FIRST® Tech Challenge
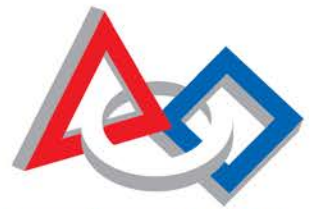# PushBot Build Guide
Part I: Getting Started

Volunteer Thank You

Thank you for taking the time to volunteer for a FIRST Tech Challenge Event. FIRST and FTC rely heavily on Volunteers to ensure Events run smoothly and are a fun experience for Teams and their families, which could not happen without people like you. With over 4,500 Teams competing annually, your dedication and commitment are paramount to the success of each Event and the FTC 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!

Official Program Sponsor

CAD and Collaboration Sponsor

FOR INSPIRATION AND RECOGNITION OF SCIENCE AND TECHNOLOGY

Revision History		
Revision	**Date**	**Description**
1	8/15/2014	Initial Release – by FTC Team #003 Australia, The Southport School
2	9/1/2014	Replaced MATRIX with TETRIX content by former FTC Team #2843, Under the Son
3	8/6/2015	Updated using the new kit of parts and new programming environment.

Contents

Introduction

What is the 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 Robots 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 Lexan 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:

> *FTC 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 FTC and other *FIRST* Robotics competitions, visit www.usfirst.org.

FIRST Tech Challenge (FTC) Core Values

FIRST asks everyone who participates in FTC to uphold and promote 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 the *FIRST* Tech Challenge.
- We inspire others to adopt these values.

What is the *FIRST* Tech Challenge PushBot Build Guide?

In early 2014, a design challenge was set by *FIRST* for experienced FTC Teams to design a basic Robot and manual for Rookie FTC Teams. The Robot and manual had to provide Rookie Teams with simple, basic instructions and images for building a PushBot that can be successful in competition for any Game Challenge.

PushBot 2 (PB2) needs to meet all FTC Competition guidelines using the current Game Manual and Forum rules, but using ONLY the Competition Kit of Parts and materials.

As part of the task, the PushBot needed to have basic programming for autonomous mode; as well as a program for manual mode. The code was to be developed in the Java programming language and deployed using the Android Studio IDE.

Depending on the Team size and student interests, some sections of this manual can be done in parallel. One group can build the Robot, while another group is installing the software, and a third group can build the electronics test bench. The efforts of these groups would come together during the wiring and testing portion.

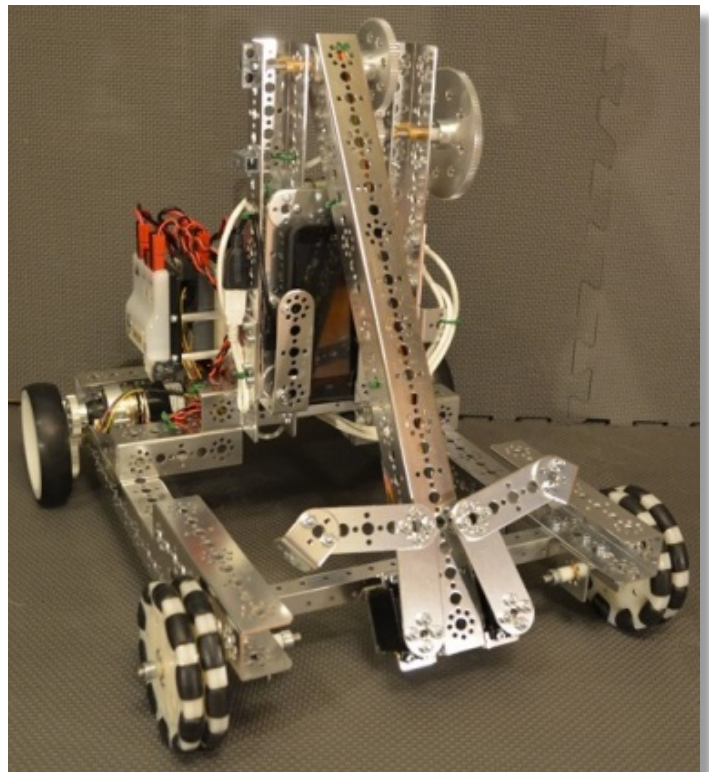### FTC Team #2843 United States – PushBot Robot.
2015 – 2016 Robot Name: PB2 (PushBot 2)

Purpose: Assist new FTC competitors to develop a sense of how an FTC Robot is constructed with the TETRIX Robotic Construction system and is programmed in Java.

Design: The PushBot has 3 DC motors and 2 servos. Its design is based around a rectangular frame. This allows structural engineering principles to be explored by Teams. The Robot has an 'arm' powered by a single DC motor, a 'hand' that is driven by two servos, and 'feet' powered by two DC motors. The 'arm' is geared down to allow the DC motor to lift heavier objects. PB2 has high clearance for driving over objects. PB2 can push objects using its gripper or a front panel can be installed to 'push' objects. This Guide will assist rookie FTC competitors in gaining an understanding of how a simple Robot built with the TETRIX Construction System can be programmed in Java. It will also guide Teams through using the new electronics available in the 2015-2016 season.

The Robot is constructed with the TETRIX Kit of Parts and an electronics kit, which includes cell phones as the communication devices and other USB devices that provide communication with new USB modules.

A link to the TETRIX Kit of Parts description is available on the [FTC Team Resources webpage](#).

Gracious Professionalism^{TM}

FIRST uses this term to describe the program's 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 everyone 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 sharing information and resources with other Teams whenever possible.**

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*

FIRST 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.

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.

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

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.usfirst.org/aboutus/youth-protection-program

Information on the US Screening process is available here: http://www.usfirst.org/sites/default/files/uploadedFiles/About_Us/US-Youth-Protection-Clearance-Process.pdf

Information on the Canadian Screening process is available here: http://www.usfirst.org/sites/default/files/uploadedFiles/About_Us/Canadian-Youth-Protection-Clearance.pdf

You can find FAQ and additional information about the *FIRST* Youth Protection Program on the FIRST website at: http://www.usfirst.org/aboutus/youth-protection-program
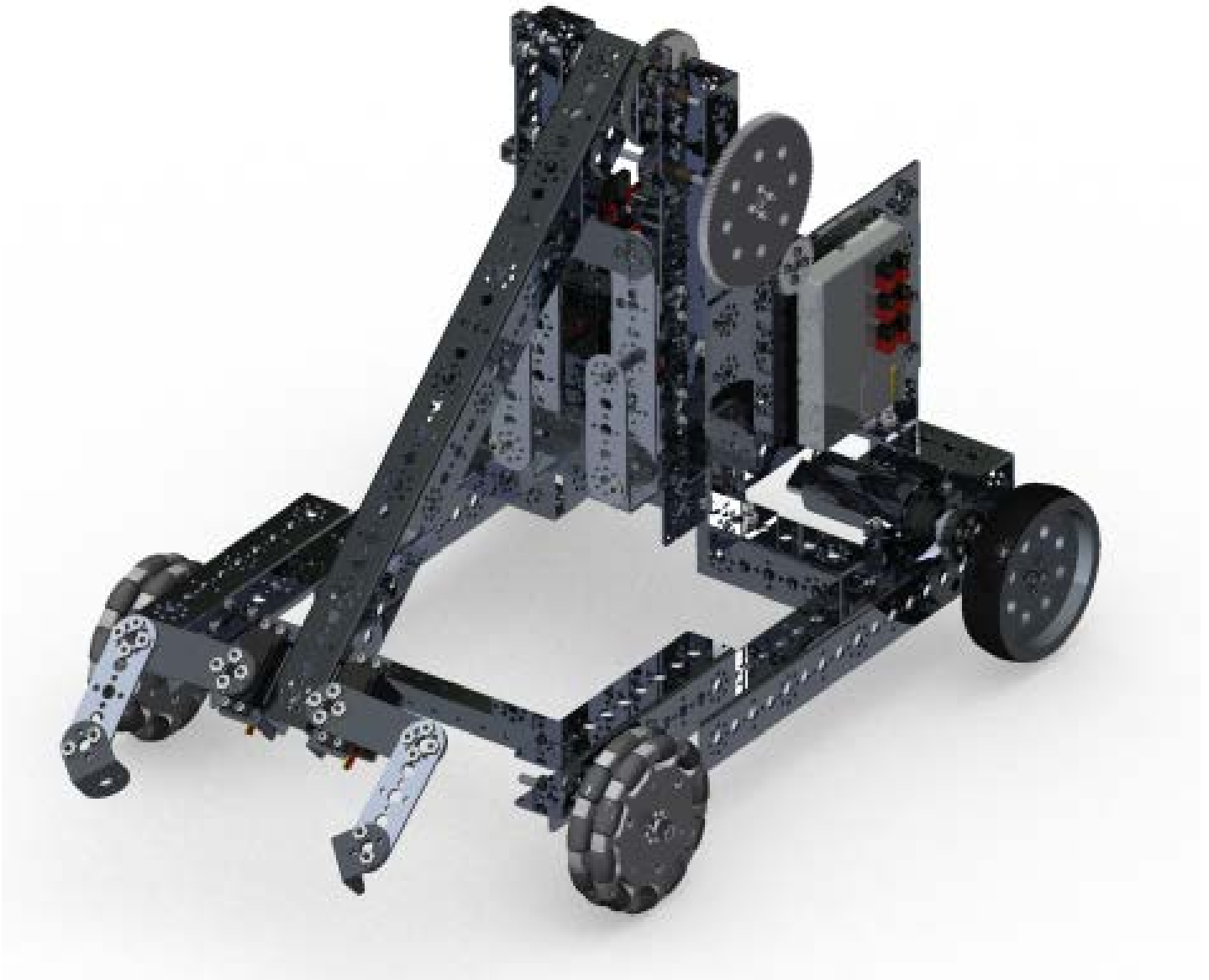
NOTICE OF NON-DISCRIMINATION
United States Foundation for Inspiration and Recognition of Science and Technology (*FIRST*®) does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Lee Doucette, Youth Protection Program Manager, 200 Bedford Street, Manchester, NH 03101, 603-666-3906, Ext. 250.

Getting Started

This section of the PushBot Build Guide includes the Robot CAD Drawing and Appendices, including the Bill of Materials, for easy reference.

Robot CAD Drawing

FIRST® Tech Challenge
Mentor Manual

Appendices

Appendix A: Bill of Materials List

This list does not include the cell phones and the cables that connect the electronics.

Quantity	Name	Common Name
2	CORE_MOTOR_CONTROLLER	Core Motor Controller
1	CORE_POWER_DISTRIBUTION_MODULE	Core Power Distribution Module
1	CORE_SERVO_CONTROLLER	Core Servo Controller
12	SCREW_SHCS_6-32_X_1_25_2011	Gear Hub Screw
1	TETRIX_731901_120_2013	120-Tooth Gear
3	TETRIX_731903_2012	Motor Power Wire
2	TETRIX_736466_2012	4" Dual Omni Wheel Assembly
2	TETRIX_738000_2012	Motor Encoder
2	TETRIX_738009_BATPACK_BRKT_2013	Battery Clip
4	TETRIX_739028_2012	40-Tooth Gear
2	TETRIX_739055_2012	4" Wheel
1	TETRIX_739057_2012	Battery Pack
2	TETRIX_739060_2012	Single Standard Scale Servo Bracket
5	TETRIX_739061_2012	Flat Bracket
3	TETRIX_739062_2012	L Bracket
2	TETRIX_739065_2012	32mm Channel
4	TETRIX_739066_2012	96mm Channel
4	TETRIX_739067_2012	160m Channel
4	TETRIX_739068_2012	288mm Channel
1	TETRIX_739069_2012	416mm Channel
1	TETRIX_739071_2012	288mm Angle
1	TETRIX_739072_2012	144mm Angle
3	TETRIX_739073_2012	Flat Building Plage
3	TETRIX_739079_2012	Motor Hub
3	TETRIX_739083_2012	TETRIX DC Motor
3	TETRIX_739086_2012	80-Tooth Gear
6	TETRIX_739088_2013	Axel
3	TETRIX_739089_2012	DC Motor Mount
3	TETRIX_739090_2012	Gear Hub Spacer
17	TETRIX_739091_2013	Bronze Bushing
6	TETRIX_739092_ 2012	Axel Collar
162	TETRIX_739094_2013	Kep Nut
64	TETRIX_739097_2013	1/2" Socket Head Cap Screw
86	TETRIX_739098_2012	5/16" Socket Head Cap Screw
11	TETRIX_739100_2012	1/8" Axel Spacer
3	TETRIX_739101_2012	3/8" Axel Spacer
6	TETRIX_739102_2012	1" Stand-off
4	TETRIX_739107_2013	32mm Stand-off
42	TETRIX_739111_2012	Button Head Cap Screw
2	TETRIX_739120_2012	Hard Point Connector
5	TETRIX_739172_ 2012	Axel Hub
6	TETRIX_739195_2012	Motor Mount Screw
2	TETRIX_739197_ 2012	Standard-Scale HS-485HB Servo Motor
2	TETRIX_739270_2013	Inside C Connector

3	TETRIX_739272_2013	160mm Flat
4	TETRIX_739273_2013	96mm Flat
4	TETRIX_739281_CORNER_BRA_2013	Inside Corner Bracket
1	TETRIX_739387_2013	2mm Spacer
2	39081	Servo Extension Wire

Appendix B: References

The right to use any unnumbered quoted text in this document has been graciously given by *FIRST* for use in this document. It may not be used outside of this document with the consent of *FIRST*.

Appendix C: Project Team Profiles

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<tr>
<td></td>
<td>Isa
Year 9 student at Great Mills High School.
Student for 1 year on Team #2843, Under the Son</td>
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<tr>
<td></td>
<td>Alanis
Year 9 student at Great Mills High School.
Student for 1 year on Team #2843, Under the Son</td>
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<td>Nanette
Year 7 student at Esperanza Middle School.
Student for 1 year on Team #2843, Under the Son</td>
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<tr>
<td></td>
<td>Laura
Year 9 student at Leonardtown High School.
Student for 7 years on Team #2843, Under the Son</td>
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	Mary Year 12 student at Leonardtown High School. Student for 7 years on Team #2843, Under the Son Volunteer for 7 years, MD FIRST
	Claudia Mentor for 1 year on Team #2843, Under the Son
	Lydean Coach for 7 years on Team #2843, Under the Son Volunteer for 7 years, MD *FIRST* ssi@the-spanglers.net
	David Mentor for 7 years on Team #2843, Under the Son Volunteer for 7 years, MD *FIRST* ssi@the-spanglers.net

Appendix D: Resources & Support

FTC Game Manuals – Part I and II - *http://www.usfirst.org/roboticsprograms/ftc/Game*

FIRST Headquarters Support
> Phone: 603-666-3906 or toll free 800-871-8326
> Email: FTCTeams@usfirst.org

USFIRST.ORG
> *FIRST* Tech Challenge (FTC) Webpage – For everything FTC.
> FTC Season Timeline – Find FTC Events in your area.
> FTC Forum – to ask questions about the annual game challenge and participate in information sharing.
> *FIRST* Championship Conferences webpage – for archived presentations and materials

FIRST Tech Challenge Social Media
> FTC Twitter Feed - If you are on Twitter, follow the FTC twitter feed for news updates.
> FTC Facebook page - If you are on Facebook, follow the FTC page for news updates.
> FTC YouTube Channel – Contains training videos, Game animations, news clips, and more.
> FTC Blog – Weekly articles for the FTC community, including Outstanding Volunteer Recognition!
> FTC Team Email Blasts – contain the most recent FTC news for Teams.
> FTC Google+ community - If you are on Google+, follow the FTC community for news updates.

Android-Based Technology Support
> FTC Technology Forum
> FTC Technology Webpage
> FTC Team Resources Webpage

Product Support
FIRST will handle questions about Team registration, grants, Events, and Affiliate Partners. Pitsco will handle questions about ordering, payment, and delivery of competition sets and materials.

- U.S. & Canada: 800-835-0686 FREE
- Outside U.S. and Canada: 620-231-0100
- U.S. Fax: 800-533-8104

Feedback

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

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