Exit Presentation

Kate Melone
12/8/16
Overview

• About Me
  – Education
  – Hobbies and Interests
  – Past Experiences

• Projects
  – Radiated Materials Tensile Testing
  – Outgassing Testing for SHERLOC on Mars 2020 Rover
  – Z2 Support
  – LCVG Flush and Purge Console

• Lessons Learned
• Future Plans
• Acknowledgements
About Me

• Born and raised in Delaware
• I have a cat named Comet
• Dream car: Lamborghini
• Favorite TV Show: Leave It To Beaver
• Space Geek
  – Manned Space Exploration
  – Crew Systems, Orbital Mechanics, Aerodynamics, Propulsion
Education

• University of Maryland, College Park
  – Go Terps!
• Pursuing my B.S. in Aerospace Engineering
  – Concentration in Astronautics
Hobbies and Interests

- **Sports**
  - Basketball, football, hockey, baseball, soccer

- **Music**
  - Listening to music and going to concerts

- **Family and Friends**
  - Spending time with family and friends
Past Experiences: UMD Research and Conferences

• Undergraduate research
  – Analog space suit joint torque elbow testing
  – Development of analog spacesuits
  – Pneumatically powered EVA Glove

• Conferences and Papers
  – AIAA Region 1 Student Paper Conference (Spring 2014, planning to go Spring 2017)
  – AIAA Young Professionals, Students, and Education Conference (Fall 2014 and Fall 2015)
Past Experiences: JSC SK3
Summer 2014 Internship

EVA Glove Sensor Feasibility II Project

• **Goals:** Develop a method and list of sensors for measuring the glove environment acting on the fingers and hands inside the glove box

• **Importance:** Obtain data that can be correlated with astronaut injury reports

• **Accomplishments:** Analyzed extensive amounts of data and assisted in writing the EVA Glove Sensor Feasibility II Report
Past Experiences: JSC EC5
Summer 2015 Internship

RoboGlove Cycle Tester

- **Goals:** Test repeatability and endurance of Force Sensitive Resistors (FSRs)
- **Importance:** Determine whether or not FSRs will suffice for long term use
- **Accomplishments:** Successfully designed and built a cycle tester by the completion of my internship
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
Tensile Testing of Radiated Materials

• Objective: Tensile test radiated space suit materials
• Purpose: Compare pre/post radiation mass, max tensile load, and max tensile extension
Radiated Materials Tensile Testing

Orthofabric

Teflon

Vectran

Dacron

Spectra

Bladder Material

nGimat Coated Orthofabric

nGimat Coated Teflon

Polycarbonate
Radiated Materials Tensile Testing

• Conducted tensile testing of various radiated materials
  – Prepared samples for testing
  – Set up tests
  – Collected data
Radiated Materials Tensile Testing

- Assembled Test Reports
- Analyzed data and put together a test results summary of total mass loss (TML), fabric appearance, maximum/minimum max load, maximum/minimum max tensile extension

<table>
<thead>
<tr>
<th>Test Keycode</th>
<th>AML-16-18, Space Site Material Testing</th>
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<tbody>
<tr>
<td>Test Name</td>
<td>Tensile</td>
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<tr>
<td>Load Mass</td>
<td>750</td>
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<td>Declaration Date: 12/15/2017</td>
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<tr>
<td>Temperature</td>
<td>75°F</td>
</tr>
<tr>
<td>Humidity</td>
<td>60%</td>
</tr>
<tr>
<td>Operator</td>
<td>Joseph Feitler and Kate Licinas</td>
</tr>
<tr>
<td>Requester</td>
<td>Joseph Licinas (JML)</td>
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<table>
<thead>
<tr>
<th>Specimen ID#</th>
<th>Minimum Load (lb)</th>
<th>Maximum Tensile Extension</th>
<th>Comment</th>
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<tr>
<td>1</td>
<td>131</td>
<td>300</td>
<td>0.91</td>
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<tr>
<td>2</td>
<td>140</td>
<td>250</td>
<td>0.91</td>
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<tr>
<td>5</td>
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<td>100</td>
<td>0.91</td>
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NOTES:

Estimated Tensile Strength:

**Use caution when interpreting load vs. elongation plot.**
Radiated Materials Tensile Testing

Tensile Testing Results Takeaways

Note: Not all values listed, larger values indicate the stress value if the value does not exceed the yield stress value in either case, if the control value is less than the yield stress, it is not calculated as the limit, rather the next max mass of the radiated sample is the new mass range.


Mass Change (Absolute Value)

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<thead>
<tr>
<th>Mass (g)</th>
<th>Mass Change (g)</th>
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<tr>
<td>67</td>
<td>0.0027</td>
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<tr>
<td>66</td>
<td>0.0041</td>
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<tr>
<td>69</td>
<td>0.0036</td>
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<tr>
<td>616</td>
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<td>611</td>
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<td>612</td>
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<td>810</td>
<td>0.0002</td>
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<td>0.0035</td>
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<td>810</td>
<td>0.0002</td>
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<td>812</td>
<td>0.0035</td>
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Mass Difference (Absolute Value)

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<thead>
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<td>0.0058</td>
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<td>0.0034</td>
<td>0.0042</td>
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<td>0.0001</td>
<td>0.0023</td>
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<td>0.0029</td>
<td>0.0092</td>
<td>0.0039</td>
<td>0.0014</td>
<td>0.0021</td>
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<tr>
<td>0.0036</td>
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<td>0.0025</td>
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<td>0.0049</td>
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<td>0.0026</td>
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<td>0.0064</td>
<td>0.0012</td>
<td>0.0086</td>
<td>0.0042</td>
<td>0.0002</td>
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</table>

Mass Tensile Extention Range:

- Max Load Range: 155.23 lb to 163.30 lb
- Max Tensile Extention Range: 21.23 to 25 in
- Standard:
  - Max Load: 155.23 lb
  - Max Tensile Extention: 25 in
- Control:
  - Max Load: 100.00 lb
  - Max Tensile Extention: 21 in

Data Notes:

- Variations in radiated materials, all samples on the same plate (plate 2, round 2) as keeping the plate was consistent with related tests, when a control sample was included in the same plate, it was on a different plate (plate 2, round 1), as keeping the plate was consistent with related tests.
- Samples from multiple locations on the plate were taken and tested, which were then averaged and reported for these tests.
- These tests were conducted in a laboratory setting with controlled conditions to ensure consistent results.

A sample of radiated charges tested in a similar manner: After being heated to a maximum of 1500°F for 2 hours, each sample was then placed in a 70% humidity environment and tested to destruction.

Max Load Failure:

- Excluding control, max load range was 155.23 to 163.30 lb, control sample fell within this range.
- Max Load value was 155.23 lb, which was the highest value, while the control (0.00 lb) was the lowest value.
- Excluding control, max load range matches those obtained, differences between min and max load was 155.23 lb.
Radiated Materials Tensile Testing: Summary of Results

<table>
<thead>
<tr>
<th>Material</th>
<th>Mass Difference (g)</th>
<th>Average Max Load Baseline (lbf)</th>
<th>Average Max Load Radiated (lbf)</th>
<th>Average Max Tensile Extension Baseline (in)</th>
<th>Average Max Tensile Extension Radiated (in)</th>
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</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>.0053</td>
<td>335.9</td>
<td>343.4</td>
<td>.410</td>
<td>.238</td>
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<tr>
<td>Teflon</td>
<td>.0053</td>
<td>30.6</td>
<td>24.1</td>
<td>3.76</td>
<td>2.01</td>
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<td>Vectran</td>
<td>.0055</td>
<td>464</td>
<td>241</td>
<td>.640</td>
<td>.444</td>
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<tr>
<td>Dacron</td>
<td>.0010</td>
<td>245</td>
<td>105</td>
<td>1.10</td>
<td>.476</td>
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<tr>
<td>Spectra</td>
<td>.0191</td>
<td>1363</td>
<td>1190</td>
<td>14.0</td>
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<tr>
<td>Bladder Material</td>
<td>.0032</td>
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<td>100</td>
<td>.85</td>
<td>.50</td>
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<tr>
<td>nGimat Coated Orthofabric</td>
<td>.0061</td>
<td>304</td>
<td>379</td>
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<tr>
<td>nGimat Coated Teflon</td>
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<td>67.1</td>
<td>51.8</td>
<td>3.32</td>
<td>2.25</td>
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<tr>
<td>Polycarbonate</td>
<td>.0034</td>
<td>1071</td>
<td>1079</td>
<td>.360</td>
<td>.325</td>
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</table>
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
Outgassing Testing for SHERLOC on Mars 2020 Rover

• SHERLOC
  – Scanning Habitable Environments with Ramen and Luminescence for Organics and Chemicals
  – Will search for organic materials altered by water environments
• Space suit materials will be placed on the SHERLOC calibration target
Outgassing Testing for SHERLOC on Mars 2020 Rover

• Became familiar with and understood contents of the Goddard outgassing database
• Put together database summary of relevant materials
• Compared to NASA’s MAPTIS materials database
• Helped to determine additional testing would be required for some samples
Outgassing Testing for SHERLOC on Mars 2020 Rover

- Requirements: Must pass ASTM E595 standards
  - <1.0% Total Mass Loss (TML)
  - <.1% Collected Volatile Condensable Materials (CVCM)

<table>
<thead>
<tr>
<th>Pass</th>
<th>Fail</th>
<th>Unsure</th>
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<tbody>
<tr>
<td>Orthofabric</td>
<td>Bladder Material (&gt;1.0% TML)</td>
<td>Spectra</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>nGimat Coated Orthofabric</td>
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<tr>
<td>Teflon</td>
<td>nGimat Coated Teflon</td>
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<tr>
<td>Vectran</td>
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<tr>
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</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>Bladder Material (&gt;1.0% TML)</td>
<td></td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>Spectra (.4% CVCM)</td>
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<td>Vectran</td>
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<tr>
<td>Dacron</td>
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<tr>
<td>nGimat Coated Teflon</td>
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</tr>
</tbody>
</table>
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
Z2 Support: Pre Manned NBL Testing

• Assisted with preparing Corn Man
• Made a communication box mockup for the Corn Man test
Z2 Support: Pre-NBL Testing

• Assisted with preparing Z2 Processing Procedures
  – DIDB
  – MAG
• Assisted with preparing data scales
• Suit Fit Checks
Z2 Support: NBL Testing

• Weigh outs
  – Assisting as needed with keeping track of weight pack adjustments

• Contact Points
  – Recording contact points during testing
  – Developing standardized system/guidelines
  – Interpreting contact points results

• NBL Data
  – Organizing and combining data into one spreadsheet
Z2 NBL Support: Contact Points Analysis
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
LCVG Modified Flush and Purge Console

• Objective:
  – Design an LCVG Flush and Purge Console

• Requirements:
  – Must be able to flush and purge the LCVG
  – Must be able to structurally test the LCVG
  – Must have access to both air and water
  – Must be as small as possible
  – ~$2000 budget

• Importance:
  – Ability to test at higher pressures
  – B34 location
LCVG Modified Flush and Purge Console

• Preparation
  – Became familiar with pressure system components
  – Pressure Systems Design Course
  – Reference previous LCVG Flush and Purge Console Design
LCVG Modified Flush and Purge Console

Breathing Air @ MAWP 30 psig

Breathing Air @ MAWP 200 psig

Water @ MAWP 60 psig

Breathing Air Source @ Maximum MAWP 200 psig
LCVG Modified Flush and Purge Console: Structure Test

**Breathing Air**
- @ MAWP 30 psig
- @ MAWP 200 psig

**Water**
- @ MAWP 60 psig

**Air**
- Breathing Air Source @ Maximum MAWP 200 psig

**Notes**
1. System fluids are compressed air or water at room temperature (0 degrees Fahrenheit).
2. System maximum pressure (SMP) is 30 psig for the air side and 60 psig for the water side.
3. System cross-leak (CL) per NFPA 3003.
4. Air vents through the CLP or MTP unless otherwise specified.
5. No tapping is 316 Stainless Steel 3/8" OD. All other tapping connections are 1/4" NPT. Outlets are 1/4" NPT.
6. System is field tested for flow, pressure, and air leakage.
7. System flow rate 30 psig can be expected for any breathing air source and maximum flow at 30 psig.

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**VALUED BY:**

**LCVG Modified Flush and Purge Console Schematic**

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30
LCVG Modified Flush and Purge Console: Purging LCVG

- Breathing Air @ MAWP 30 psig
- Breathing Air @ MAWP 200 psig
- Air
- Water
- Water @ MAWP 60 psig

Notes:
1. System fluids are compressed air or water at room temperature (6-8 degrees Fahrenheit).
2. System Box is 30.5 sq. ft. for the air side, and 36 sq. ft. for the water side.
3. Systems have flow and pressure limits.
4. System configuration can change due to plant operations.
5. System Box is 36 Stainless Steel 3/4" (1.375") or greater and thickness unless otherwise noted.
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7. System Box is 36 Stainless Steel 3/4" (1.375") or greater and thickness unless otherwise noted.
8. System Box is 36 Stainless Steel 3/4" (1.375") or greater and thickness unless otherwise noted.
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Machine Room: A27-NO-00023
Air and Water: 12/13/15

SAN FRANCISCO, CA
## LCVG Modified Flush and Purge Console: Approval Process

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Manufacturer</th>
<th>Description</th>
<th>Approval Process</th>
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<td>Andrews Bros</td>
<td>Shut-Off Valve</td>
<td>NA</td>
</tr>
<tr>
<td>AS-5F-02</td>
<td>Andrews Bros</td>
<td>Pressure Gauge (0-200 PSI)</td>
<td>NA</td>
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<tr>
<td>AS-5F-03</td>
<td>Andrews Bros</td>
<td>Rubberized Vacuum Cleaner</td>
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<td>AS-5F-04</td>
<td>Andrews Bros</td>
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### Table 1: Component Specifications

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<thead>
<tr>
<th>Component</th>
<th>Description</th>
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<tbody>
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<td>Rubberized Vacuum Cleaner</td>
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<td>AS-5F-05</td>
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<td>AS-5F-06</td>
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### Table 2: Component Specifications

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<td>AS-5F-04</td>
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### Table 3: Component Specifications

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<tr>
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<td>AS-5F-04</td>
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<tr>
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### Table 4: Component Specifications

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<td>AS-5F-03</td>
<td>Rubberized Vacuum Cleaner</td>
<td>NA</td>
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<td>AS-5F-04</td>
<td>Rubberized Vacuum Cleaner</td>
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<tr>
<td>AS-5F-05</td>
<td>Check Valve, Quick Connect</td>
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</tr>
<tr>
<td>AS-5F-06</td>
<td>Check Valve, Quick Connect</td>
<td>NA</td>
</tr>
</tbody>
</table>
Pressure Regulator

- \[ Q = C_v \times \left[ \frac{816 \times P_1}{\sqrt{S.G. \times T}} \right] \]
- \[ Q = 0.02 \times \left[ \frac{816 \times 214.7}{\sqrt{1 \times 530}} \right] \]
- \[ Q = 153 \text{ SCFH} = 2.5 \text{ SCFM} \]
LCVG Modified Flush and Purge Console: Approval Process

1876 Form

366S Form

366C Form

Hazard Analysis
LCVG Modified Flush and Purge Console: Status

- Preliminary Research/Preparation
- Design Sketches
- Technical Drawing
- Bill of Materials/ Determining Components (Calculations)
- Required Forms (1876, 366S, 366C)
- Hazard Analysis
- Pressure Systems Approval
- Order Components and Assemble
- Test/Inspect/Final Approval
Lessons Learned

• Data can be confusing at times
  – Example: Material appeared to be stronger after radiation
• A lot goes into the formal design process
  – Design review, forms, Hazard Analysis, inspection, etc.
• Understanding specifications
  – AN vs NPT
  – Tube vs Pipe
• Learning about pressure system components
  – In addition to pressure ratings, need to consider size and flow rates
Skills Acquired

• Tensile Testing
  – Prepare materials and setting up the tensile tests
  – Collect and interpret (messy) data
• Outgassing Testing
  – Understand TML and CVCM
  – Collaboration with other NASA centers
• Z2 Support
  – Hands on building mockups of components
  – Analyze data
  – Work with others; understanding what both parties need in order to make a run successful
• LCVG Flush and Purge Console
  – Both formal design and design review process
  – How to determine which components to use; flow calculations, pressure ratings, size, etc.
  – Hazard Analysis
  – How to make design tradeoffs
Future Plans

2017
- Spring: UMD
- Summer: CM4 Co-op
- Fall: UMD

2018
- Spring-Summer: Co-op
- August: Class and Graduate with B.S. in Aerospace Engineering
- Fall: UMD for M.S. in Aerospace Engineering

2019
- Spring: UMD for M.S. in Aerospace Engineering
- Summer: UMD and finish M.S. in Aerospace Engineering
- Fall: Grad co-op/Starting Ph.D.
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Questions?