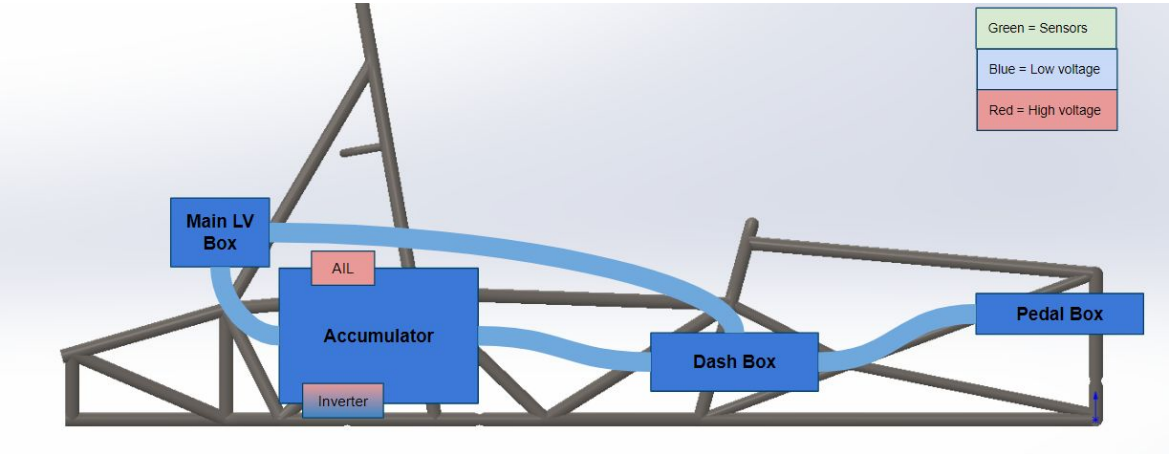
FORMULA SAE®

Systems Management Integration

Design integration, plumbing/wiring, power management, schematics. Are sensitive items protected? Proper use of data? Do systems compliment another? Are progressive project management/ organization methods evident? Special communication tools utilized? What testing/development tools have been used or created?

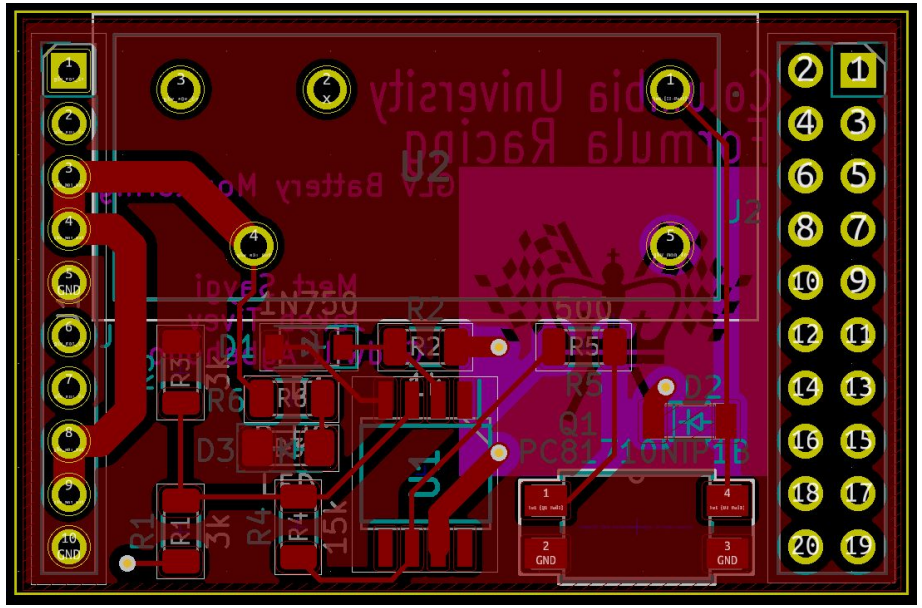
Wiring Harness and Power Management

EV Integration



- Decentralized and modular LV circuits allow for subsystem testing and redesign to happen in parallel
- 4 MCUs (one per LV enclosure and one in Accumulator) all responsible for nearby peripherals and subsystems -> allows for shorter individual wire lengths
- A CAN Bus allows for communication between MCUs and subsystems

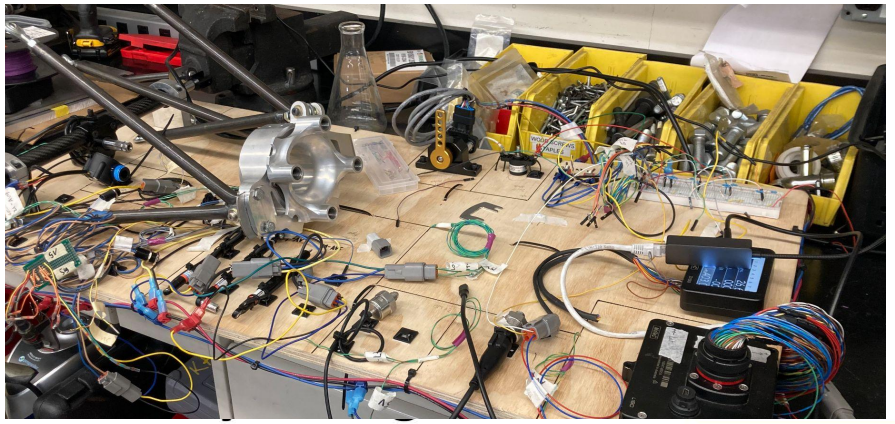
Power Management

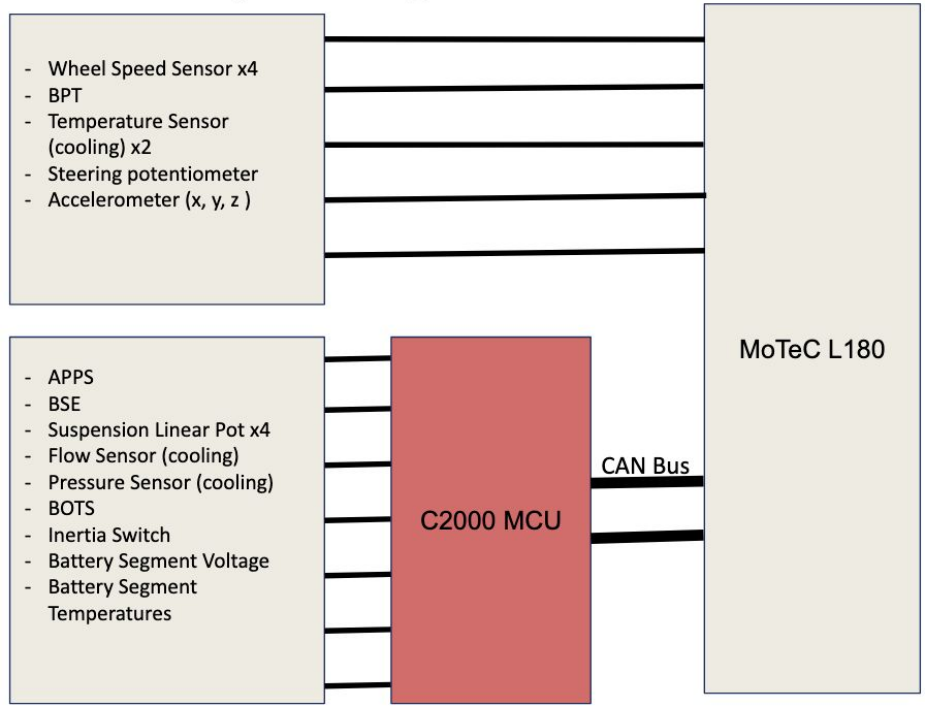


- Shorai 12V, 12Ah battery for low-power LV systems
- Subsystems fused in each enclosure
- A Low Voltage Battery Monitoring Board (pictured above) ensures that the battery does not discharge below the rated 12V to ensure a long lifetime

Data and Communication

- A MoTeC L180 data acquisition module is used to store data from sensors
- To increase the number of sensors that can connect to the MoTeC and to act on sensor data in real time some sensors are routed to an MCU and transferred to the MoTeC over the CAN bus
- A testing board for all of our sensors and the MoTeC was used to test the data acquisition system in parallel with car development





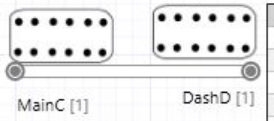
- A MoTeC D153 display screen is mounted on the dashboard
- Critical information (ie. battery pack voltage and velocity) will be displayed to the driver

Wiring Harness Software: RapidHarness

- Creates a digital mockup of wiring harnesses and the connections on the car
- Harnesses are created from connectors and wires and can store the data about each of its wires within said harness
- Devices are used to show an electrical component that has a connection to a harness (i.e. PCB Boards)
- Harness and devices make up a system, which can use signals created by the harnesses and devices to show a complete connection net of the system
- RapidHarness allows for easier and more localized access to wiring schematics and other data regarding the wiring harness for testing and presentation

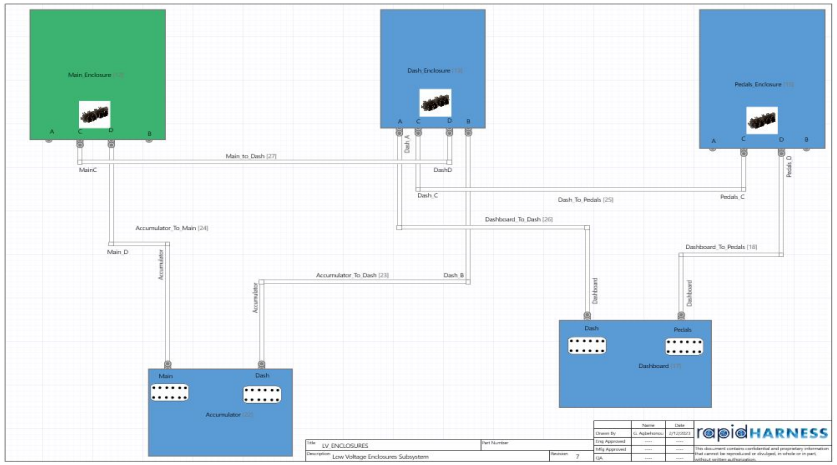
Dash_to_Main Harness (Main C to Dash D)

Notes	From	To	Conductor	Color	Gauge
PWR_12V	MainC.1	DashD.1	W5.Red		18 AWG
PWR_GND	MainC.2	DashD.2	W11.Black		18 AWG
SDS+	MainC.3	DashD.3	W6.Blue		18 AWG
SSOK_SIG	MainC.4	DashD.4	W7.Blue		18 AWG
CANH	MainC.5	DashD.5	W8.Green		18 AWG
CANL	MainC.6	DashD.6	W9.Green		18 AWG
CAN_GND	MainC.7	DashD.7	W10.Black		18 AWG
APPS_SIG	MainC.8	DashD.8	W12.Green		18 AWG
APPS_5V	MainC.9	DashD.9	W13.Red		18 AWG
APPS_GND	MainC.10	DashD.10	W14.Black		18 AWG



Notes	From	To	Conductor	Color	Gauge
PWR_12V	DashD.1	MainC.1	W5.Red		18 AWG
PWR_GND	DashD.2	MainC.2	W11.Black		18 AWG
SDS+	DashD.3	MainC.3	W6.Blue		18 AWG
SSOK_SIG	DashD.4	MainC.4	W7.Blue		18 AWG
CANH	DashD.5	MainC.5	W8.Green		18 AWG
CANL	DashD.6	MainC.6	W9.Green		18 AWG
CAN_GND	DashD.7	MainC.7	W10.Black		18 AWG
APPS_SIG	DashD.8	MainC.8	W12.Green		18 AWG
APPS_5V	DashD.9	MainC.9	W13.Red		18 AWG
APPS_GND	DashD.10	MainC.10	W14.Black		18 AWG

LV_ENCLOSURES System



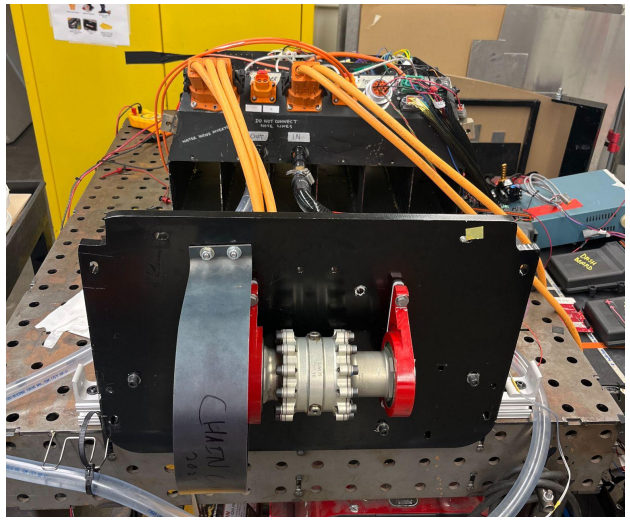
LV_ENCLOSURES
Connection Signal Net

Device / Harness	Endpoint	Signal
Accumulator	Dash.1	DCDC_ON
Accumulator_To_Dash	Accumulator.1	
Accumulator_To_Dash	Dash_B.7	
Dash_Enclosure	B.7	DCDC_EN_ACC
Accumulator	Dash.2	RTD_DASH
Accumulator_To_Dash	Accumulator.2	
Accumulator_To_Dash	Dash_B.8	
Dash_Enclosure	B.8	RTD_SIG
Accumulator	Dash.3	LED_SDC
Accumulator_To_Dash	Accumulator.3	
Accumulator_To_Dash	Dash_B.4	
Dash_Enclosure	B.4	LED_SDC_ACC
Accumulator	Dash.4	CURRENT_SENS
Accumulator_To_Dash	Accumulator.4	
Accumulator_To_Dash	Dash_B.6	
Dash_Enclosure	B.6	CT_ACC
Accumulator	Dash.5	BPT_SIG
Accumulator_To_Dash	Accumulator.5	
Accumulator_To_Dash	Dash_B.12	
Dash_Enclosure	B.12	BPT_SIG_ACC
Accumulator	Dash.6	SDS_OUT
Accumulator_To_Dash	Accumulator.6	
Accumulator_To_Dash	Dash_B.11	
Dash_Enclosure	B.11	SDS_OUT

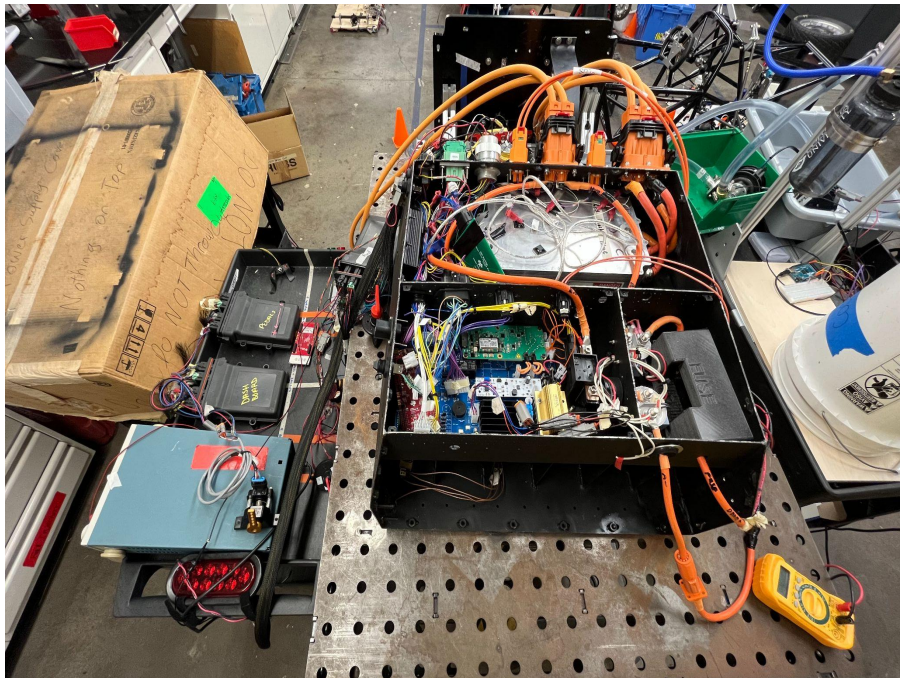
Isolated Testing

- Subteams (ie. cooling, HV, LV) had specific testing carts for a pipelined testing program and easy integration and troubleshooting off the chassis
- This allowed ups to isolate problems such as the motor plate flexing and the AIRs not flipping due to high resistance in the shutdown loop
- PCBs designed for standalone testing without the need of integrated sensors and systems

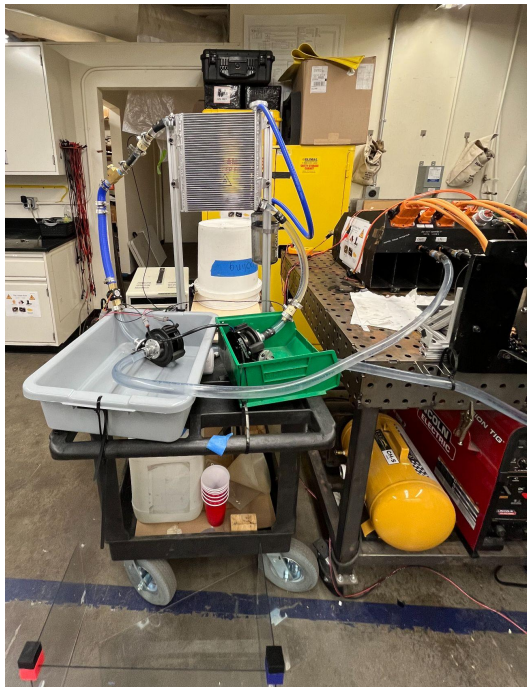
Drivetrain Test Bench



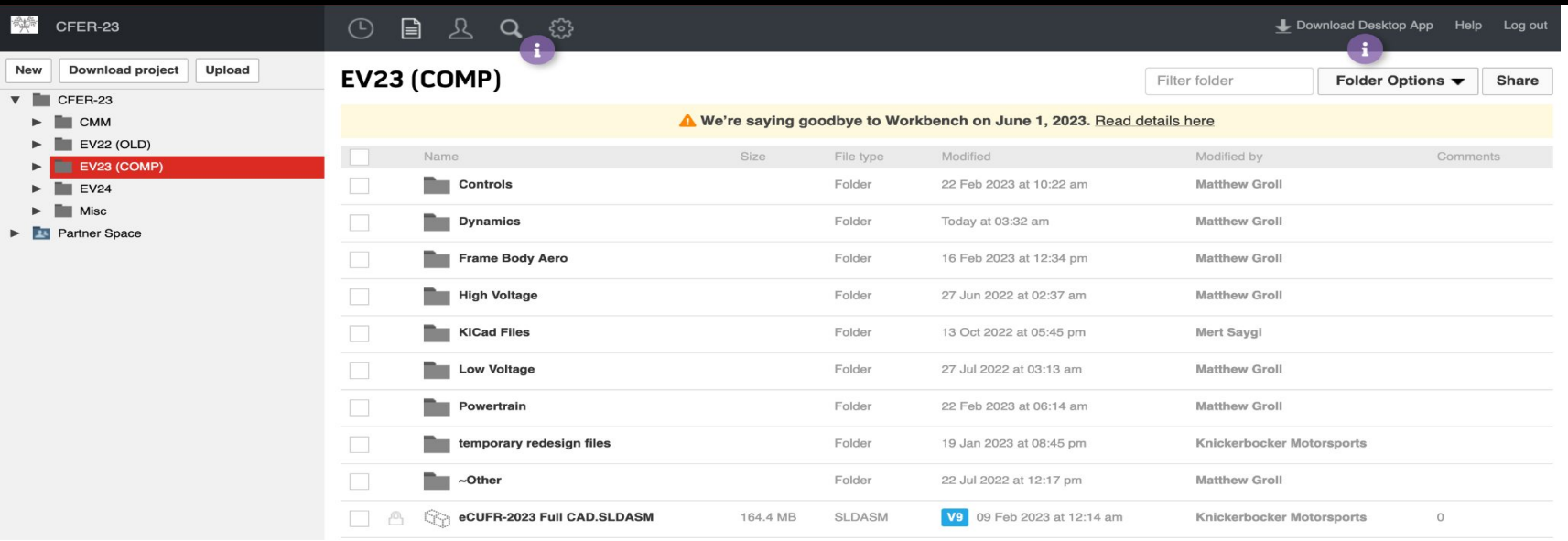
HV and LV Test Cart



Cooling Test Cart



Development Tools: GitHub and GrabCad



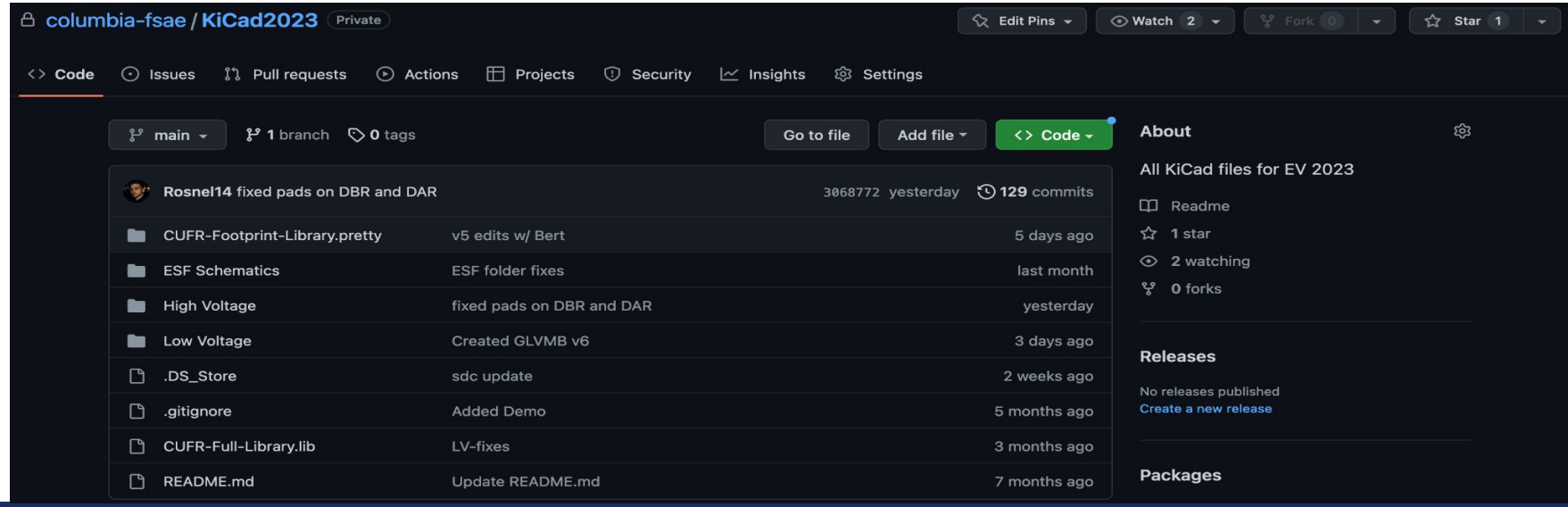
GrabCad:

- Store and version control all CAD models

GitHub:

- Store and version control all electrical schematics, PCB designs and software

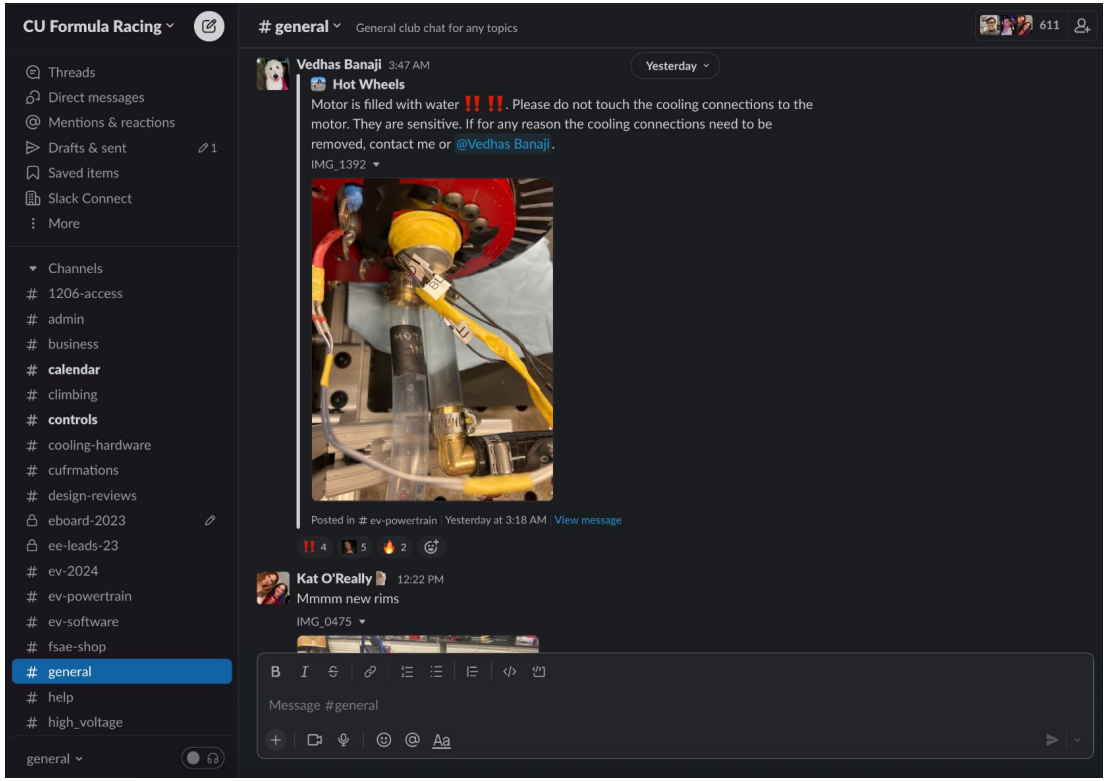
- Desktop Application allows for instant update of project folders on local device



Communication: Slack and Google Suite

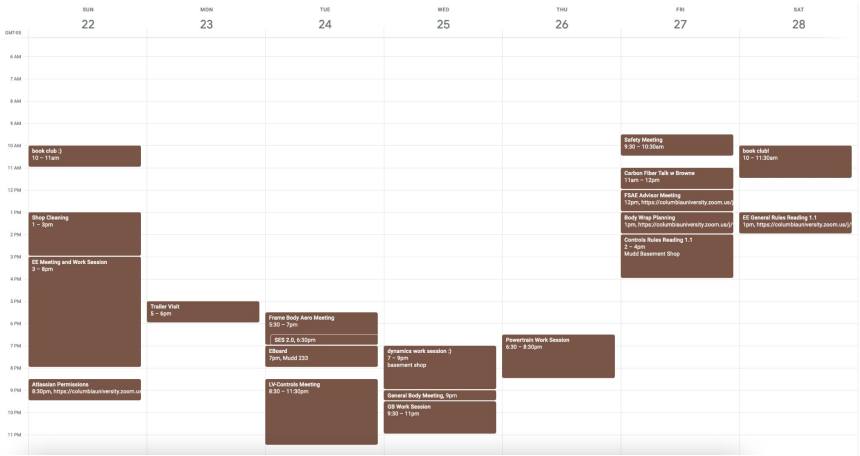
Slack:

- Fast and urgent messaging
- Topic-specific channels
- Integrated with apps for productivity



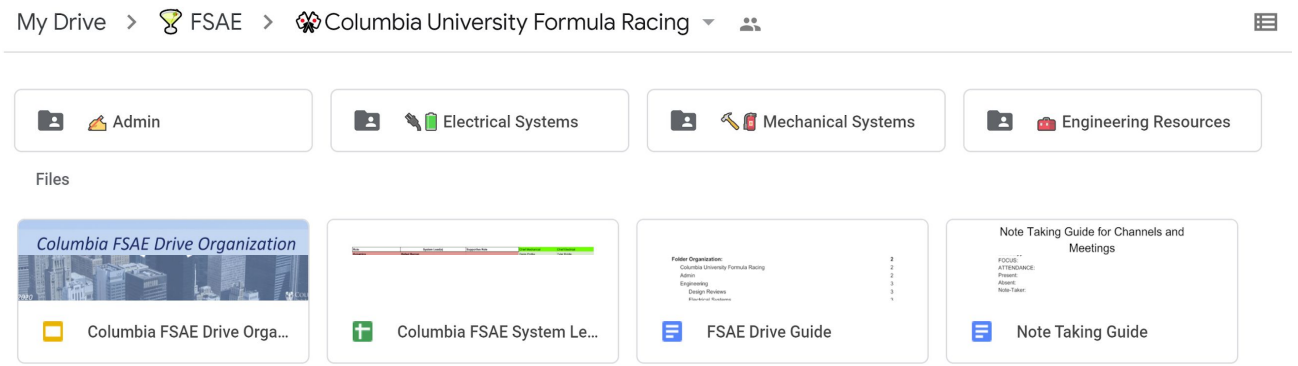
Google Calendar:

- Displays designated meeting
- Allows for integration of systems to take place in parallel with individual subteam developments



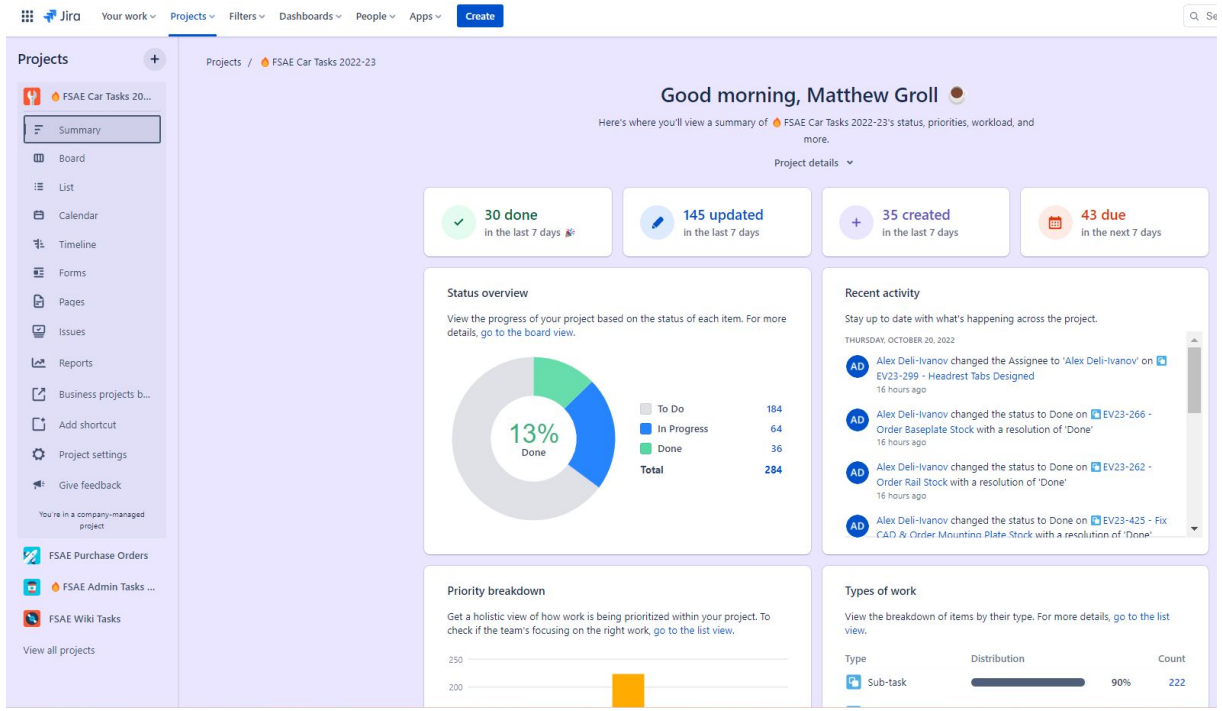
Google Drive:

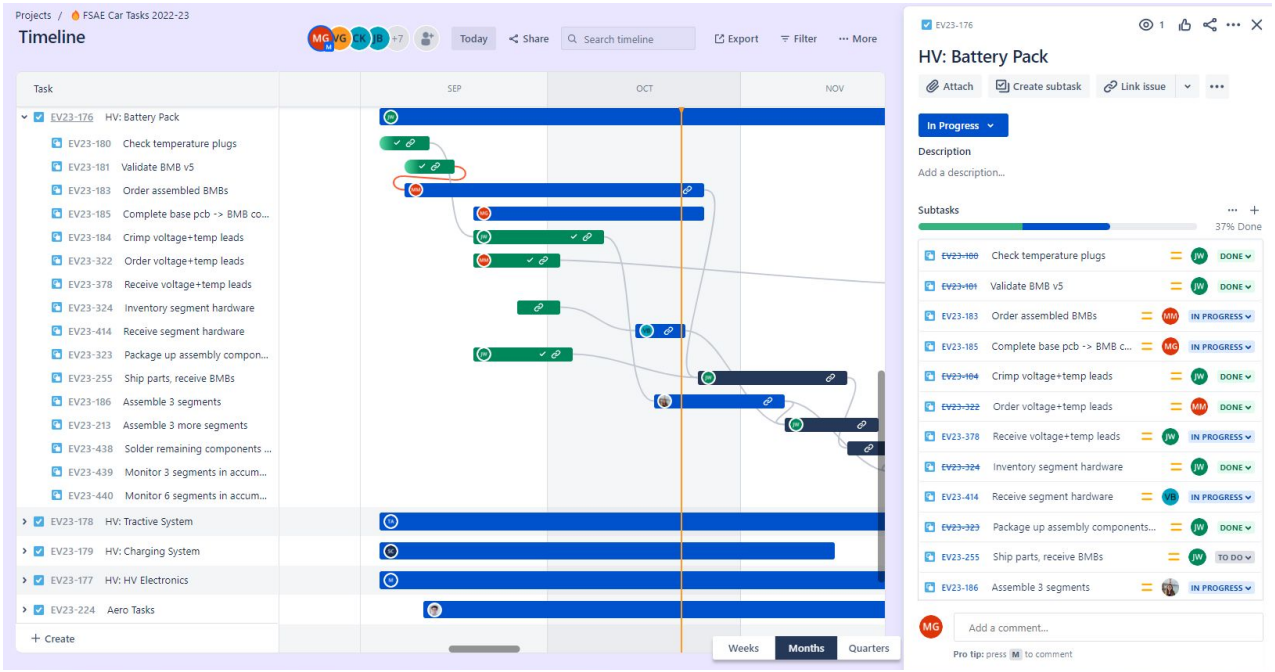
- File sharing: notes, competition documents, testing plans, data sets, reference documents, and more



Management Tools: Jira

Jira allows our team to coordinate project work on subteam, system, and component level. Task dependency can be tracked as well as progress. Updates can be communicated.





Onboarding & Knowledge Transfer

The team invests heavily in new member recruitment and retention for long-term success of our car and engineering program.

We use Confluence as a wiki to easily share information.

Process:

- Subteam-level introduction meet & greets
- “Shopping” Period with open work sessions
- Becoming an official member guarantees you access to club-wide events
- Year-long support program by the executive board
- Workshops, Office Hours, & Teaching Presentations