of *FIRST*. Give parents the opportunity to learn more about what their children are doing and to develop their own enthusiasm and appreciation for science, technology, and engineering.
- Assist in the development of new *FIRST* teams. Mentor another team or act as a resource for a new mentor or for a community member interested in getting involved with *FIRST*. Recruit new mentors.
- Lead a workshop for a local partner. Help other teams in the local community develop their skills and abilities by supporting them as

they learn a new programming language or work with a new mechanism. Share the experience and knowledge that has been gained through previous years of participation.

- Hold an open practice, build day, or scrimmage. Use the Event Guide located on the *FIRST* Tech Challenge Volunteer Resources webpage!
- Do a demonstration at a local event or community center. During outreach events, make sure that there are regular opportunities for team members to briefly describe the robot and what robotics means to them.
- Promote *FIRST* in the community through positive word of mouth and local media, where appropriate. Create flyers to hand out at events or create a press release about upcoming events and distribute it to local newspapers or websites or use *FIRST* Tech Challenge Marketing and Team Info on our Team Management Resources webpage.
- Participate in community activities and service opportunities. Wear your team or *FIRST* Tech Challenge gear and talk about your experiences.

Using the *FIRST* and *FIRST* Tech Challenge Logos

Download the *FIRST* and *FIRST* Tech Challenge logos, the *FIRST* Branding & Design Standards, and the Policy on the Use of *FIRST* Trademarks and Copyrighted Materials from the *FIRST* web at https://www.firstinspires.org/brand.

Advantages to Outreach

Most *FIRST* teams participate in outreach activities, or opportunities to showcase their skills and knowledge to the "outside" or non-*FIRST* world. Outreach activities can benefit teams by:

- Allowing teams to practice their public speaking skills and help prepare them for `judging interviews`.
- Providing a public audience to showcase the learning the students are going through.
- Creating networking opportunities for the team and individual members.
- Introducing *FIRST* Tech Challenge to potential new team members or mentors.
- Recruiting additional teams to *FIRST* and creating connections between *FIRST* teams.
- Helping achieve the mission of *FIRST* by raising awareness of *FIRST*, *FIRST* Programs, and STEM.
- Connecting the team to potential sponsors.

Navigating the Competition Season

Preparing the Team

FIRST Tech Challenge competitions are different from almost any other experience your students will have had, so helping them be prepared for what they will encounter will allow them to be more confident and focused on the team's objectives for the event. The following sections provide lots of information and tips on helping the team know what to expect and to be prepared on how to perform on the day of competition. Also, bookmark this helpful webpage on Preparing for Competition as a review tool prior to heading off to your event.

Game Rules

The team should read the Competition Manual to review the event rules and robot-building rules to be prepared for the season ahead. Each year at Kickoff (usually in early September), a new Competition Manual will be released, outlining the overall concept of the game, problems to be solved, rules,

guidelines, and policies for the *FIRST* Tech Challenge Game. All team members should read the Competition Manual carefully as soon as possible.

Before diving into the challenge, begin by discussing game rules extensively without referencing robot design at all. Make sure everyone on the team has a good understanding of the game before moving into brainstorming, so that no time is wasted on ideas that may not be permitted or that might be ineffective for the game.

Watch the [Kickoff video released by *FIRST*](#) several times, but also read the Competition Manual very carefully for important details. Have both mentors and students read the Competition Manual thoroughly and ask questions.

Create a team handbook that outlines all team responsibilities, rules, procedures, and commitments. This will help to ensure that everyone, including parents, understands how the team operates and what the rules are.

A contract can be another effective tool to set expectations. Have everyone outline concise expectations and understand what is expected of each member and the team.

FIRST Tech Challenge Competition Structure

The *FIRST* Tech Challenge program is both competition- and merit-based. The tournament structure is tiered with [levels of advancement that lead to the *FIRST* Championship](#). Teams advance by accumulating ranking points and tiebreaker points received on the field and through judged awards. To learn more about the advancement and ranking process, review the [Competition Manual](#).

Types of *FIRST* Tech Challenge Events

There are many types of *FIRST* Tech Challenge events. Some events are "official," meaning that they are a part of the advancement structure for the *FIRST* Tech Challenge. Other events are "unofficial" and could be hosted by anyone. Official event information provided by the Program Delivery Partners is promoted on the [FTC Events](#) page.

The *FIRST* Tech Challenge competition season runs from mid-October to April and includes several event types. Team saturation dictates the number and type of events in a region. Encouraging others to become involved and building the *FIRST* Tech Challenge community is the best way to encourage more events in a region. Read detailed information in [Types of *FIRST* Tech Challenge Events Extended.](#)

Tournament Registration

In addition to registering the team with *FIRST*, teams must also register for local events. Event costs, structure, and availability to compete will vary by region. Be sure to reach out to your local [Program Delivery Partner](#) for region specific event information.

Finding Tournaments

The team is responsible for finding and registering for *FIRST* Tech Challenge league, qualifying, and championship tournaments. Events are filled on a first-paid, first-served basis and many *FIRST* Tech Challenge Program Delivery Partners coordinate their own registration process, so make sure to check the Program Delivery Partner's website to determine how the team can apply.

> All events (except for *FIRST* Championship) must be registered at the local level. You MUST contact your Program Delivery Partner to compete locally.

There will be a listing of confirmed championship tournament sites on the [Events portal website](#) beginning in late September or October. As soon as event registration is open in your region, teams should apply either online or directly with the event organizer.

It is important to note that championship tournaments usually require advancement through a qualifying or league tournament, and some championship tournaments are open only to teams in a specific geographic area. Always check with the Program Delivery Partner for the event(s) that determine a team's eligibility to attend.

To receive *FIRST* Tech Challenge updates during the season, be sure that the team's profile and contact information in the Team Registration System is up-to-date and complete before registering for a tournament. Both primary and secondary contact information should be verified for accuracy.

The Event Registration Process
Once the event registration period ends, confirmed teams receive detailed information from the *FIRST* Tech Challenge partner hosting the event. This information includes specific details about the site, special instructions, forms, and schedule information. Teams can expect to pay a fee to attend a event. The Event Director will inform teams about fees and payment procedures.

Contact information for Program Delivery Partners in each area can also be found on the *[FIRST Regional Contacts portal](#)*. Outreach can be made to these individuals if tournament information is absent or there are questions. Do not miss an opportunity to compete.

Notes:
- The event schedule may not be complete until the season is well underway. Consequently, the tournament registration process is separate from the online team registration process.
- Due to limited site capacity at some tournaments, registration does not ensure acceptance at an event.
- There is no limit to the number of tournaments in which a team may participate, if space is available. However, participation in the next tournament level is based on the team's performance in its first three tournaments only. This rule applies at all levels of competition.

Spectators
Most FIRST Tech Challenge Events are open and free to spectators from the public. Encourage parents, siblings, sponsors, and friends to attend the tournament and to cheer on local teams!

What to Expect

Competition Logistics

Once a team has registered for a competition, it is a good idea to check the competition website (if applicable) regularly for changes and updates.

Before the competition:

- Confirm event start and end times, parking details, what to bring, food service and availability, and so on.
- Ensure that each team member is registered and has obtained parent consent in the online Youth Team Member Registration System.
- Print a team roster from the Team Registration System. Be sure to make sure all students have completed and signed Consent and Release forms and are registered in the Youth Team Member Registration System.
- If travel to a competition is required, follow the school or other sponsor's procedures.
- Make sure that each driver is properly insured and that any relevant and completed paperwork, such as school permission slips has been signed and gathered.

Arenas

Registration Area

At the registration table, tournament volunteers will collect paperwork, forms, and at some events, the portfolios (check with Event Director for exact location where portfolios will be collected). They will tell teams where to find the pit administration area, the arena, judging rooms, and where teams can eat lunch (if applicable). They will also give mentors a schedule for their team.

The Pit

The pit will be the team's home for the day. A specific location may be assigned at registration, but some events have areas that are first-come, first-served. Check with the officials to confirm that spectators are allowed in the pit. Some facilities allow only team members, coaches, and mentors in the area. Regardless of the station's size, be gracious and make sure the team remains within the allotted space.

Teams will have a table provided in their pit area to set up a display for other teams to see, show off their robot, and make minor repairs. Some, but not all, venues will provide chairs. Bring additional chairs if needed. If the team has any posters or banners, they should be set up to showcase teamwork and team spirit.

Electricity may be provided in the pit, but it is a good idea to make sure that laptops, robot batteries, etc. are fully charged. Some venues have no power other than a few scattered charging stations, so plan accordingly. A heavy-duty extension cord and a power strip can be especially useful. Be sure to arrive with everything the team needs. Many tournaments send out lists to assist with this.

Arena
The arena is where the official fields, alliance areas, scoring tables, and other tournament officials are located. Matches are played in the arena based on the match schedule provided to teams the morning of the competition. There will be seating for spectators and team members who are not part of the drive team.

Judging Rooms
Generally, but not always, judging takes place in rooms that are separate from the rest of the competition. Judging interviews occur before the matches begin. Teams will report to each of these rooms at some point during the day, so make sure that locations and arrival times have been clearly communicated and understood. Always show up a few minutes early for a scheduled interview time. If there is a schedule conflict, inform an event volunteer to ensure judges can be notified.

Inspections
Every robot must pass inspection prior to competing. Inspections take place close to the arena. There will be a robot inspection to ensure the robot is built out of legal parts, and a field inspection to make sure the robot control system is functioning properly. The inspections are done prior to beginning official matches.

What to Expect at an Event
Be flexible, and if there are questions about the day or team schedule, check in with the pit administration or registration table.

Make sure to review the day's schedule with team members. Competition schedules are usually very tight, so it is important to be ready and on time. Do not miss inspection or judging interviews. If the schedule for the day does fall behind, the Event Director may juggle a team's interviews to accommodate the changes. There should be one mentor who focuses on getting to scheduled judging interviews and matches on time. Delegate the responsibility of keeping the team together to other volunteers.

Each tournament is a little different, but these basic phases will occur in some form at all tournaments. Pre-season or local events may have some special rules. Check with organizers for detailed information.

> Some events hold a Coaches' Meeting where mentors receive up-to-date information and can discuss robot rule clarifications.

General Guidelines for Tournaments

Procedures
- Team members should always inform the coach/mentor when leaving the pit area (to eat, watch a match, etc.). Employ the "buddy system" where no one wanders off without someone else.
- If DRIVER/COACH designation buttons are provided, always put them in the same place when not being worn by the drive team. **Do not lose them.**
- Label everything with your team's name and number. Mark all batteries and chargers with the team name/number so they are not lost or mixed up at events.
- Have a system to keep track of which batteries are fully charged. (E.g., use a rubber band to designate a battery that has been charged and is ready to use.)
- Create checklists for the pit crew and other sub-groups on the team to ensure that checks and organizational tasks are completed throughout the day.

Communication
- Mentors and coaches should each have a main list of cell-phone numbers for everyone attending and contacts for their parents/guardians.
- Use social media and online networking tools for reporting results to parents back home and the team themselves. This can also be useful to communicate between team members at large tournaments.

Well-Being
- Eat when possible. There may not be scheduled lunch breaks.
- Bring healthy snacks and refreshments for team members to keep their energy up (if this is permitted at the venue).
- Make note of any dietary needs or restrictions of team members. Be aware of food allergies or sensitivities and students who may have medical concerns.
- Keep the energy light – encourage laughter and fun.

Documentation
- Try to have one student or mentor videotape or take pictures of match play to post on websites, publicize the team, or look back and analyze how well strategy and hardware worked during game matches. Remember that match videos may not be used when asking an event official for a game call clarification or revision.

The Pit
- Have a team theme shown through pit decorations, uniforms, and robot designs.
- A 6-foot banner is a cost-effective pit decoration. Make it two-sided, as both sides may be visible.
- Encourage your team to explore other team pits and network with other teams.

What to Bring:
- A robot.
- The team portfolio
- Any event specific paperwork (i.e., team roster)
- A first aid kit and a binder containing medical and emergency contact information for all team members.
- Rolling cart for the robot that can easily be disassembled (easier for transport). Reinforce or modify it, as necessary. Create an emergency repair kit that stays with the cart during matches.
- A small box with an assortment of metal parts, brackets, channels, flats, pieces of plastic, or sheet metal for repairs.
- Spare electrical components (motors, servos, motor controllers, servo controllers, sensors) as budget allows. Keep spare fuses in the team toolbox and an emergency repair kit at tournaments.
- Basic tools for repairs.
- Safety glasses and closed-toe shoes.

During Game Matches:
- Keep the pit tools and emergency repair materials organized. Searching will waste time and cause stress.
- During elimination matches, there are no time-outs for repairs. Check the [Competition Manual](#) for the official length of the time between matches.

Supervision and Safety

Adult supervision is a critical factor for a successful tournament. Whether the team is in the pit, moving about the site, competing in a match, make sure that all team members are supervised. Remind each person that the team is expected to demonstrate *FIRST* Tech Challenge values always. This includes mentors and team parents. Inappropriate and/or non-gracious behavior of an adult with the team can jeopardize the team's chances of winning an award or doing well in the alliance selection. Negative adult behavior could also lead to the disqualification of a team during a match and the removal of the adult from the venue.

Remember this is the team's opportunity to shine. Adult interference during the judging interview will reflect negatively on the team. A team's inability to answer questions or make robot adjustments without the direct assistance of an adult will be evident to the judges and may adversely affect the team's score. Remember, the students come first!

It is often difficult for judges and event organizers to determine if the adults accompanying a team are coaches, parents, or both. Some tournaments have restrictions on the number of adults that accompany students into the interview sessions. Be sure that *FIRST* Tech Challenge's rules on adult intervention and *Gracious Professionalism* have been communicated to all the adults and students accompanying the team. The behavior of one person reflects on everyone associated with the team.

Event Etiquette

Practicing `Gracious Professionalism` will ensure everyone has a fun experience, whether or not they win. Here are some simple tips for bringing your *Gracious Professionalism* to the event:
- Mentors need to stay in control of their own emotions. Events can be stressful, but the

focus should be on the team members having a great experience. It is hard to do that if the mentor is upset.

- Speak gently and kindly to team members when providing feedback or information always, but especially at events.
- Ensure your team stays within their designated pit space. Some teams have bigger pit displays or a larger team, but it is gracious to not invade someone else's space. Asking them to give up space is not gracious, because they may not feel as if they can say "no." Design your display to fit into the designated space.
- Coach all the team members, mentors, and parents on how to cheer in a way that honors everyone and hurts no one.
- Coach team members and mentors on appropriate ways to ask questions, challenge scores, or report issues to event volunteers and staff. Even when upset or stressed, stay gracious.
- When there are disappointments at a tournament, students take their cue from the adults around them. Remember to model *FIRST* Tech Challenge values, honor what the students achieve, and help them to focus on those achievements.
- Remember that event staff, from check-in to referees to judges, are volunteers. They have taken time out of their schedules to help run a successful event for every team that participates.

Inspections

At the event, the team should be prepared for a robot inspection and a field inspection. Most competitions will have an inspection schedule, and it is critical for teams to be on time for their inspection appointment to keep the event moving forward on time. Teams are encouraged to complete a robot inspection checklist before the competition. This will ensure a quicker and more efficient inspection process.

> Failure to pass any of the inspections will disqualify a team from competition. However, it is important to know that the inspector's main goal is to help teams pass.

Robot Inspection

During the robot inspection, inspectors will examine robot construction. Some examples of a typical hardware inspection items include: the size of the robot, safety standards for the hardware (e.g., no sharp edges or corners), and ensuring the robot contains official build components.

Field Inspection

During the field inspection, an inspector will check to ensure that the team's driver station and robot controller are connecting properly. The inspectors will run a shortened match to also check if the robot can run their AUTO program, as well as switch over to the driver-controlled portion of the match. The

goal of this inspection is to identify any potential software issues prior to official matches starting, as these could affect the robot performance during the match.

Queuing and Matches

During the day, teams will be scheduled for qualification matches, with the exact number determined by the size of the tournament and the number of teams attending. Teams are responsible for their own schedules, and failure to arrive for a match can result in a loss of points.

Listen carefully for queue calls. Teams will line up for matches in a designated area. Assign two individuals to listen for queuing calls or watch for match queue runners and keep the team on schedule. Unexpected delays may occur, so remain flexible. Remember that the tournament organizers are volunteers too.

When a match begins, the drive team will be on the field while mentors get their team settled in the team seating/standing area. Robot operators should follow the field manager's instructions on the field. Before starting, have them scan the field and their robot to make sure everything is set up properly. Once the match starts, team operators may not handle the robot.

During qualification matches, teams earn Ranking Points (RP) based on match performance. At the end of qualification matches teams will be ranked based on a sorting criteria listed in the Competition Manual. Following qualification matches, teams may advance to playoff matches where they will play on set alliances, chosen during alliance selection, and will advance through a double elimination bracket to determine an event winner. The specifics may vary depending on the size of the tournament and more details can be found in the Competition Manual.

Gameplay

Each match is made up of two distinct periods, the autonomous (AUTO) period and the driver controlled teleoperated (TELEOP) period.

AUTO Period

The AUTO period of gameplay is typically the first portion of a match where the robot's actions are controlled purely by the code created by the team. In this stage, team drivers are not allowed to handle the robot controllers or interact with the robot in any way.
Teams should consider the different starting positions and plan on ways to make their AUTO mode compatible with their alliance partners.

TELEOP Period

The TELEOP period of gameplay is part of the competition where the team's drivers control the robot.

The Drive Team members are the team representatives that participate in the match. Team leaders should encourage all students to try out these roles prior to competition and then have the team select representatives to fill the roles at the event.

In this stage, teams must choose their joystick controls and program their software accordingly.

Consider the following tips when approaching planning and programming in this game period:
- It is a good idea for teams to place a labelled diagram of their joystick controls into their portfolio. This representation will explain their controls to judges and provide an easily accessible reference for team members.
- When choosing controls, the team's programmers should approach the problem logically. It is important to remember that choosing controls at random or arbitrarily will make the robot more difficult and increase their driver(s)' training time.
- Consider the kinetics of a driver's hands versus the requirements of the program. How many buttons need to be pressed simultaneously? Is it possible to do several motions at the same time easily?
- It is a good idea to program buttons to select speed levels instead of programming joysticks to select speed by range of motion. Often, drivers will be caught up in competition and simply "peg" joysticks all the way up or down, spoiling their ability to maneuver when there are fine motor requirements.

Scoring

As the match is played, referees will track the status of the match and record each team's score as they accomplish each task. At the conclusion, the referees will confer to quickly ensure scored points and penalties have been accounted for. This is the official score which will be posted for the teams and audience to see. Questions about scoring, referee decisions, and penalties must be brought to the head referee within the appropriate allotment of time. All events will have a specific question box area for a student to go to discuss their question. The student should be prepared to present the team's concerns calmly and professionally. The head referee will listen to the students' concerns and make a final ruling. The head referee's ruling on the field is final. For game specific *FIRST* Tech Challenge rules, policies, and practices, please refer to the Competition Manual.

Question Box Etiquette
FIRST Tech Challenge rules state that only a student can address the head referee from the question box. Mentors should coach the team on what to expect and how to behave:
- When a team member has decided to ask a question, they should stand in the designated area and wait to be addressed by the head referee. This may take a few minutes, so patience is necessary.
- When addressed, present the question or concern as calmly as possible. The head referee may need to confer with the referees, so be patient. These volunteers want to ensure they are as fair and consistent as possible.
- Students are encouraged to bring items such as the Competition Manual to the head referee to show specific reasons on why they are questioning a call. This is not required, but highly encouraged.
- Once the head referee delivers a decision or explanation, graciously accept the response, or ask an additional clarifying question.

Alliance Strategy and Scouting

In tournament play, alliances are important. Teams that have performed well throughout the qualification matches may earn enough to become an alliance captain team.

Throughout the matches, teams are randomly assigned an ally and an opponent. However, in playoff matches, top-ranking teams choose their own alliance partners. For this reason, it is important that all teams pay close attention to the capabilities and attitude of other teams. If a team has earned a spot as an alliance captain, the selection of a complementary alliance partner is crucial. If a team has not ranked high enough to be an alliance captain, being selected can provide them with that opportunity. Alliances are created with the first pick going to the highest-ranked team. After an alliance invitation has been extended, a representative from the other team must come up to accept or decline the invitation. **The only rule of this process is: if a team declines an alliance invitation, *they may not be selected by any other alliance*.** In this case, the declining team does not lose their right to select if they are an alliance captain. More details on the alliance selection process can be found in the Competition Manual.

How to Get Noticed by Alliance Scouts
- Create a one-page flyer that advertises the robot's capabilities and if possible, its performance record. Bring copies to the tournament and hand them out to other teams and visitors before the qualification matches have been completed.
- Be friendly and sociable with other teams. Compatibility and a positive attitude will linger in other teams' memories.

How to Select an Alliance Partner
- Find a complementary robot to balance strengths and weaknesses in one's own robot.
- Take notes about other teams throughout the day. Track their strengths, weaknesses, strategies for defense or offense, success, and scores. Consider the types of strategies other teams have been using.
- Scouts should also move around the pits and observe the capabilities of opponents they have not yet seen play.

FIRST Tech Challenge Judging and Awards

Why Judging Interviews?

In addition to providing information to help judges make determinations about award winners, the *FIRST* Tech Challenge judging interview provides an opportunity for teams to practice and develop invaluable life skills. In addition, judging interviews and the FIRST Tech Challenge Judged Awards allow teams to be honored and recognized for the complete *FIRST* Tech Challenge experience and not just the robot and how it performs on the competition field, including:
- The overall team experience, organization, and dynamic
- Robot design, prototype, build, and iteration process

- The team portfolio
- The team business plan, budget, and funding
- Team and community outreach

Teams should look at judging interviews as practice for future job interviews and presentations. Mentors can help them prepare by coaching them on developing an elevator speech or pitch, presentation skills, and professional behavior and dress. The following sections go into greater detail about judging interviews, preparing the team, and the *FIRST* Tech Challenge awards.

> Judging is subjective, just like many things in life, but most notably like a job interview.

How Judging Works

At *FIRST* Tech Challenge Competitions (except for league meets), there are three parts to the judging process:
1. Interview with judges.
2. Evaluation of performance during the tournament.
3. Evaluation of the portfolio.

Each team will have a ten to fifteen minute "fact-finding" interview with a panel of two or three judges. At the start of the interview, teams will have a maximum of 5 minutes to present to the judges. After the team's five-minute presentation, the judges will have the opportunity to ask questions about the team, the robot, outreach efforts, etc.

The judges' interviews take place before any qualification matches so the entire team may be interviewed. When teams arrive at the tournament, the interview schedule should be included in the registration materials. Teams must know when they will be interviewed and arrive to the interview room early. Each team should have at least two student team representatives and the robot available; the entire team is encouraged to join in. Mentors (no more than two) are welcome to watch the judges' interview at most tournaments but cannot take part in the interview.

Teams may not opt out of judges' interviews. Teams may attend their scheduled judges' interviews if their robots have not passed inspection. Teams participating in an event that do not have a robot are still eligible for an interview and for judged awards.

Preparing and Practicing

Teams will be evaluated by judges in several ways, including:
- Judging interviews.
- Observations on the competition field or around the pits.
- Conversations on the competition field or around the pits.

Team members should be prepared for the more formal interview and the informal observation and conversation aspect of judging. Talk to them about the real-world application of both skill sets and set aside team meeting time for practicing both.

The Elevator Speech

Whenever you have an opportunity to speak about your team or *FIRST*, you are going to need to try to explain what it is we do, usually briefly, but that is often easier said than done. However, taking the time to prepare for these impromptu moments will make it less overwhelming when the time comes. To do so, craft an "elevator speech" to review and practice. We looked over the tips created by Mind Tools and here is what they suggest that you include:

1. Explain What You Do
2. Communicate Your Unique Selling Point
3. Engage with a Question

Wrap Up

And that is mentoring in a nutshell. *FIRST* Tech Challenge has a wealth of information on our website, and we encourage you to start with our Game & Season Materials and Team Management Resources. We also have a host of helpful videos on our *FIRST* Tech Challenge YouTube channel. We encourage all our new coaches and mentors to reach out to the local Program Delivery Partner in their area to learn more about events and specifics to your local region.

FIRST Tech Challenge is a fun way to get students involved and excited about science and technology and to help build the STEM leaders of our future. We have built an incredible community, and we are so happy you are joining!

FIRST® Tech Challenge Team Roles

Below is a list of potential roles that individuals can serve on a *FIRST* Tech Challenge team. These serve as suggestions and a starting point when developing your team. An individual can take on multiple roles; however, be sure that a single individual does not take on too many. Sharing responsibilities is great for teambuilding and creates a stronger sense of team identity.

FIRST Tech Challenge Team Roles	
Responsibilities	**Traits**
Mentor (2+ adults)	
• Read about the Mentor's Role.	• 18 years or older • Patient • Dedicated • Willing to learn
Future Mentor (1+)	
• Assist the mentor and other team members. • Gradually take on responsibilities as the season progresses, to assist the mentor.	• Receptive to feedback and coaching • Actively seeks challenge and greater responsibility • Goal-oriented • Willing to assume responsibility for his

FIRST Tech Challenge Team Roles	
Responsibilities	**Traits**
Team Captain(s) (1+ students)	
• Focuses the team. • Ensures that everyone's ideas are heard and works to find compromises. • Regularly checks team goals and deadlines. • Gathers information from sub-groups on the team and tracks team progress. • Keeps everyone on schedule with project timelines. • Manages the team schedule at events.	• Clear-headed • Organized • Confident • Punctual • Able to mediate discussion and conflict
Strategy (2+ students)	
• Discusses ways to help the team be successful in competition. • Understands the game rules and challenges thoroughly. • Gathers input from other team members to influence strategy. • Keeps an active eye for rule updates to ensure team compliance. • Searches the Internet for discussion by other teams regarding what works. • Studies the team's robot to see other ways it can do different tasks with little modification. • Communicates problems and possible solutions clearly and respectfully with team members.	• Resourceful • Creative • Innovative • Willing to take well-thought-out risks • Knows the related subject matter • Familiar with rules and regulations
Build Team (2+ students)	
• Understands and uses safety precautions while building. • Investigates different solutions to solve mechanical design challenges. • Makes decisions about mechanical design. • Works to achieve consensus among team members. • Uses guidelines from team brainstorming to build a robot. • Communicates and tests to ensure that all mechanisms on the robot work effectively together. • Works with the Quality/Compliance Control team to test and refine robot design. • Communicates problems and possible solutions clearly and respectfully with team members. • Regularly monitors forums and *FIRST* resources for rule updates, to ensure team compliance.	• Knows the related subject matter • Confident, but willing to ask for clarification • Documents carefully • Confident with use of all tools • Familiar with rules and regulations

FIRST Tech Challenge Team Roles

Responsibilities	Traits
Programming Team (2+ students)	
- Writes well-commented programs for the AUTO part of the competition. - Schedules time with the build team to test the chassis when others do not need it. - Alters the programs, as necessary. - Regularly monitors forums and *FIRST* resources for rule updates, to ensure team compliance. - Communicates problems and possible solutions clearly and respectfully with team members. - Ensure there is a hard copy of the program at events. - At events, when making any changes the drive team needs to be more efficient during the controlled portion of the match. - If the team is experienced, aids team members that are new to programming.	- Organized and has good tracking skills. - Creative - Innovative - Willing to take risks based on thorough research - Knows the related subject matter - Familiar with rules and regulations
Hardware/Tools Management (2+ students)	
- Understands the function of hardware elements and tools in the kit. - Organizes and monitors the use and location of all hardware and tools needed for building and maintaining the robot. - Keeps track of all wiring necessary to program the Robot. - Keeps track of all power strips and batteries needed for the robot. - Manages the battery charging process. - Understands and uses safety precautions when using and storing materials, and when charging batteries.	- Organized - Responsible - Uses appropriate terminology
Pit Crew (2+ students)	
- Creates safety and robot functionality checklists throughout the build season, to be used at scrimmages and competition events. - Conducts thorough safety and robot functionality checks regularly at all events. - After each match, ensure that all nuts and bolts are tight, that metal is not bent or impairing motion, and that all wires are still firmly attached. - Ensures that all materials and tools used for repair are accounted for and returned to the appropriate location after game play. - Understands and uses safety precautions always in the pit.	- Organized - Confident with use of all tools - Works well under pressure - Communicates calmly and effectively with team members

FIRST Tech Challenge Team Roles	
Responsibilities	**Traits**
Driver (2+ students and 1 backup driver)	
• Operates the robot in competition using a hand- held remote control to "drive" or move a part of the Robot. **Note:** Backup robot operators should be trained and prepared to take part in the competition, in case of illness or nerves. Practice time should include both groups, so everyone is prepared to play in front of a loud, enthusiastic audience.	• Positive attitude • Able to focus in loud, distracting environment • Attentive listener • Receptive to receiving input from Driver Coach • Dedication to practice time
Driver Coach (1+ student or adult)	
• Encourages the student members of the teams to collaborate on match strategy • In game play, watches for information from Referees and communicates with the drive team • Assists the drive team in following the predetermined strategy or changing it, if necessary **Note:** Coaches cannot touch the controllers or robot before or during a competition match.	• Calm • Clear verbal communicator • Understands team strategy and game rules
Speaking Representative (2+ students)	
• Lead the group when talking to judges, scouts, or guests in the Pit during competition. • Promote FIRST Tech Challenge and their team by speaking at community outreach events or team demonstrations. • Understand each team member's role to direct more specific questions to those individuals when necessary. **Note:** The spokesperson may be the most prominent speaker, but all team members should be prepared to speak about their robot and experience in general, and about their own roles on the team in detail.	• Confident • Polite • Good listener • Professional manner • Able to speak loudly and clearly over noise and distraction • Understands and uses appropriate terminology • Speaks clearly and concisely
Team Coopertition (whole team with 3+ student specialists)	
• Helps to establish and promote team identity and unification. • Helps to promote a positive attitude and *Gracious Professionalism*® throughout the season and at Events. • Think of ways for the team and its supporters to show their spirit and personality at events. • Assists in the design of T-shirts or pins. • Writes cheers and invents unique ways to showcase team spirit. • Encourages the drive team to do its best during game play and cheers whether the team wins or loses.	• Enthusiastic • Creative • Positive attitude • Receptive to input from the team regarding spirit ideas

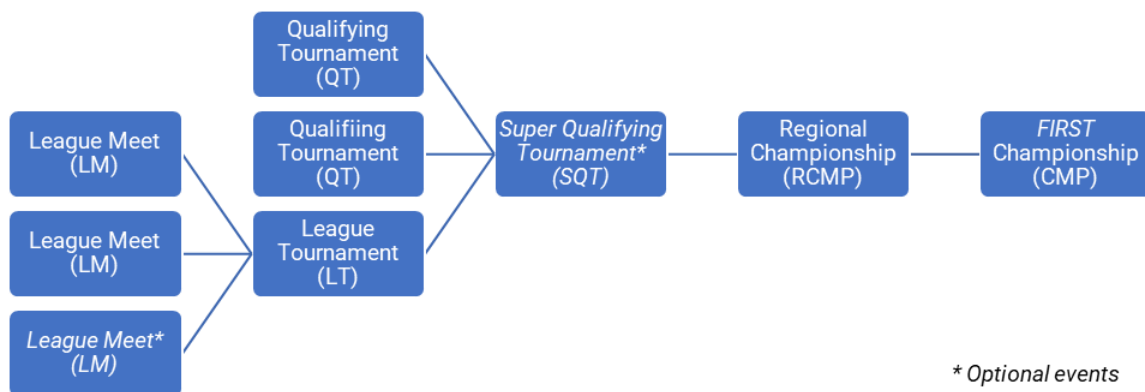| FIRST Tech Challenge Team Roles	
Responsibilities	**Traits**
Documentation (whole team with 2+ student specialists)	
• Records and documents the team's activities, actions, failures, and successes in the team notes or portfolio. • Takes photos or video footage of build process and events for use in marketing and outreach efforts. **Note:** All team members should contribute to documentation in some way, especially in the portfolio.	• Creative • Written communication skills • Visual presentation skills • Detail-oriented • Interested in layout and presentation
Marketing (1+ student)	
• Designs and creates the team logo. • Assembles promotional materials to showcase team capabilities. • Visits sponsors and potential sponsors. • Regularly updates parents and sponsors about the team's progress. • Publicizes the team in the school and community (e.g., displays, pictures of the team in action, press releases, social media, or a team web site). • Contacts the local media, surrounding schools, or civic organizations to increase public awareness of the team and how students benefit from the FIRST Tech Challenge experience. • Creates and shares promotional materials with other teams.	• Creative • Outgoing • Organized • Resourceful • Strong communication skills • Professional manner
Fundraising (2+ students)	
• Searches for unique and effective fundraising ideas. • Recruits' parents and other students to assist in the fundraising process. • Monitors money and ensures that it is submitted on time.	• Responsible • Innovative • Detail-oriented • Experience handling money
Recruitment (2+ students)	
• Promote FIRST in school and local community. • Works to bring new and varied members to the team.	• Outgoing • Personable • Enthusiastic • Professional manner • Speaks clearly and concisely

Types of *FIRST*® Tech Challenge Events Extended

Unofficial Events

Type of Event	Description of Event

Scrimmages	• These are unofficial practice tournaments. • They are usually held early in the season to practice against real competitors with the season's new game. • They often serve as practice sessions for referees and officials who are learning a game that has never been played before.
Workshops	• These events are often conducted by local Affiliate Partners or experienced teams. • They usually involve sessions on technical and non-technical topics: ○ Technical topics could include programming, CAD, and mechanical design. ○ Non-technical topics could include fundraising, team organization, and tournament day preparation.
Practice Days	• Some organizers hold events early in the season, combining a morning help session with an afternoon scrimmage. • If a practice day is held in a team's area, it is a good opportunity to obtain assistance from veteran teams and mentors, especially if the team is facing significant challenges. • The goal of a practice day is to have all attending teams competing, in some fashion, in the afternoon mini scrimmage.

Official Events

- *FIRST* Tech Challenge Program Delivery Partners and volunteers plan, coordinate, and run the competitions.
- Most events have opening and closing ceremonies, trophies and/or medals, teams with personalized T-shirts, hats, banners, and even some costumes. One major exception is League Meets, which have a different set of standards for what they can and must include.
- Teams are recognized for excellence in various aspects of the challenge and associated teamwork through judge awards or through competition.
- Event types vary from region to region. Some regions participate in leagues, while others do not. The advancement structure chart below will demonstrate the various possibilities for advancement depending on the region.
- The advancement structure does require teams to win at a qualifying, super-qualifying, or league championship to advance to a regional/state championship (see chart below).

* Optional events

Event Descriptions

Type of Event	Description of Event
League Meets (LM)	• Meets are like a traditional sporting event. • Teams compete in smaller, more frequent competitions to gain points that will advance them to the next level tournament play. • For information about the scheduling, structure, advancement, and processes that are unique to the league program and events in your region, please contact your local Program Delivery Partner.
League Tournament (LT)	• Teams in the league format compete in meets that culminate in the league tournament. • Format is like qualifying tournaments: opening/closing ceremonies, judging interviews, and competition play.
Qualifying Tournaments (QT)	• These events follow judging guidelines and a similar format to championship tournaments but have some flexibility in format and awards. • There may be anywhere from one to twelve winning teams from these tournaments advancing to a region's championship tournament.
Super-Qualifying Tournament (SQT)	• These events are held in regions with many teams and/or leagues. • In these regions, teams advance from either a league tournament or qualifying tournament to a super-qualifying tournament, and then to the regional or state championship. Super-qualifying tournaments follow *FIRST* standards in format, judging, and awards. • For information about the scheduling, structure, advancement, and processes that are unique to the super-qualifier program and events in your region, please contact your local Program Delivery Partner.
Regional Championship Tournament (RCMP)	• A regional- or state-level event. • For many teams and regions, a championship tournament is the highest level of *FIRST* Tech Challenge tournament participation. • Championships may include teams from a geographic region, province, state, country, or several countries. • Teams in the U.S. will advance from regional/state championship tournaments to the FIRST Championship based on the advancement criteria outlined in the Competition Manual. • These tournaments abide by specific standards in format, judging, awards, and overall quality. • If applying for a championship tournament, determine whether the team needs to attend a qualifying or league tournament first by checking the tournament information. Be sure to confirm the criteria that determine advancement to the championship tournament.

Type of Event	Description of Event
FIRST Championship (CMP)	• The *FIRST* Tech Challenge *FIRST* Championship event, held in conjunction with the *FIRST* Robotics Competition *FIRST* Championship, *FIRST*® LEGO® League World Festival, and *FIRST*® LEGO® League World Expo, is a global celebration of *FIRST* Tech Challenge teams from around the world. • The selection process for the *FIRST* Championship event may change from year to year, depending upon the number of spaces available and the number of teams participating in *FIRST* Tech Challenge. • Teams earn an advancement through the regional championship tournament that serves their area. **Note:** Check out the *FIRST* Championship webpage to learn more about the upcoming event and find previous *FIRST* Championship results.

Start a Team Checklist

✓ Create a *FIRST*® Account (www.firstinspires.org)
✓ Create a Team Profile
    o Invite Primary Contacts
✓ Check out available grants (https://www.firstinspires.org/robotics/team-grants)
✓ Pay Season Registration and Purchase Product
✓ Complete Youth Protection Screening (US/Canada Lead Coach/Mentors only)
✓ Invite Team Members
✓ Reach out to a Program Delivery Partner to Register for local events.
✓ Review Available Resources on the Team Management Resources page.

Useful Things to Consider

Physical Space and Storage
- Classroom (the ability to push tables/chairs out of the way) or equally sized room with open floor.
- Countertops/tables to serve as workspace.
- During practice, tape a 12 ft. (3.66 m) x 12 ft. (3.66 m) square on the ground to serve as a field.
- Large Storage Cabinet (1 or 2, depending on how much material you have)
  - Should be able to lock.
  - Look for cabinets that are roughly 6 ft. (1.82 m) tall and 3 ft. (0.91 m) wide.

Safety Considerations
- Always keep a first aid kit in the workspace, including disinfectant and bandages. Bring it to events. Any accidents should be reported immediately to mentors.
- Have a fire extinguisher in the workspace, and make sure that everyone knows where it is and how to use it.
- The workspace should be kept clean and uncluttered. Cords should be kept out of moving paths and tools and materials should be kept in a designated storage area when not in use.

Basic Tool List

- Dremel tool or disk sander
- Hex keys
- Hand drills
- Small screwdrivers
- Tape
- Tie wraps
- Wrench metric set
- Wrench SAE set
- Zip ties

Advanced Tool List (Building on the Basic Tool List, some of these require a workshop to use)

- Allen wrenches/T Hex keys
- Ball hex screwdriver
- Band saw
- Bench grinder
- Belt sander
- Chain breaker
- Deburring tool
- Drill press (mini mill)
- Drum sander
- Glue station (only if there is an available ventilation method)
- Hack saw
- Hot air guns (for bending plastics)
- Jigsaw
- Metal file
- Needle nose pliers
- Nut driver
- Sheet metal bender
- Sheet metal brake
- Table/radial arm saw
- Tubing cutter
- Variable speed drill
- Vise

Electronics

- Laptop to run your development tool.
- At least one power strip