CS/EE/ME 75 – FSAE Electric
12 October 2015

Guillaume Blanquart Azita Emami Richard Murray
Joseph Bowkett Cibele Halasz Noah Olsman Shenghan Yao

Engineering and Applied Science
California Institute of Technology

Meeting Goals and Agenda

Goals

- Review submitted GOTChA charts & suggest improvements
- Discuss the need for clear specifications as a coordination tool
- Transition progressively from class-wide homework to system-specific tasks

Agenda

8:00 Goals, Agenda, Notetaker, Announcements

8:05 Team organizational structure & SAE registration (Rob/Jake)

8:10 Review of submitted GOTChA charts

8:20 Specifications

8:40 Plan for the week

8:45 Division breakouts

9:00 Adjourn

Notetaker: _____

- Record notes and action items from meeting; post on Confluence

CS/EE/ME 75 Organization

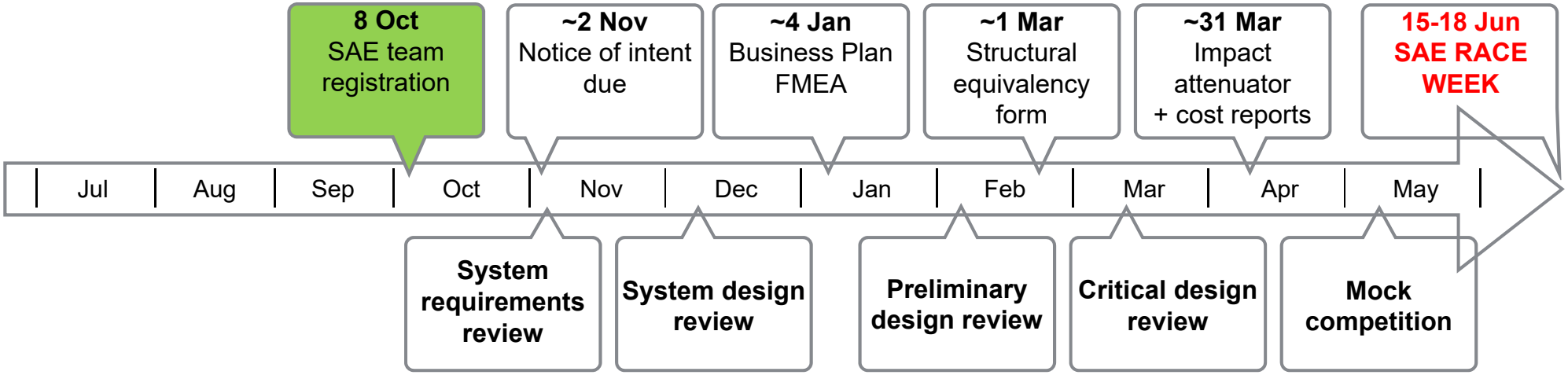
Integrated Product Team (IPT)
Project lead engineer: Rob Anderson Technical lead engineer: Jake Harmon

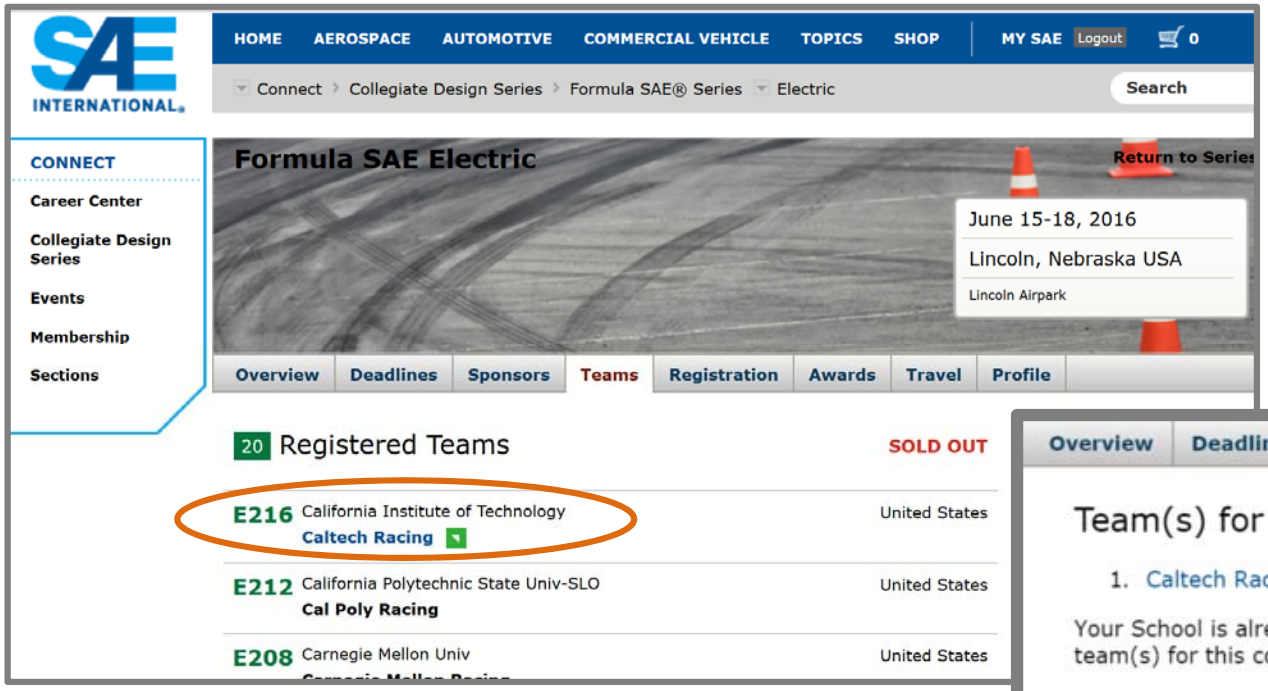
Mechanical	**Energetics**	**Operations**	**Support**
Instr: G. Blanquart	Instr: A. Emami	Instr: R. Murray	Instr: Fromer
TA: Joseph Bowkett	TA: Cibele Halasz	TA: Noah Olsman	TA: Shenghan Yao
UG lead: Evan Sloan	UG lead: Santiago N	UG lead: Anup Kishore	UG lead: Mark Lorden
• 26 Caltech ug • 2-4 advisors	• 24 Caltech ug • 2-4 advisors	• 13 Caltech ug • 2-4 advisors	• 30 Caltech ug • 2-4 advisors
• Chassis • Body shell • Drivetrain • Driver interface	• Hardware • Firmware • Software • Power	• Systems modeling • Safety procedures • Test procedures • Computing systems	• Fundraising • Communications • Facilities/equipment • Outreach/events

- Team meetings (45-60 min/week): Mondays, 8 pm, 135 Gates-Thomas
- Division meetings:
  - Mechanical: Mon, 9-9:30 pm, 135 Gates-Thomas
  - Energetics: Mon, 9-9:30 pm, 115 Gates-Thomas
  - Operations: Fri, 12-12:30 pm, location TBD
  - Support: Mon, 9:30-10 pm, 135 Gates-Thomas

TAKE NOTES !

Project/Course Timeline [Rob/Jake]





GOTChA Charts

Goals (1-3)

- Describe the goals of your project, in plain English
- Description should be understandable to your engineering friends (avoid jargon)
- Tie to the overall project goal

Objectives (3-6)

- Specific tasks that you need to complete in order to accomplish your goals
- Objectives should be "SMART"
  - Specific - concrete descriptions
  - Measurable - can tell whether you accomplished them or not
  - Attainable - possible to complete in time available
  - Relevant - lined up w/ system spec
  - Trackable - possible to monitor progress as you go
- Guide: try to include numbers and dates, when possible

Technical Challenges (4-8)

- List of problems that you expect to face in accomplishing your objectives
- Try to list anything that you are not sure about
- OK to include things that you don't yet know (eg, programming in C/C++, implementing a vision algorithm, etc)

Approach (4-8)

- Describe how you are going to tackle the technical challenges that will let you accomplish your objectives to satisfy your goals
- Make sure all of the technical challenges are addressed (otherwise how will you overcome them?)
- Can serve as a work plan for the term - what do you want to do first, next, etc

GOTChA Chart for Chassis (Mech. Div.)

stable and undamaged when traversing any kind of terrain

Goals:

> Create a chassis for a Formula SAE Electric vehicle that meets all the requirements and passes the Technical Inspection

> Design a chassis that functions properly and allows the vehicle to complete in all the events

> Develop a suspension system that allows the vehicle to remain stable and undamaged when traversing any kind of terrain without compromising mobility

> Design a chassis rigorous enough to sustain the endurance components of the competition without performance loss

> Create a chassis that earns the maximum point score in the:

- Technical Inspection
- Cost & Manufacturing
- Presentation
- Design
- Acceleration
- Skid Pad
- Autocross
- Efficiency
- Endurance

> Building a frame that is both sturdy and lightweight that can sustain the stresses from the Static and Dynamic Events and the competition

Technical Challenges:

> No previous experience designing a suspension system

> Chassis must be incredibly durable for the endurance event, while also lightweight for the acceleration and efficiency events

> Suspension system must be lightweight and effective yet withstand the endurance test and other trials

> Little to no existing work on chassis (must start from nothing)

> Need the designs from other teams with physical components that mount to the chassis (Driver Interface, Drivetrain, Batteries, Body Shell)

> Need to be mindful of limits we set on other teams via our design choices (such as weight affecting power required)

> Must have sufficient ground clearance

durable for the endurance event, while also lightweight for the acceleration and efficiency

Technical challenge or objective?

Objectives:

> Create a design for the chassis that will maintain the integrity of the vehicle throughout the competition

> Create a design for the chassis that is compatible with the other components of the vehicle that must be mounted to it

> Create a design for a suspension system that will allow the car to finish the competition undamaged and maintain the driver in a comfortable state

> Research potential suspension and frame geometries by Midterm Fall 2015

> Complete *Failure Modes and Effects Analysis* one week before SAE deadline (currently TBA)

> Complete *Structural Equivalency* spreadsheet one week before SAE deadline (February 1, 2016)

> Complete 'Suspension Parameters' and 'Frame' portion of Design Spec Sheet one week before SAE deadline (March 2[illegible] 2016)

Approach:

> Research various suspension geometries

> Research other FSAE Teams and their chassis

> Research existing chassis from similarly sized vehicles

> Utilize Slack and Confluence to coordinate weekly meetings of each crew as well as group meetings to maintain open communication lines for effective collaboration

Research other FSAE Teams and their chassis

Research existing chassis from similarly sized vehicles

Complete *Structural Equivalency* spreadsheet one week before SAE deadline (February 1, 2016)

Other GOTChA Charts

GOTChA Chart for Software Group, Fall 2015

Goals

- Organize the collaboration of software engineers working on the various software applications for the vehicle
- Architect a software design that is compliant with the SAE competition rules
- Ensure that the firmware and hardware groups are aware of software design requirements

Technical Challenges

- Breaking up the workload evenly among to group to write efficient code that will work together
- Ensuring high safety standards
- Organizing with the firmware and hardware groups

Not specific enough

Objectives

- Divide the software group into crews that work on the various software modules
- Promote collaboration between the various software crews
- Gain proficiency using Git both individually and as a software engineering unit
- Architect complete designs for each of the components and applications

Approach

- Using Github to collaborate
- Comprehensive testing strategies
- Using a test-driven development strategy
- Good documentation including initial design docs
- Thorough code reviewing procedure

Modeling GOTChA Chart

Goals

- Learn how to use modeling softwares specific to each task
- Model any systems that the Mechanical and Energetics division and their groups want us to
- Model any scenarios of failure that would possibly come up during competition
- Model the Tilt Table Inspection (part of the Technical Inspection)
- Model specific conditions in the following Dynamic Events, at the discretion of the Mechanical and Energetics divisions: Acceleration, Skid Pad, Autocross, and Efficiency
- Create models that answer questions to FMEA
- Maintain accessibility to modeling data/simulations for future collaborators

Technical Challenges

- Adams/Car has not been used by anyone in modeling
- Only @James Blackwood and @Joel Kosmatka have mechanical modeling experience
- Members of Modeling will have to work closely with crews in other divisions
- 2015-2016 FMEA has not been posted; will be working off of last year's
- Will have to finish models by hard deadlines

Objectives

- @Roshan Agrawal and @James Blackwood will get familiar with the features of Adams/Car (at most one week after the licenses have been issued)
- @Roshan Agrawal will look at the geometry of the control arms to figure out how we can make the suspension react how we want it to under different loads (once told to do so by the Mechanical Division)
- @James Blackwood will contact the Chassis Crew to determine specifically what you will be modeling (ASAP)
- @Joel Kosmatka will learn how to use SolidWorks for Aerodynamics (October 18)
- @Joel Kosmatka will look into/contact other teams regarding what they are using for their Aerodynamics software, and determine if we can use it for free or at a reduced student price (October 18)
- @Ker Lee Yap and @Sarthak Sahu will work with @Santiago Navonne to determine what software will be used to model the power systems (ASAP)
- @Ker Lee Yap and @Sarthak Sahu will model the efficiency and power of the power systems as well as model the differential, acceleration, braking, and other control systems using software algorithms, most likely written in MATLAB (at the discretion of the Energetics Division)
- Answer questions to FMEA (by end of term at latest)

Approach

- Follow the lead of the Mechanical and Energetics divisions, i.e. keep their modeling requirements a priority
- Each member will model one task until completion and not work on multiple models at the same time
- Talk to other FSAE teams (both past and present) to determine what software they are using and what they modeled
- Work with the idea that these models will be used in future presentations and have to be easily mocked up into understandable visuals
- Work with the software developers to see if they have any helpful tips for using the software and can make using the software easier and quicker

Specifications

What are they?

- Specifications = “To state explicitly or in detail”
- Describe what the component/system *should* do/be, not *how* to do it
- *Ex*: dimensions, weight, battery capacity, motor rpm, software output…

Why do we want them?

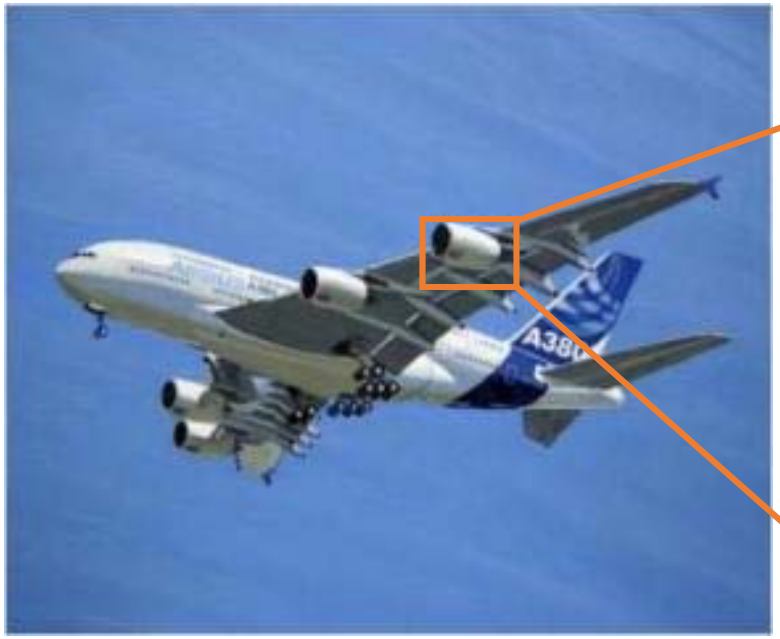
- To communicate between divisions/groups/crews
- To limit constant changes and design updates
- To avoid errors due to lack of compatibility

How to write them?

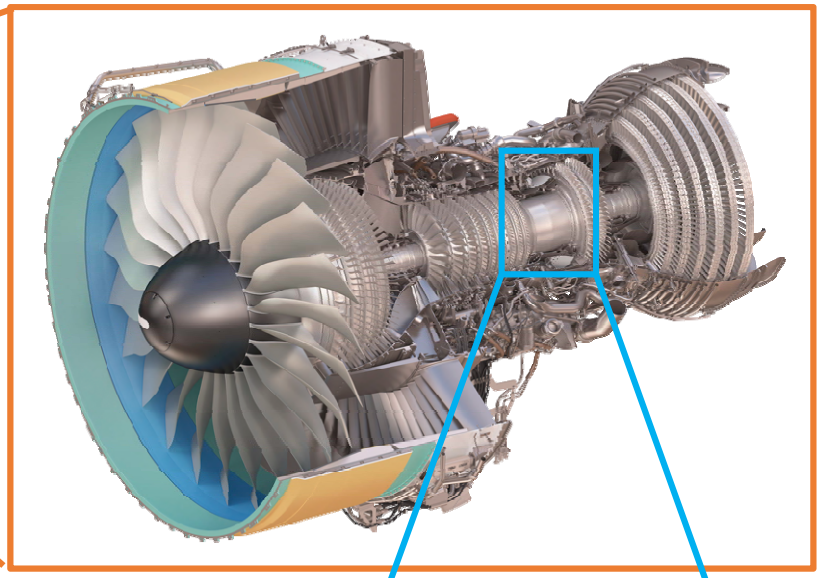
- Identify *stakeholders:*
  - who will be using your specifications?
  - who do you need specifications from?
- *Requirements*: documented requirements to be satisfied by component/system
- *Specifications*: solutions to the requirements

Example of Specifications

AIRBUS A380



Engine Alliance
GP 7270



Single
annular
combustor

AIRBUS A380 – Specifications

Specifications set by outside rules

FAA Aircraft Design Group	Aircraft Type	Minimum Wingspan(ft)	Maximum Wingspan(ft)
I	Small Regional	0	49
II	Medium Regional	50	79
III	Narrow body/ Large Regional	80	118
IV	Wide body	119	171
V	Jumbo	172	214
VI	Super Jumbo	215	262

Specifications set by performance

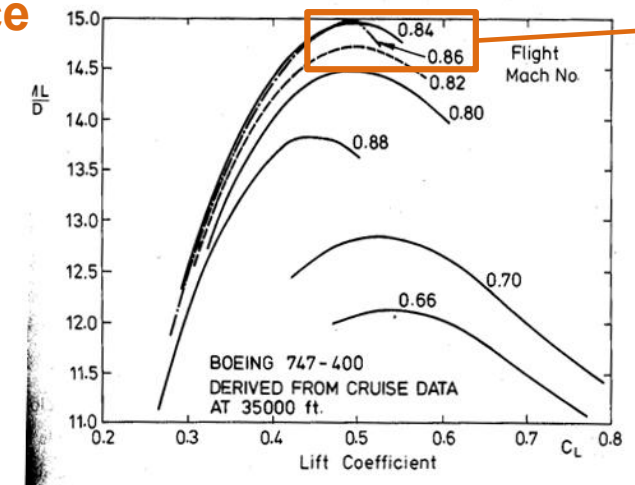


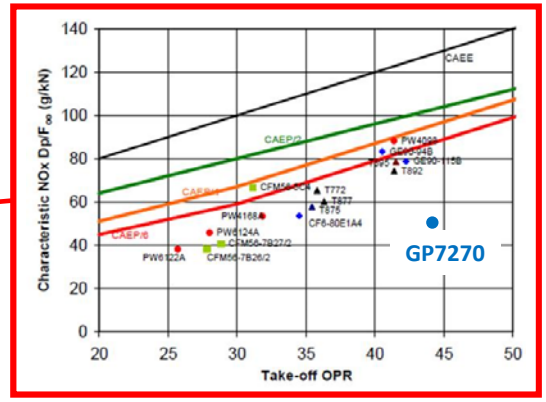
Figure 2.3. Mach number × Lift-drag versus lift coefficient for various flight Mach numbers

Measurement	A380-800
Cockpit crew	Two
Seating capacity	525 (3-class), 644 (2-class), 853 (1-class)
Length	73 m (239 ft 6 in)
Span	79.8 m (261 ft 10 in)
Height	24.1 m (79 ft 1 in)
Wheelbase	30.4 m (99 ft 8 in)
Outside fuselage width	7.14 m (23 ft 6 in)
Cabin width, main deck	6.58 m (21 ft 7 in)
Cabin width, upper deck	5.92 m (19 ft 5 in)
Wing area	845 m² (9,100 sq ft)
Operating empty weight	276,800 kg (610,200 lb)
Maximum take-off weight	560,000 kg (1,235,000 lb)
Cruising speed	Mach 0.85 (1041 km/h, 647 mph, 562 knots)
Maximum cruising speed	Mach 0.89 (1090 km/h, 677 mph, 588 knots)
Maximum speed	Mach 0.96[111] (1176 km/h, 731 mph, 635 knots)
Take off run at MTOW	2,750 m (9,020 ft)[87]
Range at design load	15,200 km (8,200 nmi, 9,400 mi)
Service ceiling	13,115 m (43,000 ft)[112]
Maximum fuel capacity	310,000 L (81,890 US gal, 68,200 imp gal)
Engines (4 x)	GP7270 (A380-861)
Thrust (4 x)	311 kN (70,000 lbf)

GP 7270 – Specifications

Specifications set by other systems

Takeoff Thrust	(SLS, ISA) Flat rated 86F / 30C 70,000 lb/311kN
Cruise Thrust	35,000ft / 10,668m 0.85Mn ISA 12,633lb/56kN
Noise	25.6dB margin to Stage 3
Emissions	Nox 51.6 ~~HC 5.4~~ ~~CO 44.9~~g/kN
OPR(Max Climb)	43.9
BPR(cruise)	8.7
Thrust Setting Parameter	N1
Length	187in/475cm
Diameter	124in/316cm
Fan Diameter	116.in/296cm
Staging	FAN 1 LPC 5 HPC 9 Single Annular Combustor HPT 2 LPT 6

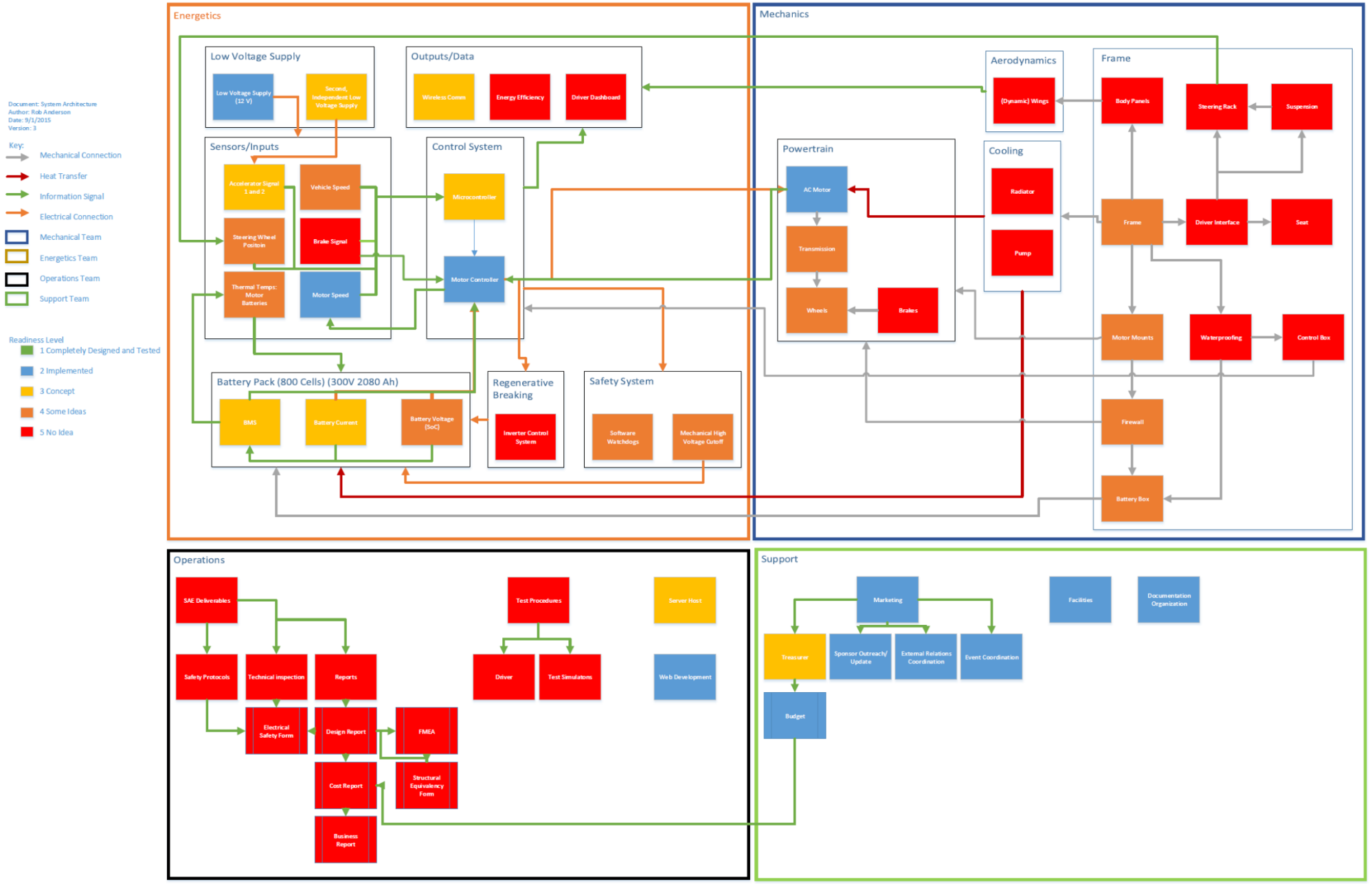


Specifications better than required

Specifications constrained by other systems

Specifications set by performance

System Architecture & Stakeholders



Plan for the Week: 12-18 Oct 2015

CS/EE/ME 75

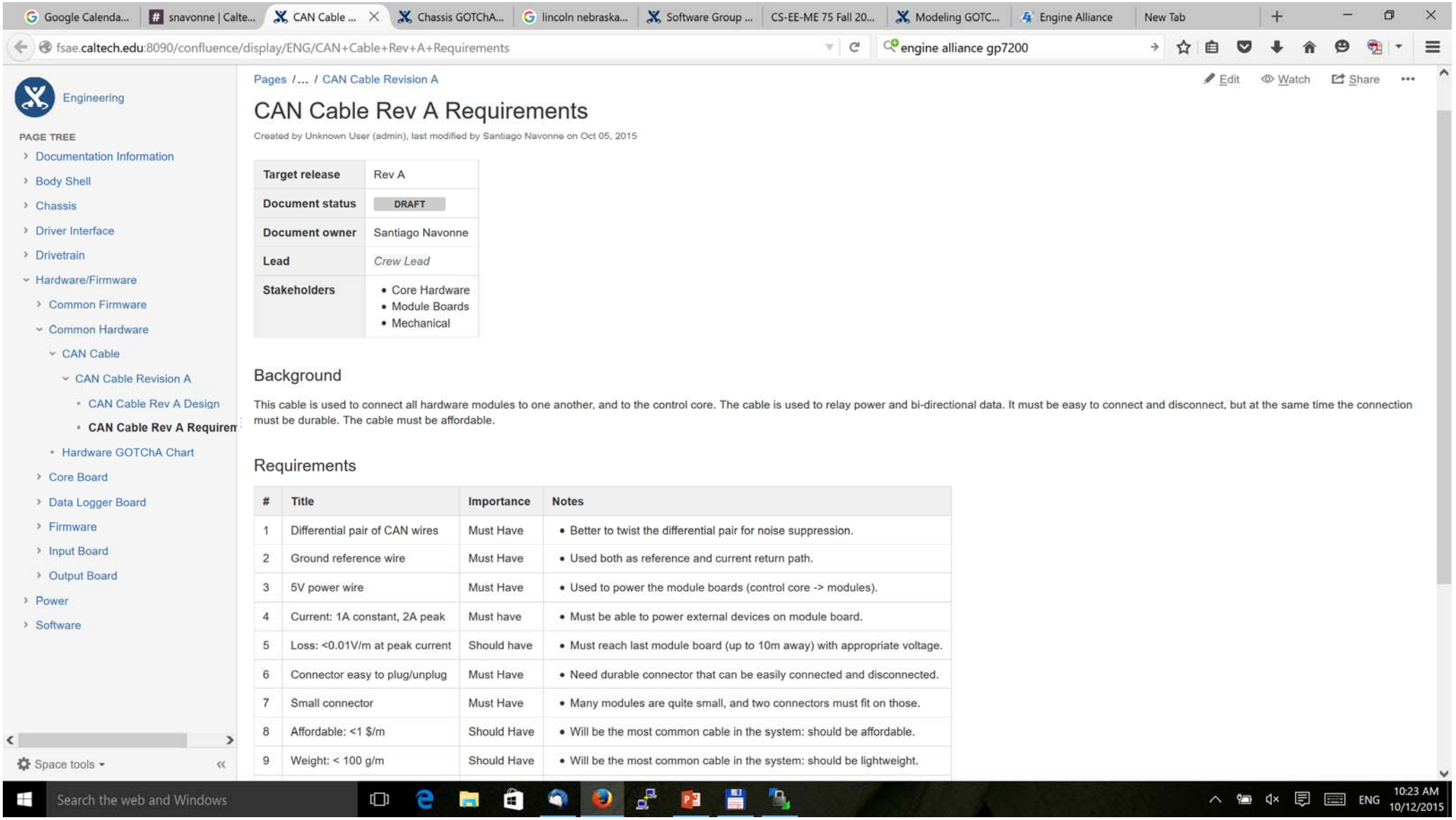
- Complete HW #1 & 2 if you haven't already (eg, late adds)

- Division breakouts (introductions, plans for the week)
  - Mechanical: 135 Gates-Thomas (weekly division meeting @ 9)
  - Energetics: 115 Gates-Thomas (weekly division meeting @ 9)
  - Operations: 235 Gates-Thomas (quick meeting, then go to appropriate division)
  - Support - no breakout session

- HW #3 out tonight, due 18 Oct (Sun), 8 pm
  - Improve GOTChA charts
  - Start to use JIRA to manage tasks
  - Identify requirements and define specifications
  - Estimate budget

Project activities (Rob)

Example of Requirements



Google Calenda... | snavonne | Calte... | CAN Cable ... | Chassis GOTChA... | lincoln nebraska... | Software Group ... | CS-EE-ME 75 Fall 20... | Modeling GOTC... | Engine Alliance | New Tab

fsae.caltech.edu:8090/confluence/display/ENG/CAN+Cable+Rev+A+Requirements

engine alliance gp7200

Engineering

PAGE TREE

- Documentation Information
- Body Shell
- Chassis
- Driver Interface
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- Hardware/Firmware
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    - CAN Cable
      - CAN Cable Revision A
        - CAN Cable Rev A Design
        - CAN Cable Rev A Requirem
      - Hardware GOTChA Chart
  - Core Board
  - Data Logger Board
  - Firmware
  - Input Board
  - Output Board
- Power
- Software

Space tools

Pages / ... / CAN Cable Revision A

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CAN Cable Rev A Requirements

Created by Unknown User (admin), last modified by Santiago Navonne on Oct 05, 2015

Target release	Rev A
Document status	DRAFT
Document owner	Santiago Navonne
Lead	*Crew Lead*
Stakeholders	• Core Hardware • Module Boards • Mechanical

Background

This cable is used to connect all hardware modules to one another, and to the control core. The cable is used to relay power and bi-directional data. It must be easy to connect and disconnect, but at the same time the connection must be durable. The cable must be affordable.

Requirements

#	Title	Importance	Notes
1	Differential pair of CAN wires	Must Have	• Better to twist the differential pair for noise suppression.
2	Ground reference wire	Must Have	• Used both as reference and current return path.
3	5V power wire	Must Have	• Used to power the module boards (control core -> modules).
4	Current: 1A constant, 2A peak	Must have	• Must be able to power external devices on module board.
5	Loss: <0.01V/m at peak current	Should have	• Must reach last module board (up to 10m away) with appropriate voltage.
6	Connector easy to plug/unplug	Must Have	• Need durable connector that can be easily connected and disconnected.
7	Small connector	Must Have	• Many modules are quite small, and two connectors must fit on those.
8	Affordable: <1 $/m	Should Have	• Will be the most common cable in the system: should be affordable.
9	Weight: < 100 g/m	Should Have	• Will be the most common cable in the system: should be lightweight.

Search the web and Windows

ENG 10:23 AM 10/12/2015