

## Integrated Solid Rocket RamJet (Mach 4)

9/16/15

### Attendance:

Alexx Jensen

Jesse Caudle

Marc Compton

Chris Fraser

### Agenda:

- Getting organized in preparation for Thursdays meeting
- Organize and distribute information about client conference call
- Key components of the design in mind
- Get official design specifications for the ramjet/questions needed to clarify

### Meeting Notes:

- Thursdays meeting
  - (Alexx) I will be creating the Excel spreadsheet for task completion 9/16/15
  - (Jesse) Create a generic form to help with organization binder in order to speed up and keep things clean.
    - (Marc) Will we need to fill this out every time, or will only certain areas
    - (Marc Jesse Alexx) The design choice alternatives section. Creating a form to quickly show what we chose and didn't chose
    - (Marc) Create a template to show the idea
- Client Conference Call
  - Dr. Crepeau is officially settled
    - (Chris) Time Zone? (Possibly One hour to max three hours ahead)
    - (Marc) Dr. C would like us to see when we can use the ME conference room based off the reoccurring meeting times to organize time for client calls. Would like Dr. M to be there as much as possible.
    - Possibly officially reserve the Conference room indefinitely
- Design Specs/Questions
  - (Jesse) Create individual lists of questions to ask by Thursdays meeting
- Key Components
  - Retractable nose cone (oblique shock waves to normal shock within)
  - Barrier between solid rocket
  - Controls both mechanically (Fins) and electronics (Computer)
  - Nozzle
  - Combustion/thermo
  - Modeling
  - Manufacturing

To do:

- Create binder template to show ideas on how to better organize the binder (Jesse) Due 9/24/15
- Create task completion spreadsheet (Alexx) Due 9/16/15
- Get ahold of Dr. Maughan's schedule to organize meetings for client calls (Marc) Due 9/16/15
- Send Jesse schedules (Alexx Marc Chris) Due 9/16/15
- Create Team logo (Chris) Due 9/24/15
- Come up with 5-10 questions (Everyone) Due 9/17/15
- Talk to Crepeau about time zone and meetings (Marc)
- Check lockers in IEEE for binder and books (Chris) Due 9/24/15

Time: 9:30 – 10:40 AM

## Integrated Solid Rocket RamJet (Mach 4)

Attendance:

Agenda:

- Discuss conference call times for future client calls
- Discuss what information was obtained during the conference call
- Steps moving forward in the design process
- Upcoming events and deadlines
- Review previous action items
  - Create binder template to show ideas on how to better organize the binder (Jesse) Due 9/24/15
  - Create task completion spreadsheet (Alexx) Due 9/16/15
  - Get ahold of Dr. Maughan's schedule to organize meetings for client calls (Marc) Due 9/16/15
  - Send Jesse schedules (Alexx Marc Chris) Due 9/16/15
  - Create Team logo (Chris) Due 9/24/15
  - Come up with 5-10 questions (Everyone) Due 9/17/15
  - Talk to Crepeau about time zone and meetings (Marc)
  - Check lockers in IEEE for binder and books (Chris) Due 9/24/15

Meeting Notes:

- 

To do:

- 

Time:

## Integrated Solid Rocket RamJet (Mach 4)

9/9/2015

### Attendance:

Alexx Jensen

Jesse Caudle

Marc Compton

Chris Fraser

### Agenda:

- Write team contract
- Create Meeting Minutes Template

### Meeting Notes:

- Created team Contract through Democratic participation

### To do:

- How fast is the cruising speed of the IRR?
  - This will be brought up in the interview
- Create Excel spreadsheet for task completion (Alexx)
- Budget Excel spreadsheet (Chris)
- Create binder and file structure for team project (Jesse)

Time: 9:30 – 10:45 (AM)

## Integrated Solid Rocket RamJet (Mach 4)

### Attendance:

Alexx Jensen

Jesse Caudle

Chris Fraser

Dr. Maughan

Dr. C

### Agenda:

- Discuss concepts that will be moved forward
  - Two designs of the nose and two designs for the diaphragm
- Research that was obtained for nose cone forces
  - Solid rocket properties
- Discuss steps moving forward with solid rocket and ramjet portions
  - Moving forward the concepts of how much fueling will be needed based off educated guesses

### Meeting Notes:

- 

### To do:

- Inform doctor (MW 12:30-2 he has class) Preferably after and not Fridays
- Conical tables gas dynamics/compressible flow conical tables (Alexx)

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

### Attendance:

Alexx Jensen  
Jesse Caudle  
Marc Compton  
Chris Fraser  
Dr. Maughan  
Jake

### Agenda:

- Discuss Research on
  - Nose cone/Diaphragm
  - Ramjet/Rocket

### Meeting Notes:

- Diaphragm
  - Found information on ablative material for rocket shell and diaphragm/nozzle
  - Looking into Design details to narrow down the two designs
- Nose Cone
  - Basic code to find a force on the cone
  - Went with shaping the cone, which dictates everyone progress forward
  - Two codes one code with single angle and one with mutlti angles
  - Gained knowledge of a cone COMPROP calculator
- Ramjet
  - Can analyze the entire combustion process
  - Assuming the numbers coming from chris we can see the airfuel ratio to calculate the needed amount of fuel
- Rocket
  - Used the fueling from the space shuttle due to availability
  - Ran into many issues with too many unknowns
  - With area ratios we can find the mach leaving
    - Through many other calcs we can find thrust and acceleration
    - Through itteration we can find the mass to calculate the amount needed
- How optimized do we want the rocket & ramjet????
- When will we transition????

### To do:

- Marc needs to contact Dr. C about new meeting time due to time change
- Get all info on for Design Review on November 11

Time: 9:30 – 10:23

## Integrated Solid Rocket RamJet (Mach 4)

### Attendance:

Alexx

Chris

Marc

Jesse

Dr. Maugan

Jake

Dr. C

### Agenda:

- Discuss ideas currently proposed for Nozzle and Diaphragm
  - Checking validity and promise of proposed ideas with client
- Confirming the specifications meet client requirements
  - I.E. speed, distance, altitude etc.

### Meeting Notes:

- Justification as to the use of a nose cone
- Specifications
  - Ensuring that nose cone can take forces
  - No components from the combustion chamber during transition
  - Mach Number to 3 with solid rocket then liquid fuel afterwards
  - Transition Speed?
    - Shock waves will vary strength and location
    - Moving cone helps solve the transition speed
    - Transition Mach will be set based off the chosen Design
- Paper in Journal Physics
  - Gives fuel consumption characteristics as well as minimum inlet speed
  - Specifications similar to that of a Cruise Missile
    - Length of the Missile needs to be defined
    - Gain information on how much solid fuel will be required to get from 0-Mach 3
    - Missile will be higher altitude
  - Light w/ a lower factor of safety
  - All other specifications are Okay'd By Dr. C
- Design Ideas
  - Piezo electronics to create movable parts
  - How far does the nose cone need to move?
    - Give a better understanding of how far the nose will need to move

- Diaphragm (Dr. C's opinion but can come up with better ideas)
  - Number 11/12 (1a & 1b)
  - Number 9 Iris as well (Limited knowledge to make an informed judgment)
  - Number 6 (More detail)
  - ***Light with very fast transition Speeds!***
- Nose Cone
  - Number 1
  - Number 3
  - Number 5

To do:

- (Need to come more prepared. Gain access to the S Drive) (Alexx) **Done**
- 0 – Mach 3 time and fuel consumption (Jesse research) 10/14/15
- Forces on the nose cone (Chris Alexx) 10/14/15
- Email reminder to Dr. C Monday before meeting 10/19/15
- Create Better more detailed designs ensuring specifications/statistics are met
- Document why we made the choices on nose cones and diaphragms
  - Decision matrix
- Research the iris (Marc) 10/14/15

Time: 9:30 – 10:40 AM



## Integrated Solid Rocket RamJet (Mach 4)

11/18/2015

Attendance:

Everyone

Agenda:

- Confirm with Dr. C that we are on the same page with design goals

Meeting Notes:

- How we felt about the Design Review
  - Need to clarify how the rocket and ramjet work specifically
  - Give a more detailed description on how they work in very simplistic detail. This will bring those who don't know up to pace and possibly clarify again for those who do
  - Keep it brief
- Things that Dr. C noticed we needed to improve upon
  - Settle on a main design
  - When we talk about the overall design there is more uniformity
- Alexx plans to 3D print small cut outs to show how each section works
- Nasa plans to deliver the math model for the nose cone Today Nov 18
  - Hopefully we can move forward with this and obtain the information needed
  - Response from Nasa
    - Stated that it was complex, but sounded like a good idea
    - From Ohio, glen research center
- Fuel in the center of the ramjet
  - Nervous about the aerodynamics of this design
  - Doesn't seem smooth
  - Would like to see the fuel possibly on the outer side of rocket
  - Perform some performance calculations between the two
  - So long as we can bring up quality engineering reasons as to why then we are okay to move forward with our design
- Step through the justifications on each of the components and why we choose them

To do:

- Citizenship forms due Friday Nov 20<sup>th</sup> Email to Dr. Maughan
- Snapshot Friday Dec 4<sup>th</sup>
- Two Design Reviews
- Next class is Tuesday after thanksgiving break
- Meet with Dr. C on Dec 2<sup>nd</sup> and Dec 9<sup>th</sup>
- If Nasa doesn't reply to Chris by the end of Nov 18<sup>th</sup> then we will move forward with manual cone calculations
- Inlet conditions due Tuesday Nov 24<sup>th</sup>

Time: 9:30 – 11:05 AM

## Integrated Solid Rocket RamJet (Mach 4)

### Attendance:

All

### Agenda:

- Discuss Math Models
- Discuss Nose Cone updates
- Discuss Pro's and Con's for diaphragm ideas and which one that we have decided to move forward with
- Discuss Design Review on the 11<sup>th</sup>

### Meeting Notes:

- Dr. C will be able to make the Design Review on the 11<sup>th</sup>
- Jesse will be discussing his math model after the meeting with Dr. C and will be Sending it off to get it looked at.
- Marc has sent Dr. C his math model
- Both models have been created using parametric studies to analyze their respective systems
- Chris was able to research information on supersonic nose cones
  - He was able to find a program through nasa called supen?
  - He would be able to obtain the code if he can prove that the group is not from another country
  - Has been looking into 4tran knowledge
  - Will be getting some examples of code, but nothing back from him yet
  - Has been looking into creating an EES code
- Dr. C notes that the Flaps won't see the temperature for a long period of time depending on the geometry of the rocket fuel
  - Pressure may be more of a factor (8 Mpa)
- One Last chance to get feedback from the people that know more than you
  - Share what you've done but get info back
  - Don't talk too much on what we're thinking, and more on what we're doing
- Invite professors that would be interested or knowledgeable
  - This is to invoke participation and potentially gain knowledge and insight
- We are aiming to create a workable system, but there is no need to make everything perfect

### To do:

- Advise Chris to ask what equations were used in the 4tran coding
- Design Review Presentation Prep (Wednesday at 9:30)
- Send Dr. C the information on our Design Review Preparation by Monday/Tuesday

Time: 9:30 – 10:30 AM

## Integrated Solid Rocket RamJet (Mach 4)

12/16/2015

### Attendance:

Chris, Marc, Jesse, Alexx

### Discussion:

Over break responsibilities to ensure the project stays on track for completion and ensuring that Dr. C's expectations are met.

Alexx- Will be performing calculations on the diaphragm to fully support the design

Chris- Will be creating the Nose cone Barrier

Jesse- Fix Binder and update webpage

Marc- Ideas for the model

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

12/2/2015

### Attendance:

Jesse Caudle  
Alexx Jensen  
Marc Compton  
Chris Frazer  
Dr. Maughan  
Jake Gilles

### Agenda:

- Discuss Snap Shot meeting time tomorrow
- Discussing the current status of the Ramjet
- Discussing what needs to be done come Dec 9<sup>th</sup>

### Meeting Notes:

- Vandal Gear gets bonus points during Snap Shot
  - Nice vandal gear
- Diaphragm
- Set inlet code to 1 meter in diameter @ 45000 ft @ range of 1000 kilometer
  - Length was 40 ft of fuel
  - Set inlet code to 1 meter @ 0 ft @ range of 1000 kilometers
    - Length was similar or longer
- The engine face has an input variable for the speed
  - This seems odd and needs to be looked into

### To do:

- Meet at 11 Dec 3 to put together Snap Shot poster board
- Chris will look into the sizing of the code and why the engine face variable can't be set higher
- Lower the overall Mach number
- Increase the speed at the engine face to approximately Mach of .4
- Meeting at 12 Monday Dec 7 in ME Conference room

Time: 9:30 – 10:20 AM

## Integrated Solid Rocket RamJet (Mach 4)

12/9/2015

Attendance:

Everyone

Agenda:

- Discuss Full Concept

Meeting Notes:

- Full Concept
- Expo Model
  - Aesthetically nice more than scaled
  - If there is a large difference use a scale with the model on the poster for expo
  - Model materials don't need to be rocket specific
  - Make sure the model is finished, don't get bogged down in the materials

To do:

- Begin looking into how to manufacture model

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

1/13/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

### Discussion:

Discussed the lack luster budget even though we haven't spent anything

### To Do:

Alexx- Obtain schedules from everyone, and create a spreadsheet to see what times work to continue meeting with Dr. C

- Also preform the FEA on the diaphragm to support the decision

Chris- Will tidy up the budget and with spending on the way be prepared for it

Jesse- Will be updating the wikipage

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

1/20/2015

### Attendance:

Dr. C, Dr. M, Chris, Marc, Jesse, Alexx

### Discussion:

- Discussed how Russ had machined a nozzle previously for Dr. C and that we should contact him to see it.
- Discussed how we decided up machining the rocket, as well as our strategies and materials for each section
- Dr. C suggested a CO2 cartridge to blow open the flaps with our fuel injection
- Wind tunnel model is lowest priority, and we should focus on the ¼ cutout model
- Dr. C will be back on April 6<sup>th</sup>

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

1/27/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Purchasing
- Nozzle
- Nose cowling
- machining

### Discussion:

- Nose
  - Fill the holes in the strainer
  - Consider bondo
  - Lazer cut and custom stamp to create a one off
  - Cowling will be 5.5" in outer diameter
  - Use ABS possibly for weight concerns on the nose cone
- Body
  - Need to change the model to accommodate the new OD
- Nozzle
  - Possibly made of acrylic
  - Scale it in proportionally so we can make it fit (this is no longer required)

Time: 9:30 – 10:30



## Integrated Solid Rocket RamJet (Mach 4)

2/10/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Diaphragm
- Nose Cone
- Diffuser

### Discussion:

- Diaphragm
  - Alexx- 3D printed a few tests for the diaphragm that resulted in poor quality and lifting material
  - Chris suggested using rafts and ensuring the table is level by using the level table function
  - For the fuel injection two ideas that were discussed were welding tips or sprinkler system tips
- Nose
  - Alexx- Had previously brought up talking to Dr. C about painting the rocket but no response
  - Deciding between aluminum and PVC to utilize
  - Decided to go with PVC as a substitute material as it is paintable and lightweight
- Diffuser
  - Questioning how long the diffuser is?
  - Should we make it out of aluminum or the same material as the Nose cone?
  - We decided to make the diffuser out of Aluminum
  - A question that arose is how the sides will be mounted.

### To Do:

- Measure the diffuser length and email everyone
- Logbooks are due next week as well as the binder
- Talk to Russ about  $\frac{1}{4}$  cut and fuel injection

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

2/17/2015

### Attendance:

Dr. C, Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Nozzle
- Nose Cone
- Closing flaps
- Diaphragm
- Diffuser

### Discussion:

- Nozzle
  - Obtained the aluminum stock
  - Will begin machining today (Facing /Boring)
  - Next week is the planned finishing time for the nozzle
- Nose
  - Obtained the PVC for the nose cone
  - Will begin working on the Mastercam file for the CNC lathe
- Closing Flaps
  -
- Diaphragm
  - 3D Print the diaphragm as it will be quicker and function better
  - Air nozzles to force the flaps open receding within the necked portion
- Diffuser
  - Machined to obtain better results that will match the scale model
- Dr. C
  - Machining the difficult portions now and focusing on the simpler portions later
    - Yes this is the game plan
- Dr. M
  - Want it to be able to break down for transportation?
    - For now press fit will be okay as a proof of concept
- Dr. C
  - Likes the idea of painting to obtain a more professional look.
    - Either black, silver, or red
  - Adding a logo may look good
    - UI, Team Name, Boeing???
  - Will be back April 7<sup>th</sup>
  - Likes the current status

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

2/24/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Nozzle
- Nose Cone
- strainer
- Diaphragm

### Discussion:

- Strainer
  - Strainer will be pushed and pulled to open/close the cowling
  - Take measurements to adjust stuff???
- Diaphragm
  - Attachment of the diaphragm?
    - Glue
    - Bolts
    - Order stock for diffuser
    - Have cutout for fuel and utilize for displaying fuel lines
- Nose cone
  - Has a three section design ready just waiting on machining time with Jake

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

2/3/2015

### Attendance:

Dr. C, Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Purchasing
- Machining
- Design Review

### Discussion:

- Chris
  - Machining nose cone design
  - Will be approximately 14" in total length
  - Due to length and shaping will be cut into three pieces to accommodate machining
  - Made out of a plastic in order to save weight as well as speed up machining the excess material
- Alexx
  - Scaled the model to have a 5" inner diameter as well as a 5.5" outer diameter
  - Cut the portions out of the solid and liquid fuel
  - Overall length will be 39"
- Jesse
  - Looked at the nozzle in office which sparked the question as to what the inlet of the nozzle should look like
    - Dr. C stated it is subsonic flow so a smooth flow look will be sufficient
- Dr. C
  - Asked if we will be creating a movable nose cone
    - Cowling will seal and he was okay with that
    - ¼ the shell while leaving the nose and nozzle whole
  - Alexx Stated that the diaphragm will be slightly off scale to support for strength and durability

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

3/2/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx, Dr. C

### Topics:

- Snapshot
- Nozzle
- Nose Cone
- strainer
- Diaphragm
- Due Dates

### Discussion:

- Strainer
  - K
- Diaphragm
  - Print parts later in the week and plan to assemble and test fit
- Nose Cone
  - Mastercam code on Monday and machining later this week
- Nozzle
  - Was delayed due to CNC code debugging.
    - Errors, wouldn't send code, zeroing error flipped, bad bit
- Cowling
  - Cut as much out as possible
  - Having doubts
  - Two suggestions proposed by Jesse and Marc
- Flash Paper
  - Will be used to simulate solid propellant
    - Dr. C will be very interested to see the demo
    - Video the demo to show Dr. C
- Dr. C
  - Mentioned that the notion of the SpaceX Alumni
  - Calculations moving forward
    - If we finish early then we plan on doing more FEA
  - Next week is snapshot do you need me?
    - No
- Housekeeping
  - Postpone next meeting to the 23<sup>rd</sup>
  - Snapshot
  - Portfolio
  - Citizenship forms

- DFMEA
- Wikipage

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

3/23/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx, Dr. C

### Topics:

- Snapshot
- Nozzle
- Expo

### Discussion:

- Snapshot
  - Snapshot went very well
  - Chris and marc did a great job rendering individual sections
  - Added a large image with label
  - Reduced words to implement more photos
- Nozzle
  - Finished 2 days after snapshot
- Expo
  - All components are on track to finish by expo

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

3/9/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

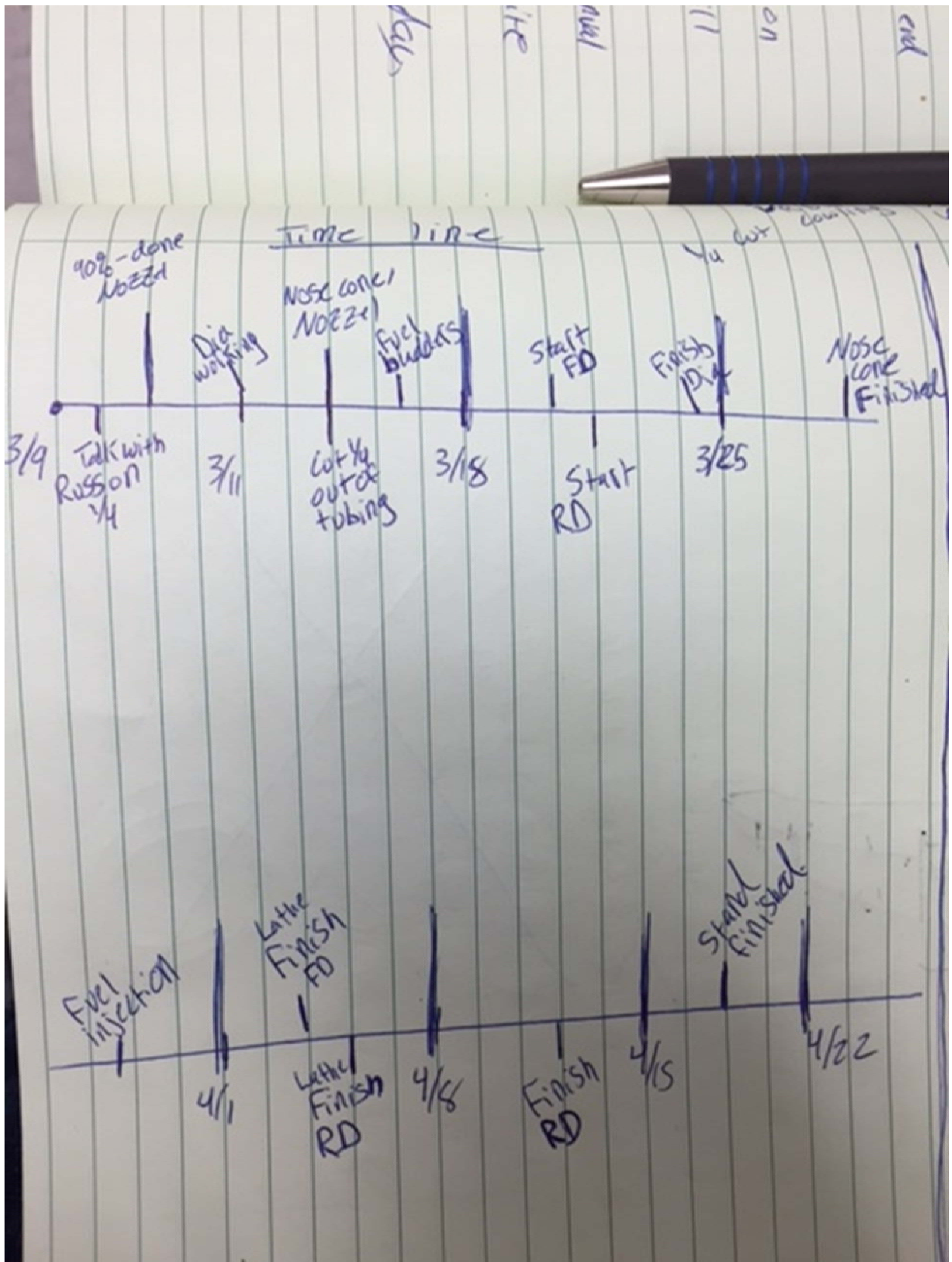
### Topics:

- Snapshot
- Machining
- Time Line

### Discussion:

- Snapshot
  - Visual aids were nice and renderings were great
  - Possibly look into using nails for diaphragm
- Machining
  - Jesse:
    - Chris will machine Thursday 10<sup>th</sup> 8-10:30 and machine until 5
      - Goal is to finish by the end of business on the 10<sup>th</sup>
  - Chris:
    - Help with Jesse
    - Create Mastercam for mill and lathe during Jesse's machining
    - Aluminum fixtures on manual lathe
    - Found stock in scrap cabinet
      - Justin and Steven can allow us to machine on Monday or Tuesday during break
    - Estimate of 2 days to machine so we will say 3
    - Motor
      - Costs 130
      - Motorized lead screws
      - No specifications
      - How will we power it?
        - Arduino and previous group had notes
      - Mounted and wires will go through supports
    - Budget – 1400
    - Lead time is 2 weeks from purchase
    - Create own stepper/dc lead screw
  - Alexx:
    - Printing
    - Fuel injection
    - Lathe CNC
- Timeline





Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

4/27/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Presentation
- Model
- Air flow

### Discussion:

- Presentation is 10-13 minutes then questions
- Model is complete and together
- Air duster cans are not optimal to blow open the flaps.
  - Dr. C asks if six jets of air would work and its seems un likely
  - Dr. C is okay with no air flow over purchasing a compressor
- Ready for EXPO

Time: 9:30 – 10:30

## Integrated Solid Rocket RamJet (Mach 4)

4/6/2015

### Attendance:

Dr. M, Chris, Marc, Jesse, Alexx

### Topics:

- Nose cone
- cowling
- Stand
- Combustion chamber

### Discussion:

- Combustion chamber
  - Needs to be machined
- Nose cone
  - Is set up to be lathed
  - Time is scheduled on Tuesday
- Cowling
  - Boring bar couldn't reach the back during the process and wasn't caught until after the point of no return
  - Will be taken to the CNC mill to finish the part
- Stand
  - Will be made out of acrylic and laser cut
- Forecast
  - Begin milling Monday-Friday
  - A week and a half of testing
- Alexx:
  - Email – rob patten
  - Website to review if we did/what we need to prepare

Time: 9:30 – 10:30