

PROJECT LEAD THE WAY

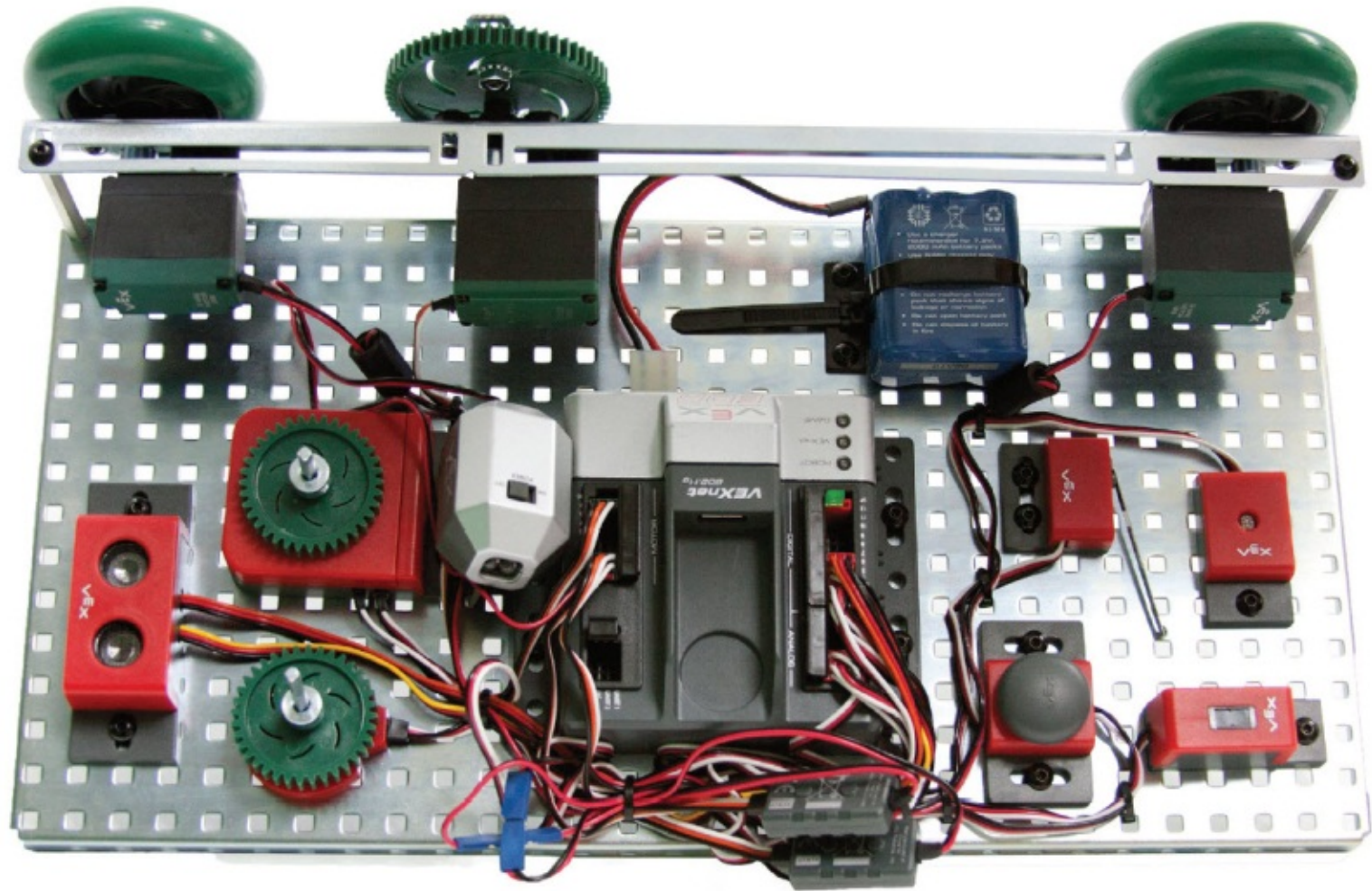
PLTW

Igniting imagination and innovation through learning.

VEX Robotics Platform and ROBOTC Software

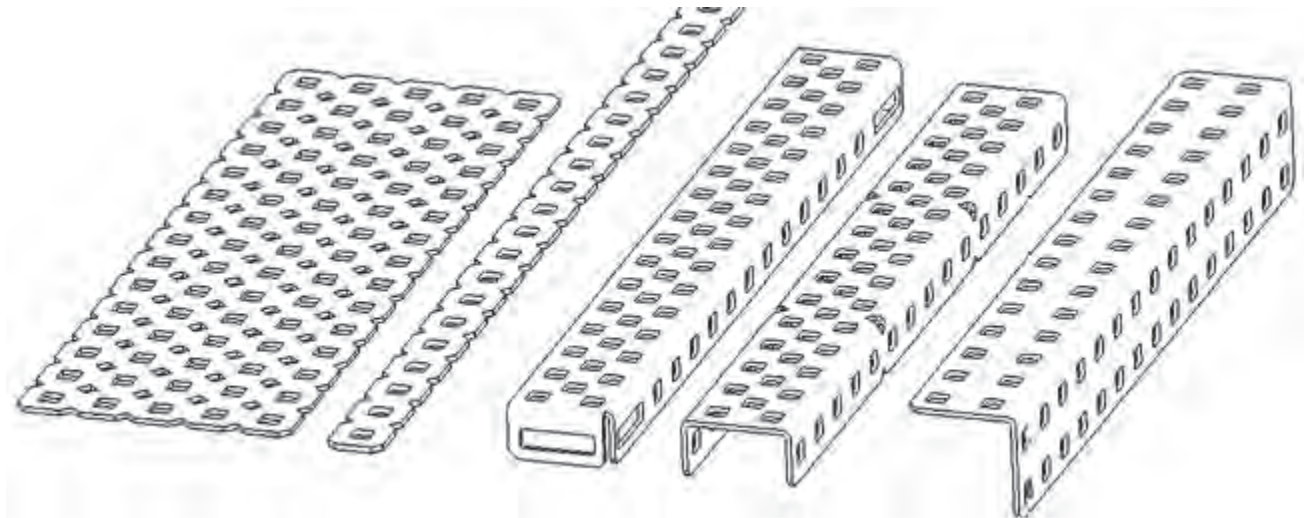
Introduction

VEX Robotics Platform: Testbed for Learning Programming



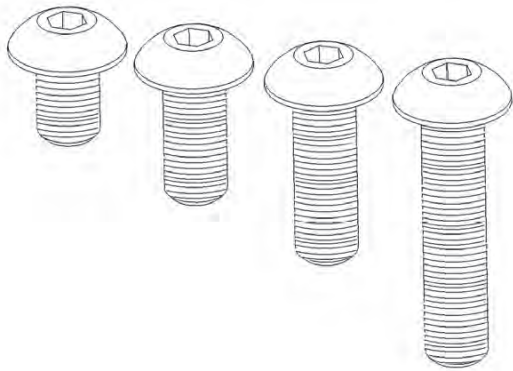
VEX Structure Subsystem

- VEX Structure Subsystem forms the base of every robot
- Contains square holes (0.182 in. sq) on a standardized $\frac{1}{2}$ in. grid
- Allows for VEX parts to be connected in almost any configuration



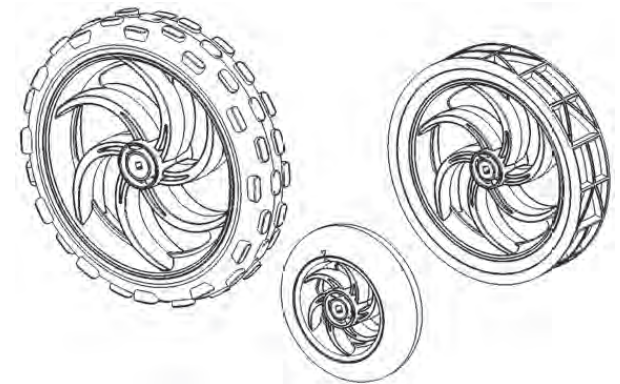
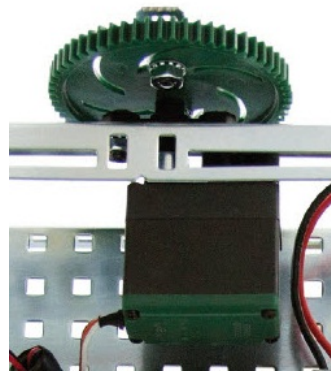
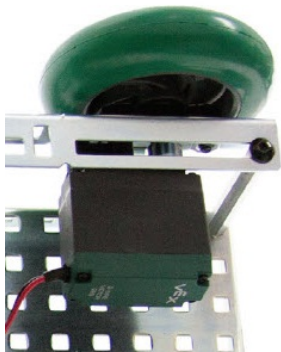
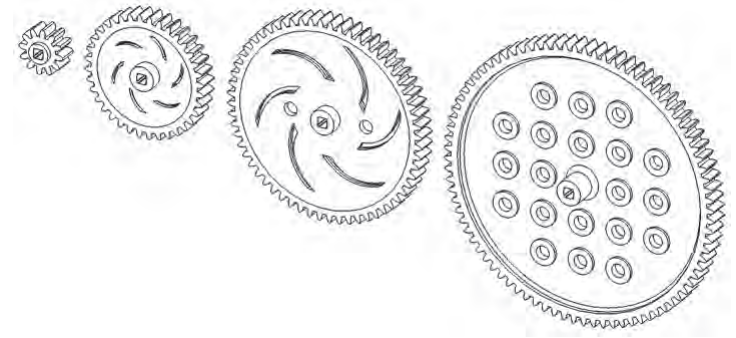
VEX Structure Subsystem

- Metal components directly attached using 8-32 screws and nuts
 - Nylock nuts have a plastic insert to prevent them from unscrewing
 - KEPS nuts have a ring of “teeth” on one side to grip the piece being installed
 - Regular nuts have no locking feature



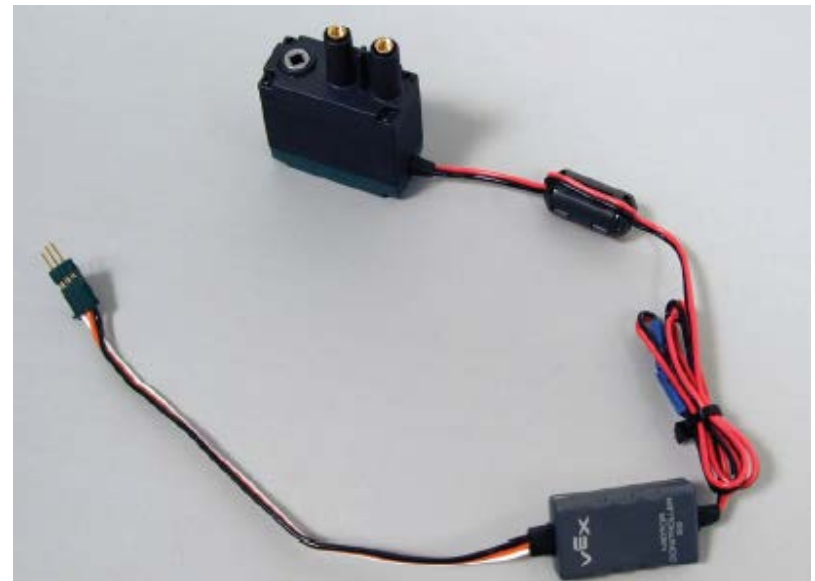
VEX Motion Subsystem

- Components which make a robot move
 - Gears
 - Wheels
 - Motors
 - Servos



VEX Motion Subsystem – Motors

- 2-wire motor 269
 - Two methods to connect to Cortex
 - Motor ports 1 and 10
 - Motor port 2-9 using Motor Controller 29
- 2-wire motor 393





VEX Motion Subsystem – Servos

- Similar in appearance to the 3-wire motor
- Very different in operation
 - Rotates between 0 and 120 degrees
 - Motor is set to a “power value”
 - Servo is set to a “position value”
 - -127 = 0 degrees, 0 = 60 degrees, 127 = 120 degrees, etc.
 - Natural Language command
 - `setServo()`

VEX Sensors Subsystem

- Provide inputs to sense the environment

- Digital Sensors:

- Bumper Switch



- Limit Switch



- Optical Shaft Encoder



- Ultrasonic Range Finder



- Analog Sensors:

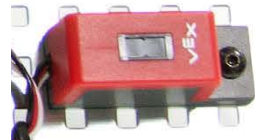
- Light Sensor



- Potentiometer



- Line follower



Potentiometers

- How it Works

- Analog sensor
- Measures rotation of a shaft between 0 and ~265 degrees
- Cortex returns values 0 - ~4095

- Caution

- Internal mechanical stops prevent potentiometer from turning a full revolution
- Excess torque against the internal mechanical stops will cause them to wear away



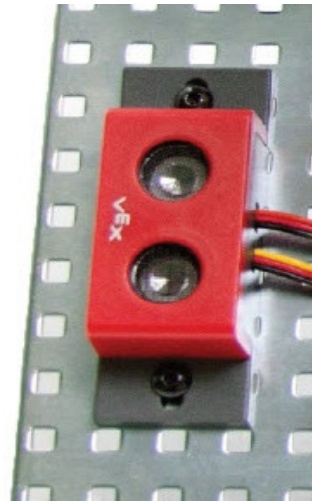
Quadrature Shaft Encoders



- How it Works
 - Digital counting sensor
 - Inner shaft spins as the encoder counts
- Capabilities and Resolution
 - 360 counts per revolution
 - Counts up and down
 - Allows you to control the distance a robot moves by monitoring how much the wheels spin

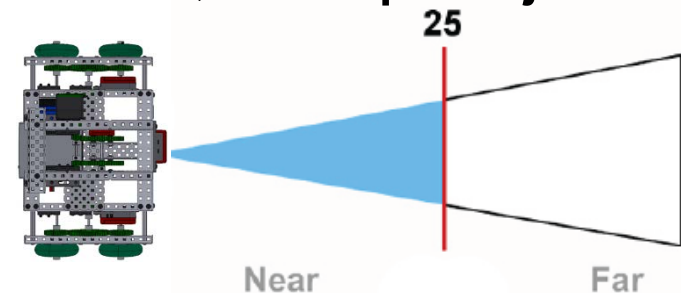
Ultrasonic

- How it Works
 - Similar to how bats and submarines sense distance
 - Digital sensor that returns distance values between 0 and 255 inches
 - Returns values of -1 or -2 if used improperly
 - Cortex resolution can be in inches, cm, or mm



Ultrasonic Range Finder

- Ultrasonic Range Finder detects objects in a “cone” field of view
- Sensor detects object distance from the center of the sensor
- Sensor distance calculations based on sound waves
 - Objects that may not be detectable include soft objects that absorb sound, sharp objects that deflect sound, etc.



VEX Cortex Microcontroller

- VEX Cortex (VEX 2.0)
- 12 Digital Ports
 - Touch sensor, ultrasonic range finder, shaft encoder
- 8 Analog Inputs
 - Light sensor, line tracking sensor, potentiometer
- 10 Motor Ports
 - Ports #1 and 10: 2-wire DC ports
 - Ports #2 through: 3-wire pulse width modulated (PWM)
- VEXnet Connection
 - Fits USB cable or wireless key for remote control and wireless programming
- Capabilities beyond POE kit
 - Supports external LCD screen, video, ...

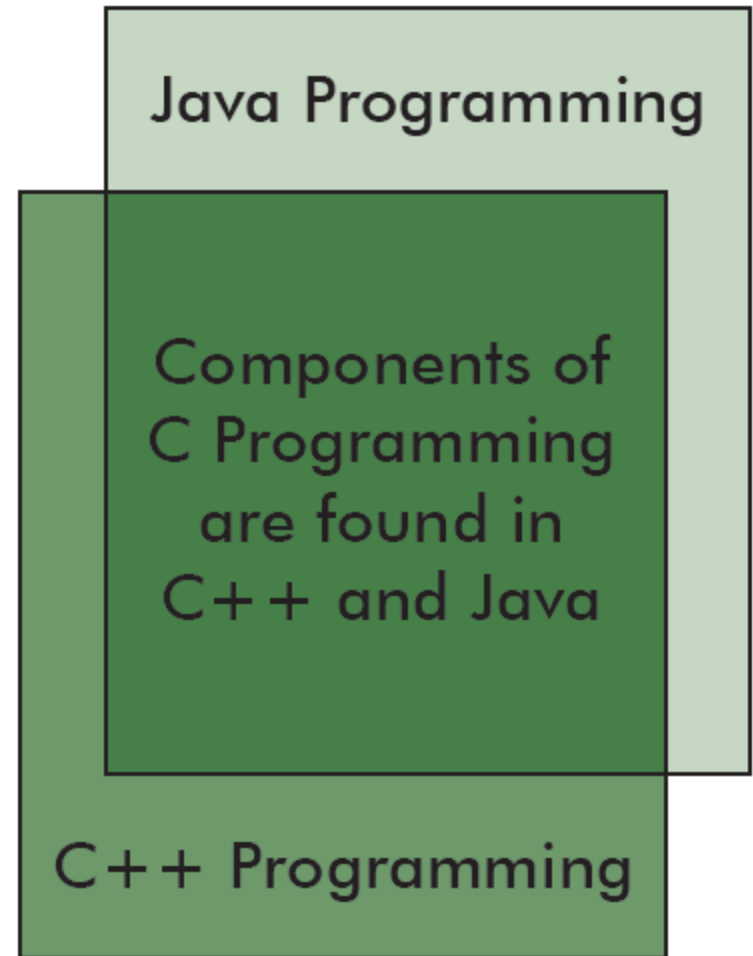


ROBOTC Software

- ROBOTC developed specifically for classrooms and competitions
- Complete programming solution for VEX Cortex and several other popular robot platforms
- Real-time debugger
- Similar to industry-standard C programming

Industry Standard Coding

- **ROBOTC**
programming is a key
components of
industry standard
programming
languages



Industry Standard Skillsets

- Java and C++, along with the Eclipse and Visual Studio IDEs, have been used to program:
 - Microsoft Windows
 - Mac OSX
 - US Navy UAV Drones
 - Flight Simulators
 - DVD Player Firmware
 - Video Games
 - Microwaves
 - CAT Scanners
 - Smart Cars
 - Satellites
 - Cell Phones
 - Electronic Toys
 - ROBOTC
 - Much, much more

ROBOTC Start Page

Displays the latest ROBOTC news, version of ROBOTC, and ROBOTC Resources

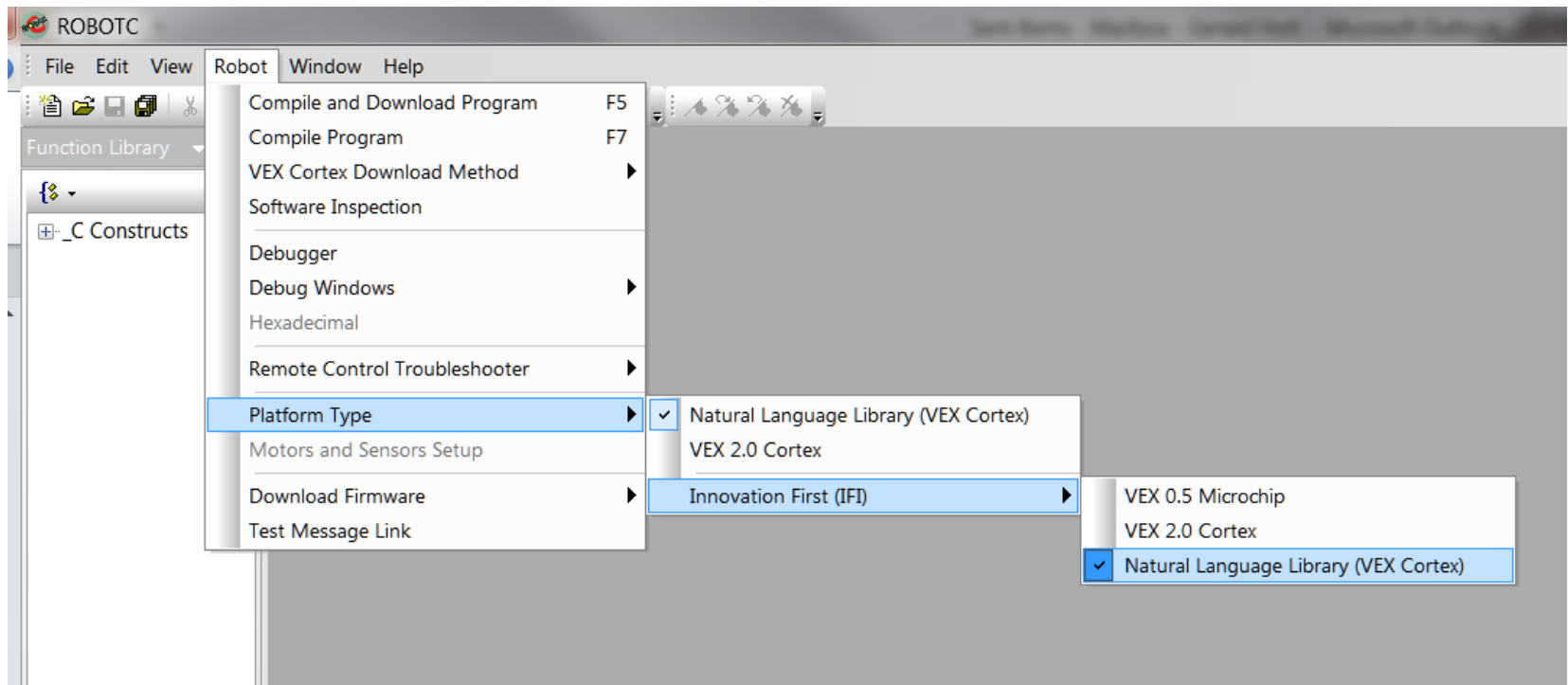
The screenshot shows a web browser window titled "Start Page" with the address bar displaying "ROBOTC for VEX® CORTEX & PIC Start Page - PLTW". The page content is organized into several sections:

- Important Information:** A section with a horizontal line below the heading.
- PLTW Resources:** A section with a horizontal line below the heading, containing:
 - ROBOTC Natural Language Documentation:** Accompanied by an image of a green gear with a red arrow pointing to a specific position, labeled "POSITION:". Below this is a list of links:
 - [Natural Language Functions - Full Details](#)
 - [Natural Language Functions - Quick Reference](#)
 - [While Loops with the Natural Language](#)
 - [If-else Statements with the Natural Language](#)
 - [Variables with the Natural Language](#)
 - The VEX Cortex Video Trainer** is a multimedia-rich curriculum features lessons for the VEX Cortex Microcontroller, which can also be applied to the older VEX PIC Microcontroller 0.5. It includes in-depth programming lessons for ROBOTC, multi-faceted engineering challenges, step-by-step videos, robotics support material, educational resources, and more.
- Latest Version:** A section containing a single link:
 - [ROBOTC 2.32](#)
- Links:** A section containing several links:
 - [ROBOTC.net](#)
 - [ROBOTC Forums](#)
 - [ROBOTC Support](#)
 - [Teaching ROBOTC for IFI](#)
 - [VEX CORTEX Video Trainer](#)
 - [Project Lead the Way](#)

At the bottom of the page, there is a promotional banner for the "VEX Cortex Video Trainer using ROBOTC BETA PREVIEW". The banner includes the text: "This multimedia curriculum features lessons for the VEX Cortex Microcontroller, which can also be applied to the older VEX PIC Microcontroller 0.5. It includes in-depth programming lessons for ROBOTC, multi-faceted engineering challenges, step-by-step videos, robotics support material, educational resources, and more." The banner also features logos for "RoboMatter" and "Carnegie Mellon Robotics Academy".

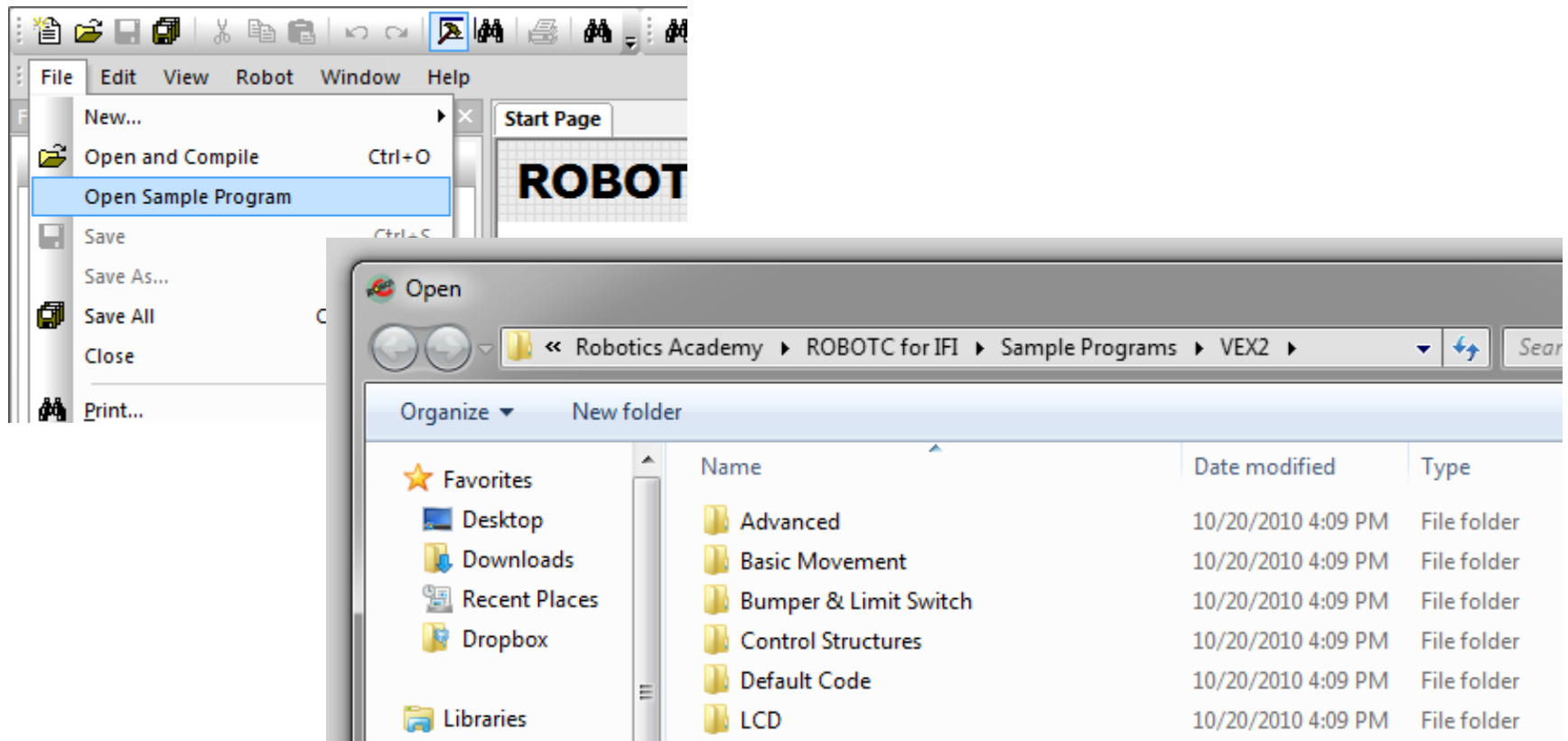
Platform Type

Allows you to toggle ROBOTC programming mode between the VEX PIC and VEX Cortex, which will enable features and commands for the system



Sample Programs

Over 75 ROBOTC Sample programs,
organized by robot behavior

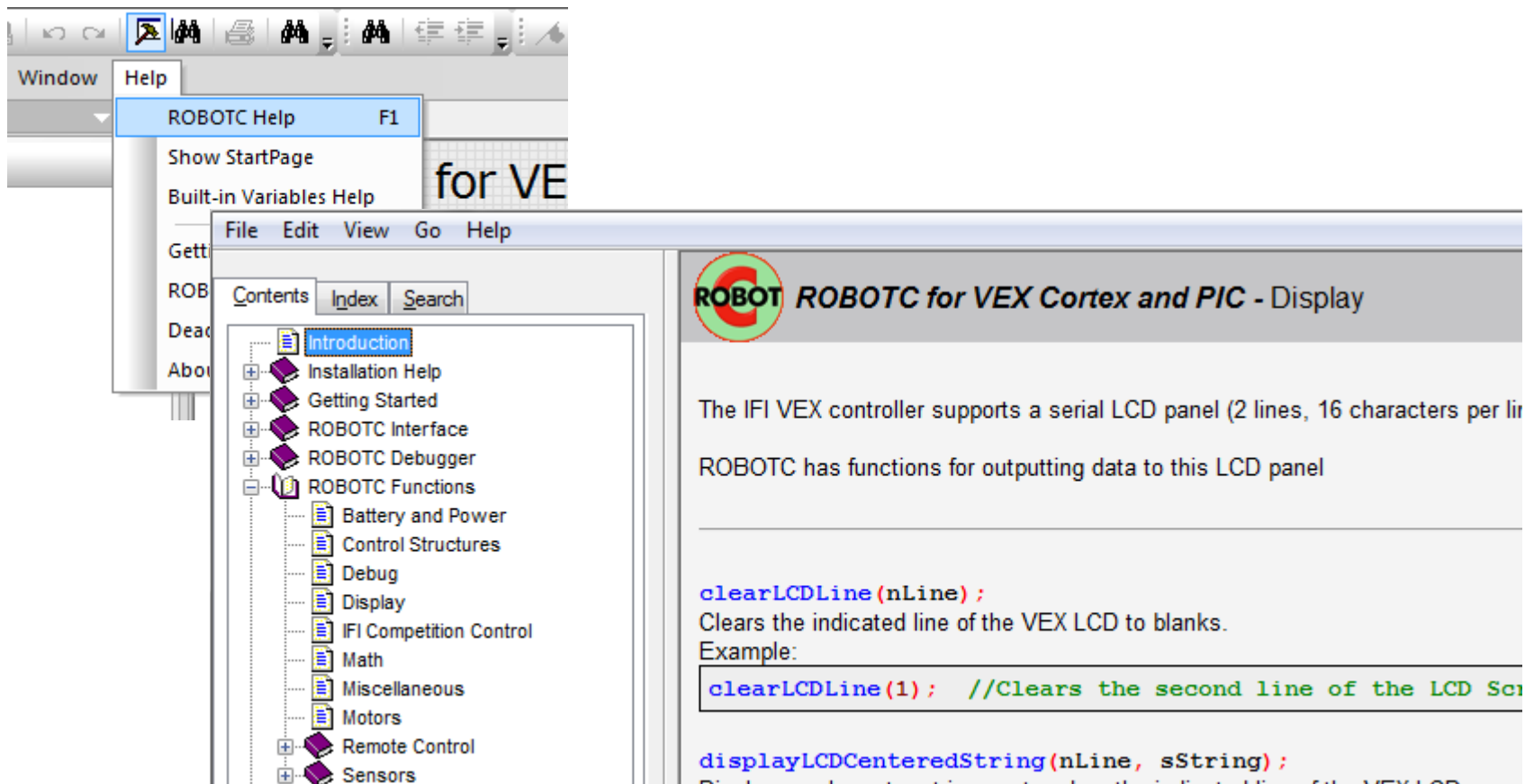


Comments

- Comments are used to make notes in code for the human programmers
- Every sample program contains comments pertaining to robot configuration, ROBOTC commands, robot behavior, etc.
- `// Single line comment` – All material after “//” is ignored by the ROBOTC compiler
- `/* Multi-line comment*/` – All material between the “/*” and “*/” symbols is ignored by the ROBOTC compiler

ROBOTC Help

In-depth explanations about ROBOTC interface, commands, debugger, etc.



The screenshot shows the ROBOTC Help application. The 'Help' menu is open, with 'ROBOTC Help' selected. The main window displays the 'Introduction' page, which includes a table of contents on the left and a main text area on the right. The text area contains a description of the VEX LCD panel and code examples for clearing and displaying text on the LCD.

ROBOTC for VEX Cortex and PIC - Display

The IFI VEX controller supports a serial LCD panel (2 lines, 16 characters per line). ROBOTC has functions for outputting data to this LCD panel.

```
clearLCDLine(nLine);
```

Clears the indicated line of the VEX LCD to blanks.
Example:

```
clearLCDLine(1); //Clears the second line of the LCD Screen
```

```
displayLCDCenteredString(nLine, sString);
```

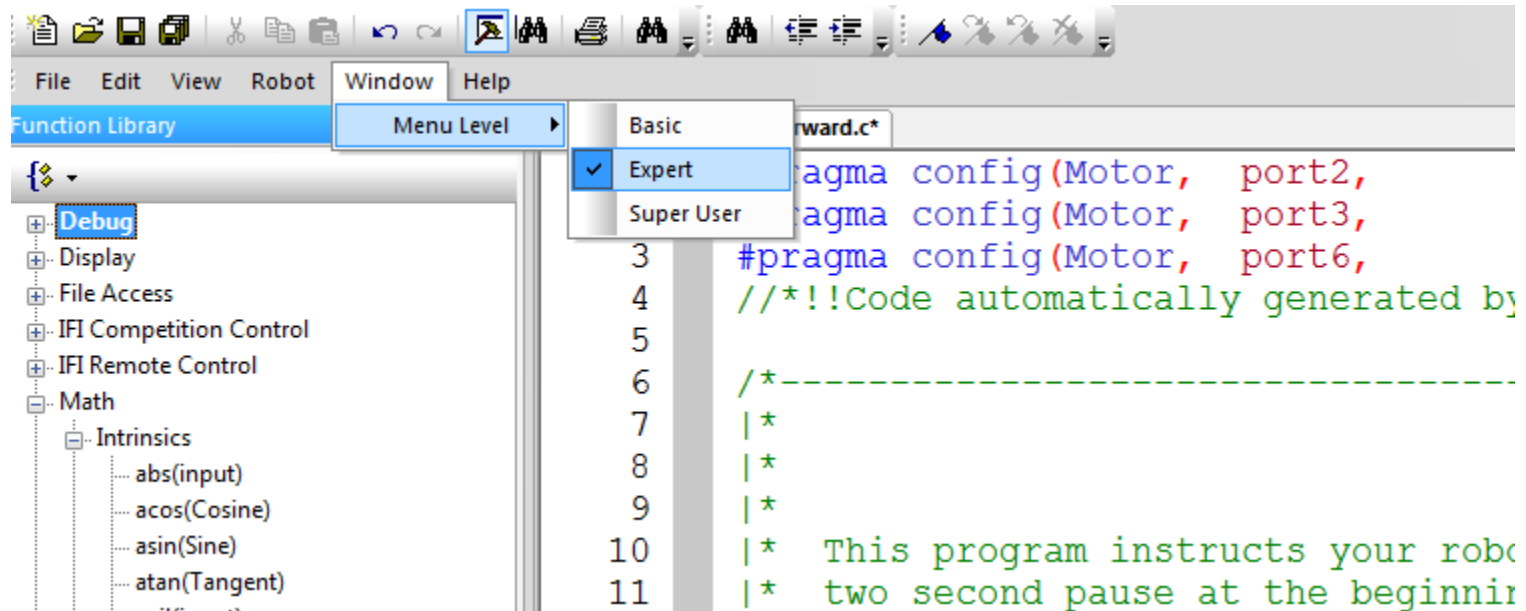
Function Library

- Available functions are listed with a description
- List of available functions will expand or shrink depending on the Menu Level

Line	Symbol	Function Name	Description
13	*	NOTES:	
14	*	1) Reversing 'rightMotor'	
15	*	"Squarebot" mode, but	
16	*	2) Power levels that can	
17	*	127 (full forward).	
18	*		
19	*	MOTORS & SENSORS:	
22	*	Motor Port 3	[Narrow right left
23	\ *	-----	
24			
25			

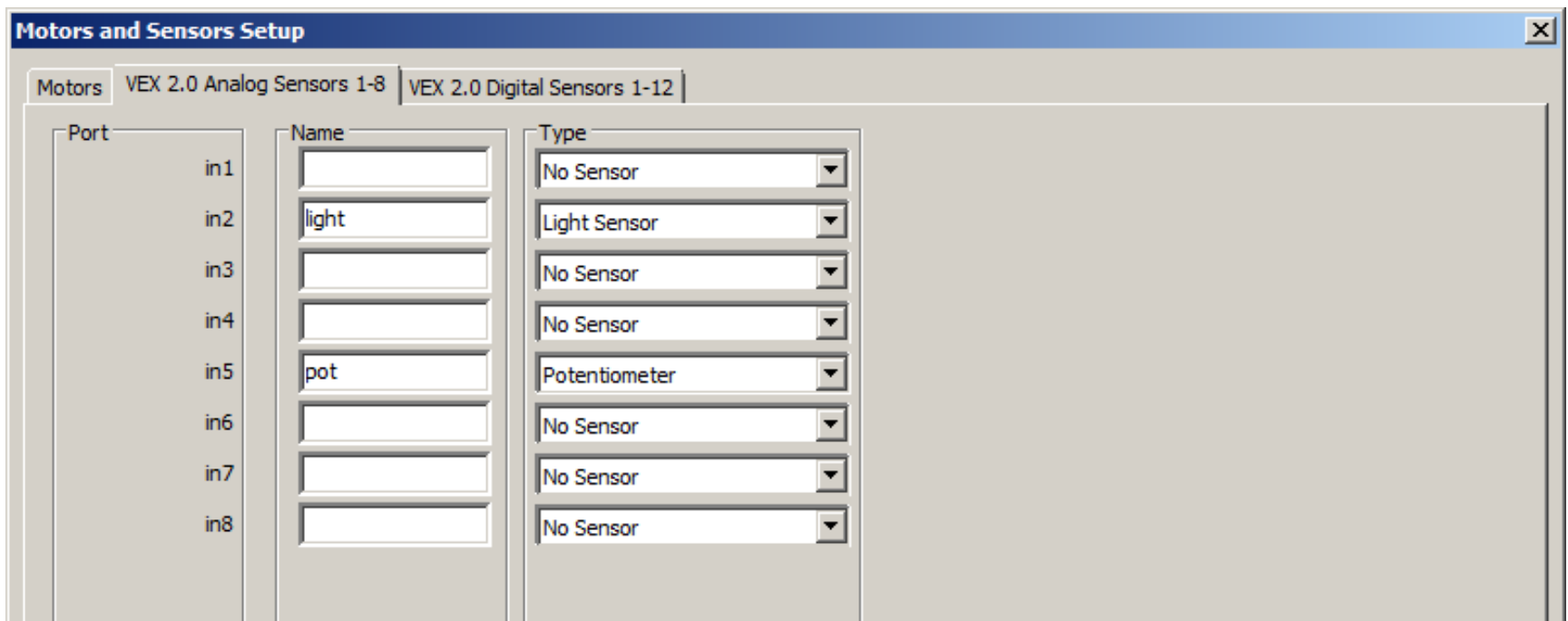
Menu Level

Customizes the ROBOTC interface and Function Library based on user's experience level



Motors and Sensor Setup

Central place to configure and name all of the motors and sensors attached to your Cortex

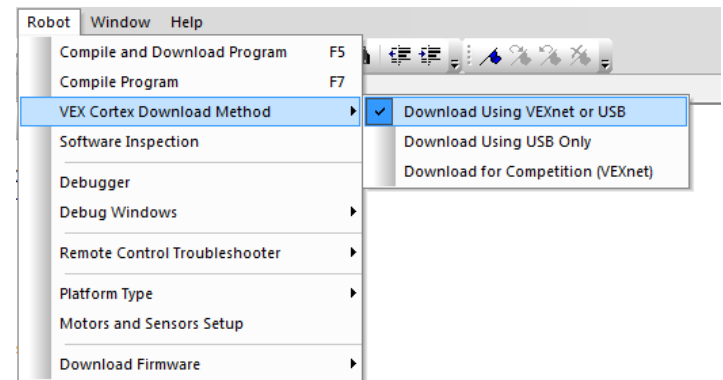


The screenshot shows a software window titled "Motors and Sensors Setup" with a close button (X) in the top right corner. Below the title bar, there are three tabs: "Motors", "VEX 2.0 Analog Sensors 1-8", and "VEX 2.0 Digital Sensors 1-12". The "VEX 2.0 Digital Sensors 1-12" tab is currently selected. The main area of the window contains a table with three columns: "Port", "Name", and "Type".

Port	Name	Type
in1		No Sensor
in2	light	Light Sensor
in3		No Sensor
in4		No Sensor
in5	pot	Potentiometer
in6		No Sensor
in7		No Sensor
in8		No Sensor

VEX Cortex Download Method

- Allows you to specify:
 - How programs are downloaded
 - Whether Cortex looks for VEXnet connection when it starts up
- Allows you to download Using VEXnet or USB; however, the Cortex will look for a VEXnet connection for up to 10 seconds before running code



References

Carnegie Mellon Robotics Academy. (2011). ROBOTC.
Retrieved from <http://www.robotc.net>