



# Final Presentation



Team Exo:

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# Overview

- Design Description
- Customer Requirements
- CAD Models
- Testing
- FlexCAN
- Project Plan



# Design Description - R80 KV110

- Integrated with hall sensors
- Special heat dissipation design
- Fast speed and high precision
- Max torque 4Nm
- Built-in plug to connect with Arduino
- Need CAN BUS to connect with the Arduino at the input pins
- Arduino can connect with computer and derive the motor
- Changes made in the code immediately affect the motor



# Setbacks and Scope Changes

The customer expressed dissatisfaction with the direction of the project, and met with the team to correct the scope. Changes to the project included:

- Removal of Torque and Speed measurements
- Removal of Brake
- Focus changed to programming and operating motors

Due to these changes, progress has been delayed, as the primary focus of the project is now different. Progress has also been delayed by the shipping of the motors, which has taken longer than originally scheduled. Without the motors, work on controlling them is somewhat limited.



# Customer Requirements

The customer asked that the team:

- Programming/validating various control modes and
- Build a test stand for the actuator that will be able to withstand peak operating conditions
- Retrofitting the exoskeleton (if time permits)

Note: These requirements have been listed in priority.



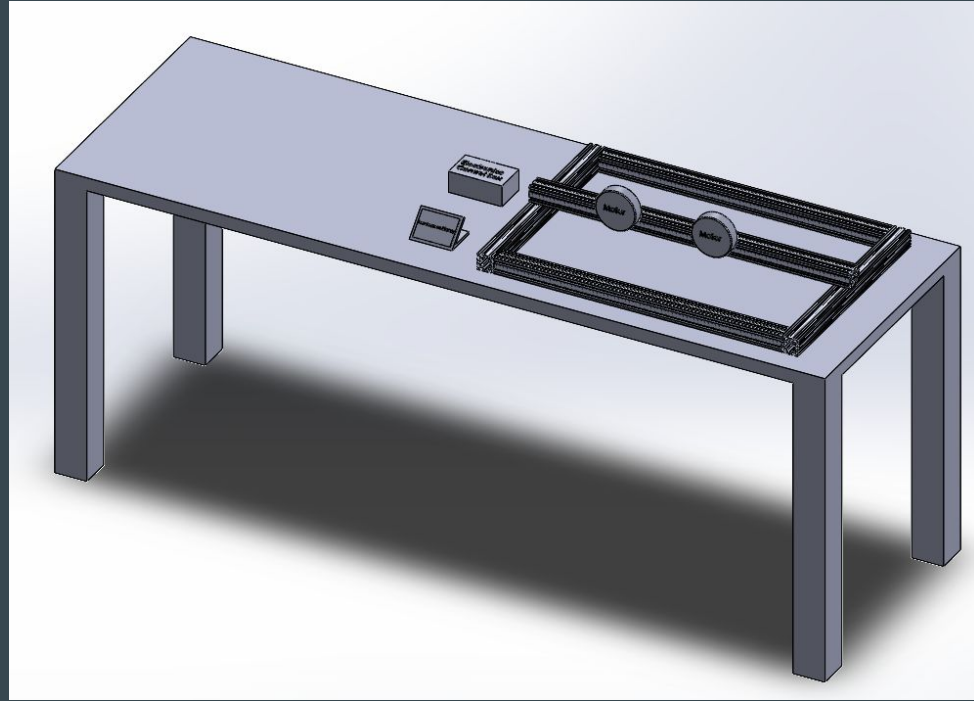
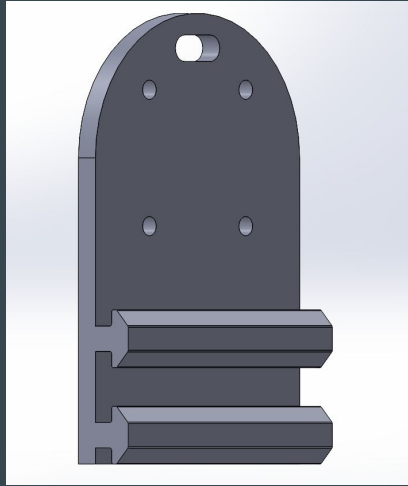
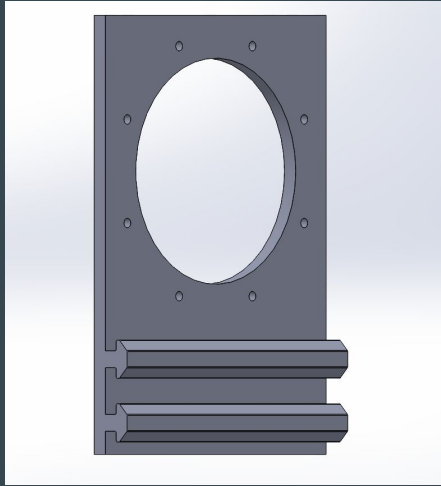
# Engineering Requirements

With the current focus being on controlling the motor, the engineering requirements are limited, as the scope is quite narrow

- Within a \$3000 budget
- Use CAN to provide current control to actuator



# CAD Models



# Open source code: FlexCAN

- FlexCAN is a serial communication driver for the CAN peripheral built into the Teensy CPUs.
- 5 versions of Teensy that the team will have to consider based on the motor compatibility
  - 3.1
  - 3.2
  - 3.5
  - 3.6
  - 4.0

Depending on which version the motors are compatible with. The version that is used will be picked. The version of Teensy that motors utilize will determine the type of code that can be modified and/or used.





# Open source code: FlexCAN (cont.)

- FlexCAN(baud, id, txAlt, rxAlt)
- Values in bold are default values if not specified
- Where on Teensy4, CAN1, CAN2, and CAN3 are available. On Teensy 3.x, CAN0 is available on all, but CAN1 exists only on Teensy 3.6.
- Baud rate: the number of signal units per second

Parameter	Description	Allowed values
baud	baudrate [bps]	Teensy 3.1/3.2/3.5/3.6: 50000, 100000, <b>125000</b> , 250000, 500000, 1000000
id	FlexCAN interface ID	Teensy 3.1/3.2/3.5: <b>0</b> (CAN0) Teensy 3.6: <b>0</b> (CAN0), 1 (CAN1)
txAlt	Alternative TX pin	Teensy 3.1/3.2: <b>0</b> (PIN3), 1 (PIN32) Teensy 3.5/3.6 CAN0: <b>0</b> (PIN3), 1 (PIN29) Teensy 3.6 CAN1: <b>0</b> (PIN33)
rxAlt	Alternative RX pin	Teensy 3.1/3.2: <b>0</b> (PIN4), 1 (PIN25) Teensy 3.5/3.6 CAN0: <b>0</b> (PIN4), 1 (PIN30) Teensy 3.6 CAN1: <b>0</b> (PIN34)



# Open source code: FlexCAN (cont.)

- Example code from FlexCAN\_T4.h
- Void is a function that returns no value
- Code is C - C ++ language
- Similar to Matlab
- Each code uses lots of if statements and defines variables for us so we use what we need
- Codes will be put into files and libraries so the code can take from those files to make the full code that the team needs for the motors

```
#include <FlexCAN_T4.h>
#include "imxrt_flexcan.h"
#include "Arduino.h"

#if defined(__IMXRT1062__)
static void flexcan_isr_can3();
static void flexcan_isr_can2();
static void flexcan_isr_can1();
#endif

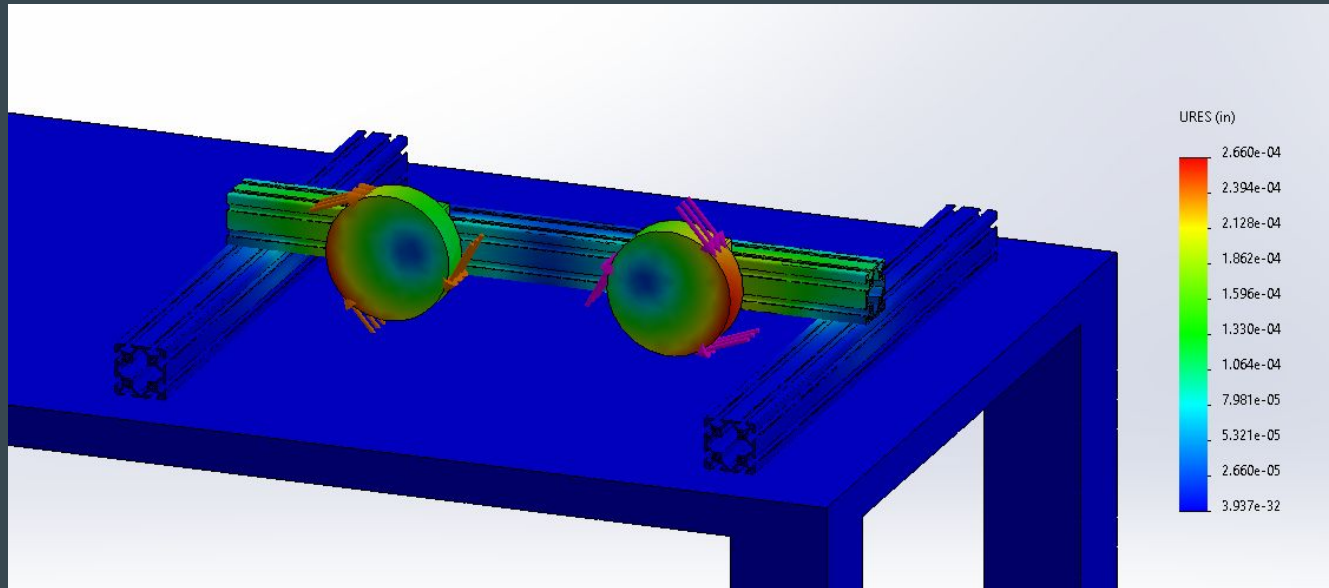
#if defined(__MK20DX256__) || defined(__MK64FX512__)
static void flexcan_isr_can0();
#endif

#if defined(__MK66FX1M0__)
static void flexcan_isr_can0();
static void flexcan_isr_can1();
#endif

FCTP_FUNC FCTP_OPT::FlexCAN_T4() {
#if defined(__IMXRT1062__)
    if ( _bus == CAN3 ) _CAN3 = this;
    if ( _bus == CAN2 ) _CAN2 = this;
    if ( _bus == CAN1 ) _CAN1 = this;
#endif
#if defined(__MK20DX256__) || defined(__MK64FX512__) || defined(__MK66FX1M0__)
    if ( _bus == CAN1 ) _CAN1 = this;
    if ( _bus == CAN0 ) _CAN0 = this;
#endif
}
#endif
```

# Testing

- Due to a delay in receiving the motors the only testing able to be accomplished was all theoretical.
- A simulation was used on the rough solidworks CAD assembly to see if the 80/20 aluminum would be the best option.
- The simulation was performed with each motor exerting peak torque of 18 Nm
- The maximum deflection was 0.0002660 inches



# Project Plan

Item	Purchase Link	Quantity	Cost Per Unit	Shipping Cost	Total Cost	Budget Remaining	Purchase Request Submitted?
T-Motor AK80-9	<a href="#">Link</a>	2	\$579.90	\$0	\$1,159.80	\$1,840.20	Yes
Teensy 4.1 Development board	<a href="#">Link</a>	1	\$37.99	\$0	\$37.99	\$1,802.21	Not Submitted
Husky 6 ft. Adjustable Height Solid Wood Top Workbench	<a href="#">Link</a>	1	\$326.45	\$0	\$326.45	\$1,475.76	Yes
Husky 26 in. 4-Drawer Rolling Cabinet Tool Box Chest in Gloss Black	<a href="#">Link</a>	1	\$140.84	\$0	\$140.84	\$1,334.92	Not Submitted
Markforged 800cc Onyx Filament Spool	<a href="#">Link</a>	1	\$207.44	\$4.50	\$211.94	\$1,122.98	Not Submitted
Markforged Carbon Fiber CFF 50cc Filament Spool	<a href="#">Link</a>	1	\$163.77	\$4.50	\$168.27	\$954.71	Not Submitted
seeed studio Serial CAN-Bus Module Based on MCP2551 and MCP2515	<a href="#">Link</a>	1	\$16.90	0	\$16.90	\$937.81	N/A

- Currently the T-Motor AK80-9 have been delayed until the end of November due to production issues
- The Husky 6 ft workbench is in our possession and waiting to be brought into the lab when the team can meet up
- The specific 80/20 aluminum and connectors still need to be priced
- Budget will be updated as more materials are required and requested



# Questions?