FIRST TECH CHALLENGE

Training and Support





VELOCITY VORTEX℠

PRESENTING SPONSOR

QUALCOMM



2016-2017 *FIRST*® Tech Challenge
Game Manual Part 1

www.firstinspires.org

200 BEDFORD STREET ■ MANCHESTER, NH 03101

FIRST

FOR INSPIRATION & RECOGNITION OF SCIENCE & TECHNOLOGY

Volunteer Thank You

Thank you for taking the time to volunteer for a *FIRST*® Tech Challenge Event. *FIRST*® and the *FIRST*® Tech Challenge rely heavily on Event Volunteers, Coaches, and Mentors alike to ensure Events run smoothly and to support students through their *FIRST*® Tech Challenge journey. The experience these students receive in the *FIRST*® Tech Challenge program will surely shape their lives in many positive ways, which could not happen without people like you. With over 4,500 *Teams* competing annually, your dedication and commitment are paramount to the success to the *FIRST*® Tech Challenge program. Thank you for your time and effort in supporting the mission of *FIRST*!



Sponsor Thank You

Thank you to our generous sponsors for your continued support of the *FIRST* Tech Challenge!

***FIRST*® Tech Challenge**
Season Presenting Sponsor

QUALCOMM®

***FIRST*® Tech Challenge**
Official Program Sponsor

Rockwell Collins

***FIRST*® Tech Challenge**
Official IoT, CAD and Collaboration Software Sponsor

ptc

Revision History		
Revision	**Date**	**Description**
1	7/1/2016	Initial Release
1.1	8/1/2016	• Section 4.0 – Updated measurements in *Playing Field* definition • Section 5.3.2 – removed column from chart: *Core Servo Controller* and/or *Legacy TETRIX Servo Controller* TETRIX 12 VDC, MATRIX 12 VDC, or REV *Robot*ics 12 VDC. • Section 5.3.3 – Added Motorola Moto G 3rd Generation and Google Nexus 5 to allowed Android devices • Section 5.3.4 – Clarified that Beta software is allowed at official Tournaments. • Added Appendices B and C – Robot and Field Inspection Checklists • New Sponsor Thank You image
1.2	9/10/2016	• Added Game Logo to cover page • Section 5.3.3 – Added Samsung Galaxy S5 to allowed Android devices • Section 7.3.5 – Added Motivate Award Engineering Notebook requirements to chart • Appendix D – Added Control Award Content Sheet and Instructions

Contents

1.0 Introduction 7
1.1 What is *FIRST*® Tech Challenge? 7
1.2 *FIRST* Tech Challenge Core Values 7
2.0 Gracious Professionalism® 8
2.1 Gracious Professionalism® for Volunteers 8
3.0 Youth Protection Program 9
3.1 Youth Protection Expectations and Guidelines 9
3.2 NOTICE OF NON-DISCRIMINATION 9
4.0 The Tournament 10
4.1 Overview 10
4.2 Tournament Definitions 10
4.3 Tournament Event Schedule 11
4.4 Tournament Rules 11
4.5 Eye Protection and Safety 15
4.6 Tournament Day Overview 15
4.6.1 Team Check-In 15
4.6.2 Robot and Field Inspection 16
4.6.3 Judges' Interviews 16
4.6.4 Drivers' Meeting 16
4.6.5 Practice Time 16
4.6.6 Opening Ceremony 16
4.6.7 Qualification Matches 17
4.6.8 Alliance Selection 18

4.6.9 Elimination Matches 19
4.6.10 Awards and Closing Ceremony 20
4.7 Tournament Types 20
4.7.1 Scrimmage 20
4.7.2 Meets and League Play 20
4.7.3 Qualifying Tournaments and League Tournaments 20
4.7.4 Super-Qualifying Tournaments 20
4.7.5 Championship Tournaments 20
4.7.6 Super-Regional Championship Tournaments 20
4.8 Eligibility and Advancement Criteria 21
4.8.1 Eligibility 21
4.8.2 Advancement 21
4.9 Team Spirit 23
4.10 Team Styling 23
4.11 Banners and Flags 23
4.12 Spectators and Etiquette 23
4.13 Scouting 24
5.0 The Robot 24
5.1 Overview 24
5.2 Robot Control System 24
5.2.1 Android Technology Definitions 25
5.3 Robot Rules 26
5.3.1 General Robot Rules 26
5.3.2 Robot Mechanical Parts and Materials Rules 28
5.3.3 Robot Electrical Parts and Materials Rules 29
5.3.4 Robot Software Rules *35*
6.0 Robot Inspection 36
6.1 Overview 36
6.2 Description 36
6.3 Definitions 36
6.4 Inspection Rules 36
7.0 Judging & Award Criteria 38
7.1 Overview 38
7.2 *FIRST* Tech Challenge Award Eligibility 38
7.3 Engineering Notebook 38
7.3.1 Overview 38

7.3.2 What is an Engineering Notebook? 39
7.3.3 Engineering Notebook Formats 39
7.3.4 Engineering Notebook Requirements 39
7.3.5 Engineering Notebook Requirements by Award 40
7.3.6 Notebook Examples 40
7.4 Judging Process, Schedule, and Team Preparation 40
7.4.1 Judging Process 41
7.4.1.1 Feedback to Teams 41
7.4.2 Judging Schedule 41
7.4.3 Team Preparation 41
7.4.4 Video Award Submission Guidelines 42
7.5 Award Categories 42
7.5.1 Inspire Award 42
7.5.2 Think Award 43
7.5.3 Connect Award 43
7.5.4 Rockwell Collins Innovate Award 44
7.5.5 PTC Design Award 44
7.5.6 Motivate Award 45
7.5.7 Control Award 46
7.5.8 Promote Award (Optional) 46
7.5.9 Compass Award (Optional) 47
7.5.10 Judges' Award 47
7.5.11 Winning Alliance Award 47
7.5.12 Finalist Alliance Award 47
8.0 *FIRST*® Tech Challenge Dean's List 48
8.1 Eligibility 48
8.2 Criteria 48
8.3 Dean's List Nominations 49
Appendices 50
Appendix A – Resources 51
Game Forum Q&A 51
FIRST Tech Challenge Game Manuals 51
FIRST® Headquarters Support 51
FIRST Website: firstinspires.org 51
FIRST Tech Challenge Social Media 51
Feedback 51
Appendix B – Robot Inspection Checklist 52

Appendix C – Field Inspection Checklist 54
Appendix D – Control Award Content Sheet & Instructions 56

1.0 Introduction

1.1 What is FIRST® Tech Challenge?

FIRST Tech Challenge is a student-centered activity that focuses on giving students a unique and stimulating experience. Each year, Teams participate in a new Game that requires them to design, build, test, and program autonomous and driver-operated *Robot*s that must perform a series of tasks.

The playing field for the Game consists of the *FIRST* Tech Challenge game pieces set up on a foam-mat surface, surrounded by a metal and polycarbonate Field frame. Each Tournament features Alliances, which are comprised of two Teams, competing against one another on the playing field. Teams work to overcome obstacles and meet challenges, while learning from, and interacting with their peers and adult Mentors. Students develop a greater appreciation of science and technology and how they might use that knowledge to impact the world around them in a positive manner. They also cultivate life skills such as:

***FIRST Tech Challenge is MORE THAN ROBOTS℠!* While competing, students develop personal and professional skills they will be able to rely on throughout their life.**

- Planning, brainstorming, and creative problem-solving.
- Research and technical skills.
- Collaboration and teamwork.
- Appreciation of differences and respect for the ideas and contributions of others.

To learn more about *FIRST* Tech Challenge and other *FIRST* Programs, visit www.firstinspires.org.

1.2 FIRST Tech Challenge Core Values

Volunteers are integral to the *FIRST* community. *FIRST* Tech Challenge relies on Volunteers to run the program at many levels, from managing a region to Mentoring an individual Team. Our Affiliate Partners coordinate the program in each region or state. These Affiliate Partners fundraise, run Tournaments, hold workshops and demonstrations, market *FIRST* Tech Challenge locally, handle public relations, and recruit Volunteers and Teams. They are a tremendous resource for Mentors and *FIRST* would not exist without them.

FIRST asks everyone who participates in *FIRST* Tech Challenge to uphold the following values:

- We display *Gracious Professionalism*® with everyone we engage with and in everything we do.
- We act with integrity.
- We have fun.
- We are a welcoming community of students, Mentors, and Volunteers.
- What we learn is more important than what we win.
- We respect each other and celebrate our diversity.
- Students and adults work together to find solutions to challenges.
- We honor the spirit of friendly competition.
- We behave with courtesy and compassion for others at all times.
- We act as ambassadors for *FIRST* and *FIRST* Tech Challenge.
- We inspire others to adopt these values.

2.0 Gracious Professionalism®

FIRST uses this term to describe our programs' intent. This is one of the most important concepts that can be taught to a young person who is learning to get along in the work world. At *FIRST*, Team members help other team members, but they also help other Teams.

Gracious Professionalism® is not clearly defined for a reason. It can and should mean different things to everyone.

Some possible meanings of *Gracious Professionalism* ® include:

- Gracious attitudes and behaviors are win-win.
- Gracious folks respect others and let that respect show in their actions.
- Professionals possess special knowledge and are trusted by society to use that knowledge responsibly.
- Gracious Professionals make a valued contribution in a manner pleasing to others and to themselves.

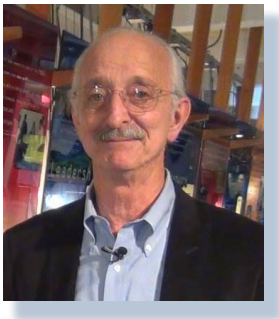
An example of *Gracious Professionalism*® is patiently listening to a Team's question and providing support despite having several pressing things to do on the day of the event.

In the context of *FIRST*, this means that all Teams and participants should:

- Learn to be strong competitors, but also treat one another with respect and kindness in the process.
- Avoid leaving anyone feeling as if they are excluded or unappreciated.
- Knowledge, pride and empathy should be comfortably and genuinely blended.

In the end, *Gracious Professionalism*® is part of pursuing a meaningful life. When professionals use knowledge in a gracious manner and individuals act with integrity and sensitivity, everyone wins, and society benefits.

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



"The FIRST spirit encourages doing high-quality, well-informed work in a manner that leaves everyone feeling valued. Gracious Professionalism seems to be a good descriptor for part of the ethos of FIRST. It is part of what makes FIRST different and wonderful."

- Dr. Woodie Flowers, National Advisor for ***FIRST***

2.1 Gracious Professionalism® for Volunteers

It is a good idea to spend time going over this concept with Volunteers. Provide Volunteers with real-life examples of *Gracious Professionalism* in practice before, during, and after the Event and recognize great *Gracious Professionalism* when you see it in action!

3.0 Youth Protection Program

The purpose of the *FIRST*® Youth Protection Program (*FIRST* YPP) is to provide Coaches, Mentors, Volunteers, employees, others working in *FIRST* programs, team members, parents, and guardians of team members with information, guidelines, and procedures to create safe environments for everyone participating in *FIRST* programs.

The *FIRST* YPP sets minimum standards recommended for all *FIRST* activities. Adults working in *FIRST* programs must be knowledgeable of the standards set by the *FIRST* YPP, as well as those set by the school or organization hosting their team.

3.1 Youth Protection Expectations and Guidelines

Coaches and Mentors are expected to read and follow elements in the *FIRST* Youth Protection Program guide that are labeled as required are mandatory in the United States and Canada, and may not be waived without the approval of the *FIRST* Youth Protection Department.

FIRST recommends that the standards set forth in the *FIRST* Youth Protection Program guide be applied outside of the United States and Canada to the extent possible. At a minimum, local regulations regarding youth protection must be complied with.

Forms are available here: http://www.firstinspires.org/sites/default/files/uploads/about/FORMS.zip

Information on the US Screening process is available here:
http://www.firstinspires.org/sites/default/files/uploads/about/us-screening-2016-2017.pdf

Everyone working with *FIRST* Teams should be familiar with the *FIRST* YPP policies.

Information on the Canadian Screening process is available here:
http://vimeo.com/30137373

You can find FAQ and additional information about the *FIRST* Youth Protection Program on the *FIRST* website at:
http://www.firstinspires.org/resource-library/youth-protection-policy

3.2 NOTICE OF NON-DISCRIMINATION

United States Foundation for Inspiration and Recognition of Science and Technology (*FIRST*®) does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Lee Doucette, Youth Protection Program Manager, 200 Bedford Street, Manchester, NH 03101, 603-666-3906, Ext. 250.

4.0 The Tournament

4.1 Overview

The *FIRST* Tech Challenge program celebrates the accomplishments of *Teams* on Tournament day. Tournaments are exciting sporting Events with head-to-head competition between *Team* built *Robots*, *Team* and *Robot* performance awards, fast paced *Robot* maintenance/repair in the Pit between Matches, cross-*Team* strategy sessions, mascots, *Team* cheers, and stupendous acts of *Gracious Professionalism*®. This section provides critical information that will help *Teams* have a fun and successful Tournament day.

4.2 Tournament Definitions

Alliance – Each *FIRST* Tech Challenge Match is comprised of two, two-*Team Alliances*. At Events with more than 20 *Teams*, the semi-final and final round *Alliances* are made up of three *Teams* each. However, only two of those *Teams* compete during any one Match.

Alliance Captain – The student representative from an *Alliance's* highest ranked *Team* chosen to represent an *Alliance* during *Alliance Selection* and for the final *Elimination Matches*. The entire *Team* may also be referred to as the *Alliance Captain*.

Alliance Selection – The process by which top-ranked *Teams* choose *Alliance* Partners for the *Elimination Matches*.

Alliance Station – The designated region where the Drivers and Coach stand or move within during Matches.

Competition Area – The *Area* where all the *Playing Fields, Alliance Stations,* Scoring tables, and other Event officials and tables are located.

Elimination Match – A Match used to determine the Winning *Alliance*. *Alliances* of two or three *Teams* face off in a series of Matches, with two *Teams* per *Alliance* playing in each Match. The first *Alliance* to win two Matches proceeds to the next round.

Playing Field – The part of the *Competition Area* that includes the 3.66 m x 3.66 m (12 ft. x 12 ft.) Field and all of the Elements described in the official Field drawings.

Pit Area – The *Pit Area* is a separate space from the competition area where *Teams* can work on their *Robot* in between Matches. The *Team* is provided a pit space which includes a table, a power source, and is generally 3.05 m (10 ft.) x 3.05 m (10 ft.). Some pit spaces may vary based on Event venue size limitations. Check with your Event Director for official pit space sizes.

Practice Match – A Match used to provide time for *Teams* to get acquainted with the official *Playing Field*.

Qualifying Match – A Match used to determine the *Teams* that qualify for the *Alliance Selection* and move on to the *Elimination Matches*. *Alliances* compete to earn *Qualifying Points* and *Ranking Points*.

Qualifying Points (QPs) – The first basis for ranking *Teams*, *Qualifying Points* are awarded for winning (two points), tying (one point), and losing (zero points) in a *Qualifying Match*.

Ranking Points (RPs) – The second basis of ranking *Teams*, *Ranking Points* are used as the tiebreakers when *Teams* have equal *Qualifying Points*. *Ranking Points* are awarded in the amount of the final score of the losing *Alliance* in a *Qualifying Match*. Both *Alliances* receive the pre-penalized score of the losing *Alliance* as their RP.

Robot - Any mechanism that has passed inspection and a *Team* places on the *Playing Field* prior to the start of a *Match*. To be legal, *Robots* must comply with the *Robot* Build rules in Section 5 of this manual.

Sports Start – A model of Competition where *Teams* start and stop their *Robot* after the 3-2-1 countdown.

Surrogate Match – *Surrogate Matches* are scheduled into the Qualification rounds of an Event if the number of *Teams* at the Event is not evenly divisible by four. The *Surrogate Match* is a way to ensure all *Teams* compete in a minimum of five *Matches*. This is an additional *Qualifying Match* for those *Teams* scheduled in a surrogate *Match* and does not count in the standings for *Qualifying Points* or *Ranking Points*. However, these *Matches* are very important in the entire standings and should be played by all as if they were regular *Qualification Matches*. *Surrogate Matches* will be marked as such on the official *Qualifying Match* schedule.

Team – An official *FIRST* Tech Challenge *Team* consists of no more than 15 student *Team* members. All *Teams* in North America are required to register through the Team Registration System, and have a minimum of TWO Lead Coach/Mentors that have registered through the Team Registration System and have passed the Youth Protection Program screening. The *Team* must be in good standing through the registration system in order to compete in *FIRST* Tech Challenge Official Events.

4.3 Tournament Event Schedule

Event schedules will be available through the Event Director prior to or at the Tournament. Qualification Match schedules are created on Tournament day by the scoring system after all *Teams* have checked-in and have passed the inspection process.

4.4 Tournament Rules

<T1> Egregious behavior by any *Team*, *Team* member, or other representative of the *Team* is not tolerated at a *FIRST* Tech Challenge Tournament. Violations of this rule can result in penalties to the *Team*, and/or the issuance of a Yellow or Red Card. Egregious behavior includes, but are not limited to, repeated and/or flagrant violation of game rules, unsafe behavior or actions, uncivil behavior towards Volunteers, Competition personnel, or Event attendees.

<T2> Yellow Cards and Red Cards are used in the *FIRST* Tech Challenge to manage *Team* and *Robot* behavior that does not align with the mission of *FIRST*. Yellow and Red Cards are not limited to just the *Competition Area*. *Teams* that exhibit egregious behavior in the *Pit Area*, Judging Rooms, stands, or any other location of the Event can be issued a Yellow or Red Card for egregious behavior.

The Head Referee may assign a Yellow Card as a warning, or a Red Card for *Disqualification* in a Match, as a result of egregious or repeated (3 or more) *Robot* or *Team* member behavior at the Event. A Yellow Card or Red Card is indicated by the Head Referee standing in front of the *Team's* Alliance Station and holding a Yellow Card and/or Red Card in the air.

Yellow Cards are additive, meaning that a second Yellow Card is automatically converted to a Red Card. A *Team* is issued a Red Card for any subsequent incident in which they receive an additional Yellow Card, including earning a second Yellow Card during a single Match. A second Yellow Card is indicated by the Head Referee standing in front of the *Team's* Alliance Station and holding a Yellow Card and Red Card in the air simultaneously after the completion of the Match. A *Team* that has received either a Yellow Card or a Red Card carries a Yellow Card into subsequent Matches, except as noted below. A Red Card results in Match Disqualification. Multiple Red Cards may lead to Tournament Disqualification. Once a *Team* receives a Yellow Card or Red Card, its *Team* number will be presented with a yellow background on the audience screen at the beginning of all subsequent Matches as a reminder to the *Team*, the referees, and the audience that they carry a Yellow Card.

Yellow Cards do not carry over from the *Qualification Matches* to the *Elimination Matches.* During the *Elimination Matches*, Yellow and Red Cards count against the entire *Alliance,* not to a specific *Team.* If a *Team* receives a Yellow Card or Red Card, it results in the entire *Alliance* receiving the Yellow Card or Red Card for that Match. If two different *Teams* on the same *Alliance* are issued Yellow Cards, the entire *Alliance* is issued a Red Card. A Red Card results in zero (0) points for that Match, and the *Alliance* loses the Match. If both *Alliances* receive Red Cards, the *Alliance* which committed the action earning the Red Card first chronologically loses the Match.

<T3> Referees have ultimate game play and scoring authority during the Competition. Their rulings are final.

a. The referees will not review any recorded Match replays or photographs.

b. All questions about a Match or scores must be must be brought forward to the Referees by using the Referee Question Box located in the *Competition Area*. Only one **student** from an Alliance is permitted to enter the question box, and must do so within the outlined time based on the type of Match being played:

   i. *Qualification Matches*: A *Team* must enter the question box to dispute a Match within the time period of three (3) Matches following the disputed Match.

   ii. *Elimination Matches/Final Matches:* A *Team* must enter the Referee Question Box to dispute a Match before the start of the next match played by the Alliance, regardless if the *Team* is participating in the next Match. The next Match played could involve different *Alliances*.

   Students are required to support their questions by referencing specific rules or posts to the Q&A section of the official *FIRST* Tech Challenge Forum. *Team* members are required to ask their questions in a gracious and respectful manner.

c. *Team* members are not allowed onto the *Playing Field* for any reason other than to place or retrieve their *Robots*. Inspection of the *Playing Field* elements by *Team* members for the express purpose of determining scoring is prohibited. Individuals and *Teams* that violate this rule will be subject to possible *Team* penalties that could include Match disqualifications or even removal from the Tournament.

<T4> No *Team*, *Team* Member, or Event attendee is allowed to set up their own Wi-Fi 802.11 (2.4GHz or 5GHz) wireless communication in the venue. Non-allowed wireless communications include, but are not limited to:

a. Cellular Hotspots (e.g. cell phones, tablets, MiFi).

b. Ad-hoc networks.

c. Nintendo DS peer-to-peer.

d. Bluetooth communication with *Robots* in the *Competition Area*.

No *Team*, Team Member, or Event attendee shall interfere with a Team's Wi-Fi Direct® communication with their own *Robot*.

The Penalty for violating rule <T4> is disqualification of the entire *Team* from the Event and their removal from the venue property. *Teams* may not appeal the penalty and no refunds will be given for registration fees, pre-paid meals, etc. *FIRST* may conduct a post-Event review and determine if any additional penalties are to be imposed upon the offending *Team*.

Teams are encouraged to report wireless security vulnerabilities to the Field Tech Advisor (FTA) at an Event. *Teams* should always keep in mind *Gracious Professionalism*®, and therefore only report valid and verifiable violations of this rule. After the FTA is alerted of a potential rule violation, he/she will confer with the Head Referee. The FTA and Head Referee will further investigate the potential violation of this rule. The final decision will be made by the Head Referee with the guidance of *FIRST* Headquarters staff if rule <T4> has been violated, and to disqualify the offending *Team*.

<T5> Wi-Fi Direct® connectivity between the Android devices used as the *Robot Controller* and the *Drivers Station* is allowed. No other wireless communication is allowed.

The Penalty for violating rule <T5> is disqualification of the entire *Team* from the Event and their removal from the venue property. The decision to disqualify the Team from the Event will be made by Head Referee with the guidance of *FIRST* Headquarters staff. *Teams* may not appeal the penalty and no refunds will be given for registration fees, pre-paid meals, etc. *FIRST* may conduct a post-Event review and determine if any additional penalties are to be imposed upon the offending *Team*.

<T6> *Team* members may be asked by the Event Director to use a specific Wi-Fi channel on the Event day. It is the intent of this rule that *Teams* must comply with the request of the Event Director if asked to use a specific Wi-Fi Channel when supported by an approved Android Device. Teams that have Android Devices that support channel changing MUST comply with the request of the Event Director to switch their channel before playing in the next Match.

<T7> Each registered *Team* may enter only one *Robot* (a *Robot* built to play the current season's game challenge) into the *FIRST* Tech Challenge Competition. It is expected that *Teams* will make changes to their *Robot* throughout the season and at competitions.

a. It is against the intent of this rule to compete with one *Robot* while a second is being modified or assembled at a Tournament.
b. It is against the intent of this rule to switch back and forth between multiple *Robots* at a Tournament.
c. It is against the intent of this rule to register and attend concurrent Events with a second *Robot*.

Violations of this rule will immediately be considered egregious, as they would be considered a deliberate violation of the rule.

<T8> Only three *Team* representatives are permitted in the *Competition Area*; two (2) student drivers, and one (1) coach who are identified by badges designating 'driver' or 'coach.' These badges are interchangeable within a *Team* in between Matches. Only student *Team* members wearing a badge designated as 'driver' may drive the *Robot* during the Match. Team representatives beyond the two student drivers and one coach will be asked to leave the competition area immediately.

<T9> *Pre-Match Robot* Setup – At the beginning of a Match, each *Alliance Robot* must be set up on the *Playing Field* in accordance with section 1.5.1 Pre-Match in the Game Manual Part 2. After *Robots* have been set up on the *Playing Field*, Drive Teams are required to stand Completely Inside the Alliance Station at the location (Station one or Station two) specified by the *Qualification Match* schedule.

a. During the *Qualification Matches*, the Blue *Alliance Robots* are set up on the *Playing Field* first, unless the Red *Alliance* waives their right to set up on the *Playing Field* second.
b. During *the Elimination Matches*, the lower seeded (e.g. 3rd seed is lower than 2nd seed) *Alliance Robots* are set up on the *Playing Field* first, unless the higher seeded *Alliance* waives their right to set up on the *Playing Field* second.

c. *Teams* may implicitly waive their right to place their *Robots* on the *Playing Field* last by placing their *Robots* on the *Playing Field* before or in conjunction with the opposing *Alliance*. There is no need to notify the referees; *Teams* waive their right by the act of placing their *Robots* on the *Playing Field*.

<T10> Scores will be recorded at the end of the *Autonomous Period* and *Driver-Controlled Period* when all objects on the *Playing Field* have come to rest. *Scores* may or may not be announced to the *Teams* until some amount of time after the *Match* has completed.

<T11> There are no time outs during the *Qualification Matches*. The Matches must progress according to schedule. If a *Robot* cannot report for a Match, at least one member of the *Team* should report to the *Playing Field* for the Match. Teams that do not show up for their scheduled Match will be considered a "no show" and not receive any points for the Match.

<T12> *Teams* are guaranteed a minimum of five minutes (5:00) between participating in consecutive Matches.

<T13> During the elimination rounds, each *Alliance* will be allotted ONE time out of no more than three minutes (3:00). Time outs must be called at least two minutes (2:00) prior to their next Match's starting time. The time out begins at the time their Match was going to start.

<T14> All *Team* members and their guests, including coaches, must wear ANSI Z87.1 certified safety glasses or prescription glasses with ANSI Z87.1 approved commercial off the shelf side shields while in the *Pit Area* or *Competition Area*.

NOTE: *FIRST* requires all *Teams* to bring and supply, for each Competition, ANSI-approved safety glasses for its *Team* members, mentors, and guests. Tinted lenses are allowed as long as Event personnel can see the Volunteer's, spectator's, or *Team* member's eyes through the safety glasses. Sunglasses or deeply shaded safety glasses used in our indoor Event environment are not acceptable.

<T15> Skateboards, roller skates, 'hover boards', and drones are not allowed at any Tournament. These items can create safety hazards to the *Teams*, spectators, or Volunteers attending the Event.

<T16> No live bands are allowed in the audience or *Pit*. No loud music, audio systems, whistles, banging sticks, blow horns, etc. are allowed. They prevent *Teams* from hearing important announcements. Power may be shut off and/or noisemakers confiscated.

<T17> Batteries must be charged in an open, well-ventilated area.

<T18> There is no painting allowed anywhere at the Tournament. This includes the *Pit Area*, *Competition Area*, and spectator areas.

<T19> *Pit* display structures may not exceed 3.05 m (10 ft.) x 3.05 m (10 ft.) in height or a limit specified by the venue, whichever is shorter.

<T20> *Teams* are not allowed to use radios and walkie-talkies anywhere in the Tournament facility.

<T21> There is no running anywhere during the Event as this is a safety hazard.

<T22> Sitting together in a group during Competition *Matches* makes the game more exciting and fun. It allows *Team* members to show support for their *Team*. *Teams* are not allowed to save seating space as there is often not enough seating to accommodate everyone. Repeated offenses could be considered egregious, and Teams could face consequences for violating this rule.

<T23> Soldering, Gluing, Brazing, or other Large Power Tools: These activities and tools are not allowed in the *Pit Areas* or at the Competitions unless the Tournament Director specifically allows them.

<T24> Because of site regulations/contracts, *FIRST* cannot allow *Teams* or individuals to sell items, such as T-shirts, pins, etc., at any Events. Fundraising for a cause is permitted with consent of the Event Director; fundraising for a *Team* is not permitted.

<T25> Check with the Event Director before bringing food to an Event, as some venues will not allow outside food on-site due to contracts and agreements.

4.5 Eye Protection and Safety

FIRST requires all *Teams* to bring and supply ANSI Z87.1 certified safety glasses for their members and guests for each Competition. Regular glasses and sunglasses do not qualify as safety glasses. *Team* members or spectators that wear prescription glasses must wear safety goggles over them or attach safety side shields. Side shields must also meet ANSI Z87.1 requirements. Tinted lenses are allowed as long as Event personnel can see the Volunteer's, spectator's, or *Team* member's eyes through the safety glasses. Sunglasses or deeply shaded safety glasses used in our indoor Event environment are not acceptable.

Everyone in the *Pit* and *Competition Areas* are required to wear approved eye protection.

Open-toed or open-backed shoes are not permitted in the *Pit Area* or in the *Competition Area*.

4.6 Tournament Day Overview

FIRST Tech Challenge Events pack a lot of activities into one day.

The main Events for a Tournament (Qualifying Tournament, League Championship, State Championship, Super Regional Championship, World Championship) are as follows:

1. *Team* Check-in
2. *Robot* and Field Inspection
3. Judges' Interviews
4. Drivers' Meeting
5. Opening Ceremony
6. *Qualification Matches*
7. *Alliance Selection*
8. *Elimination Matches*
9. Awards and Closing Ceremony

Teams participating in a League structure and attending Meets will only participate in the following activities during the meet:

1. *Team* Check-in
2. *Robot* and Field Inspection
3. Driver's Meeting
4. *Qualification Matches*

4.6.1 Team Check-In

As a *Team* arrives at the venue, the Coach or other adult Mentor should register the *Team* with the Tournament officials. The Coach or Mentor is highly encouraged to bring the Student Roster which can be printed from the Team Registration System. Any students on the list who have not submitted an electronic version must have a printed, signed Consent and Release form attached. If the Coach or Mentor does not bring the Roster from the Team Registration System, a student roster listing all students, and individual

Consent and Release Forms MUST be handed in at the time of registration for each student participating in the Event. The Coach will receive a packet of information for the *Team* that may include Drive Team badges, a judging schedule, a map of the facilities and *Pits*, and other information that is very important to the *Teams*. At this time, the *Team* should review the schedule of Events for the day, set up their *Pit Area* and get familiar with the venue, including where the practice and *Playing Fields* are and where judging takes place, and review the schedule of Events for the day.

4.6.2 Robot and Field Inspection

FIRST Tech Challenge *Robots* are required to pass *Robot* and Field inspections before being cleared to compete. These inspections ensure that all *Robot* rules and regulations are met. A copy of the official *FIRST* Tech Challenge "*Robot* Inspection Sheet" and "Field Inspection Sheet" is located in Appendices A and B of this manual. The "*Robot* Inspection Sheet" must be used by *Teams* as a guide to pre-inspect their *Robot*.

4.6.3 Judges' Interviews

At *FIRST* Tech Challenge Events, there are generally three parts to the judging process: 1) interview with judges; 2) evaluation of performance during the Tournament; and 3) evaluation of the Engineering Notebook. Each *Team* will have a ten to fifteen minute "fact finding" interview with a panel of two or three judges.

The Judges' Interviews take place before any *Qualification Matches* so that the entire *Team* may be interviewed. When *Teams* arrive at the Event, 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 participate. Mentors (no more than two) are welcome to observe the Judges' Interview at most Events, but should not participate (see Section 7.4 for more details).

Teams may **not** opt out of the Judges' Interviews, however, *Teams* may participate in Judges' Interviews if their *Robots* have not passed inspection.

4.6.4 Drivers' Meeting

The Drivers' Meeting takes place prior to the start of *Qualification Matches* and is a time when the drive *Team* meets with the referees. During this time, the Head Referee gives a brief overview of what is expected of *Teams* and any venue specific information, such as queuing paths, and explains any signals and commands referees will give during Matches.

4.6.5 Practice Time

At some Events, practice fields are set up so that *Teams* can practice throughout the Event. Every effort will be made to equalize practice time for all *Teams*, but it may also be conducted on a first-come, first-served basis. *Teams* should check with the Event Director if practice time will be allowed on the day of the Event.

4.6.6 Opening Ceremony

The Opening Ceremony is the official kickoff of the Event's activities for the *Teams*, the fans, and the public. During the Opening Ceremony, a Tournament official or the emcee will welcome the *Teams* and the public, introduce dignitaries and other special guests, and introduce the judges and the referees. Then the game will be described (usually with a video) and immediately after, the *Qualification Matches* take place.

Teams that are scheduled in the first four *Qualification Matches* will be asked by Volunteers to line up before the opening ceremonies. The *Qualification Match* schedule will be available prior to the start of Opening Ceremony. It is the *Team's* responsibility to check the schedule and make sure they are on time for their Matches.

4.6.7 Qualification Matches

Teams are randomly assigned to *Qualifying Matches* and *Alliances*. The *Qualifying Match* schedule is available prior to Opening Ceremonies on the day of the Event. This schedule indicates *Alliance* partners and Match pairings. It also indicates the *Alliance*'s color (red or blue) and the position in the *Alliance Station* (1 or 2) for the drive *Team*. These Matches start immediately after the Opening Ceremonies in accordance with the *Qualification Match* schedule. The queue Volunteer crew works together throughout the day to line up *Teams* for the Matches and maintain the schedule. It is very important to pay attention to the Match schedule and listen for announcements throughout the day. *Teams* need to know when they will compete, find out the number of the last Match before lunch, and find out which Match is the last Match of the Tournament day.

All *Teams* are ranked based on the same number of *Qualifying Matches*. In some cases, a *Team* is asked to play a *Surrogate Match* which does not count towards their standings during the Event. This additional Match is denoted on the Match schedule or announced to the *Teams* prior to the start of the *Qualifying Matches*.

At the conclusion of each Match, *Qualifying Points* (QP) and *Ranking Points* (RP) are awarded:

- *Teams* receive *Qualifying Points* based on the following:
  - Winning *Teams* of a *Qualifying Match* each receive two (2) *Qualifying Points*.
  - Losing *Teams* of a *Qualifying Match* receive zero (0) *Qualifying Points*.
  - If a *Qualifying Match* ends in a tie, all four *Teams* receive one (1) *Qualifying Points*.
  - If a *Team* is disqualified, they receive zero (0) *Qualifying Points*.
- *Ranking Points* (RP) are awarded based on the following:
  - The number of *Ranking Points* assigned for each Match is that of the losing *Alliance's* score. Both *Alliances* receive the pre-penalized score of the losing *Alliance* as their *Ranking Points*.
  - In the Event of a tie, both *Alliances* receive the same number of *Ranking Points*, equal to the lowest pre-penalized score. If a *Team* is disqualified, they receive zero (0) *Ranking Points*.
  - If both *Teams* on an *Alliance* are disqualified, the *Teams* on the winning *Alliance* are awarded their own score as their RP for that Match.

Example:

Match	Result	Red	Blue
Q-1	30-15 R	5555	8888
		4444	6666
Q-2	15-45 B	1111	7777
		3333	2222
Q-3	30-30 T	8888	4444
		7777	3333
Q-4	25-45 B	2222	5555
		6666	1111

- Q-1 – The Red *Alliance* has won the Match 30-15. *Teams* 4444 and 5555 will receive two (2) *Qualifying points*, and *Teams* 8888 and 6666 receive zero (0) *Qualifying Points*. Both *Alliances* will receive 15 *Ranking Points*.
- Q-2 – The Blue *Alliance* has won the Match 45-15. *Teams* 1111 and 3333 will receive two (2) *Qualifying Points*, and *Teams* 7777 and 2222 will receive zero (0) *Qualifying Points*. Both *Alliances* will receive 15 *Ranking Points*.
- Q-3 – This Match ended in a Tie, which will result in both *Alliances* receiving one (1) *Qualifying Point*

and thirty (30) *Ranking Points*.

- Q-4 – The Red *Alliance* originally had a Match score of 15 points (not shown in image), the Blue *Alliance* had a Match score of 45 points. The Blue *Alliance* then incurred a Minor penalty, which added 10 points to the Red *Alliances* score. The result is that the Blue *Alliance* wins, and therefore receives two (2) *Qualifying Points*. The Red Alliance receives zero (0) *Qualifying Points*. However, the lowest **pre-penalized** score between the *Alliances* is still 15, therefore both *Alliances* will receive 15 *Ranking Points*.

Teams with non-functioning *Robots* may receive credit for a *Qualifying Match* if their *Robot* has passed inspection and at least one member of the drive *Team* is present in the *Alliance Station* for the scheduled Match. If no member of a *Team* is present in the Driver Station at the start of a Match, that *Team* is declared a "no show" and receives zero (0) QP and zero (0) RP.

All questions about a Match or scores must be must be brought forward to the Referees by using the Referee Question Box located in the *Competition Area*. Only one **student** from an Alliance is permitted to enter the question box, and must do so within the time period of three (3) Matches following the disputed Match.

At the conclusion of all *Qualification Matches*, the *Teams* are ranked from first through last on the basis of their total *Qualifying Points* (QPs). If multiple *Teams* have the same QP total, these *Teams* are ranked on the basis of their total *Ranking Points* (RPs). If multiple *Teams* have the same RP total as well, then these *Teams* are ranked on the basis of their highest Match score. If still tied, the next highest Match score is used until the tie is broken. In the unlikely Event that there is still a tie based on identical Match scores, then the *Teams* are ranked by a random electronic draw. The rankings are done automatically through the Scoring System software.

4.6.8 Alliance Selection

The number of *Teams* in the *Elimination Matches* is based on the number of *Teams* in the Tournament. If there are 21 or more *Teams* in the Tournament, the *Elimination Matches* consist of *Alliances* of 3 *Teams* each. If there are 20 *Teams* or less, then the *Alliances* consist of 2 *Teams* each. There are a total of four (4) *Alliances* that will compete in the Elimination Bracket.

The *Alliance Selection* process consists of a number of rounds of selections, such that all *Alliance Captains* form *Elimination Match Alliances* consisting of the requisite number of *Teams*. These *Alliances* participate in a ladder-type Tournament to determine the Event's Winning *Alliance.* The *Alliance Selection* process is as follows:

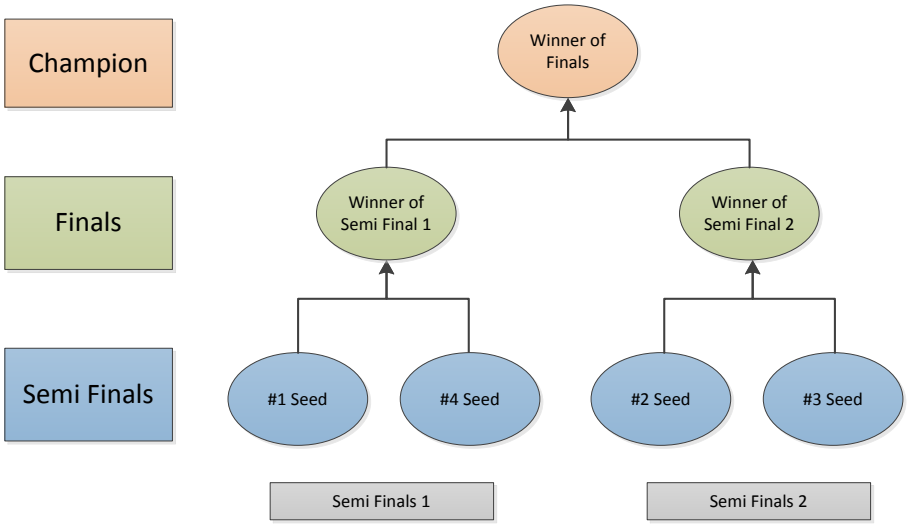
- Each *Team* chooses one student to act as the *Team's* representative. These representatives will proceed to the *Competition Area* at the designated time to represent their *Teams* in the *Alliance Selection*.
- In order of Tournament ranking, the student representative of the highest ranked *Team* not already in an *Alliance* is asked to step forward as the *Alliance Captain* to invite another available *Team* to join their *Alliance*.
- A *Team* is available if it is not already part of an *Alliance*, or has not already declined an *Alliance* invitation. If the *Team* accepts, it is moved into that *Alliance*. If a *Team* declines, it CANNOT be invited into another *Alliance*, but it is still available to select their own *Alliance* if the opportunity arises. If a *Team* declines, the *Alliance Captain* from the inviting *Team* must then extend an invitation to another *Team*.

- The process continues until all *Alliance Captains* have been designated and chosen one *Alliance* partner.
- If there are more than 20 *Teams*, the same method is used for each *Alliance Captain*'*s* second choice (the third member of the *Alliance*) from highest seed to lowest seed (i.e. 1 → 2 → 3 → 4). Any *Teams* remaining after the lowest seeded captain makes their choice do not compete in the *Elimination Matches*.

4.6.9 Elimination Matches

The *Elimination Matches* are very exciting. This is when the *Alliances* determine who the Champion of the Event is. The Matches are played in a seeded format where the top seed goes up against the 4th seed, and the number 2 seed goes up against the 3rd seed.

In the *Elimination Matches*, *Teams* do not get *Qualifying Points*; they get a win, loss or tie. Within each bracket (Semi-Finals or Finals) of the elimination, Matches are played to determine which *Alliance* advances. The advancing *Alliance* is the first *Team* to win two Matches. Any tied Matches are replayed until one *Alliance* has two wins and advances. An example Tournament bracket appears here:



During the *Elimination Matches*, two *Teams* from an *Alliance* compete on the *Playing Field*. If the *Alliance* has three *Teams*, the *Team* that sits out the first Match must play in the second Match, with no exceptions. If the *Alliances* play more than two Matches in any bracket, any combination of two *Alliance Robots* may be used. The Captain of the *Alliance* is not required to participate in every Match. No special accommodations are made for *Robots* that fail during the Semi Final and Final Rounds. *Teams* should consider the robustness of the *Robots* when picking *Alliance* partners.

If a *Team* is disqualified during an *Elimination Match*, then their entire *Alliance* is disqualified and the Match is recorded as a loss. Prior to each *Elimination Match*, the *Alliance Captain* must let the referee know which two *Teams* are playing in the upcoming Match two (2) minutes prior to the start of the Match.

All questions about a Match or scores must be brought forward to the Referees by using the Referee Question Box located in the *Competition Area*. Only one **student** from an Alliance is permitted to enter the question box. A *Team* must enter the Referee Question Box to dispute a Match before the start of the next Match played by the Alliance, regardless if the *Team* is participating in the next Match. The next Match played could involve different Alliances.

4.6.10 Awards and Closing Ceremony

The Awards and Closing Ceremony celebrates the Teams and their accomplishments throughout the Event, as well as the Volunteers who helped make the Event possible. At the Awards and Closing Ceremony, the finalists and winners of each award are announced. At most Events, the Judges will line up to celebrate and high five each team as they are announced to receive an Award.

4.7 Tournament Types

There are several types of Events and Tournaments that *Teams* and other organizers hold throughout the *FIRST* Tech Challenge season and off-season. These are categorized in the following sections.

4.7.1 Scrimmage

Anyone can host a scrimmage to prepare for a Championship or Qualifier. *Teams* hosting a Scrimmage are encouraged to notify their local Affiliate Partner that such an Event is taking place. *Teams* that choose to create and host a local Event are responsible for finding a location, organizing the format for the day, and inviting other *Teams* to participate. *Teams* may also have to secure the field elements, computers, and other items.

4.7.2 Meets and League Play

A League Meet is a one-Field Competition that uses the same Field and Game as other Events. *Teams* may participate in as few or as many League Meets as they choose, but participating in more improves their League Ranking. Some of the standard Tournament and Championship guidelines may be modified for those regions that have chosen to participate in the League format. *Teams* should contact their Affiliate Partner for more information about the scheduling, structure, advancement and processes that are unique to the League/Meet in their region.

4.7.3 Qualifying Tournaments and League Tournaments

Hosted and managed by *FIRST* Tech Challenge Affiliate Partners or Partner-appointed hosts. Qualifying Tournaments follow the judging, game guidelines, and format out lined in sections 4.6 and 7.0 of the Game Manual Part 1. Qualifying Tournaments are usually held prior to Championship Tournaments in regions where there are many *Teams*. The number of *Teams* advancing to the state Championship Tournament depends on the capacity of the state Championship Tournament, the number of Qualifying Tournaments, and the number of *Teams* attending the Qualifying Tournament. The Advancement Criteria for moving up to the next level of Tournament is detailed in Section 4.8.

4.7.4 Super-Qualifying Tournaments

These Events are held in regions with a large number of *Teams* and/or Leagues. In these regions, *Teams* advance from either a League Championship or Qualifying Tournament to a Super-Qualifying Tournament, and then to the regional or state Championship. Super-Qualifying Tournaments adhere to *FIRST* standards in format, judging, and awards.

4.7.5 Championship Tournaments

Hosted and managed by a *FIRST* Tech Challenge Affiliate Partner, Championship Tournaments abide by certain standards in format, judging, awards, and overall quality. Some Championship Tournaments require that *Teams* advance from a Qualifying Tournament or League Championship in order to advance to the State/Regional Championship. Championships may include *Teams* from a geographic region, province, state, country, or several countries. *Teams* should expect a higher level of competition, both on the field and in the Judging room at Championship Tournaments.

4.7.6 Super-Regional Championship Tournaments

Teams in the United States have the opportunity to compete in an additional level of Championship Play. Four Super-Regional Championship Events will be held, and hosted by an Affiliate Partner. Super-Regional

Championship Tournaments abide by certain standards in format, judging, awards, and overall quality. *Teams* advance from their State or Regional Championship to the Super-Regional Championship using the same advancement criteria described in section 4.8. *Teams* advance from the Super-Regional Championships to one of the *FIRST* Tech Challenge World Championships. *Teams* should expect a higher level of competition, both on the field and in the Judging room at Championship Tournaments.

4.8 Eligibility and Advancement Criteria

4.8.1 Eligibility

Teams must be registered and in good standing with *FIRST* before they are eligible to compete in Official *FIRST* Tech Challenge Tournaments.

4.8.1.1 Qualifying Tournaments

A *Team* is eligible to advance to the next competition tier from one of the first three Qualifying Tournaments they attend within a Region. A Region is defined as the area that a Championship Tournament serves.

A *Team* may participate in more than three Events in the same competition tier within a Region, but they are not eligible for consideration for any Judged Awards or advancement at Events beyond their third.

A *Team* that has won the Inspire Award in a Region is no longer eligible for consideration for the Inspire Award, or as a finalist for the Inspire Award in the same competition tier within the Region.

4.8.1.2 Championship Tournaments

A *Team* is eligible to advance to the next competition tier from the first three Championship Tournaments they attend within a Super-Region. A Super-Region is defined as the area that a Super-Regional Championship Tournament serves.

A *Team* may participate in more than three Championship Events within a Super-Region, but they are not eligible for consideration for any Judged Awards at Events beyond their third Championship Tournament.

A *Team* that has won the Inspire Award at a Championship Tournament that leads to a Super-Regional Tournament is no longer eligible for consideration for the Inspire Award, or as a finalist for the Inspire Award at a Championship Tournament within the Super-Region.

4.8.1.3 Super-Regional Championship Tournaments

A *Team* may only participate in one Super-Regional Championship Tournament.

A *Team* that has earned a spot at one of the World Championships outside of the Super-Regional system may not participate in a Super-Regional Event, even if they have earned a spot to the Event.

Teams that had previously won the Inspire Award at a Qualifying or Championship Tournament are eligible to win or be a finalist for the Inspire Award at the Super-Regional Championship Tournament.

4.8.2 Advancement

Teams advance to the next level of Competition in the order indicated below according to their eligibility and on the number of spots available. *Teams* outside North America should contact their *FIRST* Tech Challenge Affiliate Partner for information about advancement criteria. The advancement criteria will be applied to *Teams* in North America as follows:

1. *Teams* advance from a Qualifying Tournament, League Championship, or Super Qualifier to a State or Regional Championship Tournament.

2. *Teams* advance from a Regional Championship Tournament to one Super-Regional Championship

Tournament. Once a *Team* has qualified for an invitation to a Super-Regional Championship, that *Team* is no longer eligible to be invited to a second Super-Regional Championship.

3. *Teams* advance from a Super Regional Championship Tournament to one of the *FIRST* Tech Challenge World Championships. Teams who participate in the West and South Super-Regional Championship Tournament will advance to the World Championship Event in Houston, Texas. Teams who participate in the East and North Super-Regional Championship Tournament will advance to the World Championship Event in St. Louis, Missouri.

In the Event that the *Team* listed has already advanced or there is no *Team* fitting that description (as in 2nd *Team* selected at smaller Events), the advancement will continue in order.

1. Optional – Qualifier Host *Team* (*NOTE: Each region's Affiliate Partner decides if this advancement opportunity will be offered, and if so, when the host Team must be identified. The Team should compete at one other Tournament within the region and must meet the criteria set forth by the Affiliate Partner in the agreement. This advancement applies to Qualifying Tournament hosts only, and does NOT apply to host Teams of Meets, League Championships or Championship Tournaments*).
2. Inspire Award Winner*
3. Winning Alliance Captain
4. Inspire Award 2nd place
5. Winning Alliance, 1st *Team* selected
6. Inspire Award 3rd place
7. Winning Alliance, 2nd *Team* selected
8. Think Award Winner
9. Finalist Alliance Captain
10. Connect Award Winner
11. Finalist Alliance, 1st *Team* selected
12. Rockwell Collins Innovate Award Winner
13. Finalist Alliance, 2nd *Team* selected
14. PTC Design Award Winner
15. Motivate Award Winner
16. Control Award Winner
17. Highest Ranked *Team*** not previously advanced, from the Winning Division.
18. Think Award 2nd Place
19. Highest Ranked *Team*** not previously advanced, from the Finalist Division.
20. Connect Award 2nd Place
21. Highest Ranked *Team*** not previously advanced, from the Winning Division.
22. Rockwell Collins Innovate Award 2nd Place
23. Highest Ranked *Team*** not previously advanced, from the Finalist Division.
24. PTC Design Award 2nd Place
25. Highest Ranked *Team*** not previously advanced, from the Winning Division.
26. Motivate Award Winner 2nd Place
27. Highest Ranked *Team*** not previously advanced, from the Finalist Division.
28. Control Award Winner 2nd Place

29. Highest Ranked *Team*** not previously advanced, from the Winning Division.
30. Think Award 3rd Place
31. Highest Ranked *Team*** not previously advanced, from the Finalist Division.
32. Connect Award 3rd Place
33. Highest Ranked *Team*** not previously advanced, from the Winning Division.
34. Rockwell Collins Innovate Award 3rd Place
35. Highest Ranked *Team*** not previously advanced, from the Finalist Division.
36. PTC Design Award 3rd Place
37. Highest Ranked *Team*** not previously advanced, from the Winning Division.
38. Motivate Award 3rd Place
39. Highest Ranked *Team*** not previously advanced, from the Finalist Division.
40. Control Award 3rd Place
41. Highest Ranked *Team*** not previously advanced, from the Winning Division.

*The winner of the Inspire Award at each Tournament level receives an automatic invitation to the next Tournament level. Once a *Team* has won an Inspire Award at a Championship, they are no longer eligible to win the Inspire Award at additional Championship Tournaments they may attend. Similarly, once a *Team* wins an Inspire Award at a Qualifying Tournament or League Championship, they are no longer eligible to win the Inspire Award at subsequent Qualification Tournaments or League Championships within the same Region.

**Refers to qualifying ranking

4.9 Team Spirit

Competing as a *Team* is exciting as well as rewarding. Part of the fun and reward of being a *Team* member is the way the *Team* styles itself with *Team* T-shirts, trading buttons, hats, cheers, and costumes.

4.10 Team Styling

When deciding on a *Team* name or acronym, consider how to work a theme around it to make the *Team* more fun and recognizable. Refer to the Marketing and Outreach section of the website for information about *FIRST* and *FIRST* Tech Challenge logo use requirements: http://www.firstinspires.org/node/5246.

4.11 Banners and Flags

Sponsors provide *FIRST* with banners so we can display them in specified areas as a way of thanking them for their generosity. We encourage *Teams* to bring *Team* flags or sponsor banners, but we ask that you adhere to the following:

- Do not use banners or flags to section off seating. Saving group seats is not permitted.
- Hang banners in pit stations only, not on the pit walls.
- *Teams* may bring banners to the *Competition Area,* but please do not hang them there. This area is designated for official *FIRST* sponsors' banners.

4.12 Spectators and Etiquette

Teams are permitted to have 2 student drivers and 1 coach (the Drive *Team*) at the *Playing Field* during their scheduled Matches. Spectators are not allowed in the *Competition Area* at any time and must remain outside of the designated *Competition Area*. Some Events may provide media passes for one additional *Team* member to gain access to a designated "media area." Access to this area is only permitted with a media pass and only while the media representative's *Team* is on the *Playing Field*. Spectators blocking the sidelines or accessing the media area without a pass will be asked to move. Repeated violations of this rule are considered egregious behavior.

4.13 Scouting

In the qualifying rounds, the scoring system selects each *Team*'s ally and opponent for each Match. In elimination rounds, top ranking *Teams* are able to choose their own *Alliance* partners. *Teams* should select *Alliance* Partners with abilities that complement their own strengths. Scouting during the qualifying rounds is a good way to learn the capabilities and limitations of the *Teams* and *Robots* competing at the Event.

The following scouting strategy has been provided by the 2007 *FIRST*® *Robot*ics Competition Chairman's Award winners, *FIRST Robot*ics Competition *Team* #365, the Miracle Workerz.

Teams use different methods to record information about other *Teams* – paper, computer, tablets, etc. Use whatever method is most comfortable for your *Team*. Scouting is important to determine how you complement other *Teams* in your *Alliance* and how you match up against your opponents. No matter how you record it, focus on information which will be useful to your *Team* when you meet your *Alliance* partners to discuss strategy.

Some possible areas to gather information include:

- CAPABILITIES – what can the *Robot*/*Team* do and what does it not do?
- STRATEGIES – what does the *Robot*/*Team* do during the Match? How does the *Team* play the game?
- PERFORMANCE – how well does the *Robot*/*Team* do what it attempts? What are the *Robot's* strengths and weaknesses?
- AUTONOMOUS – what does the *Robot* do in autonomous mode? Does the *Team* have multiple program options?

The more data points you can collect on strategies and performance, the better understanding you will have of a given *Team*. Information on a *Team*'s capabilities can be obtained by visiting the *Team* in the *Pit Area* or watching Match play.

5.0 The *Robot*

5.1 Overview

A *FIRST* Tech Challenge *Robot* is a remotely operated vehicle designed and built by a registered *FIRST* Tech Challenge *Team* to perform specific tasks when competing in the annual game challenge. This section provides rules and requirements for the design and construction of a *Robot*. *Teams* should be familiar with the *Robot* and game rules before beginning *Robot* design.

5.2 Robot Control System

A *FIRST* Tech Challenge *Robot* is controlled by an Android based platform powered by Snapdragon processors. *Teams* will use two (2) Android devices to control their *Robot* and compete in a "*Sports Start*" model of competition. One Android device will be mounted directly onto the *Robot* and act as a *Robot Controller*. The other Android device will be connected to a pair of gamepads and will act as the *Driver Station*.

For more information, tutorials, and to access our Android Technology forum, please visit:
http://www.firstinspires.org/node/5181

5.2.1 Android Technology Definitions

Core Device Interface Module – A USB-enabled device that can be used to provide input/output ports for the *Robot Controller*. The *Core Device Interface Module* has 8 digital I/O ports, 8 analog input ports, 2 analog output ports, 2 PWM output ports and 6 high speed (100kHz) I^2C ports.

Core Legacy Module – The device that acts as a bridge between the Android *Robot Controller* and LEGO NXT compatible devices (motor controllers, servo controllers, and sensors).

Core Motor Controller – A USB-enabled DC motor controller with two (2) motor control channels.

Core Power Distribution Module – The electronic device that connects the *Robot Controller* Android device to one or more USB-enabled modules such as the *Core Legacy Module, Core Motor Controller*, *Core Servo Controller*, and the *Core Device Interface Module*. The *Core Power Distribution Module* draws power from the 12V TETRIX battery, the 12V MATRIX battery, or the 9.6V MATRIX battery to power an internal USB Hub, DC motor controllers and servo controllers, and certain specified electronics.

Core Servo Controller – A USB-enabled servo controller with six (6) servo control channels.

Driver Station – The component *Teams* use to provide human input to the *Robot Controller*. This is accomplished through hardware consisting of an Android device, an adapter cable, an unpowered USB hub and up to two gamepads.

Java – The recommended programming language for the *Robot Controller*.

Legacy TETRIX DC Motor Controller - TETRIX DC Motor Controller used with the legacy NXT/Samantha control system. This controller is used in conjunction with the *Core Legacy Module*.

Legacy TETRIX Servo Controller - TETRIX Servo Controller used with the legacy NXT/Samantha control system. This controller is used in conjunction with the *Core Legacy Module*.

Legacy MATRIX DC Motor/Servo Controller – MATRIX DC Motor/Servo Controller used with the legacy NXT/Samantha control system. This controller is used in conjunction with the *Core Legacy Module*.

Legacy Sensors – *Legacy Sensors* are any LEGO approved NXT-compatible sensor including sensors from LEGO and HiTechnic.

Mini USB to OTG (On-The-Go) Micro Cable – The connection between the *Robot Controller* and the *Core Power Distribution Module*.

Modern Robotics Sensors – Sensors designed by Modern *Robot*ics that connect to the *Core Device Interface Module*.

OTG Adapter – Connects a non-powered USB hub to Micro USB OTG (On-The-Go) port on the *Driver Station* Android device.

Robot Controller – An Android device located on the *Robot* that processes *Team* written software, reads on board sensors, and receives commands from the Drive *Team* by way of the *Driver Station*. The *Robot Controller* sends instructions to the motor and servo controllers to make the *Robot* move.

USB Mini Type B Cable – These cables are used to connect the USB-enabled modules (*Core Legacy, Core DC Motor Controller, Core Servo Controller* and *Core Device Interface*) to the *Core Power Distribution Module*.

The cables provide 5V DC power to the modules and send information to/from the modules.

5.3 Robot Rules

Anyone that has attended a *FIRST* Tech Challenge Tournament knows that *Teams* think outside the kit-of-parts to create unique and creative *Robot*s. The intent of the *Robot* construction rules is to create a level *Playing Field* and a framework for *Teams* to build *Robot*s that safely play the annual game challenge. Teams should read all of the *Robot* rules prior to building. Teams can also reference our Legal/Illegal Parts List on our website for common legal and illegal *Robot* parts. Some supplier's websites may claim that a part is *FIRST* Tech Challenge approved, the only official references for the legality of parts and materials are the Game Manual Part 1, the Legal/Illegal Parts List, and the Official Q&A Forum.

5.3.1 General Robot Rules

It is the intent of *FIRST* to encourage creativity in design to the extent that it does not present a safety hazard or unfairly affect the opportunities of the opposing-alliance *Teams* to compete. Although there is significant creative freedom allowed in the *Robot* design rules, *Teams* should consider the adverse effects of any design decisions that they make. When considering your *Robot* design and your game strategy, ask yourself the following questions. If the answer to any of these questions is yes, the design component is probably not allowed:

- Could it damage or disable another *Robot*?
- Could it damage the *Playing Field*?
- Could it injure a participant or Volunteer?
- Is there already a rule that prohibits this?
- If everybody did this, would the game play be impossible?

<RG01> Illegal Parts - The following types of mechanisms and components are not allowed:

a. Those that could potentially damage *Playing Field* components. For example, high traction wheels (e.g. AM- 2256) and high grip tread (e.g. Rough top) that may damage the *Playing Field* are not allowed.

b. Those that could potentially damage or flip other competing *Robot*s.

c. Those that contain hazardous materials such as mercury switches, lead, or lead containing compounds, or lithium polymer batteries (except for the Android devices' internal battery).

d. Those that pose an unnecessary risk of entanglement.

e. Those that contain sharp edges or corners.

f. Those that contain animal-based materials (due to health and safety concerns).

g. Those that contain liquid or gel materials.

h. Those that contain materials that would cause a delay of game if released (e.g. ball bearings, coffee beans, etc.).

i. Those that are designed to electrically ground the *Robot* frame to the *Playing Field*.

j. Pneumatics

<RG02> Maximum Starting Size - The maximum size of the *Robot* for starting a Match is 45.72 cm (18

inches) wide by 45.72 cm (18 inches) long by 45.72 cm (18 inches) high. The *Robot* Sizing Box will be used as the official gauge in determining conformance to this rule. To pass inspection a *Robot* must fit within the box while in its Match start configuration and orientation without exerting force on the sides or top of the box. *Robots* may expand beyond the starting size constraint after the start of the Match. The alliance flag and pre-loaded game elements may extend outside the starting volume constraint.

The *Robot* must be self-supporting while in the *Robot* Sizing Box by either:

a. A mechanical means with the *Robot* in a power-OFF condition. Any restraints used to maintain starting size (i.e. zip ties, rubber bands, string, etc.) MUST remain attached to the *Robot* for the duration of the Match.

b. A *Robot* Initialization Routine in the Autonomous operation mode (op mode) program that may pre-position the servo motors, with the *Robot* in a power-ON condition, to the desired stationary position. If the *Robot* Initialization Routine does move the servos when a program is executed, there must be an indicator on the *Robot* of this fact. A warning label placed near the *Robot*'s main power switch is required. Affix the image ("WARNING! - *Robot* moves during Initialization Routine") to your *Robot* near the *Robot* main power switch if servos are commanded to move during the initialization routine:



<RG03> *Robot* Controller Mount - The *Robot Controller* MUST be accessible and visible by competition personnel. If a Team's *Robot* Controller is not accessible and/or visible to competition personnel, the Team may not receive adequate support from the field personnel.

The *Robot Controller* shall be mounted such that the display screen is protected from contact with the *Playing Field* elements and other *Robot*s. This and other electrical components (batteries, motor and servo controllers, switches, etc.) make poor bumpers and are unlikely to survive the rigors of game play when attached in a *Robot*-to-*Robot* contact area.

Important Note: The *Robot Controller* contains a built-in wireless radio that communicates with the Android device in the *Driver Station*. In addition to protecting the device from impact, the *Robot Controller* should not be obscured by metal or other material that could block or absorb the radio signals from the *Robot Controller*.

<RG04> Alliance Flag Holder - *Robot*s MUST include a mounting device to securely hold one Tournament supplied *FIRST* Tech Challenge *Robot* Alliance Identification Flag throughout an entire Match. Because of the need to clearly identify a *Robot*'s Alliance, the flag MUST be mounted at the TOP of the *Robot* and be clearly visible throughout the Match. Flag posts are typically a soda straw or wooden dowel with dimensions that are close to 0.635 cm (0.25 inches) outer diameter x 0.5 cm (0.20 inches) inner diameter x 21 cm (8.25 inches) length with a triangular flag 10.16 cm (4.0 inches) high x 15.24 cm (6.0 inches) wide. These may vary from Event to Event; Alliance Flag Holders should be able to securely hold both solid core dowels and open core straws. Mounting devices that damage the flag post are not acceptable.

<RG05> Team Number Display - *Robot*s MUST prominently display their *Team* number (numerals only, e.g. "12345") on two separate signs.

a. The judges, referees, and announcers must be able to easily identify *Robot*s by *Team* number.

b. *Team* number must be visible from at least **two** opposite sides of the *Robot* (180 degrees apart).

c. The numerals must each be at least 6.35 cm high (2.5 inches), at least in 1.27 cm (0.5 inches) stroke width, and in a contrasting color from their background. Teams can use Arial Font, Bold, 250 point to meet the minimum size requirements.

d. *Team* numbers must be robust enough to withstand the rigors of Match play. Example robust materials include: 1) self-adhesive numbers (i.e. mailbox or vinyl numbers) mounted on polycarbonate sheet, wood panel, metal plate, etc.; 2) Ink jet or laser printed numbers on paper and laminated.

<RG06> Allowed Energy Sources - Energy used by *FIRST* Tech Challenge *Robot*s, (i.e., stored at the start of a Match), shall come only from the following sources:

a. Electrical energy derived from approved batteries.

b. A change in the position of the *Robot* center of gravity.

c. Storage achieved by deformation of *Robot* parts. *Teams* must be very careful when incorporating spring-like mechanisms or other items to store energy on their *Robot* by means of part or material deformation.

<RG07> Launching *Robot* Parts - Parts of the *Robot* itself may not be launched, even if the part launched is still connected to the *Robot* by wire, rope, or cable.

<RG08> Launching Game Scoring Elements – *Robot*s are allowed to launch game Scoring Elements through the air. It is expected that *Teams* will launch the elements with just enough velocity to score. If the referees feel that a *Robot* is launching Scoring Elements with excessive velocity that would cause a safety issue if they were to leave the field the *Robot* will be required to be inspected. *Robot*s must then demonstrate that a launched Game Element cannot travel in the air more than a distance of 4.88 m (16 ft.) or more than 1.83 m (6 ft.) in elevation.

5.3.2 Robot Mechanical Parts and Materials Rules

<RM01> Allowed Materials - *Teams* may use raw and post-processed materials to construct their *Robot*s, provided they are readily available to the majority of *Teams* from standard distributors (e.g. McMaster-Carr, Home Depot, Grainger, AndyMark, etc.).

Examples of allowed raw materials are:
- Sheet goods
- Extruded shapes
- Metals, plastics, wood, rubber, etc.
- Magnets

Examples of allowed post-processed materials are:
- Perforated sheet and diamond plate
- Injection molded parts
- 3D printed parts
- Cable, string, rope, filament, etc.
- Springs of all types: compression, extension, torsion, surgical tubing, etc.

<RM02> Allowed Commercial Off The Shelf Parts - *Teams* may use Commercial Off The Shelf (COTS) mechanical components that have a single degree of freedom. A single degree of freedom system is a system whose motion is defined just by a single independent co-ordinate (or function)[1].

It is the intent of *FIRST* is to encourage *Teams* to design their own mechanisms rather than purchasing pre-designed and pre-manufactured solutions to achieve the game challenge.

Examples of a single degree of freedom:

- Linear Slides
- Gearboxes
- Pulleys
- Lazy Susan

Examples of multiple degrees of freedom:

- Pre-fabricated gripper assemblies
- Ratcheting wrenches

[1] See http://www.tech.plym.ac.uk/soe/james/my_papers/STRC201_SDOF_JMWB.pdf Accessed on 6/16/2016

<RM03> Holonomic Wheels - Holonomic wheels (omni or mechanum) are allowed.

<RM04> 3D Printed Parts - 3D printed parts are allowed.

<RM05> Modifying Materials and COTS Parts - Allowed materials and legal COTS parts may be modified (i.e. drilled, cut, painted, etc.), provided no other rules are violated.

<RM06> Allowed Assembly Methods - Welding, brazing, soldering, and fasteners of any type are legal methods for assembling a *Robot*.

<RM07> Lubricant - Any type of COTS lubricant is allowed, provided that it doesn't contaminate the *Playing Field*, game elements, other *Robot*s, etc.

5.3.3 Robot Electrical Parts and Materials Rules

There are many possible ways to build and wire a *Robot*. These rules provide specific requirements on what is allowed and what is not allowed. *Teams* must ensure that electrical and electronic devices are used consistent with manufacturer's requirements and specifications. *Teams* are encouraged to review the *Robot* Electrical Wiring Guide for suggestions on how to build a *Robot* with safe and reliable wiring.

<RE01> Main Power Switch - The *Robot* Main Power Switch must control all power provided by the *Robot* main battery pack and it must be used in one (1) of the following configurations:

a. *FIRST* strongly recommends that *Teams* purchase a separate Main Power Switch, either TETRIX (part #W39129) or MATRIX (part# 50-0030). This is the safest method for *Teams* and Field personnel to shut down a *Robot*.

b. *Teams* may use the *Core Power Distribution Module* on/off switch as their Main Power Switch.

With either configuration, the *Robot* main power switch MUST be mounted/positioned to be readily accessible and visible to competition personnel. A Main *Robot* Power label must be placed near the Main Power Switch of

the *Robot*. Affix the image ("MAIN *ROBOT* POWER") to your *Robot* near the Main Power Switch.



<RE02> Battery Mount - Batteries MUST be securely attached to the *Robot* in a location where they will not make direct contact with other *Robot*s or the *Playing Field*.

<RE03> *Robot* Main Battery - *Robot* main power is provided by exactly one (1) battery pack that connects directly to a single *Core Power Distribution Module* or through a switch that connects to a single *Core Power Distribution Module*. Voltage and/or current sensors are allowed to connect between the battery pack and the *Core Power Distribution Module.*

The only allowed *Robot* main power battery packs are:

a. *Core Motor Controller, Core Servo Controller, Legacy TETRIX DC Motor Controller,* and *Legacy TETRIX Servo Controller* based systems must use one (1) of the following:
   i. TETRIX (W39057, formally 739023) 12 VDC battery pack
   ii. MATRIX (14-0014) 12 VDC battery pack
   iii. REV Robotics (REV-31-1302) 12 VDC Slim Battery pack
b. *Legacy MATRIX DC Motor/Servo Controller* unified module based systems must use one (1) of the following:
   i. Legacy MATRIX (14-0004) 9.6 VDC battery pack if the 9.6 VDC Legacy MATRIX DC Motors are used.
   ii. MATRIX (14-0014) 12 VDC battery pack if TETRIX, AndyMark, REV Robotics, or MATRIX 12 VDC Motors are used.
   iii. REV Robotics (REV-31-1302) 12 VDC Slim Battery pack if TETRIX, AndyMark, REV Robotics, or MATRIX 12 VDC Motors are used.

<RE04> Fuses - Where present, fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications; fuses may not be shorted out. Fuses must not exceed the rating of those closer to the battery; if necessary, a fuse may be replaced with a smaller rating.

<RE05> *Robot* Power - *Robot* power is constrained by the following:

a. Allowed electronic devices may only be powered by power ports on the *Core Power Distribution Module* except as follows:
   i. The *Core Power Distribution Module* is powered by the *Robot* main battery.
   ii. The *Robot Controller* is powered by its internal battery.
   iii. Allowed sensors connected to the *Core Device Interface Module* and the *Core Legacy Module*.
   iv. Light sources per <RE12>.
   v. Video cameras per <RE13>.
b. External power adapters or voltage converters are not allowed.

<RE06> Android Devices - The following Android devices are allowed:

- ZTE Speed
- Motorola Moto G 2nd Generation
- Motorola Moto G 3rd Generation
- Google Nexus 5
- Samsung Galaxy S5

No other devices may be used as *Robot Controllers* or in *Driver Stations* in *FIRST* Tech Challenge competitions.

a. Exactly one (1) Android device must be used as the *Robot Controller* and the USB interface may only connect to the *Core Power Distribution Module*.
b. Exactly one (1) Android device must be used as a component of the *Driver Station*.
c. The *Robot Controller* Android device must be powered by its own internal battery; external power is not allowed.
d. The *Driver Station* Android device must be powered by its own internal battery; external power is allowed from a COTS USB external battery pack that is connected to the allowed USB hub.

<RE07> Control Module Quantities - *Robot* control module quantities are constrained as follows:

a. Exactly one (1) *Core Power Distribution Module* is required.
b. No more than two (2) *Core Device Interface Modules* are allowed.
c. No more than two (2) *Core Legacy Modules* are allowed.
d. Any quantity of *Core Motor* and *Core Servo Controllers* are allowed.
e. No more than two (2) *Legacy MATRIX DC Motor/Servo Controllers* (unified module) are allowed.

<RE08> Motor and Servo Controllers - Motor and Servo Controllers are allowed in only one of the following two configurations (cannot mix configurations).

a. *Core Motor Controllers, Core Servo Controllers*, *Legacy TETRIX DC Motor Controllers, and Legacy TETRIX Servo Controllers* in any combination.

b. *Legacy MATRIX DC Motor/Servo Controllers* (unified module).

<RE09> DC Motors – A maximum of eight (8) DC motors are allowed. The only allowed motors are as follows:

a. *Core Motor Controller* and *Legacy TETRIX DC Motor Controller* based systems must use the following 12 VDC motors in any combination.
    i. TETRIX: W39530
    ii. AndyMark: AM-2964, AM-2964a, AM-3102, AM-3103, AM-3104
    iii. MATRIX: 50-0012, 50-0013, 50-0014, 50-0073
    iv. REV *Robot*ics: REV-41-1300, REV-41-1301

b. *Legacy MATRIX DC Motor/Servo Controller* based systems powered by a 12 VDC Battery must use the following 12 VDC motors in any combination.
    i. TETRIX: W39530
    ii. AndyMark: AM-2964, AM-2964a, AM-3102, AM-3103, AM-3104
    iii. MATRIX: 50-0012, 50-0013, 50-0014, 50-0073
    iv. REV *Robot*ics: REV-41-1300, REV-41-1301

c. *Legacy MATRIX DC Motor/Servo Controller* based systems powered by a 9.6 VDC Battery must only use MATRIX 9.6 VDC motors (14-0001, 14-0009) in any combination. No other DC motors are allowed

for use with the *Legacy MATRIX DC Motor/Servo Controller*.

d. No other DC motors are allowed.

The allowed battery, motor controller, servo controller, and DC motor combinations are summarized in the following table. The check symbol (✓) indicates that the DC motor is allowed with the controllers and batteries listed in the rows above it. The "X" symbol is present for DC motors that are not allowed for the listed controller and battery combination.

Controllers:	***Core Motor Controller* and/or *Legacy TETRIX DC Motor Controller***	***Legacy MATRIX DC Motor/Servo Controller* (Unified Module)**	
Batteries:	**TETRIX 12 VDC, MATRIX 12 VDC, or REV *Robot*ics 12 VDC**	**MATRIX 9.6 VDC**	**TETRIX 12 VDC, MATRIX 12 VDC, or REV *Robot*ics 12 VDC**
TETRIX W39530	✓	X	✓
AndyMark AM-2964	✓	X	✓
AndyMark AM-2964a	✓	X	✓
AndyMark AM-3102	✓	X	✓
AndyMark AM-3103	✓	X	✓
AndyMark AM-3104	✓	X	✓
MATRIX 50-0012	✓	X	✓
MATRIX 50-0013	✓	X	✓
MATRIX 50-0014	✓	X	✓
MATRIX 50-0073	✓	X	✓
REV-41-1300	✓	X	✓
REV-41-1301	✓	X	✓
MATRIX 14-0001	X	✓	X
MATRIX 14-0009	X	✓	X

<RE10> Servos – A maximum of twelve (12) servos are allowed. Any servo that is compatible with the attached servo controller is allowed. Servos may only be controlled by an allowed Servo Controller.

> Teams should be prepared during *Robot* inspection to show documentation confirming that the servos individually and together on the same servo controller do not exceed the manufacturer specifications for the controller.

Core Servo Controllers and *Legacy TETRIX Servo Controllers* may control up to two (2) VEX EDR 393 Motors per module. A VEX Motor Controller 29 must be used in between a servo module and each VEX EDR 393 motor. The VEX EDR 393 motor is considered a servo and it is subject to the overall total maximum of twelve (12) servos.

<RE11> Sensors - Sensors are subject to the following constraints:

a. Compatible sensors from any manufacturer may be connected to the *Core Device Interface Module*.
b. Passive electronics may be used as recommended by sensor manufactures at the interfaces to the sensors.
c. Voltage sensors are allowed; except on an output port of a motor or servo controller.
d. Current sensors are allowed; except on an output port of a motor or servo controller.
e. Simple I2C multiplexers are allowed and they may only be connected to and powered from the I2C connections available on the *Core Device Interface Module*.
f. *Legacy Sensors* are allowed and must be directly connected to the *Core Legacy Module*.
g. The HiTechnic Touch Sensor Multiplexor (NTX1060) is allowed.
h. The HiTechnic Sensor Multiplexor (NSX2020) is **not** allowed.

<RE12> Light Sources - Light sources (including LEDs) are allowed; these may not be focused or directed in any way (for example: lasers and mirrors are not allowed). Approved light sources may include an internal (as supplied by the manufacturer) battery pack or battery holder. Additional approved power sources for lights are the power ports on the *Core Power Distribution Module*, a motor-control port on the *Core Motor Controller Module,* or a motor controller port on the *Legacy TETRIX DC Motor Controller*.

<RE13> Video Cameras - Video recording devices (GoPro or similar) are allowed providing they are used only for non-functional post-Match entertainment and the wireless capability is turned off. Approved video cameras must be powered by an internal (as supplied by the manufacturer) battery.

<RE14> *Robot* Wiring - *Robot* wiring is constrained as follows:

a. USB Surge Protectors connected to USB cables are allowed.
b. Ferrite chokes (beads) on wires and cables are allowed.
c. Either A *Mini USB to OTG (On-The-Go) Micro Cable* or a *Mini USB adapter* and *OTG (On-The-Go) Micro Cable* is used to connect the *Robot Controller* Android device to the built-in USB input port of the *Core Power Distribution Module*.
d. Stand-alone USB hubs are allowed.
e. Anderson PowerPole, and similar crimp or quick connect style connectors are required to connect downstream electronics with the *Core Power Distribution Module* and are recommended for joining electrical wires throughout the *Robot*. Power distribution splitters are recommended where appropriate to reduce wiring congestion. All connectors and distribution splitters should be appropriately insulated.
f. Installed connectors (such as battery-pack connectors, battery charger connectors, and *Core Power Distribution Module* power input connectors) may be replaced with Anderson PowerPole or any compatible connector.
g. Power and motor control wires must use consistent color coding with different colors used for the Positive (red, white, brown, or black with a stripe) and Negative/Common (black or blue) wires.
h. Wire and cable management products of any type are permitted (e.g. cable ties, cord clips, sleeving, etc.).
i. Wire insulation materials of any type are permitted when used to insulate electrical wires or secure motor control wires to motors (e.g. electrical tape, heat shrink, etc.).
j. Power, motor control, servo, encoder, and sensor wires and their connectors may be extended, modified, custom made, or COTS subject to the following constraints:
    i. Power wires are 16 AWG or larger.
    ii. Motor control wires are 22 AWG or larger.
    iii. PWM (servo) wires are 20 AWG or 22 AWG.
    iv. Sensor wires should be the same size or larger than the original wiring.

Teams should be prepared during *Robot* inspection to show documentation confirming the wire gauges used; particularly for multi-conductor cables.

<RE15> Modifying Electronics - Approved electrical and electronic devices may be modified to make them more usable; they may not be modified internally or in any way that affects their safety.

Examples of modifications that are allowed:

- Shortening or extending wires
- Replacing or adding connectors on wires
- Shortening motor shafts
- Replacing gearboxes and/or changing gears

Examples of modifications that are **not** allowed:

- Replacing an H-Bridge in a motor controller
- Rewinding a motor
- Replacing a fuse with a higher value than specified by the manufacturer
- Shorting out a fuse

<RE16> *Driver Station* Constraints – Teams provide their own *Driver Station* and it must comply with the following constraints:

a. The *Driver's Station* must consist only of:
   i. One (1) Android device
   ii. One (1) OTG Cable
   iii. No more than one (1) non-powered USB hub
   iv. No more than two (2) gamepads
b. The *Driver Station* Android device USB interface may only connect to either:
   i. A Mini *USB to OTG* (On-The-Go) cable or combination of cables connected to an unpowered USB Hub, or
   ii. One (1) gamepad
c. One optional COTS USB external battery connected to the USB Hub to charge the Android device is allowed.
d. The only allowed gamepads are listed below. They may be used in any combination.
   i. Logitech F310 gamepad (Part# 940-00010)
   ii. Xbox 360 Controller for Windows (Part# 52A-00004)
e. The touch display screen of the *Driver Station* must be accessible and visible by competition personnel.
f. The *Driver's Station* Android device must be set to airplane mode, and Bluetooth must be turned off.

Important Note: The *Driver Station* is a wireless device with a built-in wireless radio. During a Match, the *Driver Station* should not be obscured by metal or other material that could block or absorb the radio signals from the *Driver Station*.

<RE17> Additional Electronics – Electronic devices that are not specifically addressed in the preceding rules are not allowed. A partial list of electronics that are not allowed includes: Arduino boards, Raspberry Pi, relays, and custom circuits.

5.3.4 Robot Software Rules

<RS01> Android Device Names - Each *Team* MUST "name" their *Robot Controller* with their official *FIRST* Tech Challenge *Team* number and –RC (e.g. "12345-RC"). Each *Team* MUST "name" their Driver Station with their official *Team* number and –DS (e.g. 12345-DS). Spare Android devices should be named with the *Team* number followed by a hyphen then a letter designation beginning with "B" (e.g. "12345-B-RC", "12345-C-RC").

<RS02> Recommended Programming Language - *Java* is the recommended programming language for the *FIRST* Tech Challenge. Programming must be done using one of the following applications:

a. Android Studio – a text-based integrated development environment.

b. App Inventor – a visual blocks-based programming tool.

c. Java Native Interface (JNI) & Android Native Development Kit (NDK) – teams can incorporate native code libraries into their apps using the JNI framework and the Android NDK.

If mandatory updates are announced by *FIRST* later in the season, *Teams* must install them prior to the time of competition. Additionally, beta versions of the software are allowed at official Tournaments.

IMPORTANT: Rule <RS02> does not require that teams upgrade to the latest version of the software. A mandatory upgrade would only be invoked if *FIRST* determined that there was a critical software fix that has to be adopted by teams. Mandatory upgrades will be communicated in the following ways:

- Via Team Blast – The mandatory upgrade and version number will be communicated to Teams on the Team Blast, which will also show the date that the required upgrade must be made.
- Online – the minimally required software will be listed on our Technology Resources page, along with the date Teams are required to make the mandatory software upgrade.
- Forum – The minimally required software will be listed in the Technology Forum page, along with the date Teams are required to make the mandatory software upgrade.

Templates for all programming choices are available through the links located at http://www.firstinspires.org/node/5181.

<RS03> Allowed Android Operating Systems - The only allowed operating systems for the *Robot* Controller and Driver Station Android devices are:

a. ZTE Speed: 4.4 or higher (Kit Kat)

b. All other Android Devices: 6.0 or higher (Marshmallow)

<RS04> Motionless *Robot* at Start of Match Periods - Immediately prior to the start of the Autonomous Period and during the pause between the end of the Autonomous and the start of the Driver Controlled periods, *Robot*s shall be motionless, with the exception of initialization of positioning for servos. Violations subject the *Robot* to random repositioning by the Head Referee. Repeated violations may be considered egregious behavior and be subject to penalties.

<RS05> Autonomous to Driver-Controlled Transition - During Field Inspection, the *Drive Team* must demonstrate using the *Driver Station* that their *Robot* switches between Autonomous mode and Driver-Controlled mode.

<RS06> *Robot Controller* App - The *Robot Controller* must have a designated "FTC *Robot Controller"* app that is the default application for the *Core Robot modules (Legacy, Servo, Motor, and Device Interface).*

<RS07> *Driver Station* App - Teams must install the official "FTC *Driver Station"* app onto their *Driver Station* Android Device and use this app to control their *Robot* during a Match. The *Driver Station* software version number must match the version number of the *Robot Controller* app.

<RS08> Android Device Operating System Settings - The *Robot Controller* and *Driver Station* must be set to airplane mode, and Bluetooth must be turned off.

<RS09> Wi-Fi Direct Channel Changing App - The *Robot* Controller must have the *FIRST* Tech Challenge "Wi-Fi Direct Channel Changing" App installed (ZTE Speed ONLY).

6.0 *Robot* Inspection

6.1 Overview

This section describes *Robot* Inspection for the *FIRST* Tech Challenge Competition. It also lists the inspection definitions and inspection rules.

6.2 Description

The *FIRST* Tech Challenge *Robot* will be required to pass *Robot* and Field inspections before being cleared to compete. These inspections will ensure that all *Robot* rules and regulations are met. Initial inspections will take place during *Team* check-in/practice time. The official "*Robot* Inspection Checklists" are located in Appendices B and C. **Teams are required to conduct a self-inspection of their *Robot* and submit the completed *Robot* Inspection forms to the *Robot* Inspectors.**

6.3 Definitions

Robot Initialization Routine – A set of programming instructions inserted immediately prior to the Match control loop of the Autonomous or Driver-Controlled programs that serves to ready the *Robot* for a Match.

Robot Sizing Box – A sturdily constructed cube with the interior dimensions: 45.72 cm (18 inches) wide by 45.72 cm (18 inches) long by 45.72 cm (18 inches) high that has one open side with an interior opening size of 45.72 cm (18 inches) wide by 45.72 cm (18 inches) long. The Sizing Box is used for *Robot* Inspection as outlined in Section 6.4.

6.4 Inspection Rules

<I1> Inspection - Every *Robot* will be required to pass a full inspection before being cleared to compete. This inspection ensures that all *FIRST* Tech Challenge *Robot* rules and regulations are met. *Teams* are required to conduct a self-inspection of their *Robot* and submit the completed inspection forms at Tournament check-in or at another designated place.

All *Robot* configurations must be inspected before being used in competition.

a. If significant changes are made to a *Robot* after it has passed the initial inspection, it must be re-inspected before it will be allowed to compete.

b. Referees or inspectors may request the re-inspection of a *Robot*. The *Robot* is not allowed to participate in a Match until it passes re-inspection. Refusal to submit to re-inspection will result in disqualification of the *Team* from the Tournament.

c. Appendices B and C of this manual contain copies of the *Robot* and Field Inspection forms and provide additional information about the inspection process.

d. A *Robot* may be rejected at inspection if, in the judgment of the Lead Inspector, it is unsafe.

<I2> Practice Matches - *FIRST* Tech Challenge *Teams* must submit their *Robot* for inspection prior to participating in practice rounds. At the discretion of the Lead Inspector, the *Robot* may be allowed to participate in practice rounds before passing inspection.

<I3> Qualification Matches - The *Team*'s *Robot* must pass all inspections before participating in *Qualification Matches*. Noncompliance with any *Robot* design, construction rule, or programming requirements may result in disqualification of the *Team* at a *FIRST* Tech Challenge Event.

<I4> Re-Inspection - The *Team* is required to request a re-inspection of their *Robot* by an Inspector when a modification to improve performance or reliability of their *Robot* has been made.

<I5> Safety - It is the Inspector's responsibility to evaluate *Robots* to insure each *Robot* has been designed to operate and function safely. Section 5 and Game Manual Part 2, Section 1.6.1 specify the safety rules and limitations that apply to the design and construction of all *Robots*.

<I6> Passing Inspection - *Robot* inspection is a Pass / Fail process. A *Robot* has passed inspection when ALL requirements listed on the official *FIRST* Tech Challenge "*Robot* and Field Inspection Sheets" have been successfully met and recorded as passed by an Inspector.

<I7> All Mechanisms are Inspected - At the time of Inspection, the *Robot* must be presented with all mechanisms (including all components of each mechanism), configurations, and decorations that will be used on the *Robot* during the competition. It is acceptable for a *Robot* to play Matches with a subset of the mechanisms that were present during inspection. Only mechanisms that were present during Inspection may be added, removed, or reconfigured between Matches. The *Robot* should be assembled in a typical configuration used for Match play when reporting for inspection.

a. *Robot* and all mechanisms must be inspected in every starting configuration.
b. If mechanisms are swapped out between Matches, the reconfigured *Robot* must still meet all *Robot* rules and inspection criteria.
c. The sum total of all electronics (motors, servos, *Core* modules, Android devices, etc.) used in the construction of all of the mechanisms and base *Robot*, whether they are used on the *Robot* at the same time or not, may not exceed the constraints specified in the *Robot* construction rules.

<I8> Wheel/Tread Playing Field Damage Test - *Robot* Inspectors have the authority to request that a *Team* test their wheels/treads that they feel might cause damage to the playing field. Since not every tread or wheel can be evaluated and posted as a legal or illegal part, the tread test is a quick way to determine if a *Team's* wheels/treads are competition legal.

The *Robot* Inspector should place the *Robot* on top of a field tile and against an immovable surface (wall), and run the wheels at full power for 15 seconds. If there is any physical damage to the floor tile, then the wheels will not be allowed. Discoloration or black marks alone are not considered field damage. Remember, the test must be made with the *Robot* at the weight the *Robot* will be at during the Competition since this will affect the degree of damage.

7.0 Judging & Award Criteria

7.1 Overview

This section provides a complete description of all of the *FIRST* Tech Challenge Awards; the judging process, award criteria, Engineering Notebook guidelines, and philosophy that *Teams* need to be aware of in preparation for participating at *FIRST* Tech Challenge Tournaments.

Teams have spent a significant amount of time designing, building, programming their *Robot*, and learning what it takes to be part of a *Team*. For many *Teams*, the Event is the reward for all their hard work throughout the season. While there are several types of Events, they all offer a fun and exciting way for *Teams* to demonstrate the result of their efforts.

The judged awards represent a positive way we recognize *Teams* who embody important values like *Gracious Professionalism*®, Teamwork, creativity, innovation, and the value of the engineering design process. These judging guidelines are a part of the road map to success.

FIRST Tech Challenge judging sessions do not include written or verbal feedback for students. The judging is a subjective process; and students are encouraged to learn the important life skill of self-evaluation. This helps students prepare for professional interviews while developing other real world life skills. For a copy of the *FIRST* Tech Challenge *Team* Judging Session Self-Reflection Sheet please visit the website: http://www.firstinspires.org/node/5226

7.2 FIRST Tech Challenge Award Eligibility

To ensure fairness to all *Teams* and to provide equal opportunity for all *Teams* to win an award at a Tournament, *Teams* are only eligible to win an award at the first three Qualifying Tournaments/League Championships they attend within a Region. A Region is defined as the area that a Championship Tournament serves.

A *Team* may participate in more than three Championship Events within a Super-Region, but they are not eligible for consideration for any Judged Awards at Events beyond their third Championship Tournament. A Super-Region is defined as the area that a Super-Regional Championship Tournament serves.

Those *Teams* who compete in more than three Qualifying Tournaments, League Championships, and Championship Tournaments do so for the purpose of being involved in the fun and excitement of the Tournament and not with the intention of winning awards or advancing to the next Tournament level.

Each season, *Teams* are allowed to win the Inspire Award only once during each Tournament tier (Qualifying Tournament/League Championship, Championship) within a state or region. Once a *Team* wins the Inspire Award at a Qualifying Tournament, they are not eligible for consideration for the Inspire Award and are only eligible to win the other judged or Alliance awards at subsequent Qualifying Tournaments. The same restriction applies to *Teams* attending multiple League Championship Tournaments and Championship Tournaments. Each *Team* is responsible for informing Tournament organizers and judges if they are ineligible for awards or advancement based on these policies. It is the *Team*'s responsibility to let the Tournament Director know if they have already won the Inspire Award at the same level Competition within a region.

7.3 Engineering Notebook

7.3.1 Overview

This section describes the requirements for creating the Engineering Notebook, including formatting guidelines, Judges' tips, and the use of various forms of engineering support. It also provides links for sample pages from an award winning Engineering Notebook.

7.3.2 What is an Engineering Notebook?

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

Throughout the process of building and designing a *Robot*, *Teams* will come across obstacles, lessons learned, and the need to draw things out on paper. This is where *Teams* will use an Engineering Notebook. These notebooks follow the *Team* from kickoff throughout the Competitions. Judges review a *Teams* Engineering Notebook to better understand the journey, design, and *Team* as a whole.

The Engineering Notebook is a complete documentation of the *Team*'s *Robot* design. This documentation should include sketches, discussions and *Team* meetings, design evolution, processes, obstacles, and each *Team* member's thoughts throughout the journey for the entire season. A new notebook should be created for each new season.

Please visit our website for a complete guide on writing and managing a Team Engineering Notebook.
http://www.firstinspires.org/sites/default/files/uploads/resource_library/ftc/engineering-notebook-guidelines.pdf

7.3.3 Engineering Notebook Formats

Teams may choose to record their season with either handwritten or electronic documents. There is no distinction made between handwritten and electronic Engineering Notebooks during judging; each format is equally acceptable.

- Electronic: *Teams* may choose to use electronic programs to create their Engineering Notebook. For the purposes of judging, *Teams* must print out their Engineering Notebooks and place them in a binder, no larger than 3 inches. Only one copy is required per *Team*.
- Handwritten: *Teams* can choose from spiral-bound, laboratory, or documentation notebooks available through their school or local office supply store. *Teams* can also use loose leaf paper and place them in a three ring binder no larger than 3 inches.

7.3.4 Engineering Notebook Requirements

1. Teams may not submit more than two notebooks at a competition.
2. The *Team* Number and *Team* Name must appear on the outside of the Engineering Notebook. Engineering Notebooks will not be considered without this information.
3. Attach a summary page to the front cover of the Engineering Notebook. The summary should be a brief, one-page narrative about the *Team*, the school or organization, and an overview of the highlights of the *Team*'s season. The *Team* summary page should also include the *Team* number and point the Judges to pages in the Engineering Notebook that the *Team* would most like the Judges to consider.
4. The Engineering Notebook must be divided into multiple sections, including:
    a. An Engineering Section that includes the *Robot* design processes.
    b. A *Team* Section that includes information about the *Team* and outreach activities.
    c. A business plan, strategic plan or sustainability plan.

7.3.5 Engineering Notebook Requirements by Award

The chart below provides a quick overview of the Engineering Notebook requirements by Award:

Engineering Notebook Requirements by Award	
Inspire Award	• Engineering Notebook must be submitted, and must include an Engineering Section, a *Team* Section and a Business or Strategic Plan. The entire Engineering Notebook must be high quality, thoughtful, thorough, detailed and well organized.
Think Award	• Engineering Notebook must have an Engineering Section that includes entries describing underlying science, mathematics, and game strategies. • Engineering Notebook must demonstrate that the *Team* has a clear understanding of the engineering design process, with pictures or drawings and details documenting all stages of *Robot* design. • Notebook must recount the *Team's* journey, experience and lessons learned throughout the season.
Connect Award	• An Engineering Notebook must be submitted and must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. The plan could include fundraising goals, sustainability goals, timelines, outreach, and community service goals.
Rockwell Collins Innovate Award	• *Team* must submit an Engineering Notebook with an Engineering Section that documents the design process and how the *Team* arrived at their design solution.
PTC Design Award	• *Team* must submit an Engineering Notebook with an Engineering Section that includes detailed *Robot* design drawings.
Motivate Award	• An Engineering Notebook must be submitted and must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. The plan could include fundraising goals, sustainability goals, timelines, outreach, and community service goals.
Control Award	• The Engineering Notebook must include an Engineering Section that documents the control components.

7.3.6 Notebook Examples

Scanned copies of award-winning Engineering Notebook examples are posted on the *FIRST* website. It is strongly encouraged for *Teams* to look over these as great examples of what the judges will be looking for when reading through the Engineering Notebooks.

7.4 Judging Process, Schedule, and Team Preparation

The schedules at the *FIRST* Tech Challenge Tournaments may vary from site to site. Exact times for both the Matches and meeting with judges cannot be given within this manual. All *Teams* receive the schedule prior to or during check-in at the Competition.

7.4.1 Judging Process

At *FIRST* Tech Challenge Championship Tournaments, there will be three parts to the judging process:

1. Interview with the judges.
2. Evaluation of performance.
3. Evaluation of the Engineering Notebook.

Each *Team* will have an interview with a panel of two or three judges. No awards will be determined on the basis of this interview alone. Judges use the guidelines provided in this section to assess each *Team*.

Teams should present their Engineering Notebooks at the Pit Administration Table during check-in unless otherwise directed by the Tournament officials. The Engineering Notebooks are generally provided to the judges prior to the *Team* interviews.

After the judges review the submitted Engineering Notebooks, complete the initial *Team* interviews and evaluate the *Team* and *Robot* performance during Matches, they convene to review their assessments and create a list of top candidates for the various judged awards. Judges may require additional impromptu discussions with *Teams* if necessary. Deliberations are usually completed during the *Elimination Matches*. When the judges have finished their deliberations, the Engineering Notebooks are returned to *Teams*.

Teams are asked to bring their *Robot* to the judge interview. This is the best chance for *Teams* to explain and demonstrate their *Robot* design to the judges in a quiet and relaxed environment.

7.4.1.1 Feedback to Teams

FIRST Tech Challenge does not permit feedback provided to *Teams* during or after their Interview has taken place at official Tournaments. *FIRST* Tech Challenge judging is a subjective process; the goal is to prepare student *Team* members with real life Interview skills, and to continue to build upon those skills from Event to Event.

FIRST encourages *Teams* to utilize the Self-Reflection Sheet to evaluate themselves through the Interview. This sheet is accessible online. *Teams* should not ask the Judges for feedback after the interview is complete. An essential aspect of *FIRST* Tech Challenge Judging is the subjectivity, and that *FIRST* Tech Challenge encourages students to learn how to self-evaluate. Although it may be that *Teams* are discouraged by this, learning this process is an invaluable life skill.

7.4.2 Judging Schedule

The judging generally takes place in a separate area away from the noise of the Competition and pit. *Teams* follow the schedule that outlines *Team* interview times and locations. In some cases, *Teams* may receive this information in advance, but more often, *Teams* will receive this information when they check-in on the morning of the Event.

Upon arrival, *Teams* should familiarize themselves with where the judging will occur and allow enough time to get there. To keep this process on time throughout the Event, we require that all *Teams* arrive at the judge queuing area five minutes before their scheduled judging interview.

7.4.3 Team Preparation

Teams are strongly encouraged to read and understand the award requirements for each award to assess where they are within an award category and help them establish higher goals. These guidelines are the same ones used by the judges during each Tournament, Super-Regional Championship, and at the *FIRST* Tech Challenge World Championship Tournaments. Please see the Award Categories section of this manual for award requirements, and also look over the Engineering Notebook Requirements by Award to ensure the *Team's* Engineering Notebook meets the required criteria by award.

The judges want to know highlights about the *Team*; its history and make up; what the *Team* achieved during the Competition season; and the experiences that were gained. *Team* representatives' abilities to answer the questions or elaborate on *Robot* design functions or attributes are evaluated during the *Team* interview. Check with the Event organizer to see if Mentors and Coaches are allowed to observe the *Team* interview. Mentors may not contribute to the judging process. Mentors should always keep in mind that the *FIRST* Tech Challenge is a student-centered activity and it is about giving the students a unique and stimulating experience in all aspects of the program.

7.4.4 Video Award Submission Guidelines

The submission process for this award may vary by Tournament. Please check with the Event Director for details. Winning videos will be submitted to *FIRST* and used to promote the higher values of *FIRST* Tech Challenge. *Teams* can also send their Promote videos directly to *FIRST*; however, these submissions will not be formally judged.

- The video must be submitted at least one week prior to Tournament day. Instructions for submitting videos may vary from Tournament to Tournament. Please check with the Event Director for details.
- Videos must be submitted in AVI, WMV or MOV format. Remember that the winning video may be shown on a large screen during the awards ceremony. *Teams* should use the best resolution available for the final version.
- Only one video submission per *Team* will be considered. *Teams* may submit new or updated videos at each Tournament.

7.5 Award Categories

7.5.1 Inspire Award

This judged award is given to the *Team* that truly embodied the 'challenge' of the *FIRST* Tech Challenge program. The *Team* that receives this award is a strong ambassador for *FIRST* programs and a role model *FIRST* Tech Challenge *Team*. This *Team* is a top contender for many other judged awards and is a gracious competitor. The Inspire Award winner is an inspiration to other *Teams*, acting with *Gracious Professionalism*® both on and off the *Playing Field*. This *Team* is able to communicate their experiences, enthusiasm and knowledge to other *Teams*, sponsors, their community, and the Judges. Working as a unit, this *Team* will have demonstrated success in accomplishing the task of designing and building a *Robot*.

Required criteria for the Inspire Award:

- ***Team* must demonstrate respect and *Gracious Professionalism*® toward everyone they encounter at a *FIRST* Tech Challenge Event.**
- ***Team* is a strong contender for several other Judged awards. The Inspire Award celebrates the strongest qualities of all the Judged Awards.**
- **The *Team* is an ambassador for *FIRST* programs and demonstrates and documents their work in their community.**
- ***Team* dynamic is positive and inclusive, and each *Team* member contributes to the success of the *Team*.**
- **Engineering Notebook must be submitted, and must include an Engineering Section, a *Team* Section and a Business or Strategic Plan. The entire Engineering Notebook must be high quality, thoughtful, thorough, detailed and well organized.**
- ***Robot* design is creative and innovative, and the *Robot* performs reliably on the field. *Team***

communicates clearly about their *Robot* design and strategy to the judges.
- ***Team* presentation is professional and engaging.**

7.5.2 *Think Award*

Removing engineering obstacles through creative thinking.

This judged award is given to the *Team* that best reflects the journey the *Team* took as they experienced the engineering design process during the build season. The Engineering Section of the notebook is the key reference for judges to help identify the most deserving *Team*. The ***Team's*** Engineering Section must focus on the design and build stage of the ***Team's*** *Robot*. Journal entries must include those describing the underlying science and mathematics of the *Robot* design and game strategies, the designs, re-designs, successes, and opportunities for improvement. A *Team* is not a candidate for this award if they have not completed the Engineering Section of the Engineering Notebook.

Required criteria for the Think Award:

- ***Team* must demonstrate respect and *Gracious Professionalism*® toward everyone they encounter at a *FIRST* Tech Challenge Event.**
- **Engineering Notebook must have an Engineering Section that includes entries describing underlying science, mathematics, and game strategies.**
- **Engineering Notebook must demonstrate that the *Team* has a clear understanding of the engineering design process, with pictures or drawings and details documenting all stages of *Robot* design.**
- **Notebook must recount the *Team's* journey, experience and lessons learned throughout the season.**

Strongly suggested criteria for the Think Award:

- *Teams* should tab/flag 6 to 8 pages of the Engineering Section to support entries on the summary page.
- Engineering Notebook should be organized and follow the formatting guidelines provided by *FIRST* and include a Summary Page. Note: *Teams* should review the Engineering Notebook section of this manual for a complete description and format specifications.

7.5.3 Connect Award

Connecting the dots between community, *FIRST*, and the diversity of the engineering world.

This judged award is given to the *Team* that most connects with their local science, technology, engineering and math (STEM) community. A true *FIRST Team* is more than a sum of its parts, and recognizes that engaging their local STEM community plays an essential part in their success. The recipient of this award is recognized for helping the community understand *FIRST*, the *FIRST* Tech Challenge, and the *Team* itself. The *Team* that wins the Connect Award aggressively seeks engineers and explores the opportunities available in

the world of engineering, science and technology. This *Team* has a clear Business or Strategic Plan and has identified steps to achieve their goals.

Required criteria for the Connect Award:

- ***Team* must demonstrate respect and *Gracious Professionalism*® toward everyone they encounter at a *FIRST* Tech Challenge Event.**
- **An Engineering Notebook must be submitted and must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. The plan could include fundraising goals, sustainability goals, timelines, outreach, and community service goals.**
- ***Team* provides clear examples of developing in person or virtual connections with individuals in the engineering, science, or technology community.**
- ***Team* actively engages with the engineering community to help them understand *FIRST*, the *FIRST* Tech Challenge, and the *Team* itself.**

7.5.4 Rockwell Collins Innovate Award

Bringing great ideas from concept to reality.

The Rockwell Collins Innovate Award celebrates a *Team* that not only thinks outside the box, but also has the ingenuity and inventiveness to make their designs come to life. This judged award is given to the *Team* that has the most innovative and creative *Robot* design solution to any or all specific field elements or components in the *FIRST* Tech Challenge game. Elements of this award include elegant design, robustness, and 'out of the box' thinking related to design. This award may address the design of the whole *Robot*, or of a sub-assembly attached to the *Robot*. The creative component must work consistently, but a *Robot* does not have to work all the time during Matches to be considered for this award. The *Team's* Engineering Notebook should be marked with journal entries to show the design of the component(s) and the *Team's Robot* in order to be eligible for this award, and entries should describe succinctly how the *Team* arrived at that solution.

Required criteria for the Rockwell Collins Innovate Award:

- ***Team* must demonstrate respect and *Gracious Professionalism*® towards everyone they encounter at a *FIRST* Tech Challenge Event.**
- ***Team* must submit an Engineering Notebook with an Engineering Section that documents the design process and how the *Team* arrived at their design solution.**
- ***Robot* or *Robot* sub-assembly must be elegant and unique in its design.**
- **Creative component must be stable, robust, and work reliably.**
- ***Robot* design is efficient and consistent with *Team* plan and strategy.**

7.5.5 PTC Design Award

Industrial design at its best.

This judged award recognizes design elements of the *Robot* that are both functional and aesthetic. All successful *Robots* have innovative design aspects; however, the PTC Design Award is presented to *Teams* that incorporate industrial design elements into their solution. These design elements could simplify the *Robot's* appearance by giving it a clean look, be decorative in nature, or otherwise express the creativity of the *Team*. The winning design should not compromise the practical operation of the *Robot* but complement its purpose. This award is sponsored by Parametric Technology Corporation (PTC), developers of the CAD tools,

Creo and Mathcad. PTC gives licenses to the *FIRST* Tech Challenge student *Teams* for these software products to help them with their designs.

Required criteria for the PTC Design Award:

- ***Team* must demonstrate respect and *Gracious Professionalism*® toward everyone they encounter at a *FIRST* Tech Challenge Event.**
- ***Team* must submit an Engineering Notebook with an Engineering Section that includes detailed *Robot* design drawings.**
- ***Team* demonstrates industrial design principles, striking a balance between form, function, and aesthetics.**
- ***Robot* differentiates itself from others by its aesthetic and functional design.**
- **Basis for the design is well considered (i.e. inspiration, function, etc.).**
- **Use of PTC's Creo is not required to be eligible; however, *Teams* that use them in their design are given extra consideration for this award.**

7.5.6 Motivate Award

Sparking others to embrace the culture of *FIRST*!

This *Team* embraces the culture of *FIRST* and clearly demonstrates what it means to be a Team. This judged award celebrates the *Team* that exemplifies the essence of the *FIRST* Tech Challenge competition through *Team* building, *Team* spirit and exhibited enthusiasm. This is a *Team* who makes a collective effort to make *FIRST* known throughout their school and community, and sparks others to embrace the culture of *FIRST*.

Required criteria for the Motivate Award:

- ***Team* must demonstrate respect and *Gracious Professionalism*® toward everyone they encounter at a *FIRST* Tech Challenge Event.**
- **An Engineering Notebook must be submitted and must include a Business or Strategic plan that identifies their future goals and the steps they will take to reach those goals. The plan could include fundraising goals, sustainability goals, timelines, outreach, and community service goals.**
- **The *Team* is an ambassador for *FIRST* programs.**
- ***Team* can clearly demonstrate the successful recruitment of new *Teams*, mentors, coaches and volunteers who are not otherwise active within the STEM community.**
- ***Team* can articulate the individual contributions of each *Team* member, and how these attribute to the overall success of the *Team*.**

Strongly suggested criteria for the Motivate Award:

- All *Team* members participate in their presentation, and actively engage with the judges.
- *Team* shows a creative approach to materials that market the *Team* and *FIRST*.

7.5.7 Control Award

Mastering *Robot* intelligence.

The Control Award celebrates a *Team* that uses sensors and software to enhance the *Robot's* functionality on the field. This award is given to the *Team* that demonstrates innovative thinking in the control system to solve game challenges such as autonomous operation, enhancing mechanical systems with intelligent control, or using sensors to achieve better results on the field. The control component should work consistently on the field. The *Team's* Engineering Notebook must contain details about the implementation of the software, sensors, and mechanical control.

Required criteria for the Control Award:

- ***Team* must demonstrate respect and Gracious Professionalism toward everyone they encounter at a *FIRST* Tech Challenge Event.**
- ***Team* must apply for the Control Award by filling out the Control Award Content Sheet, located in Appendix D.**
- **The Engineering Notebook must include an Engineering Section that documents the control components.**
- **Control Components must enhance the functionality of the *Robot* on the *Playing Field*.**

Strongly suggested criteria for the Control Award:

- Advanced software techniques and algorithms are encouraged.
- Control Components should work reliably.

7.5.8 Promote Award (Optional)

This judged award is optional and may not be given at all Tournaments. Please contact your Tournament director to determine if it will be given at an Event you attend.

The Promote Award is given to the *Team* that is most successful in creating a compelling video message for the public designed to change our culture and celebrate science, technology, engineering and math. *Teams* must submit a one-minute long public service announcement (PSA) video based on the PSA subject for the season.

Teams may win the Promote Award only once at a Championship level Event and only once at a qualifying level Event.

PSA Subject for 2016 – 2017 Season:

"This is how I plan to pay *FIRST* forward…"

Required criteria for the Promote Award:

- **Video must meet the following criteria:**
  - **Video cannot be longer than 60 seconds.**
  - **Video must be of a high quality, as submissions may be used at a later time to promote *FIRST*.**
  - ***Team* must have rights to music used in the video.**
  - **Video must have strong production value.**

  - **Video must be submitted by the designated deadline.**
- ***Team* must present a thoughtful and impactful video which appeals to the general public.**
- **Creativity in interpreting the annually assigned theme is required.**
- **Follow video award submission guidelines.**

7.5.9 Compass Award (Optional)

A beacon and leader in the journey of the *FIRST* Tech Challenge.

The Compass Award recognizes an adult Coach or Mentor who has provided outstanding guidance and support for a *Team* throughout the year, and demonstrates to the *Team* what it means to be a Gracious Professional. The winner of the Compass Award will be determined from candidates nominated by *FIRST* Tech Challenge *Team* members, via a 40-60 second video submission, highlighting how their Mentor has helped them become an inspirational *Team*. We want to hear what sets the Mentor apart.

Required criteria for the Compass Award:

- **Video must meet the following criteria:**
  - **Video cannot be longer than 60 seconds.**
  - **Video must be of a high quality, as submissions may be used at a later time to promote *FIRST*.**
  - ***Team* must have rights to music used in the video.**
  - **Video must be submitted by the designated deadline.**
- **Video highlights the mentor's contribution to the *Team* and demonstrates what sets the mentor apart.**
- **Follow video award submission guidelines.**

7.5.10 Judges' Award

During the course of the competition, the judging panel may encounter a *Team* whose unique efforts, performance or dynamics merit recognition, yet doesn't fit into any of the existing award categories. To recognize these unique *Teams*, *FIRST* offers a customizable Judges Award. The judging panel may select a *Team* to be honored, as well as the name of the Judges' Award. The Judges Award recognizes a *Team* for their outstanding efforts, but does not factor into the Advancement Criteria.

7.5.11 Winning Alliance Award

This award will be given to the winning alliance represented in the final Match.

7.5.12 Finalist Alliance Award

This award will be given to the finalist alliance represented in the final Match.

8.0 *FIRST*® Tech Challenge Dean's List

In an effort to recognize the leadership and dedication of *FIRST's* most outstanding *FIRST* Tech Challenge students, the Kamen family sponsors an Award for selected top students known as the *FIRST* Dean's List. Since its introduction in 2010, the *FIRST* Dean's List Award has attracted the attention of prestigious colleges and universities who desire to recruit *FIRST* Dean's List students. Similar to the very prestigious National Merit Scholarship Award winners, there are three (3) "categories" of *FIRST* Dean's List Award students:

1. ***FIRST* Dean's List Semi-Finalists**
    - *FIRST* Dean's List Semi-Finalists are the students nominated by each *Team* to compete for the *FIRST* Dean's List Finalist spots.
2. ***FIRST* Dean's List Finalists**
    - The students selected to be recognized at each State/Regions Championship that are in the running for the *FIRST* Dean's List Winner spots.
3. ***FIRST* Dean's List Winners**
    - The group of 10 students who are the final selection for the Dean's List Award at the *FIRST* World Championship.

Each *FIRST* Tech Challenge *Team* is invited to select up to two (2) students who are in the 10th or 11th grade (sophomores or juniors) as *FIRST* Dean's List Semi-Finalists. The students who earn *FIRST* Dean's List Award status as a Semi-Finalists, Finalist or Winner, are great examples of student leaders who have led their *Teams* and communities to increased awareness for *FIRST* and its mission. These students have also achieved personal technical expertise and accomplishment. It is the intention of *FIRST* that these individuals will continue on, post-Award, as great leaders, student alumni, and advocates of *FIRST*.

Prestigious colleges have expressed great interest in meeting *FIRST* Dean's List's Award winners and *FIRST* hopes that each *Team* will take advantage of the opportunity to nominate the most qualified students as *FIRST* Dean's List Nominees!

For more information on the Dean's List Award, and to see past *FIRST* Tech Challenge winners, please visit our website! http://www.firstinspires.org/*Robot*ics/ftc/deans-list

8.1 Eligibility

Every registered *Team* in North America can submit up to two (2) students as *FIRST* Dean's List Award Semi-Finalists.

- Students must be a sophomore (grade 10) or junior (grade 11) to be eligible for this Award.
- The Coach or Mentor nominating the student(s) must submit an essay explaining why the student should receive this Award. The essay must be 4,000 characters or less.

8.2 Criteria

Criteria for selection of the *FIRST* Dean's List shall include, but not be limited to a student's:

- Demonstrated leadership and commitment to the ideals of *FIRST;*
- Interest in and passion for a long term commitment to *FIRST* and its ideals;
- Overall individual contribution to their *Team*;

- Technical expertise and passion;
- Entrepreneurship and creativity;
- Ability to motivate and lead fellow *Team* members; and
- Ability to effectively increase awareness of *FIRST* in their school and community.

The Mentor or Coach, who is not related to either of the students chosen as the team's Dean's List Semi-finalists, should gather the required information in order for the student *Team* member to interview for the *FIRST* Dean's List Finalist designation at one (1) Qualifying Event, League Championship or Interview Only Event. Applications will require:

- Nominee name
- Nominee Grade
- Nominee GPA
- Qualifying Event for the Dean's List Interview to Take Place
- Nomination essay of no more than 4,000 characters
- Photo of Semi-Finalist (optional)

A photograph of the *FIRST* Dean's List Semi-Finalist is encouraged, but optional. Coaches can submit up to three photos of the student, and *FIRST* encourages at least one of the photos to be a head shot of the student. The essay submission and such photos may be used, in promotion of the recipient and/or the Award, at the discretion of *FIRST*.

8.3 Dean's List Nominations

There are specific instructions on how to submit Dean's List Nominations. The Dean's List Submission Guide has been created for Coaches and Mentors looking to submit a student for the Dean's List Award. Please visit our website for a copy of the Guide, which provides in depth information about the Dean's List, and step by step visual aids to complete the nominations.

2016-2017 *FIRST*® Tech Challenge

Game Manual Part 1

Appendices

Appendix A – Resources

Game Forum Q&A

http://ftcforum.usfirst.org/forum.php

Anyone may view questions and answers within the *FIRST*® Tech Challenge Game Q&A forum without a password. In order to submit a new question, you must have a unique Q&A System User Name and Password for your team.

FIRST Tech Challenge Game Manuals

Part 1 and 2 - http://www.firstinspires.org/node/4271

FIRST® Headquarters Support

Phone: 603-666-3906

Email: FTCTeams@firstinspires.org

FIRST Website: firstinspires.org

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

FIRST Tech Challenge Volunteer Resources – To access public Volunteer Manuals.

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

FIRST Tech Challenge Social Media

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

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

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

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

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

FIRST Tech Challenge Google+ community - If you are on Google+, follow the *FIRST* Tech Challenge community for news updates.

Feedback

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

Appendix B – Robot Inspection Checklist

Team Number: _____ Robot Inspection Status (circle): **PASS / FAIL**

✓	**Robot Size Inspection**	**Rule #**
	Robot is presented at inspection with all mechanisms (including all components of each mechanism), configurations, and decorations that will be used on the Robot during the competition.	<I7>
	Separately test the Robot in all of its unique starting (pre-match setup) configurations. The Robot fits within the Sizing Box without exerting undue force on the sizing box sides and top.	<RG02>
	Robot Motion Warning Label is attached if servo motors move during the Robot initialization.	<RG02>b
✓	**General Robot Rules**	**Rule #**
	Robot does not contain any components that could damage the Playing Field or other Robots.	<RG01>a&b
	Robot does not contain materials that are hazardous.	<RG01>c
	Robot poses no obvious unnecessary risk of entanglement.	<RG01>d
	Robot does not contain sharp edges or corners.	<RG01>e
	Robot does not contain animal-based, liquid, or gel materials.	<RG01>f&g
	Robot does not contain materials that would cause a delay of game if released.	<RG01>h
	Robot does not contain elements that are designed to electrically ground the Robot frame to the Playing Field.	<RG01>i
	Robot does not contain pneumatics.	<RG01>j
	Robot Controller is accessible and visible by competition personnel.	<RG03>
	Alliance Flag Holder is present and adequately holds the Flag during normal Robot operation.	<RG04>
	Team number is visible from at least 2 sides (180 deg. apart). Numerals must be at least 6.35 cm high (2.5 inches), at least in 1.27 cm (0.5 inches) stroke width.	<RG05>
	Energy used by the Robot, (i.e., stored at the start of a Match), shall come only from approved sources.	<RG06>
	Robot is not capable of launching its own components.	<RG07>
	Team understands that Robots may not launch a Game Element more than a distance of 4.88 m (16 ft.) in the air or more than 1.83 m (6 ft.) high. [Teams are not required to demonstrate compliance during the routine Robot Inspection that occurs before the Qualification Matches.]	<RG08>
✓	**Robot Mechanical Parts and Materials Rules**	**Rule #**
	All components on the Robot are from allowable raw materials and Commercial Off The Shelf products.	<RM01> <RM02>
✓	**Robot Electrical Parts and Materials Rules**	**Rule #**
	Separate Main Power Switch OR Core Power Distribution Module Switch (if used as main power switch) is installed properly, labeled, and readily accessible and visible to competition personnel.	<RE01>
	All batteries are securely attached to the Robot in a location where they will not make direct contact with other Robots or the Playing Field.	<RE02>
	Exactly one (1) Robot Main Battery Pack of an approved type is on the Robot and it is properly connected to the Core Power Distribution Module.	<RE03>
	Where present, fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications.	<RE04>
	Allowed electronic devices are only powered by power ports on the Core Power Distribution Module except for: Core Power Distribution Module, allowed sensors connected to the Core Device Interface Module and the Core Legacy Module, light sources, and allowed video cameras. The Robot Controller is only powered by its internal battery.	<RE05>
	Robot uses exactly one (1) of the following Android devices as its Robot Controller: ZTE Speed, Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Google Nexus 5, or Samsung	<RE06>

	Galaxy S5. The Android device's USB interface only connects to the Core Power Distribution Module.	
	Exactly one (1) Core Power Distribution Module is mounted on the Robot.	<RE07>a
	No more than two (2) Core Device Interface Modules are mounted on the Robot.	<RE07>b
	No more than two (2) Core Legacy Modules are mounted on the Robot.	<RE07>c
	No more than two (2) Legacy MATRIX DC Motor/Servo Controllers (unified module) are allowed.	<RE07>e
	Either a combination of Modern Robotics and Legacy HiTechnic motor and servo controllers (any combination), OR Legacy MATRIX motor and servo controllers (no more than two) are mounted on the Robot.	<RE08>
	Robot contains a no more than eight (8) DC motors of the allowed models and they are compatible with the attached Motor Controller and Robot Main Battery.	<RE09>
	Robot contains no more than twelve (12) servos. They must be compatible with the attached servo controller and not exceed the manufacturer specifications for the controller.	<RE10>
	Robot contains only allowed sensors and they are connected only to the Core Device Interface Module, Core Legacy Module, or compatible simple I2C multiplexers that are connected to the Core Device Interface Module.	<RE11>
	Light sources (including LEDs) are not focused or directed in any way and they are powered by allowed methods.	<RE12>
	Video recording devices, if used, are powered by an internal battery and their wireless communication capability is turned off.	<RE13>
	Power and motor control wires must use consistent color coding with different colors used for the Positive (red, white, brown, or black with a stripe) and Negative/Common (black or blue) wires.	<RE14>g
	Power, motor control, servo and encoder wires are the correct size.	<RE14>j
	Approved electrical and electronic devices may be modified to make them more usable; they may not be modified internally or in any way that affects their safety.	<RE15>
✓	**Wheel/Tread Playing Field Damage Test Performed at the Discretion of the Inspector**	**Rule #**
	Robot did not damage the Playing Field tile. [This is an optional test that is performed only when an Inspector believes that the drivetrain tread may damage a Playing Field tile.]	<I8>

General Comments or Reason(s) for Failure (if any):

I hereby state that all of the above is true, and to the best of my knowledge all Robot construction rules and regulations of the *FIRST*® Tech Challenge have been abided by.

Robot Inspector

Team Student Representative

Appendix C – Field Inspection Checklist

Team Number: _____ Field Inspection Status (circle): **PASS / FAIL**

✓		**Drive Team Members Present**	**Rule #**
		Coach	<T8>
		Driver 1 (required); Driver 2 (optional)	<T8>
✓		**Driver Station Hardware Rules**	**Rule #**
		Driver Station consists only of one Android device (ZTE Speed, Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Google Nexus 5, or Samsung Galaxy S5).	<RE06> <RE16>
		Driver Station Android device USB interface is only connected to either a Mini USB to OTG cable or combination of cables connected to an unpowered USB Hub, or One (1) gamepad.	<RE16>b
		No more than one (1) optional Commercial Off The Shelf USB external battery connected to the USB hub is allowed.	<RE06>d <RE16>c
		The Driver Station consists of no more than two of the allowed gamepads (Logitech F310 or Xbox 360 in any combination).	<RE16>d
		The touch display screen of the Driver Station must be accessible and visible to field personnel.	<RE16>e
DS	**RC**	**Driver Station (DS) and Robot Controller (RC) Software Rules**	**Rule #**
		Android device is named with the official Team number followed by –DS or –RC as appropriate.	<RS01>
		Android operating system satisfies the requirements: ZTE Speed – version 4.4 or higher or all other allowed Android devices – version 6.0 or higher.	<RS03>
		The Android device is set to airplane mode, and Bluetooth is turned off.	<RE16>f <RS08>
		Android Wi-Fi Direct device name does not include a newline character in the name.	
		Robot is not connected to any local networks.	
		All remembered Wi-Fi Direct Groups have been removed.	
	NA	Driver Station uses the official FTC Driver Station app to control the Robot.	<RS07>
NA		The FTC controller app is the default application, the application launches, and no other messages pop up.	<RS06>
NA		The FTC Wi-Fi Direct Channel Changing App is installed on the Robot Controller (for ZTE Speed devices only).	<RS09>
NA		Robot Controller is set to the correct Wi-Fi Direct channel (if required by the tournament, ZTE Speed, Motorola Moto G 2nd Generation, and Motorola Moto G 3rd Generation only).	<T6>
✓		**Robot Operation Verified at the Playing Field**	**Rule #**
		Robot Controller connects with the Driver Station.	
		Robot is motionless prior to the start of the Autonomous and Driver-Controlled periods.	<RS04>
		Robot switches between Autonomous and Driver-Controlled operation correctly.	<RS05>
		Robot starts and stops when commanded by the Driver Station.	
		The Stop Button, when pressed on the Driver Station, functions and stops the Robot.	
		The Team understands how to disable their Robot, if instructed to do so by a Referee.	
✓		**Queuing Process Information Provided at the Playing Field**	**Rule #**
		Team understands that software changes are not allowed in the Queue Area.	
		Team understands that the Match schedule is only an estimate. Matches may start prior to or after the scheduled time. It is the Team's responsibility to monitor schedule changes and show up when required.	
		Team knows where to receive alliance flags and where to return them after the Match.	

General Comments or Reason(s) for Failure (if any):

I hereby state that all of the above is true, and to the best of my knowledge all software, Driver Station and Robot Controller rules of the *FIRST*® Tech Challenge have been abided by.

Field Inspector

Team Student Representative

Appendix D – Control Award Content Sheet & Instructions

To be considered for the Control Award, Teams must submit a Control Award Submission Form. On this form, Teams identify and summarize the key control elements that make their robot unique. Included is a description of key observable actions for Judges to look for as well as the sensor and algorithm use that make it all possible. Judges will use this form for both evaluating control designs and when observing robots on the competition field. Information on this form will typically fit on one page, with an additional page for each autonomous mode described. Optionally, additional summary pages may be added at the end to help the judges understand key developmental activity.

Autonomous Objectives
List the overall actions that the robot is capable of completing. These should include scoring actions as well as other positioning and defensive operations. The robot does not have to do accomplish all these in every program, but should be demonstrable in at least one autonomous program.

Sensors Used
List the sensors used to control the robot and a brief description of how they are used.

Key Algorithms
List the key algorithms that make your robot unique or are vital to its success on the field. Particularly complex or unique algorithms or those that integrate the use of multiple sensors are good candidates to highlight here.

Driver Controlled Enhancements
List any advanced control elements that are used during the driver controlled period to enhance performance. These may include signaling operations when a certain condition is detected on the field, auto-complete functions, fail-safe algorithms, or just any enhancements that make the control of the robot easier or more efficient for the driver.

Engineering Notebook References
Judges also use the *Teams* Engineering Notebook to evaluate details of the Control elements. To help guide this effort, Teams should provide pointers to where in the Engineering Notebook control related information is located.

Some things to consider including as pointers are: Team goals for control activities, strategies for autonomous mode, robot performance with and without added sensors, requirements for successful autonomous operation, performance improvements using algorithms and sensors, and testing results.

Autonomous Program Diagrams
For autonomous operations, Teams should draw and label a typical path the robot takes. The labeled points identify key observable actions the robot makes. For each labeled point, a brief description of what is taking place should be noted (see example below). Especially describe those key operations where adjustments are made to ensure accurate and repeatable performance.

For Teams with multiple autonomous programs, it is not necessary to document every program on a separate sheet. It is sufficient document the most commonly used or complex programs and note variances for the rest.

Additional Summary Information (optional)
For those Teams that have developed many different control features, they may want to provide additional information to assist the judges in understanding their work. This is a place where Teams can provide more detailed information about their designs. It should be organized such that separate topics are easily identified and can be quickly found.

Control Award Submission Form

****Please turn in this sheet during your Judge Interview along with your Engineering Notebook****

Team #	Team Name:

Autonomous objectives:

Sensors used:

Key algorithms:

Driver controlled enhancements:

Engineering notebook references:

Autonomous program diagrams:

