Lucas Roberge
STEM Legacy
10/5/22
Engine Focus

RATIONALE

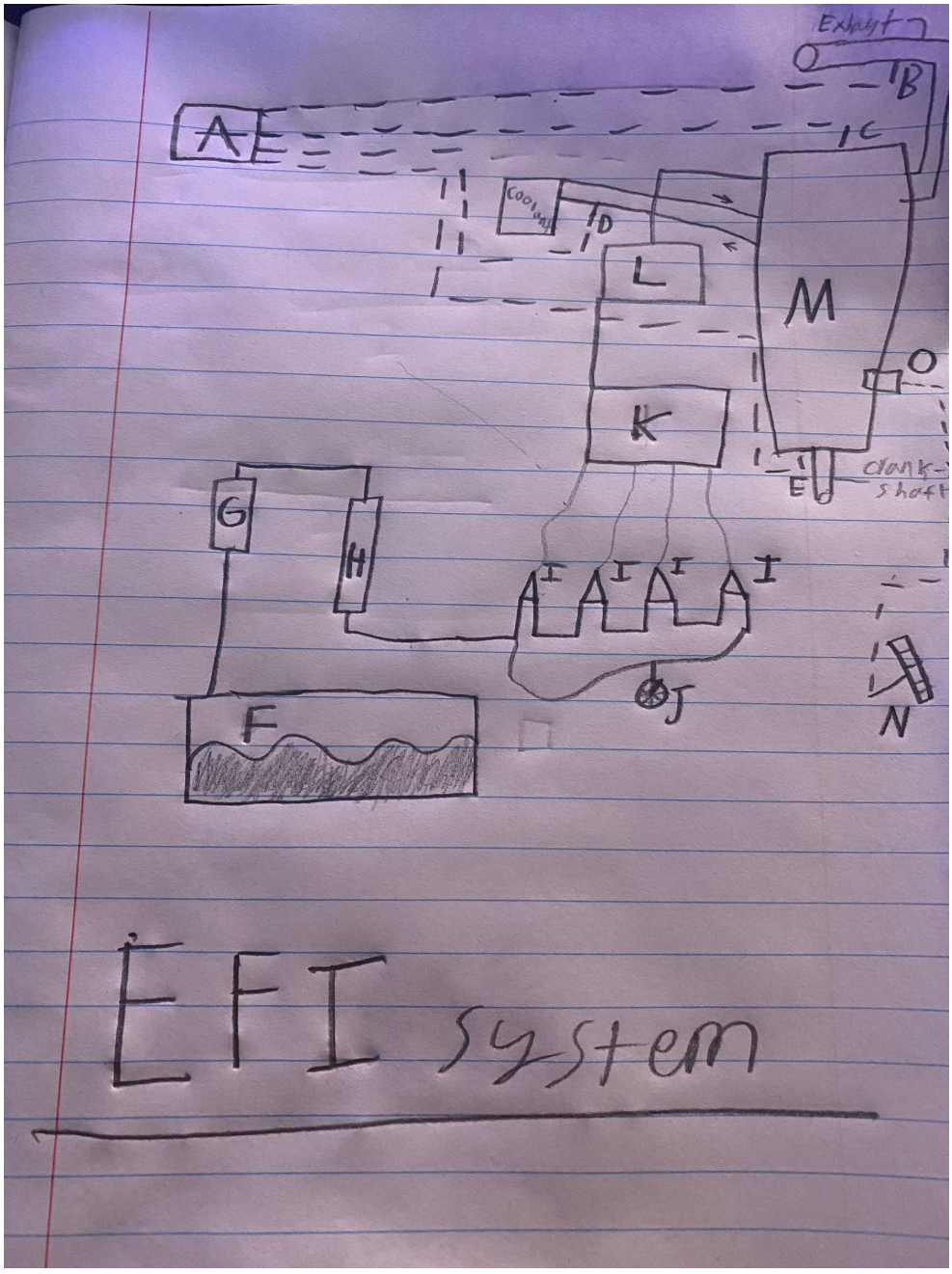
We have been assigned the project of constructing a recumbent motorcycle controlled by hub-centered steering, two-wheel steering, dual suspension, and an EFI system. I will build a two-cylinder, EFI system-controlled Honda GX610 small engine. The project constraint I have been assigned is that eventually. The overall goal for this year for me is to create not only a functioning engine with the necessary constraints applied but also research fuels and efficiency upgrades that can assist in environmental impact. The primary part of an EFI system in an engine is the ideal stoichiometric stability it holds. It will automatically change fuel injection rates into the combustion chamber in order to control engine efficiency, meaning it will never run too rich or too lean. The other main point is the EFI system allows for upgradability beyond the scope of a conventional carburetor. It is simple and fast to tune an EFI system, using code and rare hardware adjustments. The overall efficiency of my proposed engine changes will be highly beneficial, as the EFI system will not only optimize the engine's combustion efficiency but will also assist in preventing "knocking" and other discrepancies within the engine's workings. I personally expect the fuel and EFI changes to have a major impact on my engine's carbon emissions, along with elongating the lifespan of the included parts and reducing waste. This project will benefit the motorcycle industry by providing yet another option for fuel efficiency and environmental safety.

WORKING PRINCIPLES

The EFI system (Electronic Fuel Injection System) is an integral part of the modern engine. It uses an ECU (A) (Electronic Control Unit) to manage the stoichiometric balance within the combustion chamber, preventing the engine from running too rich or too lean. The ECU automatically adjusts itself via various sensors placed in the engine. The first is an O2 sensor (B) placed in the exhaust to manage the amount of air being pumped into the combustion chamber. Next, a knock sensor (C) allows for high-frequency vibrations to be recognized by the ECU in order to assist with ignition and engine lifespan. The coolant temperature sensor (D) detects the engine's operating temperature. Finally, the crankshaft position sensor (E) will detect RPM and translate information to the ECU in order to set ignition timing. Using all of the information gathered from these sensors, the ECU is capable of ideal operating conditions and maximum efficiency at all altitudes, and all typical temperatures, and is capable of adapting to most flex fuels with minimal conversion needed. The process of EFI combustion is as follows: The fuel (F) is pressurized through piping via a fuel pump (G) next to the gas tank. The pressurized fuel is run through a fuel filter (H) and ran into the fuel injectors (I) (average of 4) with a pressure gate (J) following the injectors in order to recycle excess fuel. The injected fuel runs into a distributor (K), which distributes a certain amount of fuel into the accumulator (L) depending on the ECU's direct sensor inputs. The fuel is then distributed into the accumulator, which pressurizes the fuel once more in order to prevent dry fuel lines. The accumulator will run fuel into the flow of the combustion chamber (M), allowing for efficient and constant combustion.

When the operator presses the fuel pedal (N), the throttle body (O) allows for air to flow into the engine creating the combustion needed for mechanical power.

Below is a detailed diagram of an EFI system:



OPERATION AND CRITERIA FOR SUCCESS

My “final activation mode” for the vehicle’s engine will include a simple user interface. It will include a log of the running code post-deactivation, allowing troubleshooting and assistance in bug fixing. During the present activation, there will be no manipulation of the interface or programming of the EFI during run time. The system will initiate after the starter motor is activated via the button included on the frame. The EFI will be in its own space, disconnected from the UI until the run time is reviewed after the activation period. Overall, in order for my project to be successful, I would be required to have completed or proceeded into the troubleshooting portion of the installation process with my custom EFI system. I intend to have fully completed functional programming for my system, along with having received and successfully installed all necessary components.

Below is an example chart of variable Air to Fuel data received during an EFI run time:

Target A/F "Fuel Map" for Open-Loop Control (1995 3000GT Spyder VR4)															
RPM	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500
LOW	14.0	14.7	19.8	19.8	19.8	19.8	18.8	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
	14.0	14.7	14.7	16.4	16.4	16.4	16.5	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
	14.0	14.7	14.7	14.7	14.7	14.7	14.7	15.7	15.7	15.3	14.9	14.9	14.9	14.9	14.9
	14.0	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	13.9	13.3	13.3	13.3	13.3	13.3
	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.5	12.9	12.9	12.9	12.9	12.9
L	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.3	13.3	12.6	12.1	11.8	11.8	11.8
O	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	13.6	12.9	12.2	11.8	11.3	11.3	11.3
A	13.6	13.6	14.7	14.7	14.7	14.7	14.7	14.7	13.3	12.5	11.9	11.4	10.9	10.9	10.9
D	13.4	13.4	13.8	14.3	14.3	14.7	14.7	13.1	13.1	12.2	11.5	11.1	10.7	10.7	10.7
	13.4	13.4	13.4	13.4	13.4	13.6	13.6	12.1	12.1	11.6	11.2	10.8	10.5	10.5	10.5
	13.4	13.4	13.4	13.4	13.1	13.1	13.1	11.8	11.8	11.2	10.7	10.5	10.3	10.3	10.3
	13.4	13.4	13.4	13.4	12.9	12.9	12.5	11.6	11.3	10.5	10.4	10.3	10.2	10.2	10.2
	13.4	13.4	13.4	13.4	12.9	12.9	12.5	11.6	11.3	10.5	10.4	10.3	10.2	10.2	10.2
HIGH	13.4	13.4	13.4	13.4	12.9	12.9	12.5	11.6	11.3	10.5	10.4	10.3	10.2	10.2	10.2

CONTINGENCIES

IN CASE OF INCOMPATIBLE SOFTWARE WITH HARDWARE

- Research the newest EFI control software language
- Purchase and order related EFI hardware module
- Attempt rewiring from ECU to sensors to eliminate the possibility of human error

IN CASE OF DYSFUNCTIONAL FUEL INJECTION

- Remove the fuel injectors and inspect for clogs
- Flush system with cleaning agent in search of contaminated fuel
- Run a system check on the EFI system code to assure functionality
- Investigate fuel pumps for clogs or contaminated fuel
- Perform system checks on fuel distributors and accumulators to ensure fuel availability

IN CASE OF ENGINE KNOCK

- Adjust programming in EFI system with lower air-to-fuel ratios
- Attempt to switch to a higher octane flex fuel that requires minimal adjustment
- Research possible hardware issues within the combustion chamber

IN CASE OF EXTERNAL SCENT OF FUEL

- Investigate sensor outputs and change fuel injection rates accordingly
- Perform systems check on accumulator and distributor and combustion chamber to assure hardware issues aren’t involved
- Check the externals of the gas tank to assure the seal is airtight

IN CASE OF ENGINE STALL

- Tighten the internal combustion seal and parts

- Check ECU logs for discrepancies
- Check fuel lines for leaks and fuel for contaminates

IN CASE OF ENGINE FIRE (Post Extinguish)

- Disassemble the engine and remove damaged parts
- Locate and test the ECU for functionality
- Salvage wiring
- Investigate seemingly intact parts for discrepancies

IN CASE OF FUEL CONTAMINATION

- Immediately flush engine of fuel
- Remove fuel injection lines and injectors/accumulator/distributor and check for debris
- Remove fuel filter and replace based on discrepancies
- Flush fuel tank and use externally sourced fuel

GOAL FOR FEBRUARY

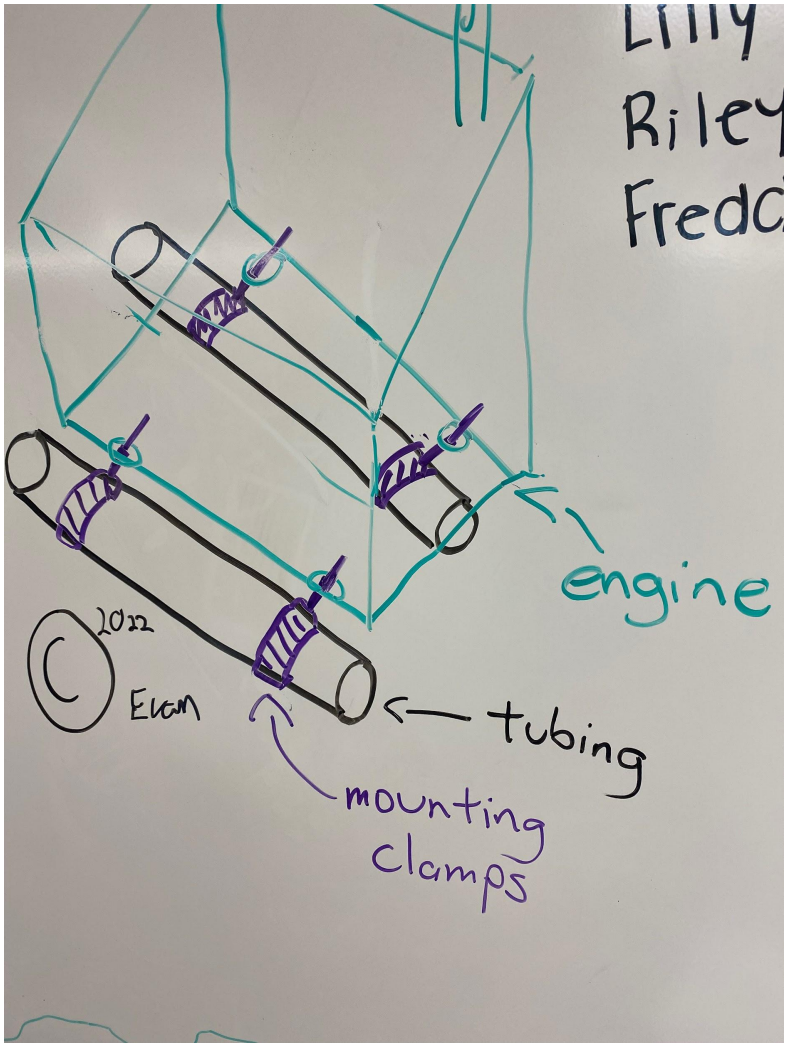
By February, the engine should be in an early state. It will include the installed and correct versions of the hardware. The ECU will not yet be programmed but will be heavily in progress.

CONCORDANCES

CONNECTION #1

My engine will be attached at the base of the frame via a strong mount. Although my project is primarily independent, I will need this mount and mounting place to be done at least by May of 2023.

Below is a quick diagram of the mounting:



TECHNICAL DRAWINGS AND INSTRUCTIONS

(ALL INSTRUCTIONS ARE IN CHRONOLOGICAL ORDER)

ENGINE PREPARATION

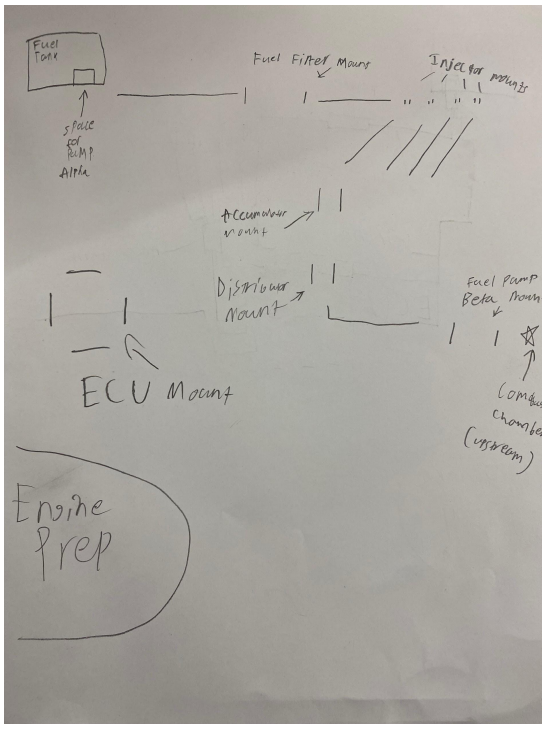
Open a slot in the fuel tank for a line that feeds fuel pump Alpha.

Allow space for fuel pump Alpha and fuel filter from the planned line.

From the planned line, install mounts for injectors.

Close to the injector install site, install mounts for the accumulator and distributor.

From there, open section for fuel pump Beta upstream from the combustion chamber.



HARDWARE INSTALLATION

Run a fuel line from the fuel tank.

Install fuel pump Alpha in the allocated slot.

Run the line through fuel pump Alpha into the fuel filter.

Install fuel injectors in the allocated slot.

Run the fuel line into the injectors evenly.

Run custom fuel lines from injectors.

Install the distributor.

Run the custom fuel lines into the distributor.

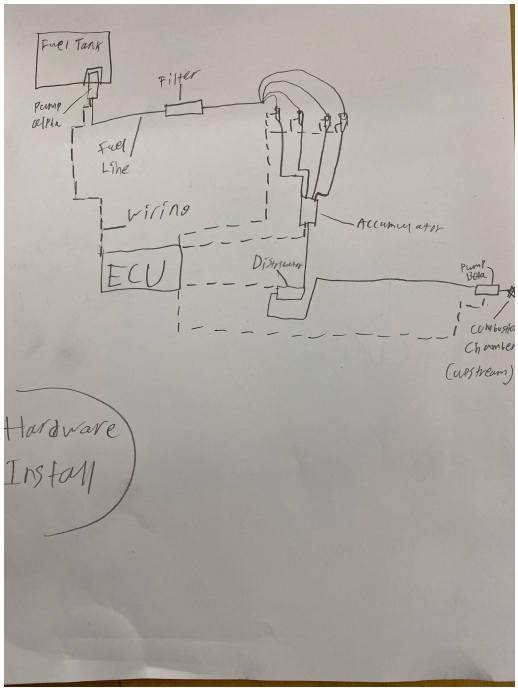
Run a fuel line from the distributor.

Install the accumulator.

Run the fuel line to the accumulator.

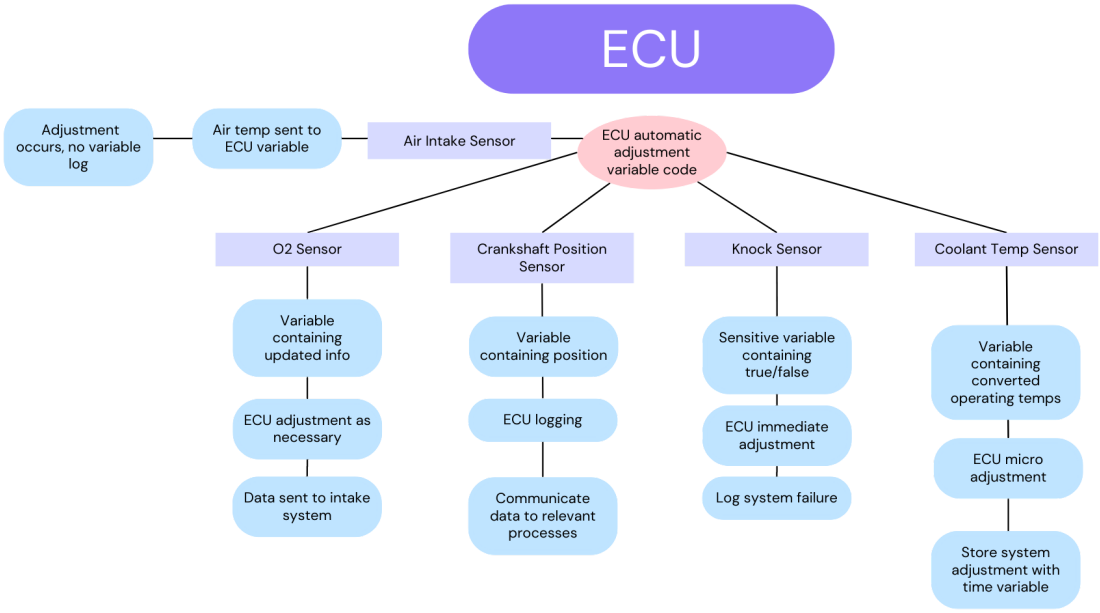
Install fuel pump Beta.

Run the fuel line through fuel pump Beta into the upstream combustion chamber.



PROGRAMMING (ECU)

Below is a Block Diagram of the programming processes:



Although a simple diagram, this outline shows the technical process through which the code will proceed.

These systems are all connected. These wiring diagrams are not shown here but were represented in this drawing:

Below is a programming “skeleton” of the future code (variable diagram):

```
//Below are the instance fields. These variables are defined early on as an important
part of the process.
void(setup)
{
//serial interface setup
//initiate protocol variable for runtime design
//integrate report variable for runtime and contingencies
//PGN setup
//Address claim/setup
//setup name and system designations
} //end setup
//integrate loop variable (void)
{
//timer units defined data traffic and protocol performance reporting (including reception)
//this function will set the ignition timing and upkeep the engine during runtime
}
} //end switch
} //end if
} //end loop
```

MATERIALS

Perfect-size EFI conversion kit with all necessary parts:

https://www.alibaba.com/showroom/small-engine-fuel-injection-kit.html

EFI Software Reference:

http://www.megamanual.com/mt29.htm

http://www.megamanual.com/begintuning.htm

Software for EFI.zip (840.6KB, 无限期)

进入下载页面

A simple manual for tuning software.zip (8.7MB, 无限期)

进入下载页面

Arduino x2:

https://store-usa.arduino.cc/products/arduino-uno-rev3

WORKING PLAN

Day 1-2: Begin installation prep for engine parts

Day 3: Complete installation prep / individual part tests

Day 4-8: Early stages of part installation

Day 9: Test what is installed so far, fixes

Day 10-15: Complete installation (rough draft)

Day 16: Test what is installed so far, fixes

Day 17: Full test of parts

Day 18: ECU programming start

Day 19-23: Fully learn programming language

Day 24-26: Early sensor testing

Day 27-30: Sensor installation once verified

Day 31-36: Programming

Day 37-38: Bug fixes

Day 39-40: Finalization of programming

Day 41-46: Testing of engine systems, fixes

Day 47-49: Finalization of Engine with working EFI

Day 50: Completed Product is a test ran, last-minute fixes