▶Rural Rookie Resource

A Guide to New Teams in the FTC Robotics Competition

▶ **Team 4433 Smokin' Motors**   {**www.cwrobotics.org**}
▶ **Conrad Weiser High School**

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Introduction

The FIRST Tech Challenge (FTC) is a great way of keeping students interested in math and science and to prepare them for college. However, for a school in a rural community with limited financial resources and a lack of experience at robotics, it can be a daunting task to get started. That is exactly the challenge we faced at Conrad Weiser High School, which is located in southwestern Berks County, Pennsylvania, an area dominated by cows and tractors, but limited in high technology.

This Rural Rookie Resource guide is designed to help rookie teams in a rural areas like ours get started in FTC by describing our failures and explaining learning experiences. Hopefully this will reduce the frustration level of other rookie teams and allow them to get off on the right foot with their first robot.

The robotics kits and software that make up the FTC experience are very detailed and the information is voluminous. This more than anything made getting started in FTC very difficult for our team. A common problem was getting answers to some very basic questions. We hope to provide those answers in this guide.

We want to emphasize that this guide is not designed to help you score lots of points in a competition or build a world-class robot. The focus is on getting a new team off on the right foot.

Getting the Kit

Before getting the kit you need to register the team and get a team number. The registration is done through the *Team Information Management System* (TIMS) online at https://my.usfirst.org/ftc/tims/site.lasso.

The logon and password for TIMS will let you edit your team name, mailing address and contact information. After registering the team you can order your kit from the link on the TIMS site.

Click the "order kit" button at the bottom of the screen and it will take you to the Lego Education website to buy the kit. You have to set up a password protected account with Lego Education to order the kit and any extra parts. Please remember that this is a different log-in and password than the one established in TIMS. We ordered the competition kit and the resource kit in September. The competition kit was delivered in a timely manner but the resource kit wasn't delivered until January and we struggled figuring out what extra parts we needed.

In a nutshell, the competition kit by itself is not adequate to build a competitive robot. The team will need other parts. For example, we needed extra motors and motor clamps, a router, a second game controller, and extra USB cable. See the next section for ordering parts. Some of the items we ordered are in the resource kit, but ours wasn't delivered until January so we had to order them separately.

The competition kit comes with a couple of books: *Getting Started with Labview for FTC* and *a Tetrix Manual.* These guides show different techniques for building a basic robot. You should probably look through each one before you really start and decide which approach you want to experiment with. As we discuss later, though, the "Getting Started" book is really important at understanding how LabView can be used to program the robot.

When the kit arrives it's a good idea to organize tools and parts right away. We found it helpful to get a

separate toolbox with sorting cubicles to help us stay organized. We should have paid more attention to screws and other small parts because they should be kept separate and labeled properly.

Ordering Parts

As mentioned above, rookie teams should be prepared to order additional parts. When you click the order kit link in TIMS it also shows a "related products" tab that illustrates the resource kit. Please note that there are more parts available than what's illustrated on the "related products" tab. The hard part is finding them on the website. Here are the steps to find spare parts:

1. Go to the FTC website http://www.usfirst.org/roboticsprograms/ftc/default.aspx?id=968 and click "Team Resources."

2. Click "TETRIX Resources" to get spare parts.

3. Click "Purchase TETRIX spare parts."

4. Clicking that link will take you to another Lego education website where you can purchase the extra parts you'll need.

5. In the upper right corner of the website is a "sign in" link. You will have to set up another account with Lego education if you didn't already do so when ordering the kit.

6. Please note that if you have more than one person placing orders you will both need Lego Education accounts because the account links to an email address.

After completing the steps noted above you can go shopping for extra parts. It's much easier to bookmark the site to avoid all of the steps. Here is the link: https://parts.ftcrobots.com/

Please note that it's important to sign in each time you make a purchase because FTC teams get a discount and shipping priority if there's a backorder. For example, we ordered a gear pack that was backordered but we did not sign into the account. When we got the backorder notice, our coach called customer service to ask about when it might arrive. When we mentioned the upcoming competition the customer service representative asked for our team number and we got the backordered part. We also found out (too late) that teams get a discount on parts. The retail price on the gear pack, for example, is $99.95, but the FTC team price is $69.97.

Another lesson learned about parts is that it's important to know the terminology before ordering parts. For example, there's a difference between gears and sprockets. We really needed sprockets but ordered gears instead.

It's also a good idea to make a list of the parts you'll need so you can make one or two larger orders rather than weekly smaller orders. This helps save on shipping costs and helps the team keep track of what was ordered and what is still needed. Teams should also be aware that Lego Education conducts inventory around Thanksgiving which may delay shipments.

Team Meetings

One of the challenges we had was finding adult help at team meetings. Parents took the lead, but it would have been nice to have mentors with technology or engineering experience to provide guidance. We recommend lining up the mentors first, order the kit, and then get students involved. Coaches and mentors should have the opportunity to review the kit and manual before getting students involved. The coaches and mentors will be able to answer student questions if they've had the chance to review the materials and get organized first.

Another reason we recommend having the kit before starting meetings is that some students lost interest

in our meetings because there wasn't anything to do without the kit.

The team should plan to meet at least two hours, three times per week. This is a minimum recommendation depending on everyone's schedule. Adding extra practice sessions when you are close to a competition is also a good idea.

The Coaches and/or mentors should have a list of things to do so the team knows what's expected that day and they can get started and be productive right away. Coaches should also encourage the team to take turns on the various jobs so that if someone is absent there's another person there who can get the job done.

After the robot is built, team members should take turns operating the robot and writing entries in the engineering notebook. The engineering notebook should be kept current. Team members must be made aware that the notebook is also evaluated at the competition.

We spent more time and money building the playing field than was necessary. We recommend just building a few key components so the team can practice using the robot with main playing field elements. The key elements of the playing field are the ones that earn points or are obstacles to overcome. You don't need an entire playing field to do this. Remember that the playing field is designed for four teams and rookie teams don't have to build an entire playing field their first year.

One of the things we did that was very helpful early in the process was going to an off season scrimmage. We got to see assembled robots and took away some ideas from that. We also saw the logistics of how competitions work, watched inspections, and saw the playing field fully assembled. It was worth the trip and highly recommended for rookie teams to get a better idea of what they're doing.

Fund Raising

Our team was lucky since we had a corporate sponsor who paid for the initial kit purchase, extra parts, and registration fees. In addition, we sent letters to local engineering firms. Only one of those letters resulted in a sponsorship, but it was very helpful!

Making personal contacts with people in technology companies is also an effective way to raise funds. Sometimes that person can guide you to the right office to make an inquiry.

Although some teams sell products to raise funds, we did not do that our rookie year. Our team was small and a product sale would not have been very profitable.

Gracious Professionalism

This resource guide would be incomplete without a note about gracious professionalism. FIRST is an amazing organization with lots of people who are eager to help rookies. We highly recommend taking advantage of their experience and help. If you're stuck on something contact your regional director who can contact other teams nearby to help.

For example, when we found out that the gears we ordered were backordered we contacted the regional director to ask for his help. He sent out a request to nearby teams and within a week a team sent us the gears! It is a perfect example of gracious professionalism at work.

Building the Robot

As a rookie team, we are not in a very good position to give your team advice on robot design. However, there are a few things we found while building our own robot that you might find useful. Before building it's a good idea to design what you want the robot to do on graph paper or use a CAD software program. A low-tech, cost effective approach is to use graph paper first then cardboard before purchasing more

expensive materials. It's easier to make changes to a cardboard model.

After building the robot chassis it's time to attach the NXT brick. It's important to note before hooking up the NXT brick to the controllers (these drive the motors and servos), that the diagram that accompanies the controllers has an error. The picture shown below is from the controller package. Note the cable that plugs into the NXT brick and the controller. Unfortunately, it is in the wrong port on the NXT brick. The cable should be plugged into the port identified with the red arrow below.
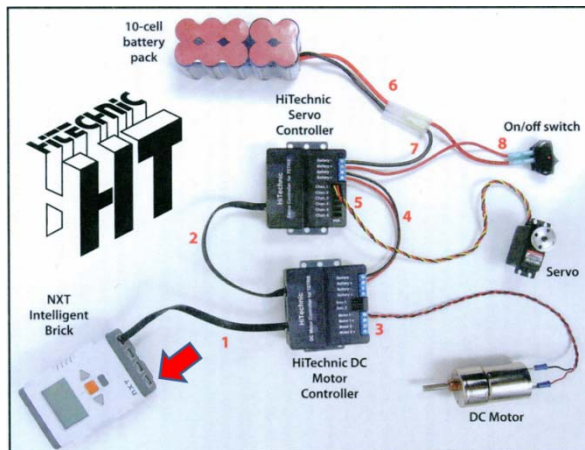
We did find out later that you can reconfigure the program used to control the robot to use the port shown on the diagram. However, the default programs that you can use to get up and running quickly are set for the port with the red arrow. Plugging into that port (#1) right away will save you a lot of aggravation.

Working with Samantha

Samantha is a module that must attach to your robot and uses a Wi-Fi network connection to communicate with your computer. The two game controllers attach to the computer via usb cables and are used to drive the robot during the "tele-operated" part of the competition. [*Note that you only get one controller in the kit but it helps to have two of*

them – driver and gunner]. Samantha is new in 2010 and presumably will be used in the future. In any case, Samantha can be a bit difficult to set up. We found a blog for one team in Texas that was overjoyed when they got Samantha working after 2 months of trying! Anyway, Samantha looks like the picture below:

It has a usb port that connects with the NXT brick and a power port that hooks to that big battery pack you received with your kit.

There are two very important things you need in order to get Samantha working with your robot. First you should get the same wireless network router that is used in the competition. In 2010, this is the Cisco® Linksys® E1000 Wireless-N Router. We found it for about $50 on Amazon.com. While other routers would probably work, it makes sense to get acquainted with the router you will see at the competition. The second thing you need to do is name your NXT brick with your team number (4433 in our case).

Naming the NXT brick is not that difficult, but we could find no documentation on how to do this! We stumbled upon the trick while updating the firmware on our NXT brick (see below). The method we used to name our brick was to open the LabVIEW software on the computer. As we will discuss below under "Programming the Robot", LabVIEW is probably the easiest way of getting started with programming for the robot.

First, turn on your NXT brick and connect it via usb cable to your computer. You do not need to have it attached to your robot yet. Now, start LabVIEW. You will see a screen that looks like this one:

Click the "Launch LabVIEW" button in the top right corner of the dialog. Next you will see another window where you can load a LabVIEW program (called a VI or "vee-eye"). Since we are just going to set the name of the brick, choose the top one called "Blank VI" in the top left corner of the dialog.

Now you should select **Tools|NXT Tools|NXT Terminal** from the menu.
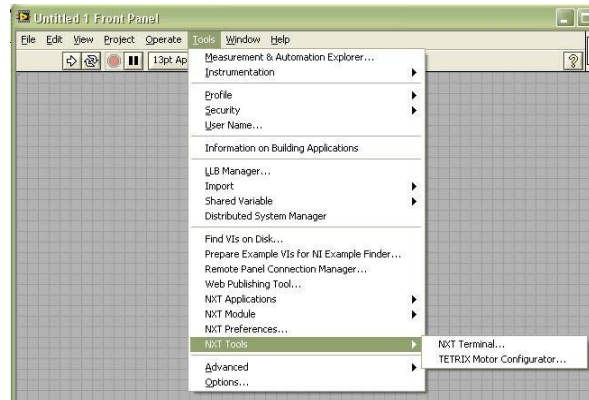
Selecting this menu option brings up yet another window that will now hopefully show the battery status of your brick. If you do not see a green bar that illustrates the battery level, try unplugging the usb cable and plug it in again. The computer should chirp at you when it sees the brick.

At the top of this final window (the NXT Terminal), you will see a button that says "Rename…". Click this button to set the name of the NXT brick. This name must be your team number. Obviously this procedure is not that hard but it took our team a long time to figure out.

Now that the NXT brick has a valid name, you can set up Samantha on the wireless network router and your computer. We will not go through this procedure in detail because the FTC web site has a good document that tells how to do this. Go to http://www.usfirst.org/roboticsprograms/ftc and click

on **Samantha Resources** on the left side of the window. Then click the **Wireless Setup** button on the right. These are circled in red below.
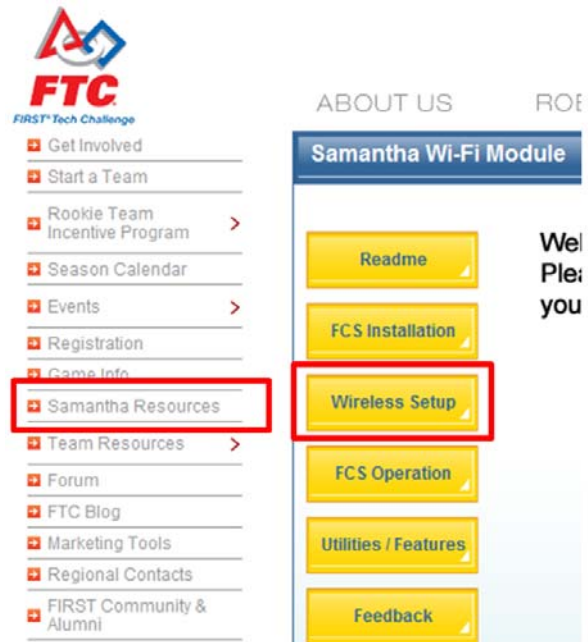
Next click the **Router** button which will appear to the right of the Wireless Setup button. [*Note that you will also see a button called Ad Hoc which can be used to hook Samantha directly to your computer without a router – we do not recommend this* approach]. Finally choose your operating system and download the instructions to set up the wireless router. We chose Windows XP for our older laptop and **None** for network security. We found the document easy to follow and had no problems getting everything to work.

In the next two sections, we will get right into driving the robot using Samantha, which will also serve to confirm you have everything set up correctly. However, you can do a quick test right now. Connect a usb cable from Samantha to the NXT brick, turn on power to Samantha and to the NXT Brick, and turn on the wireless router. The red light should be glowing on Samantha, indicating that it has power. The white light on Samantha should be flashing, telling you that it sees the wireless router.

The blue light on top of Samantha should be on which means that the NXT brick is properly connected to Samantha. Now it's time to spin the wheels.

One other thing to note about setting up your wireless network is the SSID name you give it. The document we used seemed to indicate that you should call it FTC_FIELD which is what is used at the competition. When you get to the competition, though, a new configuration will be uploaded to your Samantha by the software inspection team. When we returned from the competition, we could not reconfigure out Samantha back to its original state for our network. Through some trial-and-error we found that if we renamed our wireless network from FTC_FIELD to FTC_TEST, we could then reconfigure the Samantha properly. It appears to be a problem with the Samantha firmware that it will not allow you to go from an encrypted network called FTC_FIELD to an open network called FTC_FIELD.

Testing Robot Movement

There are two ways of programming the robot, at least for the FTC competition. These include the LabVIEW program described above and ROBOTC. LabVIEW is a graphical programming language and ROBOTC is based on the popular C programming language. We found LabVIEW to be a relatively easy way of getting our robot up and running. In addition, our team is made up of freshmen and sophomores with no C programming experience so LabVIEW was the obvious choice.

We found that National Instruments, the makers of LabVIEW, provides excellent introductory materials to get you going quickly. Two documents in particular were very important in helping us through the early days of robot testing and programming. These include:

1) *Getting Started with NI LabVIEW for FTC*

2) *Using the FTC Program Templates with the FIRST Field Control System*

The first document can be found here: http://decibel.ni.com/content/docs/DOC-7152

The second document can be found here: http://ftp.ni.com/evaluation/academic/ftc_templates_tutorial.pdf

Web addresses (URLs) tend to change with time so if those links do not work, you can probably find them using a Google search or go to the FTC web site and look there.

One of the first things we found out about using LabVIEW for the FTC competition is that you need a very important software toolkit that is NOT installed with LabVIEW. This is called the **LabVIEW for FTC 2010-2011 Toolkit**. Before going any further, you should get this software from http://ni.com/info and enter the info code **FTCSoftware** (the second document shown above pointed this out).

We recommend that you start with **Getting Started with NI LabVIEW for FTC**. The beginning of this document discusses basic robot construction and provides some helpful suggestions. On page 3-4, instructions are provided for updating the firmware on the NXT Brick. This is necessary and is part of the software checklist at the competition so you might as well get this done right away. You should also check before the competition that the firmware version has not been updated recently.

The one confusing aspect of the instructions was the location of the LabVIEW folders which contain the firmware, templates, etc. The document refers to a folder called **National Instruments\LabVIEW 2009\Targets\NI\NXTToolkit\Firmware**. On our computer it was under **c:\First Robotics\Targets\NI\NXTToolkit\Firmware**. So if these documents refer to a folder you do not have, you need to figure out where the LabVIEW software was installed and look there.

After updating the firmware, the "Getting Started" document discusses the use of a test program called **TheMechanic.vi**. This is a great way to make sure the motors that drive the wheels are set up correctly. This was a great success for us when we got the wheels to move!

Driving the Robot

Once you have LabVIEW installed along with the FTC Toolkit, you are ready to start programming the robot. Even if you have never done any programming, LabVIEW comes with a template called **FTCTeleopBasic.vi** which you can use to drive the robot. You do not need to make any changes to this program in order to drive the robot, assuming you are using two motors on one controller to drive the wheels. In fact, the FTC competition requires that you use either the FTC Teleop Basic VI or the FTC Teleop Full VI template as your starting place for the teleoperated part of the competition (that is, using the game controller).

Page 8 of the 2nd document referenced above (Using the FTC Program Templates with the FIRST Field Control System) is a good place to start. The earlier pages show you how to modify the template but in the early stages, this is just confusing. There is really no need to modify the template if you just want to make sure you can control the robot via the wireless network and Samantha.

At this point make sure the NXT Brick is turned on and connected to the computer via the usb cable. We found it helpful to have 2 usb cables. One is used to connect the brick to the computer and the other is used to connect the brick to Samantha. The one that connects to Samantha is probably tied down to the robot and so is therefore not long enough to reach the computer. These cables are really cheap and you may even have an extra one you can borrow from another piece of computer equipment (that's what we did!)

Start at the bottom of page 8 where it discusses deploying and running programs on the NXT Brick. The first step is to deploy the **Program Chooser** to the NXT Brick. This program is provided with the toolkit so it's just a matter of opening it in LabVIEW and deploying it to the brick.

The next step is to deploy the FTC Teleop Basic program. The text says to use the one you modified but you can use the unmodified version that comes with the toolkit.

After deploying those two programs to the brick, disconnect the usb cable from the computer and connect the brick to Samantha. Make sure Samantha, the wireless router, and the NXT brick are all turned on. Connect one of your game controllers to the computer. On the NXT Brick, run the Program Chooser and select the TeleopBasic program.

At the bottom of page 9, follow the steps to run the FTC Field Control System (FCS) software. You need to download this software from the FTC web site where you found the instructions for setting up the router and Samantha. You'll need to scroll down a bit as it is hidden at the bottom of the page (see below).
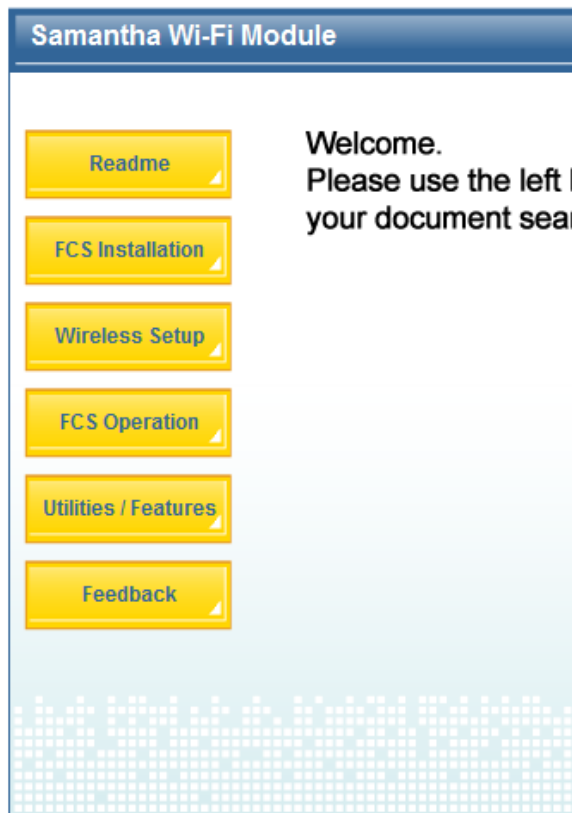
Samantha FCS Download - Extract the file from the
Samantha Documentation - Extract folder from .zip
Browser."

Download the FCS software and install it. You
should now have an icon on your desktop called
Samo FCS:

Double-click to run the FCS. We found this part
confusing as the documentation is a bit vague. The
first step when running the FCS is to identify the
game controller you will be using. Just click a button
on the game controller then click OK. Now you
should see a new page called the Competition page.

Click the **Configuration** button and Uncheck the
first option called "*Autonomous Time Period*". At this
point you only want to drive the robot manually using
the TeleopBasic VI program so you do not want to
use the autonomous part. Click OK when you are
done.
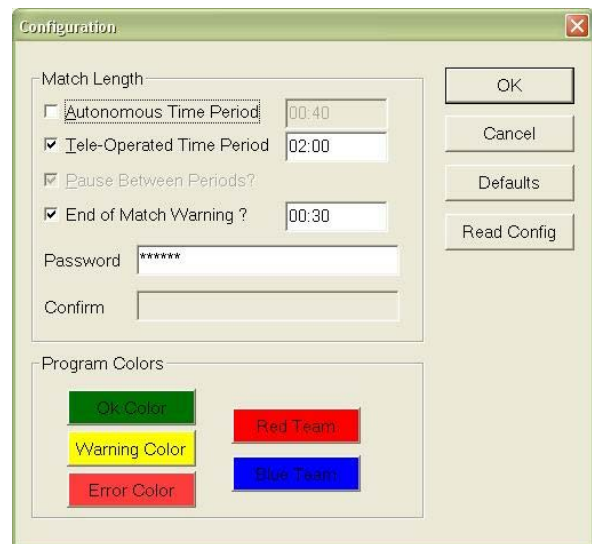
Now you should be back to the Competition page.
Click the **Choose** button. Now if everything is
hooked up correctly and you gave your NXT brick
your team number as its name, you should see your
team number next to an IP address (something like
192.168.1.xxx).

Double-click your team number. The rectangle below "Red Team 1" should turn green when the robot is ready to run.
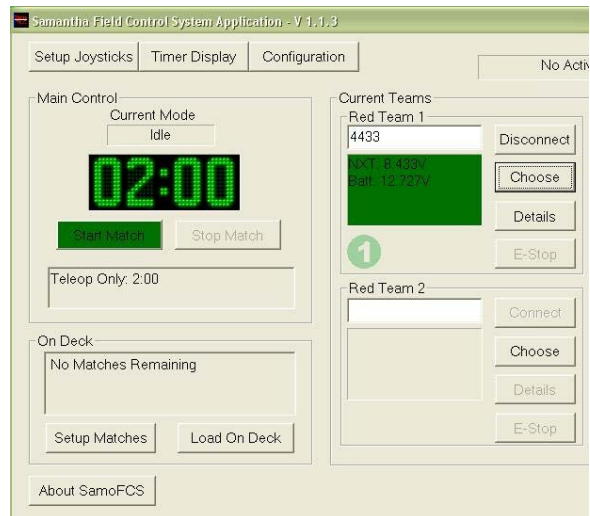
You can now click the **Start Match** button and the joystick on the controller should make the robot move forward, backward, and turn. With the help of the National Instruments documents cited above we were able to get this far.

If you are not successful at getting your robot to move, you should probably go back through these two documents step-by-step and try again. Document any problems you encounter and their solutions. Please send them to us so we can add them to the RRR. Our contact details are provided at the end of this document.

Programming the Robot with LabVIEW

We do not have the expertise to provide a "how to" guide on LabVIEW programming. We are really just learning ourselves at this point. However, we can give you some hints and show you a great web site that might help. Also, we now have a guide to using RobotC so if you would rather use that programming environment, skip to that guide.

After our initial success at getting the robot to move with two motors hooked to one controller, we came to an obvious question: "How do we control other motors and servos?" The Teleop Basic VI program just controls two motors that drive the wheels. We

needed other motors and servos to make the robot perform other tasks.

We first hooked up a third motor and a servo to our robot for testing. The robot we were using to test the programming is shown below:
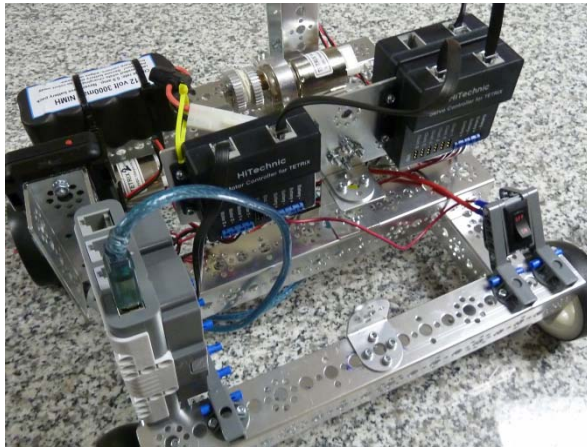
We simply wired the controllers up in series, all terminating at Port 1 on the NXT brick. Controller 1 (closest to the brick) drives the wheels. Controller 2 (facing the camera on the right side) drives the servos. Controller 3 (behind controller 2) drives the third motor. Page 6 and 7 of the "Using the FTC Program Templates…" document describes how to run the **TETRIX Motor Configurator** where you assign names, controller numbers, etc. to your motors and servos. This was relatively easy to do.

The more challenging part was figuring out how to modify the Teleop Basic VI to take commands from the 2nd game controller and make the third motor and the servo move. We initially had a lot of difficulty with this because of our inexperience with LabVIEW. We found a really great web site, though, called www.ftcmastery.com which has a free introductory video for LabVIEW programming. You can also pay to have access to additional videos and training information. While we did pay to access the other videos, this first free video was sufficient to allow us to get our third motor and servo working.

Our modified LabVIEW Teleop Basic VI is shown as an attachment to this guide. While it may look primitive to experienced teams, it does work! Hopefully it will give you some ideas if you are having trouble getting past this step.

Preparing for Competition

Before going to a competition it's important to make sure that the team, coaches, and mentors all understand the game rules. Review the Game Manual one more time and double check everything about your robot. Go through the hardware inspection checklist item-by-item and ask yourself if it would pass or fail. Fill out the Bill of Materials from the template provided and take receipts and documentation with you to the competition.

Finally, remember that it's your rookie year and be proud of what you've accomplished. Our goal was simple but hard to achieve: build a robot that moves back and forth. At one point we said it would be a "minor miracle" if we accomplished that simple goal. But we did!

Yes, it was a minor miracle that we made it to the competition and now our goal is even more simple: to have fun. After all of the hard work, re-work, and frustration, we accomplished what we set out to do and now we just want to have some fun with the robot we worked so hard to build.

Important Web Resources

This is where you register your team in TIMS: https://my.usfirst.org/ftc/tims/site.lasso

This is where you order the competition kit: http://www.usfirst.org/roboticsprograms/ftc

This is where you order parts: https://parts.ftcrobots.com/

Another source for parts: http://www.hitechnic.com/products

A source for sheet aluminum and other fabrication supplies. http://www.mcmaster.com/#

This is where you can see free introductory video for LabVIEW programming: www.ftcmastery.com

Contact Our Team!

Ms. Adele Schade, Conrad Weiser High School teacher who took the lead in establishing this team. She recruited students and graciously let the team use her classroom for our build meetings. You can contact her at mailto:a_schade@conradweiser.org

Marge Rumbaugh helped to form the team with Adelle Schade's help. She was the initial coach until the build/rebuild process became too technical. She did the fundraising, organizing, and purchasing. You can contact her at marge.rumbaugh@gmail.com.

Mr. Jim Rumbaugh is our software/programming mentor and coach. Please feel free to contact him with any questions at jrumbaugh@groundwatermodels.com.