



Manufacturing Status Review

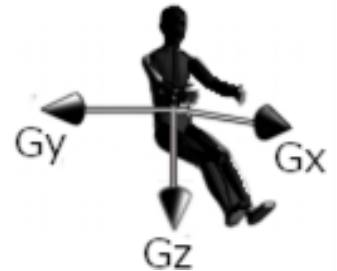
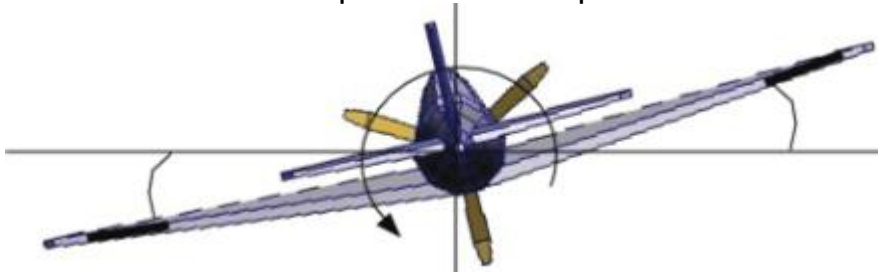
CHAIR



CHAIR Overview

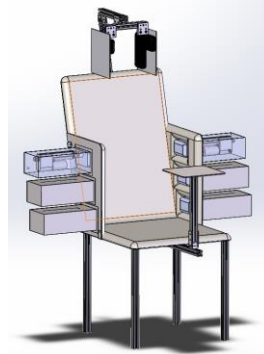


- Customer's Goal
 - Provide multiple sensory cues to remote pilots to increase aircraft attitude awareness
- Team CHAIR's Role
 - Create a proof of concept research tool that can be further developed into a complete system used by remote pilots
- Levels of Success
 - Level 1: Discrete, static tilt cueing about the body x axis
 - Level 2: Continuous, sinusoidal tilt cueing about the body x axis
 - Level 3: Variable tilt profile developed in real time through joystick control

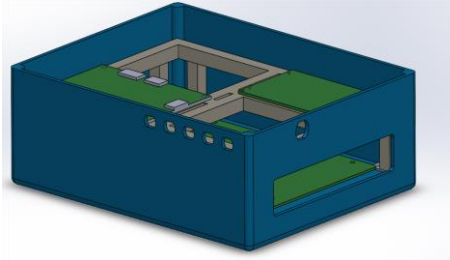


Critical Project Elements

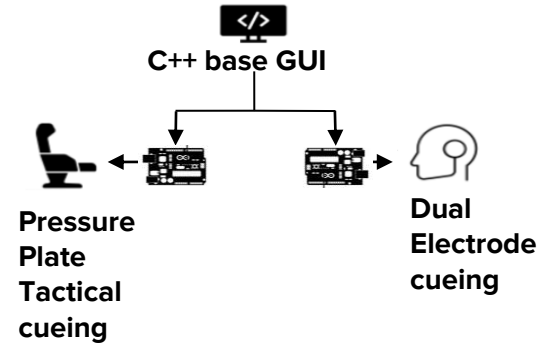
- **TCS** (Tactile Cueing System)
 - 3 pressure plates on each side
 - Actuators, Circuits and Hardware
 - Extension of pressure pads integrated with sensor feedback



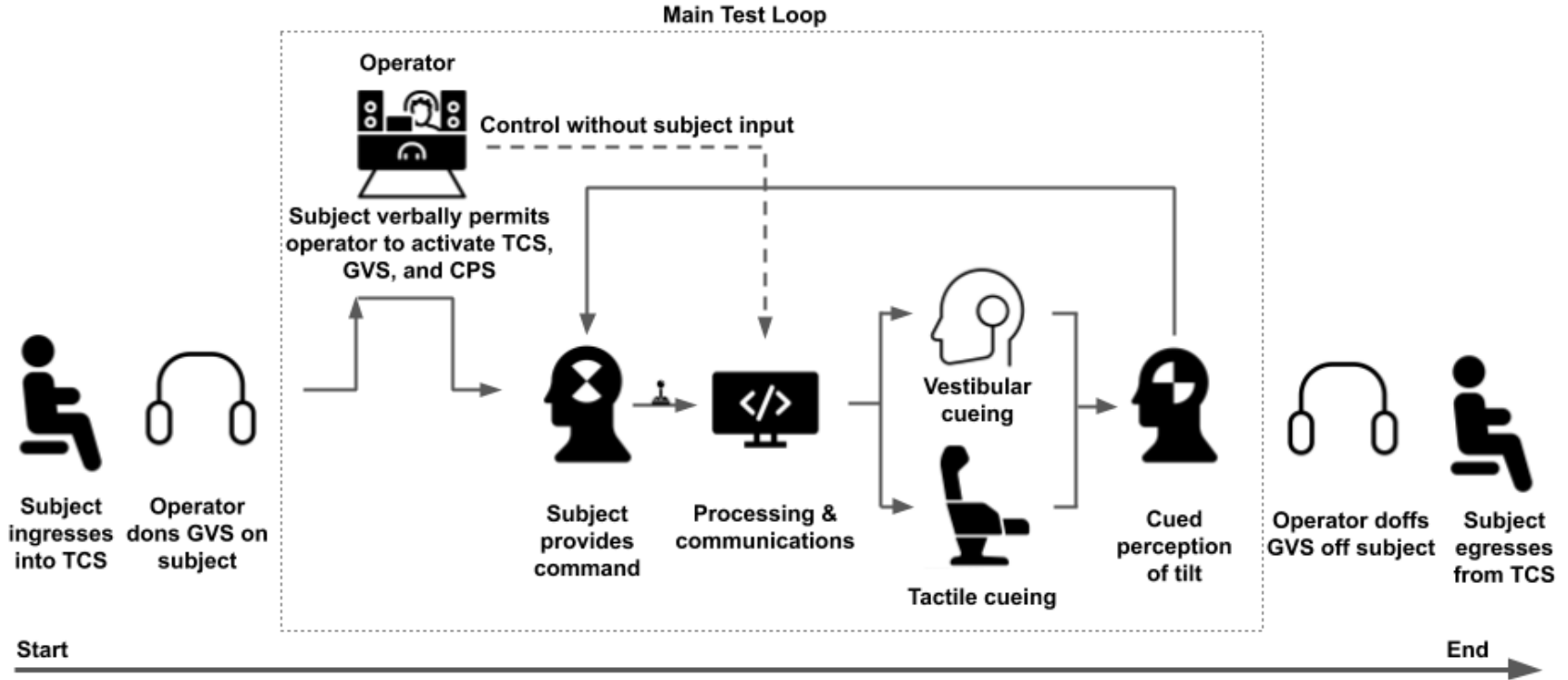
- **GVS** (Galvanic Vestibular Stimulator)
 - Multi-Electrode Setup
 - Skin-Electrode Interface
 - Current Control



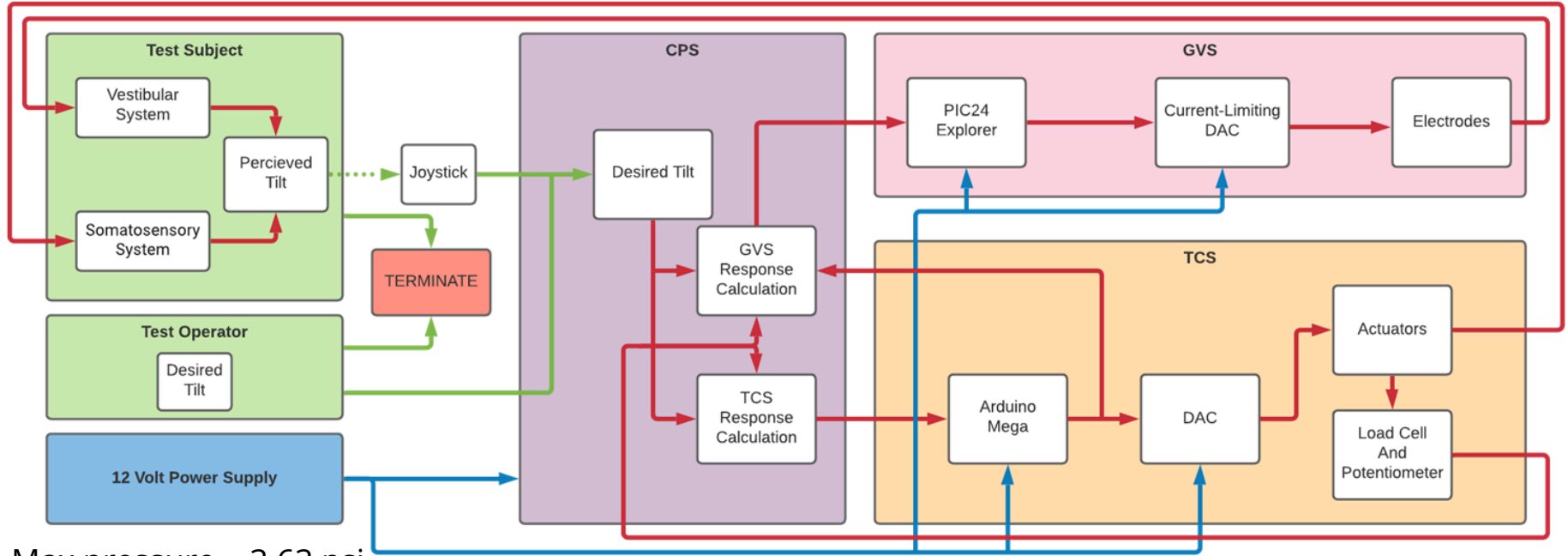
- **CPS** (Central Processing System)
 - Control Flow
 - Interfacing with the TCS, GVS or GUI



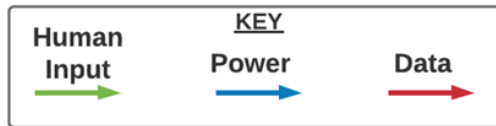
ConOps



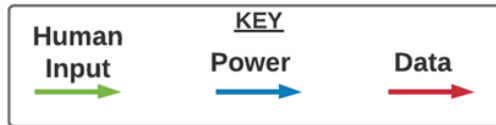
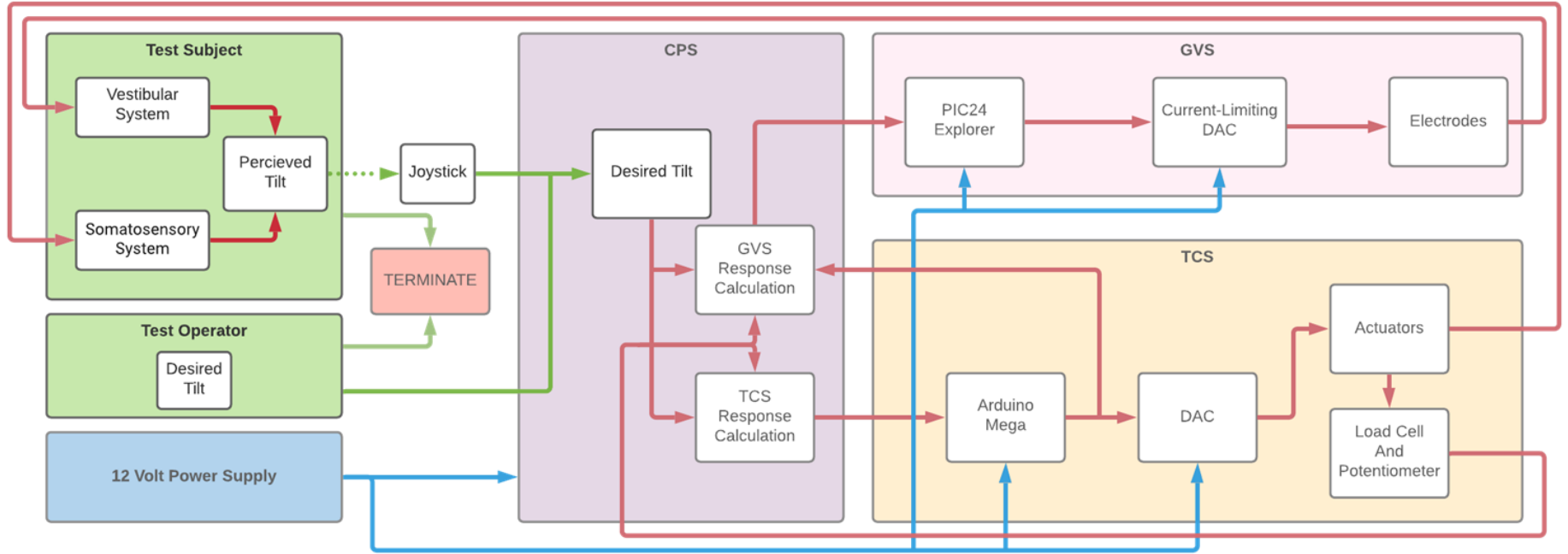
Functional Block Diagram



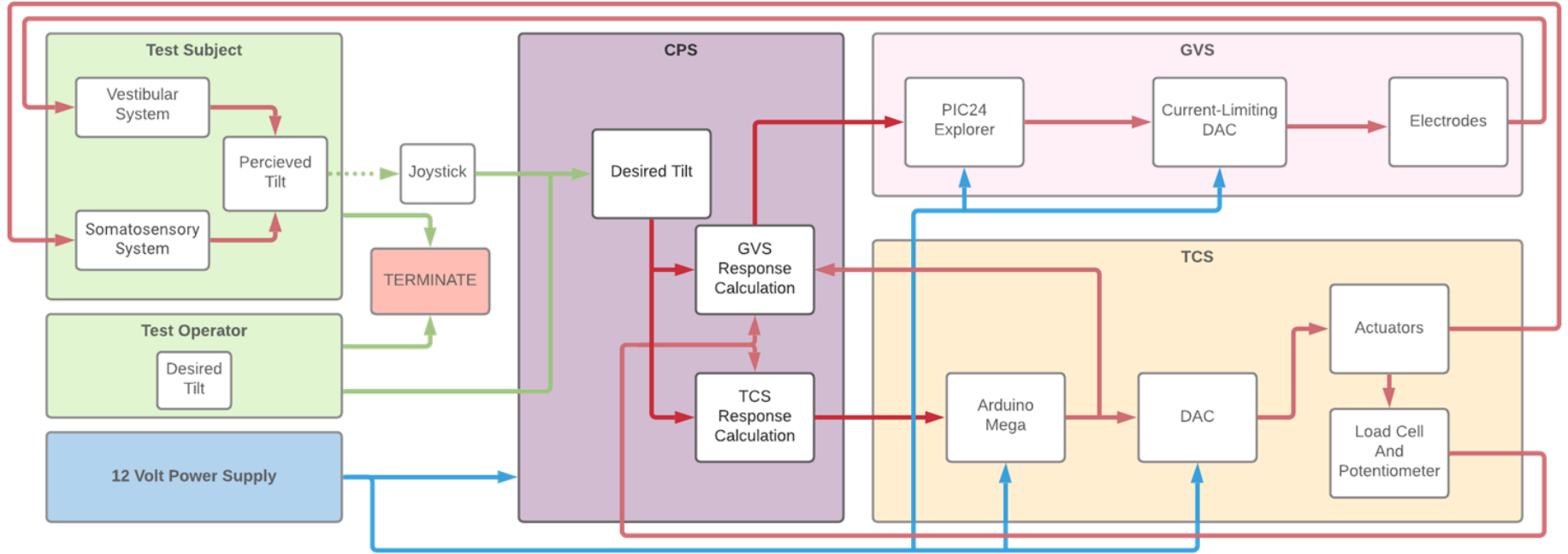
Max pressure = 3.63 psi
Max amperage = 4 mA
Max lag = 200 ms
Max incongruence = 100 ms



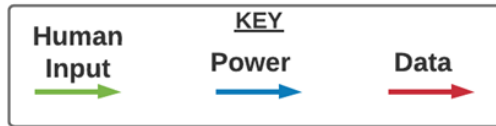
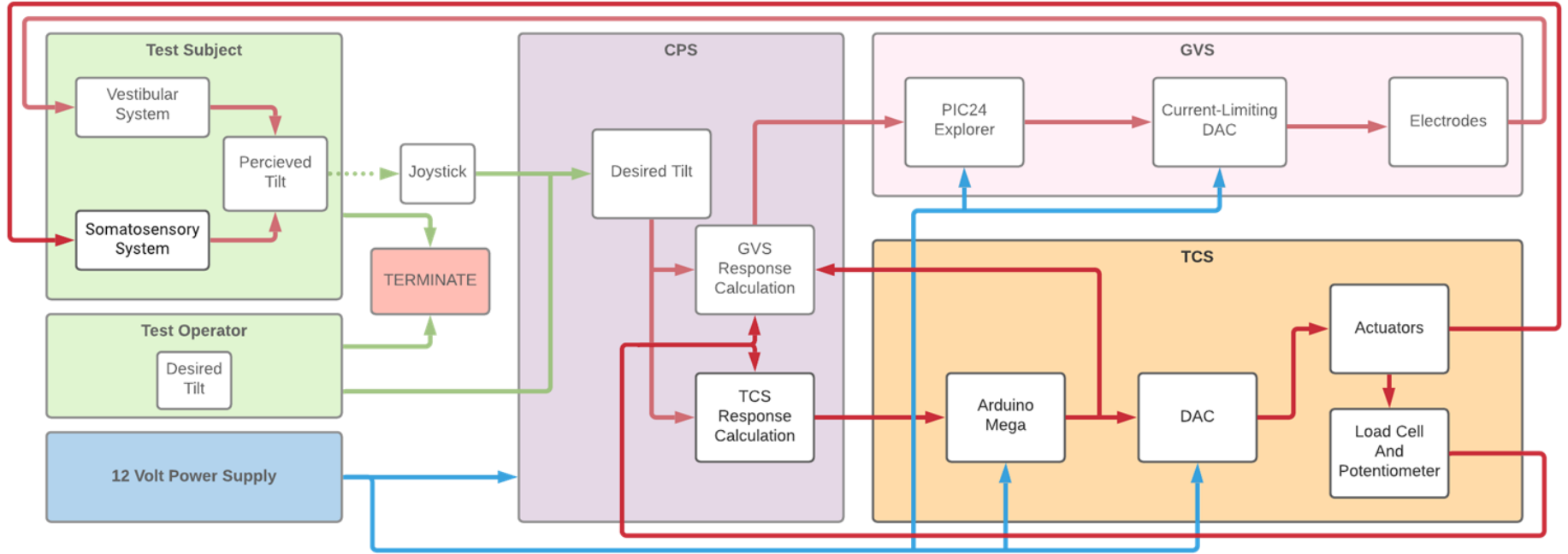
Functional Block Diagram



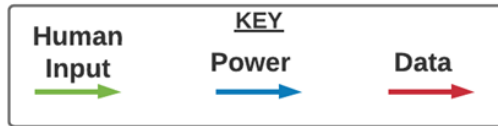
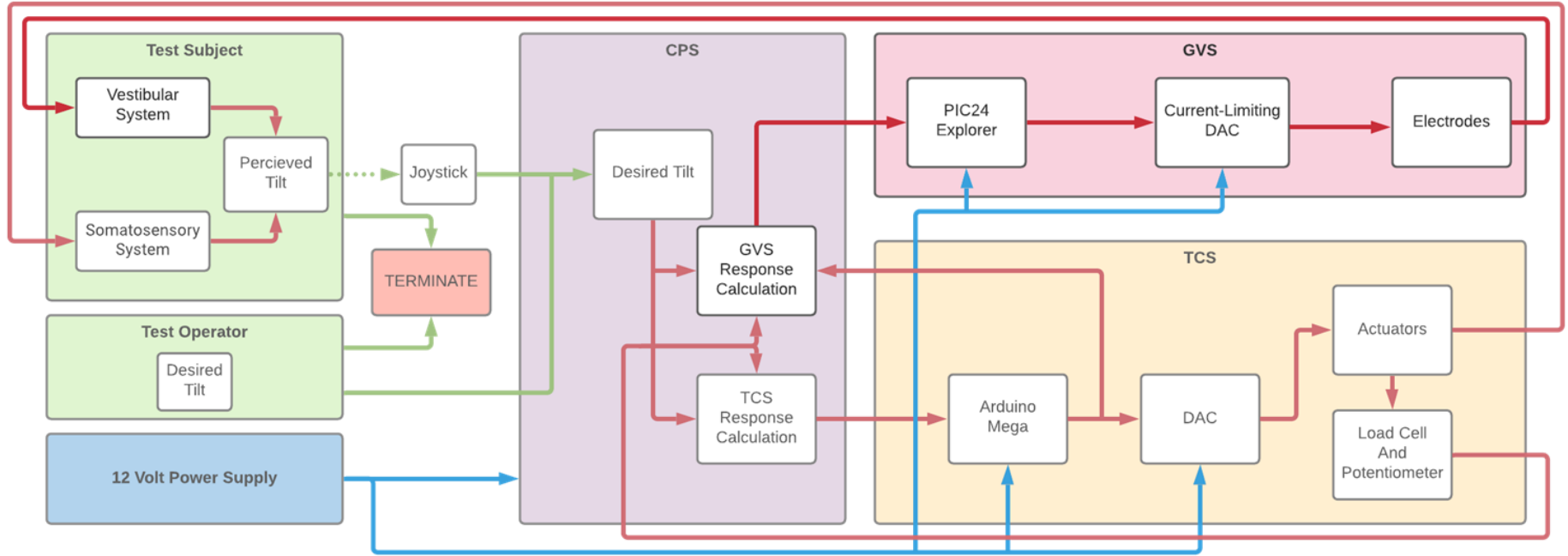
Functional Block Diagram



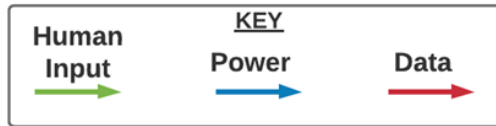
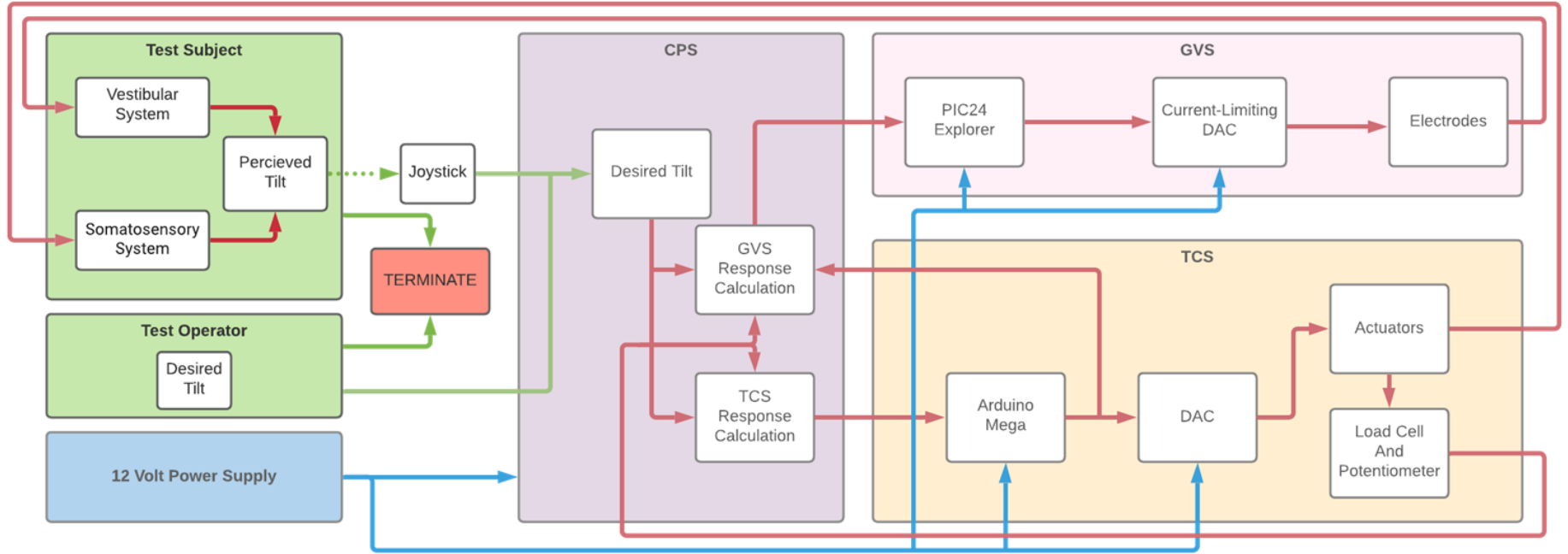
Functional Block Diagram



Functional Block Diagram



Functional Block Diagram

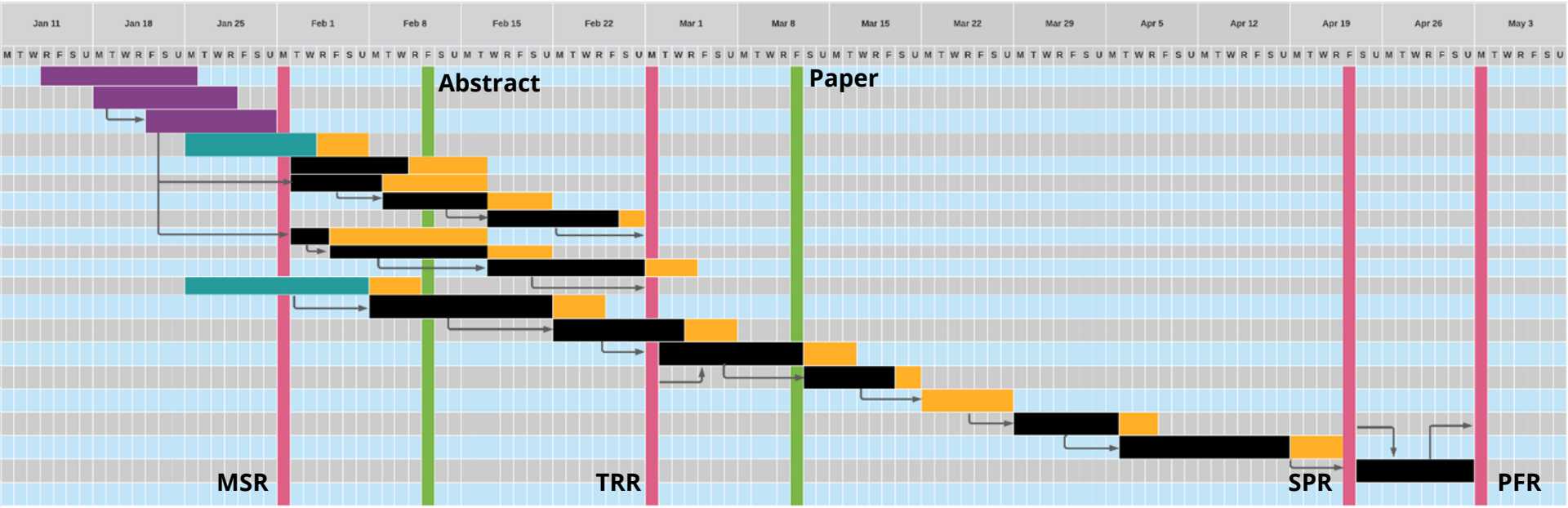


Schedule

Legend

- Complete
- In Progress
- Margin
- Task Behind Schedule
- Milestone
- Future Tasks
- AIAA Deadline

- Critical Path
- Pink Milestones; Reviews
- Green Milestones; AIAA Deadlines



Schedule

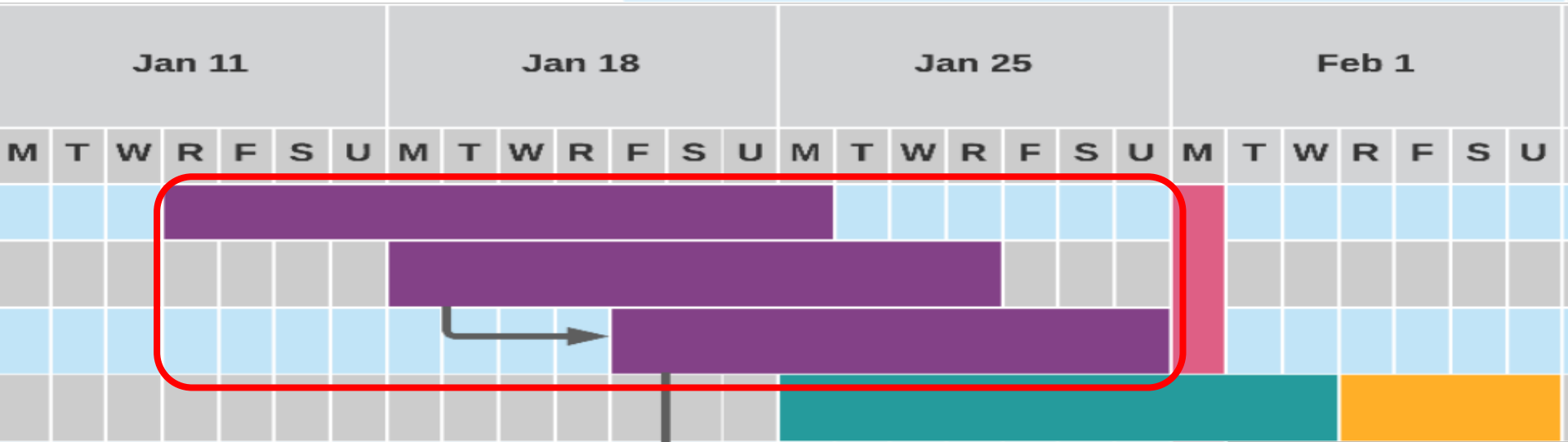
Remote Inventory of Winter Orders

Finalizing Manufacturing Schematics & Plans

Send Primary Work Orders

Odering of Remaining Material

Legend



Schedule

Remote Inventory of Winter Orders

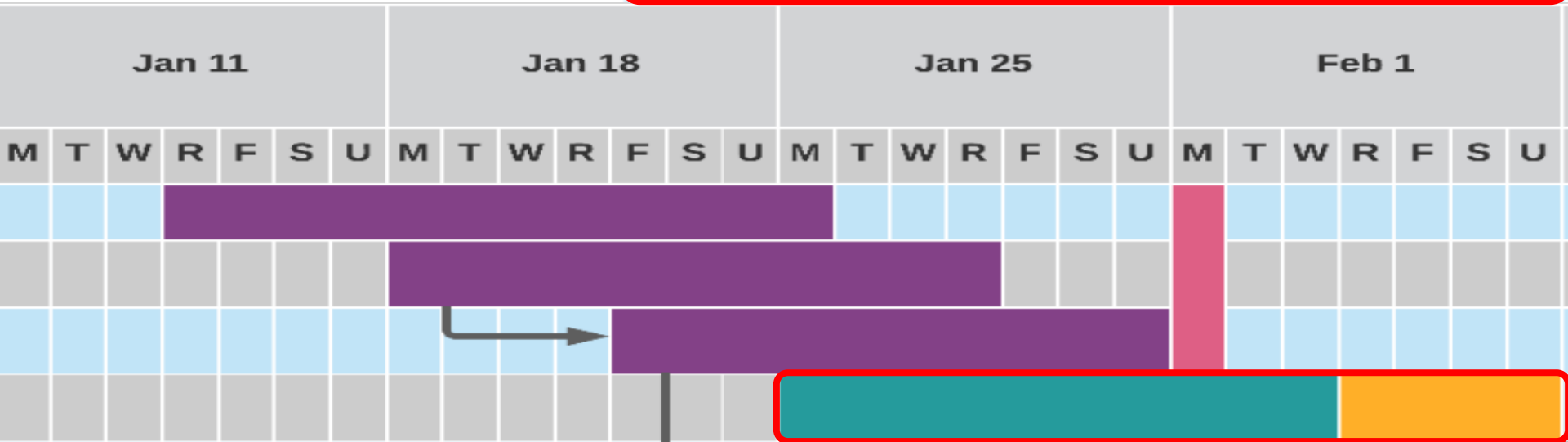
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Schedule



Physical Inventory of Materials

Breadboard Prototyping

Circuit Revisions

Circuit Assembly

Feb 1

Feb 8

Feb 15

Feb 22

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Schedule

Legend



Physical Inventory of Materials

Breadboard Prototyping

Circuit Revisions

Circuit Assembly

Feb 1

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Feb 22

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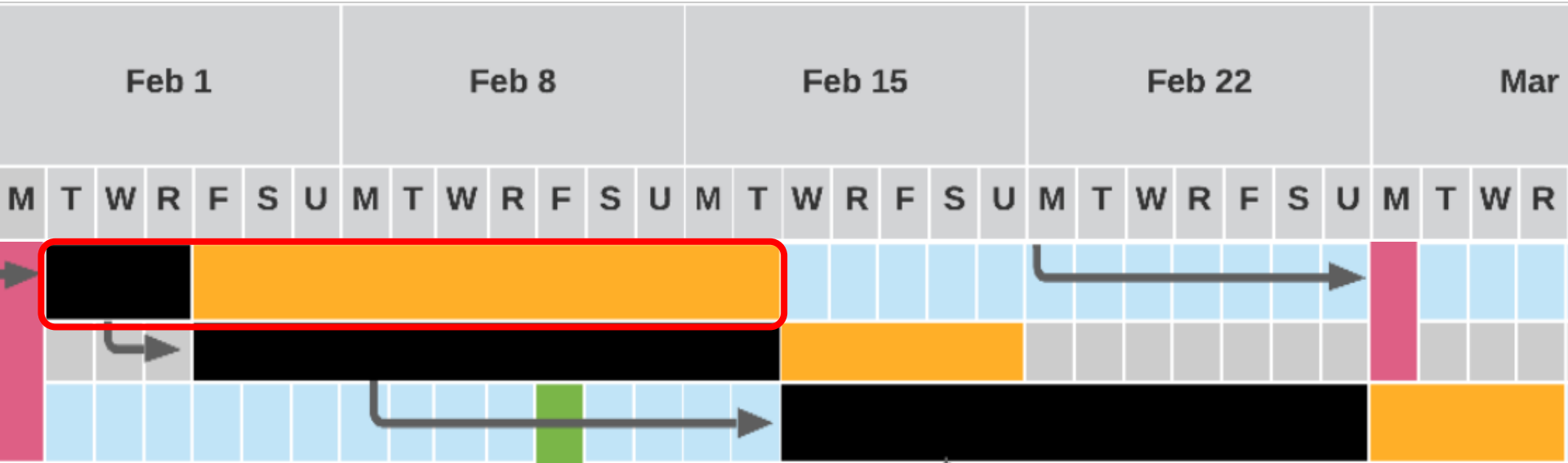
Schedule



Send Secondary Work Orders

Actuator Control Prototyping

Assembly of Final Structure



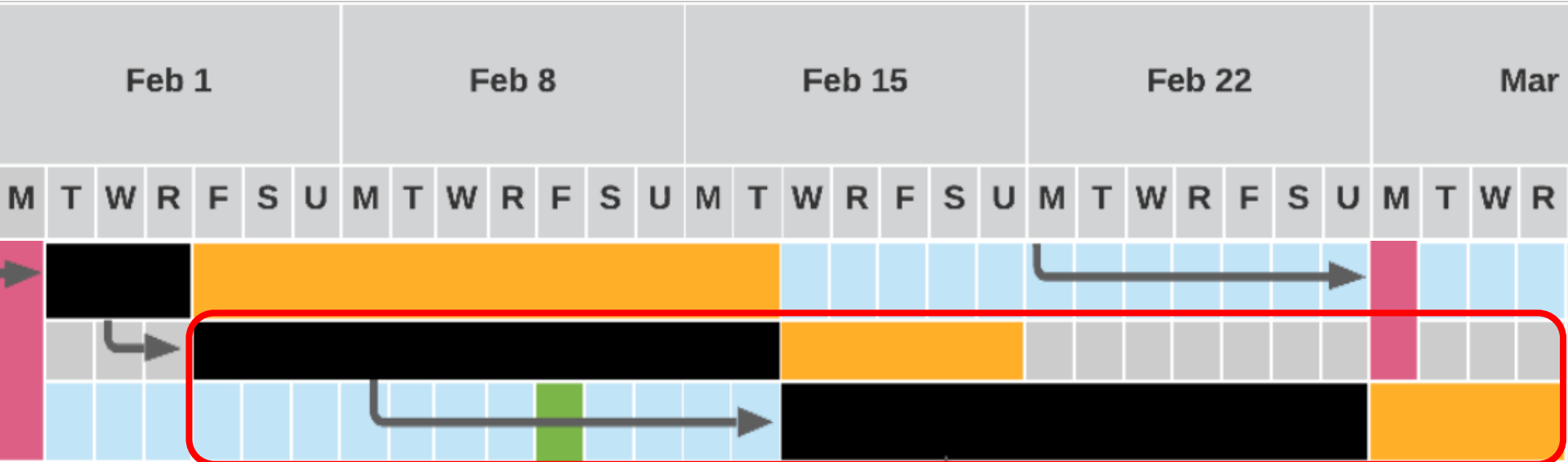
Schedule



Send Secondary Work Orders

Actuator Control Prototyping

Assembly of Final Structure



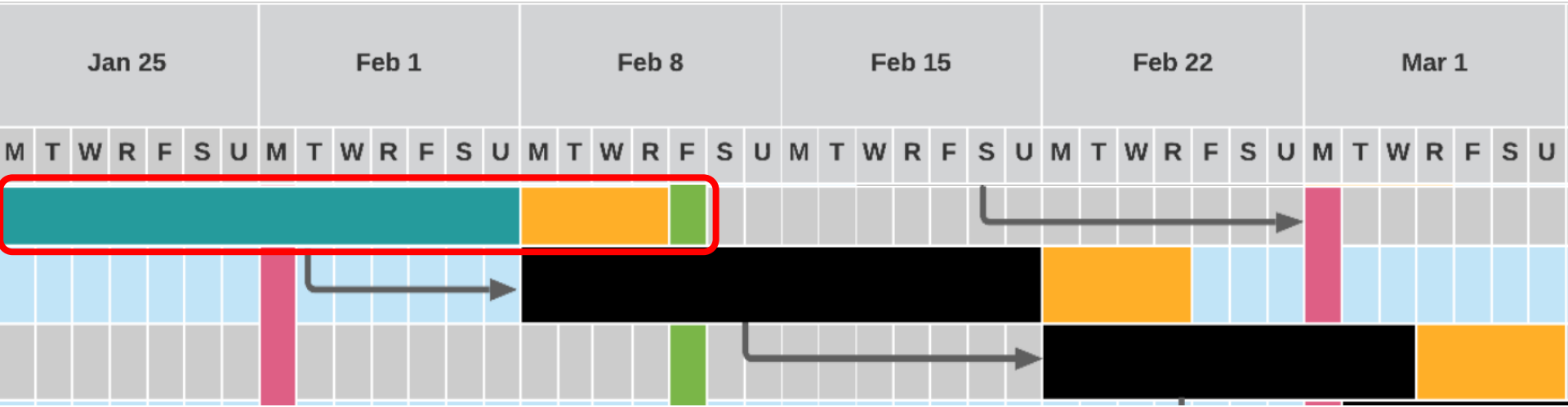
Schedule



CPS Main Script & MCU Logic

Integration of Software

Debugging of Software



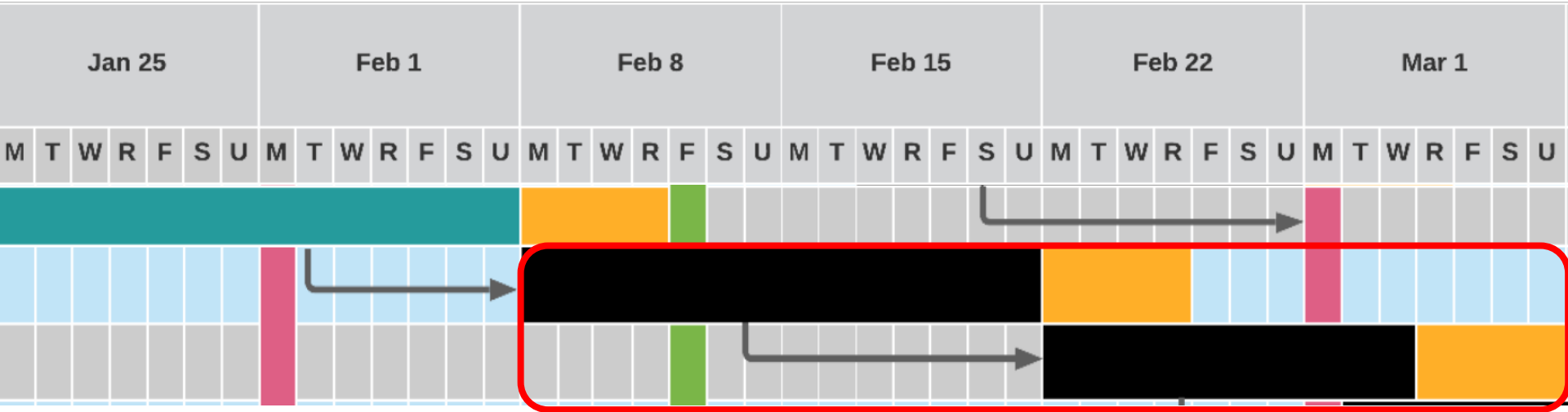
Schedule



CPS Main Script & MCU Logic

Integration of Software

Debugging of Software



Schedule

Legend



Safety Testing of Subsystems

Final Assembly of CHAIR

Spring Pause

Mar 1

Mar 8

Mar 15

Mar 22

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Schedule

Safety Testing of Subsystems

Final Assembly of CHAIR

Spring Pause

Legend



Mar 1

Mar 8

Mar 15

Mar 22

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Schedule

Legend

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- AIAA Deadline

Safety Testing of CHAIR

CHAIR Verification & Validation

Draft Conclusions for SFR

Mar 29

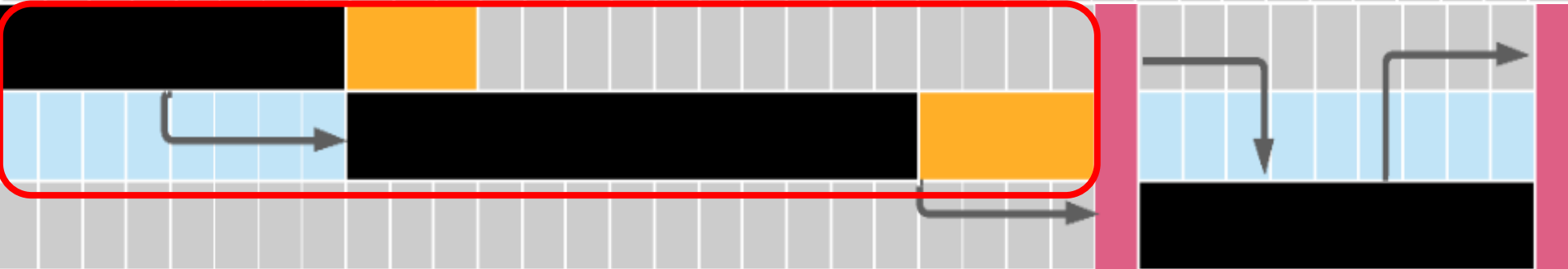
Apr 5

Apr 12

Apr 19

Apr 26

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Schedule

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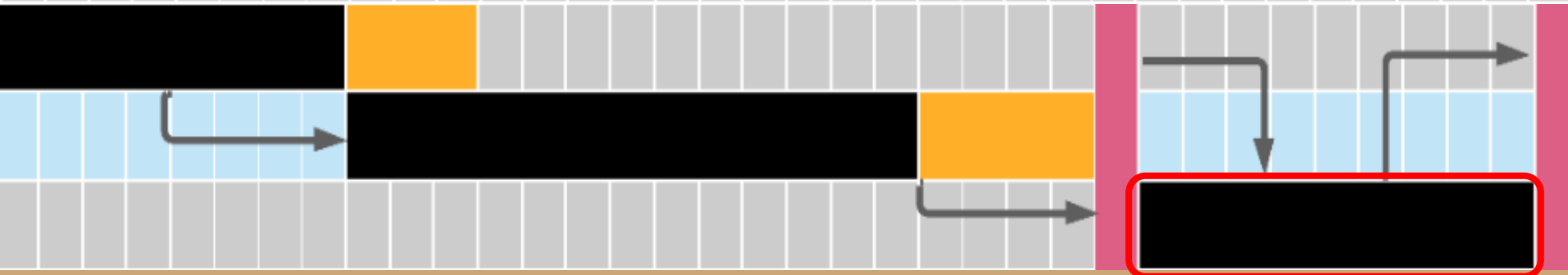
Apr 5

Apr 12

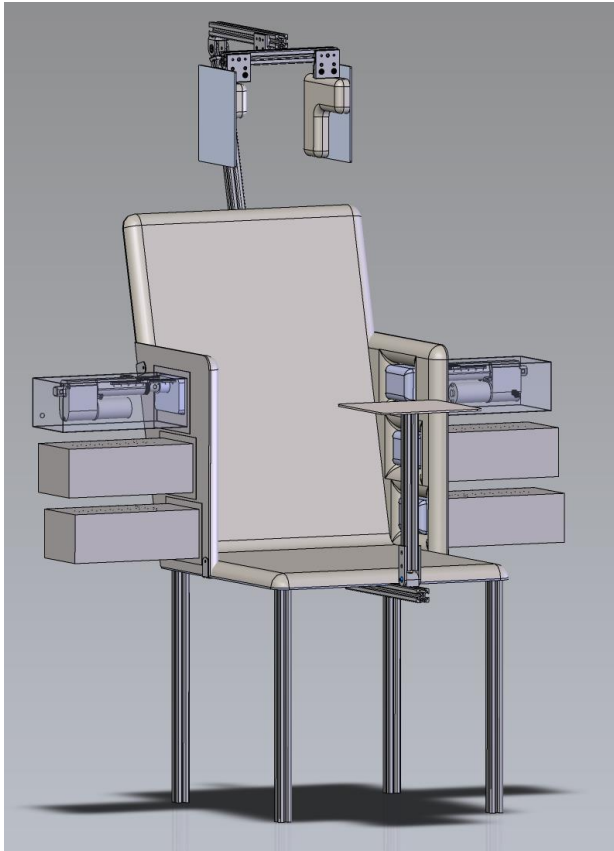
Apr 19

Apr 26

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Hardware Critical Components



Primary Structure: seat pan, seat back, side panels, legs

Secondary Structures: mechanisms housings, joystick table, headrest, harness

Completely manufactured from stainless steel with exception of 80/20 pieces and accessories

Hardware Component Status

Key



Ready for Integration



Work order submitted



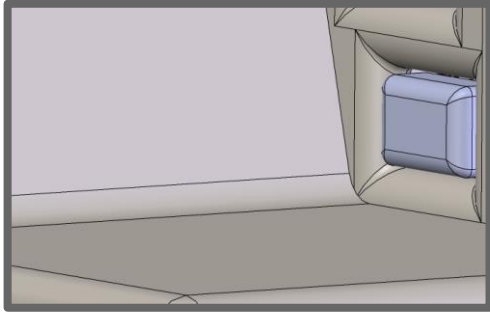
Dependency Remaining



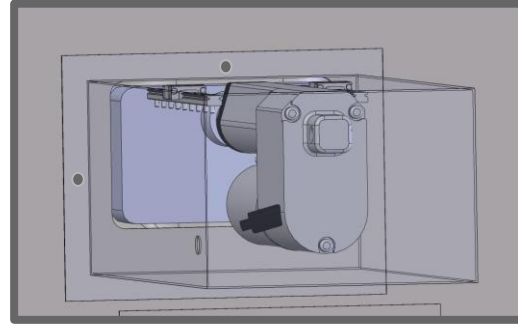
Still In Design Phase

Component	Method of Manufacture	Status
Seat back, seat pan, side panels	Cut from 1/8" sheet steel	Work order submitted
Mechanisms housings	Cut from 1/32" sheet steel + weld	Work order submitted
Pressure plates	Cut from 1" wood	Work order submitted
Headrest	Cut from 1/32" sheet steel	Work order submitted
Joystick table	Cut from 1/8" sheet steel	Work order submitted
Legs	Cut from 80/20 member	Creating CAD drawings

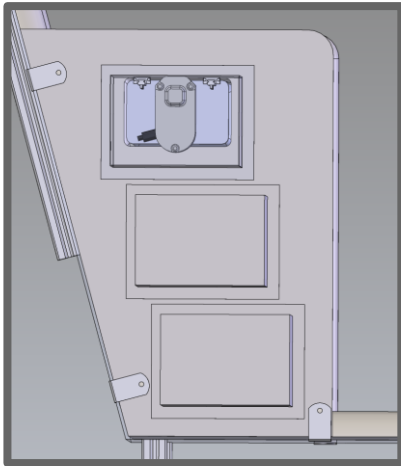
Hardware Critical Assembly



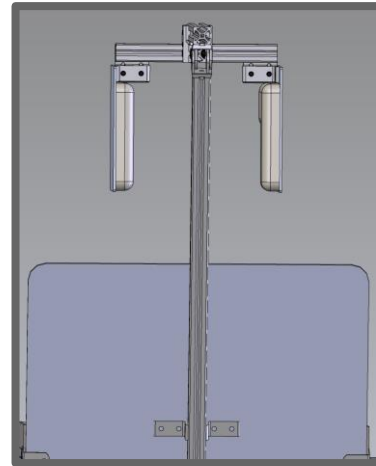
Seat back to seat pan: weld



Mechanisms housings to side panels: fasteners



Side panels to seat: brackets



Headrest to seat back: brackets

Hardware Assembly Status

Key



Ready for Integration



Work order submitted



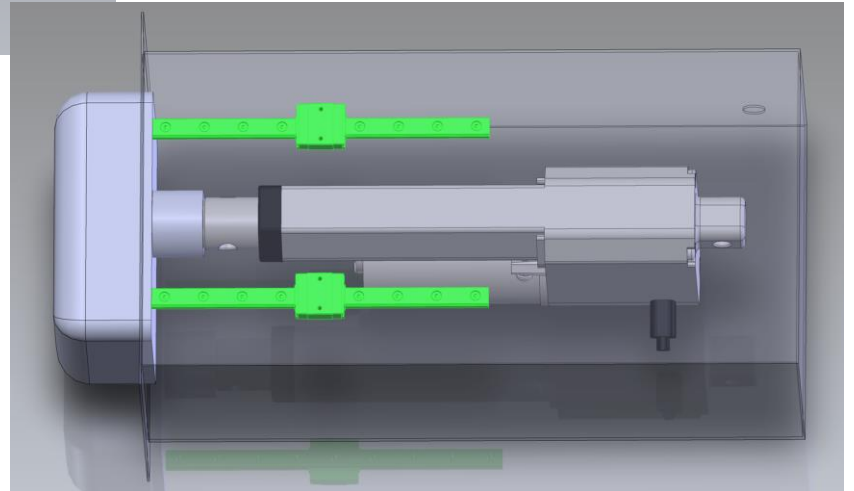
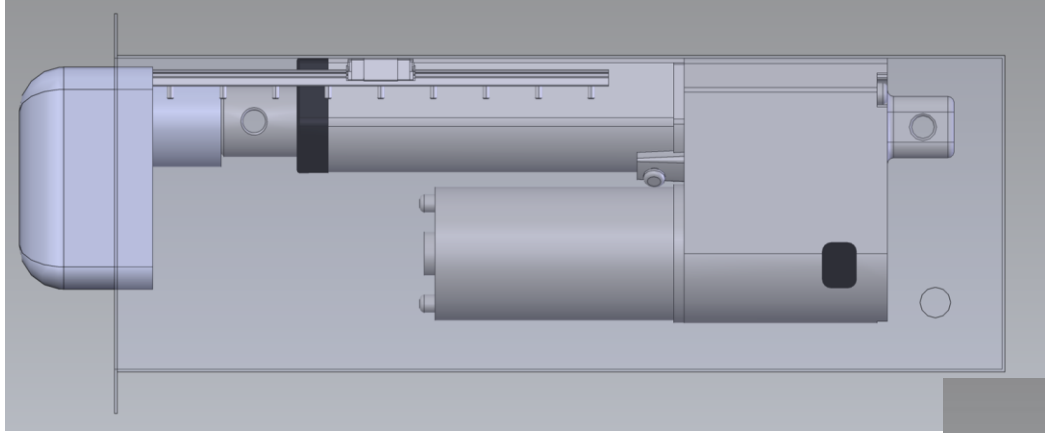
Dependency remaining



Still In Design Phase





Assembly	Method of Join	Status
Seat back and seat pan	Weld	Work order submitted
Seat and side panels	#10-32 fasteners, nuts and brackets	Waiting on parts
Mechanisms housings to side panels	#10-32 fasteners, nuts	Waiting on parts
Headrest to chair	T-nut brackets, fasteners, nuts	Waiting on parts
Joystick table to chair	T-nut brackets, fasteners, nuts	Waiting on parts
Legs to chair	¼-20 fasteners	Waiting on parts
Upholster with foam and fabric	Epoxy	Waiting on parts
Harness to chair	Fasteners, nuts	Waiting on parts

Mechanisms Housing Assembly



TCS Electronic Component Status





Key

	Ready for Integration
	Ordered, not yet rec'd
	Ready to Order
	Still In Design Phase

Component	Method of Manufacture	Status
Test PCB	Advanced Circuits	Awaiting Final Review
Full Circuit PCB	Advanced Circuits	Design Completed
PCB Housing	3D Printing	Design Completed
Molex Connectors	Digikey	On Order (TBD)
Connecting Wires	Digikey/CU Boulder	On Order (TBD)

GVS Electronic Component Status

Key

	Ready for Integration
	Ordered, not yet rec'd
	Ready to Order
	Still In Design Phase

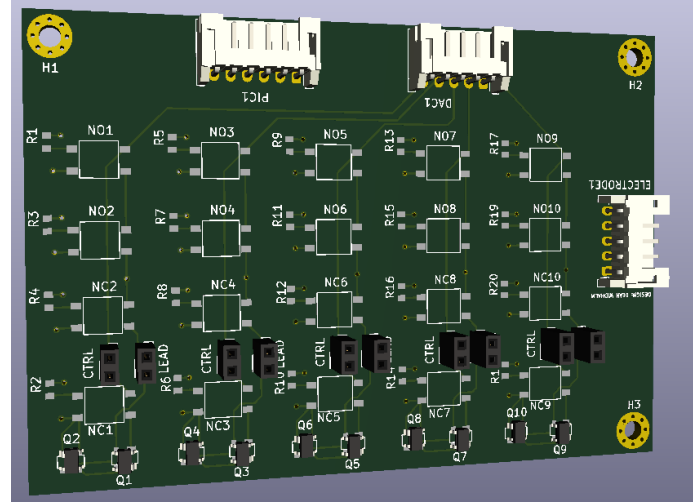
Component	Method of Manufacture	Status
PIC Microcontroller	COTS	Received
LTC2662 DAC	COTS	On Order (02/10)
Power Circuit	Custom PCB	Awaiting Final Review
Housing	In-house 3D print	Design Completed
Connection Elements	COTS	On Order (02/02)

Electronics PCB Design



TCS Printed Circuit Board

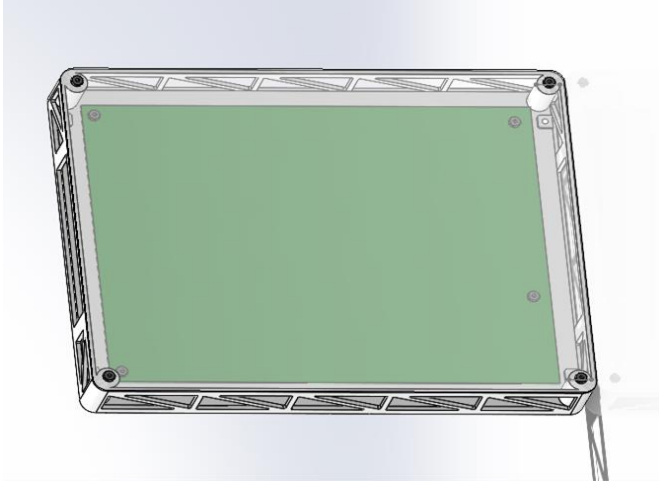
- Includes proper connectors for the Arduino, actuators, and load cells
- Includes mounting holes to secure board to housing



GVS Printed Circuit Board

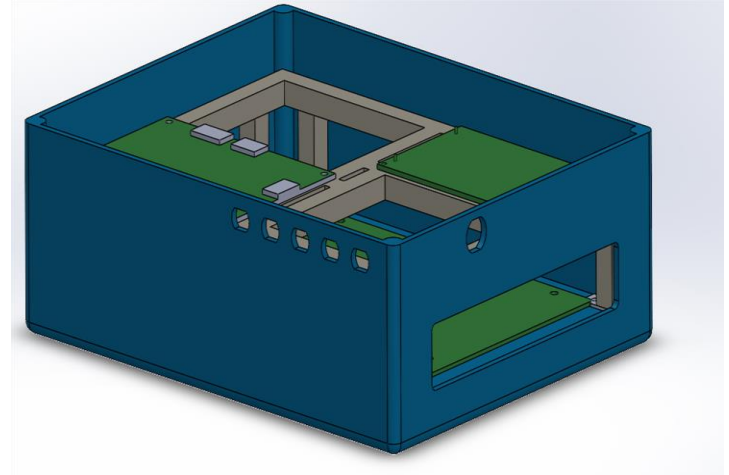
- Includes proper connectors to the microcontroller, the DAC, and the GVS harness
- Includes mounting holes to secure board to housing

Electronics Housing Design



TCS Housing

- Mounted on back of plate of Chair
- 3D Printed Base/Walls
- Laser cut acrylic faceplate
- Threaded inserts to hold screws



GVS Housing

- Sits next to chair
- 3D Printed Housing
- Laser cut acrylic faceplate
- Keyed holes for 24V power and banana plugs

Electronics Assembly Status

Key



Ready for Integration



Work order submitted



Dependency remaining



Still In Design Phase

Assembly	Method of Assembly	Status
TCS Test Printed Circuit Board	Electronics Shop/Soldering	Awaiting Final Review
GVS Printed Circuit Board	Electronics Shop/Soldering	Awaiting Final Review
TCS Printed Circuit Board	Electronics Shop/Soldering	Awaiting testing completion
TCS Housing	ITLL	Awaiting testing completion
GVS Housing	ITLL	Awaiting testing completion

Software Critical Components

Main CPS

- Controls main logic flow
- Process input data for sending to subsystems
- Process sensor output for readability and safety

PIC Code

- Control functionality of GVS

Arduino Code

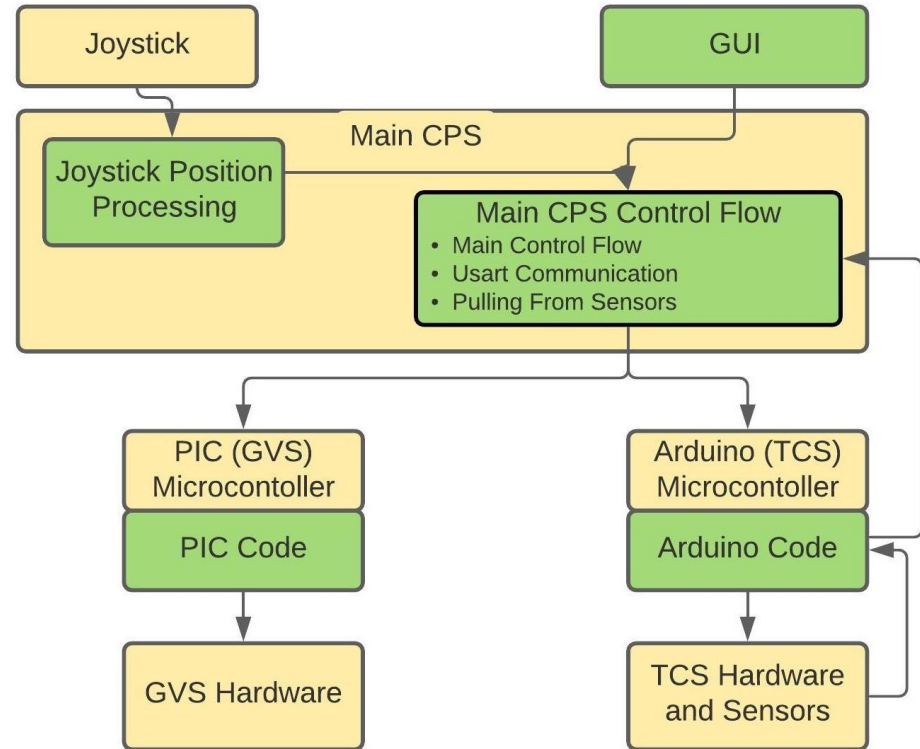
- Control functionality of TCS

Joystick Processing

- Calibrate relation between joystick position and outputs
- Send joystick outputs to CPS

GUI

- Provide an easy method of uploading and storing cueing profiles
- Provide real-time data visualization to test controller



Software Status

Key



Done



More Than 50% Done



Underway & Progressing Without Issue



No Significant Work Done / Progress halted

Main CPS (65%)	Mostly Complete: Still needs UART communications and joystick interface, along with integrated system testing
PIC Code (15%)	Early Development: Software flowchart complete & working 8-bit prototype built.
Arduino Code (10%)	Early Development: Code has been written for interfacing with actuators and sensors, needs UART code
Joystick Processing (50%)	Early Development: Joystick has been obtained and coding has started
GUI (20%)	Preliminary layout complete, small prototype application made with Qt software

Main Software Tasks

Task	Challenges	Plan
Main CPS Control Logic	No significant issues (Mostly Done)	Test with joystick data and UART communication
UART Communication With Microcontrollers	Different amounts of data being sent to PIC (GVS) Vs Arduino (TCS) Coordinating timing of GVS and TCS Cues	Creating In depth plans Getting this done early (Next 2 weeks)
Arduino Embedded Code	We haven't written proper code (Only Test Code Written)	We have multiple team members with experience and there are lots of libraries

Procurement Status

Items Received	47
Items in Autoclave	15
Items Pending	15
Items Backorder	1
Items Planned	21
Total Items	99

- Key Items
 - Linear actuators [received]
 - Building Materials [Received]
 - Electronics [received/pending]
- Planned Items
 - Screws/fasteners
 - < 1 week
 - PCB prints
 - ~2 weeks
 - Fabric
 - Same day pickup
 - Electronic Housing materials
 - Same day pickup

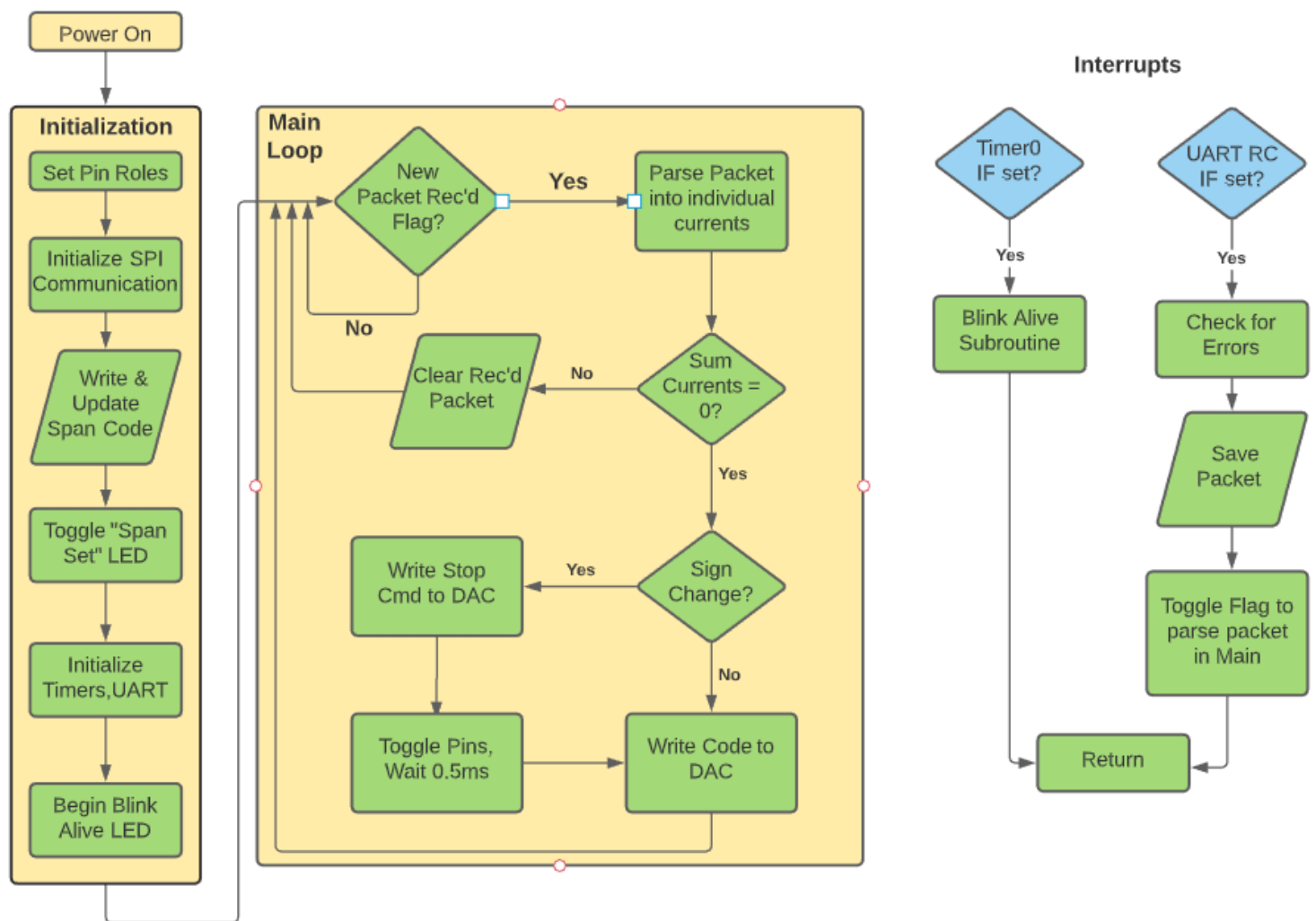
Financial Budget Status

Estimated Totals	
Estimated Total Expenses:	\$ 4,373.51
Estimated Remaining Budget:	\$ 626.49
Actual Money Spent	
Money Spent:	\$ 3,834.48
Money to be Spent:	\$ 539.03

Backup Slides

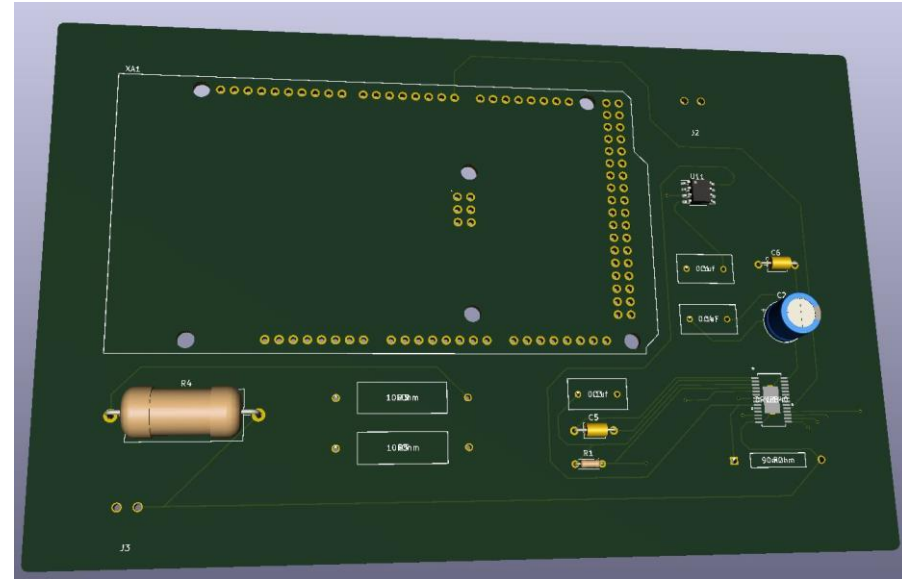
Approximate Hardware Assembly Times

Assembly	Method of Join	Time to Complete
Seat back and seat pan	Weld	1 week
Seat and side panels	#10-32 fasteners, nuts and brackets	2 days
Mechanisms housings to side panels	#10-32 fasteners, nuts	1 week
Headrest to chair	T-nut brackets, fasteners, nuts	<1 day
Joystick table to chair	T-nut brackets, fasteners, nuts	<1 day
Legs to chair	¼-20 fasteners	<1 day
Upholster with foam and fabric	Epoxy	1 week
Harness to chair	Fasteners, nuts	1 day



Test PCB

- Custom PCB currently being printed for one actuator
- Assembly and testing of single actuator will take place to verify code and hardware
- Final changes to full PCB will be made following tests



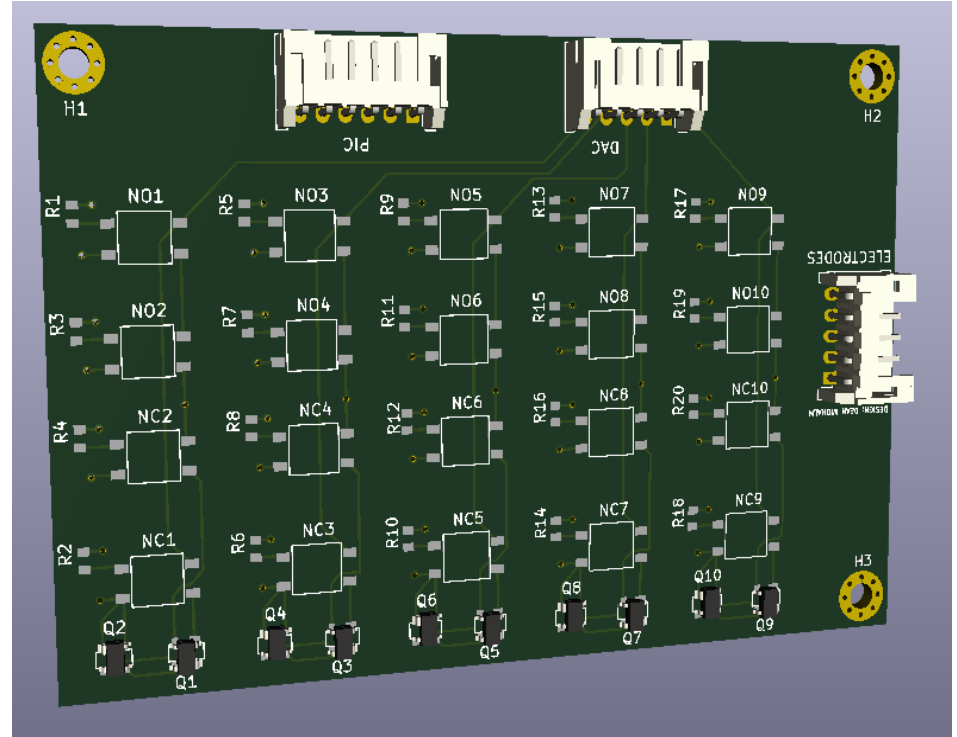
TCS Electronics Testing Schedule

- Week of 1/24
 - Finish PCB design and send out purchase orders for testing electrical parts
- Week of 1/31
 - Compile initial Arduino code used for testing
 - Manage and track purchase orders
- Week of 2/7
 - Assembly of Test PCB Board
 - Breadboard Test of IC components
 - Final Connections made for testing actuators
- Week of 2/14
 - Testing of single actuator with test PCB board

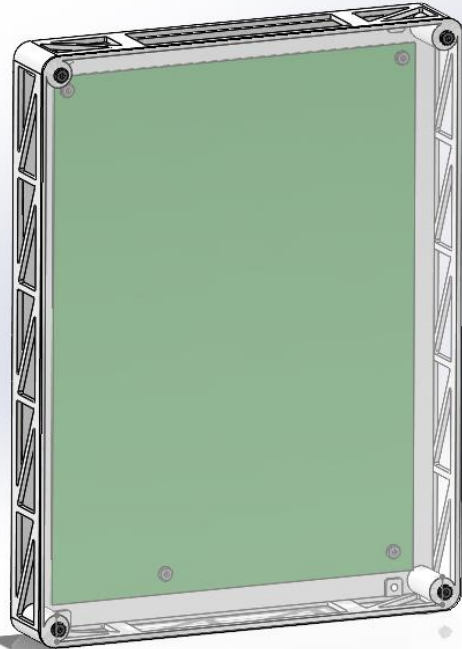


GVS PCB Design

- Week of 1/31
 - Send out PCB for fabrication
 - Submit housing files for printing
- Week of 2/7
 - Populate PCB board
 - Test & Verify PCB board
 - Repeat of breadboard test from Fall
- Week of 2/14
 - Complete integration into housing



Housing



- Mounted on back of plate of Chair
- 3D Printed Base/Walls
- Laser cut acrylic faceplate
- Threaded inserts to hold screws
- Side Cutouts for ventilation/save material costs
- Top/Bottom wall cutouts to feed wiring

Dimensions are tentative pending necessary changes to the PCB

Housing

- 3D Printed Housing
- 3D Printed truss for PCBs
- Acrylic faceplate
- Keyed holes for 24V power and banana plugs
- Large window for access to PIC access panels

