



### **VTT Rotor: Back EMF Test Fixture Midterm Presentation I**

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Advisor: Dr. Louis Cattafesta Sponsor: Danfoss Turbocor – Brandon Pritchard Instructors: Dr. Chiang Shih, Dr. Nikhil Gupta

Date: 2/17/2015

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## **Presentation Outline**

- Background and Motivation
- Final Prototype
- Key Design Components:
  - Extruded Aluminum Baseplate
  - Ball Screw
  - Live Center Assembly
- Current Status
- Drawing Updates
- Gantt Chart
- Conclusion

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Stato Magnetic

79



Drive

(Drill)

## **Motivation and Goal**

- Need test fixture to qualify rotors Bearing
- Will measure back electromotive force (EMF)
- Test fixture for smaller rotors already developed
- Several constraints on design

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65 cm

30 cm





## **Design Challenges**

- Budget: \$4,000
- Overcoming magnetic force of 60-80 pounds
- Centering rotor within stator
  - Deviations in the height of components will compromise validity of quality tests
  - Motor shank needs to support rotor weight
- Spatial Constraints:



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### **Initial Prototype**

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Track

**Live Center Support** 

**Solid Aluminum Baseplate** 

Linear Guides

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# **Extruded Aluminum Baseplate**

- All components will be fastened to 90x180 mm Extruded Aluminum Baseplate
- Components connected with fastening nuts
- Allows for alignment



- Large cross section will provide support and prevent deflection
- Cost:
  - \$391.12 for baseplate, \$33.10 for nuts (x100)

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## **Ball Screw, Linear Guides**



- Misumi Ball Screw selected with block mounting nut
  - 15 mm diameter, 10 mm lead
  - Must also purchase bearing blocks
- Misumi Heavy Load Linear Guides selected with clamps
  - Update to design: 1240 mm total length, two connecting blocks per guide
  - Rated for 155 N-m, FOS of 4.4
  - Total Cost (Ball Screw, Guides, Clamps, Bearing Blocks): \$1217.48



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Misumi SX2R28-1240 Linear Guides

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## **Live Center and Housing**

- Live Center used to center the rotor
- Will be press fit into the support system
- Original live center support rode inside grooved track
  - Issues with wear over time
- New design involves live center support connecting to linear guides
  - Held in place by linear guide clamp

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### Live Center Housing

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Live Center Selected





## **Current Project Status**

- Final Design Review was held at Turbocor at the end of the Fall 2014 semester
  - Design approved
  - Purchase orders for individual parts submitted
- Spring Turbocor Meetings
  - Drawings for custom parts finalized
  - Purchase orders for aluminum submitted
- Next Step: Manufacturing Stage
  - As parts arrive from suppliers and custom made parts are machined, assembly of test fixture will begin

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## Selected Drawing Revisions



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### **Gantt Chart**

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		Jan 4, '15	Jan 18, '15	Feb 1, '15	Feb 15, '15	Mar 1, '15	M	lar 15, '15	Mar 2	29, '15	Apr 1	2, '15
Task Name 👻	% Complete	F T S	W S T M	F T S	W S T M	F T S	W S	S T M	FT	S W	S	Т
▲ Parts Ordering	10%			1	)							
Submission of Drawings for Custom Parts	80%		<b>h</b>									
Creating Operations Manual	0%		ш́-									
Part Arrival	0%		<b>Test</b>									
Obtain Custom Machined Parts	0%		Ť									
▲ Assembly	0%			i i	*							
Construct Extruded Aluminum Subassembly	0%											
Construct Stator Housing Subassembly	0%											
Construct Live Center Subassembly	0%											
Construct Motor Subassembly	0%											
Construct Ball Screw Subassembly	0%											
Construct Final Assembly	0%											
Testing and Presentation	0%								Ě			
Rotor Fitment & Alignment Testing	0%											
Motor Operation Testing	0%									- Ě		
Emergency Stop Testing	0%									<b>ě</b> ,		
Oscilloscope Fitment and Testing	0%									, i	Ξh	
Testing Prototype	0%										Т,	
Troubleshooting Prototype (If Necessary)	0%										Ľ	Щ.
Presentation and Final Test at Turbocor	0%											Ľ.

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## **Conclusion & Future Work**



- Drawings for custom made parts finalized.
- Once drawings are approved and parts start arriving, assembly may begin
- Participating in the ASEE Poster Competition and the ASME's SPDC Poster Competition.
- After assembly, several tests need to be performed
- Final goal: Implementation ready by April 14<sup>th</sup>, 2015

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## **Questions or Comments?**



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 For more information, see our website: http://eng.fsu.edu/me/senior\_design/2015/team04/



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### **Motor Bearing Support**



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### **Bottom of Stator Housing**







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### **Top of Stator Housing**



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### **Linear Guide Spacer**



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### **Live Center Baseplate**

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### **Live Center Frontplate**







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### **Linear Guide Connector**



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# Live Center Upright Support



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### **Motor Base Support**



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### **Prototype Subassemblies**





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### **FEM: Rotor Connection**

Stress in MPa Max Stress: 4.19 MPa Nylon Tensile Strength: 76 MPa

### Displacement in mm Max: 0.048 mm



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### **Linear Guides**

- Vendor: Misumi
- Part Number: SX2R28-1240
- Unit Height: 1240 mm
- Moment due to Magnetic Force:
  - 35 N-m
- Allowable Moment:
  - 155 N-m
- Factor of Safety:
  - 4.4



## **Motor and Motor Drive**

Danfoss

- Vendor: Automation Direct
- Motor: E2007A AC Motor, 2 HP, 1800 RPM, 3 phase
- 24 ft-lb start up torque, 11 ft-lb needed
- Factor of Safety: 2.2
- Drive: GS1 2 HP AC Drive, 3 phase





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E2007A AC Motor

GS1 AC Drive

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