1. <u>Save and compile your onboard code:</u>
    a. Save all source files that you have altered.
        i. *The C++ Eclipse IDE does not automatically save your changes when you clean and build your code.*
        ii. *If a source file has been altered and not yet saved, an asterisk will appear on the left side of the source file tab. The source file tab is found on the top left edge of the text editor window.*
        iii. *If you begin the compiling process during or immediately after the saving process is complete, your changes may not be made to the compiled code.*
        iv. *To avoid save failures, save twice before compiling. You can save twice by clicking the save icon then deleting and immediately re-adding a semicolon in one of your source files and clicking the save icon again.*
    b. Clean and build your code.
        i. *Under the "Project" tab on the ribbon bar, ensure "Build Automatically" is selected. This will automatically compile your code after the cleaning process.*
        ii. *Under the "Project" tab on the ribbon bar, click the "Clean" button. This will delete your old compiled code and recompile your current project.*
        iii. *Use the file explorer to navigate to the AscTec_SDK_v3.0 folder in your Eclipse workspace folder. Find the file "main.hex" and ensure that its modified date is current. If the modified date is older than expected, recompile your code.*

2. <u>Flash your compiled code to the drone:</u>
    a. Power off your drone.
    b. Set both board switches to program mode.
    c. Connect the drone to a USB port on the computer you are using to flash.
        i. *USB 2.0 and USB 3.0 ports both work equally well.*
    d. Power on the drone.
    e. Open the device manager on the computer and check the USB serial port COM number.
        i. *The COM number will change if you change drones and remain constant if you use the same drone.*
    f. Open "Flash Magic" from the start menu.
    g. Ensure the Flash Magic settings are correct as seen in Appendix A
        i. *The intermittent EWS server connection can cause your saved Flash Magic profile to be lost. Always ensure that the option profile is correct and be prepared to alter it if necessary.*
        ii. *Under "Step 3" in the Flash magic application ensure the most recent "main.hex" file is selected by clicking the "Browse…" button and selecting the "main.hex" file with the same modified date as seen in step 1.b.iii.*
    h. Click the "Start" button on the Flash Magic application.
        i. *Autobaud error typically means that one or both switches on the drone are not set to program mode. To fix, repeat steps 2.a through 2.h (omit 2.f).*
        ii. *A failure to connect to drone error can occur when drone is powered down, or the USB cable tethering the drone is not fully attached. To fix, disconnect the USB cable from the computer and repeat steps 2.a through 2.h (omit 2.f).*

3. <u>Ensure your drone is communicating with the ground station properly:</u>
    a. Power off the drone.
    b. Disconnect the USB cable from the drone.
    c. Set both onboard switches to run mode.
    d. Connect the proper ground station to the computer via a USB cable
        i. *Ensure the number on the ground station matches the number on the matching device on the drone.*
        ii. *USB 2.0 is usually more stable than USB 3.0.*
        iii. *Ensure that the two ground station LEDS (yellow and green) flash briefly when the ground station is initially connected to the computer. If they do not, disconnect the USB cable and reconnect it in another USB port on the computer.*

e. Power on the drone.
    i. *A continuous tone played by the drone's speaker means that there is a runtime error in the onboard code. If this occurs, power off the drone, correct the runtime error in the onboard code, and repeat steps 1, 2, and 3.*
    ii. *A continuous pattern of long-short tones played by the drone's speaker means that the IMU was unable to initialize due to movement during the powering on phase. If this occurs, power off the drone and, when powering it back on, make sure to hold it steady.*
f. Open the ACI tool program interface.
g. Select "Connect to serial device" and enter device number as "0".
h. Select "Set variables to request".
i. Select "Select variables". Type "1" next to all variables.
    i. *Make sure that all expected variables are shown. Some memory addresses are used elsewhere in the onboard code, so if an expected variable does not appear, change its address in the onboard code. Make sure to alter the offboard code to match this alteration.*
j. Select "Set transmission rate" and type "20" for every packet. (20 = 50Hz. packet rate)
k. Select "Request packet number and type 1"
    i. *If you type the improper pack number, you must restart the ACI tool and repeat steps 3.g through 3.k.*
l. Press the escape button on the keyboard.
m. Select "Set commands to request".
n. Select "Select commands". Type "1" next to all commands.
    i. *Make sure that all expected commands are shown. Some memory addresses are used elsewhere in the onboard code, so if an expected command does not appear, change its address in the onboard code. Make sure to alter the offboard code to match this alteration.*
o. Select "Request packet number and type 1"
    i. *If you type the improper pack number, you must restart the ACI tool and repeat steps 3.g through 3.o.*
p. Press the escape button on the keyboard.
q. Select "Set parameters to request".
r. Select "Select parameters". Type "1" next to all parameters.
    i. *Make sure that all expected parameters are shown. Some memory addresses are used elsewhere in the onboard code, so if an expected parameter does not appear, change its address in the onboard code. Make sure to alter the offboard code to match this alteration.*
s. Select "Request packet number and type 1"
    i. *If you type the improper pack number, you must restart the ACI tool and repeat steps 3.g through 3.s.*
t. Press the escape button on the keyboard.
u. Select "Show requested variables".
    i. *Ensure that all variables are displaying the proper memory addresses and expected values. An unidentified error can cause the ACI tool to show all memory addresses as the same value. If this occurs, uninstall and reinstall the ACI tool and repeat steps 3.g through 3.u.*
    ii. *Any variables that are reliant on the mocap system will give garbage data. This is because the drone cannot simultaneously communicate with the ACI tool and the mocap system.*
v. Press the escape button on the keyboard.
w. Select "Show requested commands".
    i. *Ensure that all commands are displaying the proper memory addresses and expected values. An unidentified error can cause the ACI tool to show all memory addresses as the same value. If this occurs, uninstall and reinstall the ACI tool and repeat steps 3.g through 3.u.*

        ii. *Any commands that are reliant on the mocap system will give garbage data. This is because the drone cannot simultaneously communicate with the ACI tool and the mocap system.*
    x. Press the escape button on the keyboard.
    y. Select "Show requested parameters".
        i. *Ensure that all parameters are displaying the proper memory addresses and expected values. An unidentified error can cause the ACI tool to show all memory addresses as the same value. If this occurs, uninstall and reinstall the ACI tool and repeat steps 3.g through 3.u.*
        ii. *Any parameters that are reliant on the mocap system will give garbage data. This is because the drone cannot simultaneously communicate with the ACI tool and the mocap system.*
    z. Close the ACI tool application.

4. <u>Set up the motion capture system:</u>
    a. Power off the drone.
    b. Move the drone to the center of the room.
        i. *The green X on the floor marks the closest approximation of the (0,0,0) location*
    c. Close the mocap software if it is running.
    d. Reopen the mocap software
        i. *If the error "Another instance is already running" appears, click "ok", wait 5 seconds, then attempt to reopen the mocap software*
    e. When prompted, select "Open existing project".
    f. Select the most recent project with "AE483" in its title. This project is usually near the top of the browser.
    g. Make your drone rigid body 1.
        i. *Click and drag left mouse button to form a box over "Rigid Body 1" as displayed in the live mocap feed window. Right click the now highlighted "Rigid Body 1" and select "remove".*
        ii. *Click and drag left mouse button to form a box over the five points that constitute your drone. Right click and select "Create Rigid Body".*

5. <u>Center your drone and prepare for flight test:</u>
    a. Gather the proper RC Transmitter and power it on.
        i. *The color tape on the -x axis of the drone matches the color of the tape on the transmitter.*
        ii. *Ensure that the transmitter is charged to at least 10.0V. Any lower voltage can lead to intermittent binding failures.*
    b. Run the ground station code.
        i. *Whereas Visual Studio 2010 does save changes made to source code before compiling and deploying, it is best practice to select save all before selecting "Run without debugging".*
        ii. *Selecting any other build option than "Run without debugging" will cause slow execution of the ground station code.*
    c. Ensure that the ground station executable starts and reads "Waiting for variable list..."
        i. *If you receive the error "Failed to open device with FT_OPEN. Exiting...", exit the ground station executable, unplug the ground station, repeat step 3.d, and attempt steps 5.b and 5.c again.*
        ii. *If you receive a pop-up error about the fprintf command, ensure that the filepath designated to save the flight data exists. This filepath is defined around line 90 of the ground station code in main.c.*
        iii. *If "Waiting for variable list..." does not appear after several seconds, press enter on the keyboard. This will update the readout of the ground station executable and should force show the "Waiting for variable list..." prompt. If the "Waiting for variable list..." prompt still does not appear, close the ground station executable and repeat steps 5.b and 5.c.*

d. Power on the drone and ensure that the ground station initiates communication. The ground station will prompt “Record Data [Hit Enter to Begin]” when it initiates drone communication. This prompt may take several seconds to appear.
    i. *If the ground station has not initiated communication with the drone, exit the ground station executable, power off the drone, unplug the ground station, repeat step 3.d, power the drone back on, and repeat steps 5.b through 5.d.*
e. Press enter on the keyboard and ensure that the live mocap data displayed at the bottom of the ground station executable is accurate. If it is, use this live feed to zero the drone’s position and orientation.
    i. *If the live mocap data is garbage, exit the ground station executable, unplug the ground station, repeat step 3.d, repeat all of step 4, and repeat steps 5.b through 5.e.*
f. Power off the drone (without moving it), close the ground station executable, and attach all safety mechanisms to drone.

6. <u>Begin the flight test:</u>
    a. Repeat steps 5.b through 5.d.
    b. Bind the RC Transmitter.
        i. *The best time to begin the binding process is just after the drone has powered on when the rotors twitch.*
        ii. *The throttle analog on the transmitter must be all the way down to bind to the drone.*
        iii. *Some transmitters, regardless of battery level, display intermittent binding failures. If this occurs, power off the transmitter, wait approximately 5 seconds, power the transmitter back on, wait approximately 5 more seconds, and attempt to bind the transmitter to the drone. If the transmitter fails to bind again, power off the transmitter and the drone, close the ground station executable, power the transmitter back on, and repeat all of step 6.*
    c. Press enter on the keyboard to begin collecting data.
        i. *Due to alterations made to the onboard and ground station code outlined by appendix f, variables and parameters generated onboard the drone and passed with the aciPublish() function cannot be sent to the ground station for recording. This means that only ground station variables can be used to print telemetry to output file.*
    d. Engage the controller using the transmitter.

7. <u>Closing and cleanup procedures:</u>
    a. Close the ground station executable.
        i. *Press ctrl+c to close.*
    b. Disengage the controller using the transmitter.
    c. Disconnect the drone from the RC transmitter.
    d. Power off the RC transmitter.
    e. Power off the drone.
    f. Close the mocap software.
    g. Disconnect the ground station from the computer.

8. <u>Auxiliary observations:</u>
    a. The drones with black nuts holding the rotors to the motors behave differently than the drones with the silver nuts holding the rotors to the motors. In general, the silver nut drones behave better.
    b. A controller that works well on one drone can be unstable on another. It is important to either use the same drone and always connect all the safety equipment.
    c. The finite difference state estimation method used in the default controller to estimate velocity decreases the system’s resilience to rotor damage. If a rotor is significantly damaged, it is important to replace that rotor. Failure to do so can result in an unstable system.