Software Skills Workbook

USE CASE	**MENTOR SIGNATURE**
SOFTWARE SETUP SKILLS:	
USE CASE: NETWORKING	
USE CASE: ROBOT RADIO SETUP	
USE CASE: CONNECT DRIVE STATION TO RoboRio	
USE CASE: DRIVER STATION JOYSTICK	
USE CASE: SOFTWARE UPDATES	
USE CASE: PNEUMATIC AND POWER DISTRIBUTION SETUP	
USE CASE: SRX ESC MOTOR CONTROL MODULE SETUP	
USE CASE: ROBOT TROUBLESHOOTING LIGHTS	
PROGRAMMING SKILLS:	**Date completed**
LEARNING NEED TO KNOW JAVA AND FRC PROGRAMMING	
LEARNING FRC JAVA ROBOT PROGRAM STRUCTURE	
FIRST FRC - FIRST ROBOT PROGRAM	
TEAM 2228 PROGRAMMING DESIGN PROCESS	
TEAM 2228 PROGRAMMING STYLE GUIDE	
ROBORIO DEVICE CONTROL PROGRAMMING	
ADVANCED PROGRAMMING	
OTHER SUB-SYSTEM PROGRAMMING	
ROBOT MOTION CONTROL	
VISION	

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REVISION HISTORY

DATE	DESCRIPTION OF CHANGE
V171205	RJV: added content
V171201	Original

1 INTRODUCTION

1.1 Purpose

The purpose of this workbook is to provide a reference for FRC programming and exercises to demonstrate software team skills.

1.2 Scope

The document covers the skills needed by software team members

1.3 Audience

The audience for this document is the software team.

1.4 References

FIRST software reference documentation

1.5 Definitions

CID Control Interface Document
ESC Electronic Speed Control

2 OVERVIEW

2.1 Description

The software skills workbook is organized into five sections

1. Setup Skills
2. Programming skills
    a. Program Design and standards
    b. Program creation / download / debug
3. RoboRio device I/O programming
4. Advanced programming skills
5. Other sub-system programming

3 SOFTWARE SETUP SKILLS

3.1 USE CASE: NETWORKING

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software Procedures
2. Right click on each "RoboRio networking" topic and open in a new window, then read FIRST documentation

3.1.1 Exercise

1. Configure the drive station network from FIRST documentation

3.2 USE CASE: ROBOT RADIO SETUP

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software Procedures

2. Right click "Programming your radio for home use" and open in a new window then read FIRST documentation

3.2.1 Exercise

1. Program radio for home use using the FIRST documentation

3.3 USE CASE: CONNECT DRIVE STATION TO RoboRio

1. Go to HFLRobotics website - resources - Software Handbook - section 7 – Driver station
2. Read FIRST Driver station documentation

3.3.1 Exercise

1. Startup drive station on the laptop and connect to the RoboRio

3.4 USE CASE: DRIVER STATION JOYSTICK

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - Driver station
2. Read FIRST Driver station documentation with regard to the joystick

3.4.1 Exercise

1. Determine the I/O port numbers for X-Y axis and game controller buttons
2. Update robotmap.java

3.5 CAN BUS SUBSYSTEM

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - Using the CAN subsystem with roboRIO
2. Read Software Handbook using the CAN subsystem links to FIRST documentation

3.5.1 USE CASE: PNEUMATIC AND POWER DISTRIBUTION SETUP

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - configuring and updating pneumatics and power distribution

3.5.2 Exercise

1. Setup pneumatic and power distribution modules per FIRST documentation
2. Update pneumatic and power distribution firmware
3. Update RobotMap.java class with CAN ID’s

3.5.3 USE CASE: SRX ESC MOTOR CONTROL MODULE SETUP

1. Go to HFLRobotics website - resources - Software Handbook - section 12 - talon SRX user guide and software manual
2. Read section 2 of the Talon SRX Software Reference Manual

3.5.4 Exercise

1. Setup SRX motor control module CAN ID's per FIRST documentation
2. Update RobotMap.java class with CANID’s

3.6 USE CASE: SOFTWARE UPDATES:

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software Procedures
2. Right click "installing frc update suite" and open in a new window and read FIRST documentation and read FIRST documentation

3.6.1 Exercise

1. Update Eclipse

3.7 USE CASE: ROBORIO FIRMWARE UPDATE

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software Procedures
2. Right click "updating RoboRio firmware" and open in a new window and read FIRST documentation

3.7.1 Exercise

1. Check firmware version or Update RoboRio firmware

3.8 USE CASE: ROBOT TROUBLESHOOTING LIGHTS

1. Go to HFLRobotics website - resources - Software Handbook - section 6 – troubleshooting
2. Right click on each "Troubleshooting" topic and open in a new window, then read FIRST documentation

3.8.1 Exercise

1. Look for lights on robot (RoboRio, SRX, radio) and document their state
2. Look at driver station log file

4 ADVANCED SETUP SKILLS

4.1 USE CASE: "NEW" ROBORIO SETUP - REQUIRES MENTOR

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software Procedures
2. Right click on each "Configuring the RoboRio" topics and open in a new window, then read FIRST documentation

4.1.1 Exercise

1. Configure RoboRio using FIRST documentation
2. Update RoboRio firmware using FIRST documentation
3. Install Java 8 on RoboRio using FIRST documentation

5 PROGRAMMING SKILLS BASE

5.1 FRC PROGRAMMING SKILLS

1. Go to HFLRobotics website - resources - Software Handbook - section 13- software training
2. Click on “Team 2228 Software Training Slides” link to HFLRobotics.com resources

5.1.1 LEARNING NEED TO KNOW JAVA AND FRC PROGRAMMING

1. If you are new to JAVA programming Click on “FRC JAVA Software Program Design” training slides.
2. Read computer science section, java basics and RoboRio device I/O

5.1.1.1 Exercise

1. Complete JAVA exercises

5.1.2 LEARNING FRC JAVA ROBOT PROGRAM STRUCTURE

1. Right click on “FRC Software Design and Program Structure” and review slides in a new window

5.1.3 FIRST FRC - FIRST ROBOT PROGRAM

1. Go to HFLRobotics website – resources - Engineering training module "FRC Software Design and Program Structure" and review the training slides
2. Go to HFLRobotics website - resources - Software Handbook - section 6 – software procedures
3. Right click on “Creating and Running Robot Programs” and read FIRST documentation in new window

5.1.3.1 Excercise

1. Create a project and benchtop test program
2. Tether to USB port and download / debug program
3. Through a wireless connection download / debug benchtop test program

5.2 TEAM 2228 PROGRAMMING DESIGN

5.2.1 TEAM 2228 PROGRAMMING DESIGN PROCESS

1. Go to HFLRobotics website - resources - Software Handbook - section 3 - software design process and read this section
2. Go to HFLRobotics website - resources - Software Handbook - section 4 - "build season software tasks and deliverables and read this section

5.2.2 TEAM 2228 PROGRAMMING STYLE GUIDE

1. Go to HFLRobotics website - resources - Software Handbook - section 10 – programming style guide and read this section. (THIS IS THE STANDARD ON CODE STYLE FOR TEAM 2228!)

6 ROBORIO DEVICE CONTROL PROGRAMMING

6.1 USE CASE: SMART DASHBOARD

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - driver station
2. Read FIRST documentation on displaying values on the smart dashboard

6.1.1 Exercise

1. Create a new project and using "iterative Robot"
2. Create a program to display some values and display them on the smart dashboard
3. Organize the values into two groups on the smart dashboard

6.2 USE CASE: DRIVER STATION JOYSTICK

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - driver station
2. Read FIRST documentation on displaying values on the smart dashboard

6.2.1 Exercise

1. Create a new project and using "iterative Robot"
2. Create a program to display on the smart screen the joystick X-Y values and button actions

6.3 ROBORIO SENSORS

6.3.1 RobRio Test Panel

1. Go to HFLRobotics website - resources - Electrical Handbook - section 3 - Robot design
2. Read what is a "Control Interface Document(CID)"
3. Create CID document
4. Create RobotMap.java class, defining all the I/O
5. Connect I/O to RoboRio from Test Panel

6.3.2 RoboRio Input-Output Pprogramming Documentation

6.3.3 USE CASE: DIGITAL I/O:

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - FRC JAVA and JAVA Library
2. In "Sensors" right click on switches to a new window and read FIRST Documentation

6.3.3.1 Exercise

1. Create new project “RoboRioIO” using "Iterative Robot" and create a program to:

   USE CASE: DIGITAL INPUT
2. Using switch "SW1" toggle up for logic 1 (true) and down for logic 0 (false)
3. Display true and false state on smart dashboard

   USE CASE: DIGITAL OUTPUT:
4. Extending use case digital input turn LED "LD1" on for true and off for false

6.3.4 USE CASE: ANALOG INPUT:

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - FRC JAVA and JAVA Library
2. In "Sensors" right click on analog input , potentiometers, analog triggers to a new window and read FIRST Documentation

6.3.4.1 Exercise

1. Using “RoboRio” project create an analog program to:

   USE CASE: ANALOG INPUT
2. Read analog input and display analog and analog digital value on smart dashboard
3. when analog value is above 1 volt turn read LED LD1 on
4. When analog value is between 2 and 3 volts turn LED LD2 on
5. When analog value is above 4 volts flash LED LD3 on and off on a 1 second cycle (use WPI library function “delay()”)

6.4 ROBORIO ACTUATORS

6.4.1 USE CASE: RELAY OUTPUT

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - FRC JAVA and JAVA Library
2. In "Actuators" right click on On/Off control of motors and other mechanisms – Relays to a new window and read FIRST Documentation

6.4.1.1 Exercise

1. Using “RoboRio” project create an relay program to:

   USE CASE: RELAY I/O:
2. Turn both relay outputs of the "SPIKE" relay off
3. Place motor select switch "ESC" in up position
4. Using switch "SW1" in up position turn "SPIKE" relay FWD on - FWD light should turn on
5. Using switch "SW2" in up position turn "SPIKE" relay REV on - REV light should turn on

   USE CASE: RELAY MOTOR CONTROL
6. Place motor select switch "ESC" in down position and put "SW1", "SW2" in down position
7. Create relay motor control program to turn on motor in FWD direction with "SW1" and REV direction with "SW2"

6.4.2 USE CASE: PWM OUTPUT(SERVO):

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - FRC JAVA and JAVA Library
2. In "Actuators" right click on Repeatable Low Power Movement - Controlling Servos with WPILib to a new window and read FIRST Documentation

6.4.2.1 Exercise

1. Using “RoboRio” project create an PWM program to:
   USE CASE: PWM OUTPUT
2. Use analog value to control servo location (Hint: raw analog value / 4096)
3. Display analog value and power on smart dashboard

6.4.3 USE CASE: MOTORS

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - FRC JAVA and JAVA Library
2. In "Actuators" right click “Driving motors with speed controller objects (Victors, Talons and Jaguars)” to a new window and read FIRST Documentation

6.4.3.1 Exercise

1. Using “RoboRio” project create an PWM program to:
2. Use analog value to control motor power(speed) (Hint: (raw analog value -2048)/2048)
3. Display analog value and power on smart dashboard

7 ADVANCED PROGRAMMING

7.1 USE CASE: GITHUP UPLOAD/DOWNLOAD FUNCTIONS

7.2 USE CASE: TIME AND DATE FUNCTIONS

7.3 USE CASE: "Chooser" PROGRAMMING

1. (The chooser program sets the robot up to run an autonomous program from a selection of of options)
2. Review 2017 robot program on Github
3. Create a new project and using "iterative Robot" create a chooser program
4. The chooser program shall have 4 selections
5. A selection when active will print to the console the selection made

7.4 USE CASE: STATE MACHINE

1. Complete the "Robot device control software tasks"
2. Review 2017 robot program and review with a mentor the construction of a state machine
3. Create a new project and using "iterative robot" create a traffic light state machine
4. Set "SW1" and SW2" to down
5. The first traffic light state machine will cycle through all the traffic light states
6. The second traffic light state machine will use "SW1"
7. "SW1" in an up state will immediately cycle to a red light
8. (We only have one set of traffic lights - at the red light, the traffic light reflects the other side)
9. After a 2 second delay, the traffic light will cycle to green

7.5 USE CASE: DATA LOGGER

1. Create a new project and using "iterative Robot" create a logger class

8 OTHER SUB-SYSTEM PROGRAMMING

8.1 CAN BUS SUBSYSTEM

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - Using the CAN subsystem with roboRIO
2. Read CAN subsystem links to FIRST documentation

8.1.1 USE CASE: MOTOR CURRENTS

1. Go to HFLRobotics website - resources - Software Handbook – section 6 - Using the CAN subsystem with roboRIO and read Power Distribution Panel FIRST documentation.

8.1.1.1 Exercise

1. Using pwm forward and reverse program read the motor current from the PDP module and display on the smart dashboard

8.1.2 USE CASE: PNEUMATIC OPERATION

1. Go to HFLRobotics website - resources - Software Handbook - section 7 - FRC JAVA and JAVA Library
2. In "Actuators" right click on Operating a compressor for pneumatics and Operating pneumatic cylinders – Solenoids to a new window and read FIRST Documentation

8.1.2.1 Exercise

(There is a problem with this use case - find them)

1. USE CASE: COMPRESSOR

2. Use switch "SW1" as a pressure switch;
3. If down turn on the compressor (turn on LED "LD4")
4. If up turn compress off (turn off LED "LD4")
5. USE CASE: PNEUMATIC CYLINDERS
6. Using switch "SW2" in up position extend cylinder (turn on LED "LD6" and turn off LED "LD5")
7. Using switch "SW2" in dwn position retract cylinder (turn off LED "LD6" and turn LED "LD5" on)

8.2 ESC SRX PROGRAMMING

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software links
2. Right click "Talon SRX user guide and software manual" to open in a new window
3. Download user guide, software manual, motion control manual

8.2.1 USE CASE: SRX ESC PWM CONTROL

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software links
2. Right click "Talon SRX user guide and software manual" to open in a new window
3. Read the manuals
4. Connect a CIM motor to one of the SRX ESC modules
5. Leveraging "PWM FORWARD AND REVERSE" code, develop code to run a motor from the SRX module

USE CASE: SRX MOTOR FUNCTIONS
(There are problems with this use case - find them)

1. Run the motor using the analog input and read the current from the motor and display on the smart dashboard
2. Turn motor off
3. With switch "SW1" in up position change the direction that motor turns with respect to analog input
4. Turn motor off
5. With switch "SW2" in down position reverse the operation of the analog input (low voltage-high speed; high voltage-low speed)
6. Turn motor off
7. With switch "SW3" in up position run motor at 70% power; in down position turn motor off
8. With switch "SW4" in down position set "brake" mode on motor stop (watch result)
9. With switch "SW4" in up position set "coast" mode on motor stop (watch result)

8.2.2 USE CASE: SRX ENCODER FUNCTIONS

1. Connect CIM encoder to a SRX module
2. Create and new project using "iterative robot"
3. In testPeriodic display the encoder on the smart dashboard
4. rotate the CIM motor shaft Clock wise(CW) and see if the encoder increases in value
5. If it decreases reverse encoder direction in software
6. From a button on the game controller run the motor a power level and display encoder on the smart dashboard
7. Stop the motor with either a game controller or when the encoder reaches a defined count

8.3 CAN LED STRIP PROGRAMMING

8.3.1 USE CASE: SETUP

1. Go to CAN LED strip web page http://www.mindsensors.com/content/88-cheat-sheet-for-canlight-led-strip-controller-kit-for-frc-robots
2. Load required libraries to eclipse
3. Read "Guides - Full Tutorial on the mindsensors Configuration Tool"
4. Download configuration tool

8.3.2 USE CASE: PROGRAMMING LED STRIP

1. Read "Guides - The Complete Guide on Getting Started with CANLight"
2. Read "Documentation - Java" document
3. Read "Guides - C++/Java Library Installation and Examples"
4. USE CASE: CANLED CLASS
5. Create a new project with iterative robot
6. Create a CANLED class with the following methods1 basicColor 2 LEDFlash3 cycleColor 4 LEDFade
7.

8.4 HEADING MODULE PROGRAMMING

NAVX is a heading module using accelerometers and manometers to provide High Accuracy, Low-latency Yaw, Pitch and Roll Angles

8.4.1 USE CASE: SETUP

1. Download libraries https://www.pdocs.kauailabs.com/navx-mxp/software/roborio-libraries/

8.4.2 USE CASE: PROGRAMMING

1. Read yaw document https://www.pdocs.kauailabs.com/navx-mxp/guidance/yaw-drift/
2. Read code examples https://www.pdocs.kauailabs.com/navx-mxp/examples/field-oriented-drive/
3. Download code from Github https://github.com/kauailabs/navxmxp

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8.4.3 USE CASE: CREATE TEST PROGAM

1. Create new project using iterative robot
2. Create class NAVXModule with the following functions
    a. Calibrate
    b. Reset
    c. read axis heading
    d. PIDHeadingCorrection (future)
    e. Rotate to angle (future)

8.5 ROBOT MOTION CONTROL

1. Go to HFLRobotics website - resources - Software Handbook - section 6 - software links
2. Right click "Talon SRX user guide and software manual" to open in a new window
3. Download user guide, software manual, motion control manual

8.5.1 USE CASE: POWER OUTPUT AND ENCODER DISTANCE

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8.5.2 USE CASE: ROBOT TURN - ROTATE

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8.5.3 USE CASE: SRX PID FUNCTIONS

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8.5.4 USE CASE: SRX MAGIC MOTION FUNCTIONS

8.5.5 USE CASE: MOTION PROFILING

8.1 VISION