

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

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Slide 1 of 15



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### **Presentation Outline**

- Background
- Design Challenges
- Initial Prototype
- Risks and Risk Mitigation
- Fall Schedule
- Conclusion and Future Work

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Stator



Drive

(Drill)

## Background

- 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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30 cm

65<sup>°</sup>cm





- Must overcome magnetic force during insertion
- Rotor must be centered within stator to specified tolerance (0.5 mm)
- Rotor must be spun at a minimum of 1000 RPM
- Spatial Constraints:



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### **Project Goal**

- Fully designed, manufactured and tested back EMF test fixture
- Submission package to Turbocor:
  - 3D Prototype
  - Bill of Materials
  - Drawing Package
- Conform to all constraints outlined by Turbocor
- Efficient use of resources and time

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## **Motor Selection**

- Calculations indicate:
  - 9 ft-lb Torque
  - 0.7 HP required
- Key Considerations:
  - AC preferred
  - 1000 RPM minimum capability
  - Shank Diameter
- Marathon Electric AC Motor
  - 2 HP
  - 3600 RPM



Shank

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## **Design Configuration**



- Rotor to be lowered by a crane, then there are three options for next step:
  - Rotor can then be moved into stator
  - Stator can be moved over rotor
  - Both can be moved
- Moving both = most ergonomically efficient
- Live center connection can either hinge or slide along track



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#### **Rotor Centering**

- Rotor must be axially aligned within stator
  Tolerance: 0.5 mm
- Old design used bearings, durability issues
- Live center to be utilized

Ball Bearings

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# **Overcoming Magnetic Force**

Danfoss

- 60-80 pound magnetic force exerted when rotor is inserted into stator
- Three options considered:
  - 1) Ball Screw
  - 2) Rack and Pinion
  - 3) Pneumatic Actuator



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## **Design Selection Matrix**



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Design (1-10)	Safety (30%)	Accuracy (25%)	Ease of Use (20%)	Durability (15%)	Cost (10%)	Total
Ball Screw	9	8	7	6	6	7.6
Pneumatic Device	3	5	2	6	3	3.75
Rack and Pinion	7	3	5	4	5	4.95

Ball Screw most viable option

Durable, safe, low cost, cannot be back-driven

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## **Initial Prototype**



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## **Risks and Mitigation**



- Scheduling Setbacks
  - Delay in ordering parts, manufacturing
  - Mitigation: Set deadlines ahead of class schedule
- Design Risks
  - Vibration at motor to rotor connection
  - Mitigation: Nylon/rubber boot, vibration analysis
  - Misalignment of rotor within stator
  - Mitigation: Live center, FMEA
  - Other design risks (failure of shank, live center)

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#### **Fall Schedule**



	%			Aug 31,	'14	S	ep 14,	'14		Sep 28,	'14	(	Dct 12	, '14		Oct	26, '14	1	N	lov 9,	'14		Nov	23, '14	ļ	De	c 7, '1	.4
Task Name 👻	Com 🗸	Duration 🗸	27	31 4	8	12	16	20	24	28 2	6	10	14	18	22	26	30	3	7	11	15	19	23	27	1	5	9	13
Preliminary Design Stage	100%	25 days	•																									
Initial Design Conception	100%	8 days																										
Design Development	100%	7 days			Ĭ	, 	1																					
Redesign	100%	10 days																										
Advanced Design Analysis	30%	22 days								ř								η										
Final Design Development	70%	7 days								-		-	h															
Final Design Analysis	25%	7 days											-		h													
Final Design Decided	0%	8 days													Ĭ.													
Final Design Stage	0%	16 days															Í	Ť			_							
Complete Assembly	0%	14 days															I				-							
Subassembly 1 (Support Table)	0%	14 days															I					I						
Tolerances	0%	4 days																	հ									
Table Legs	0%	5 days																	<b>*</b>	h								
Table Top	0%	3 days																		ì								
Subassembly 2 (Test Fixture)	0%	14 days															I					I I						
Tolerances	0%	2 days																Ш.										
Live Center Support	0%	2 days																	հ									
Stator Housing	0%	2 days																	<b>*</b>	h								
Motor Assembly	0%	2 days																		ЪĻ								
Track System	0%	2 days																			ηİ							
Test Fixture Base Plate	0%	2 days																			Ъh							
Power Screw	0%	2 days																										
Parts Ordering	0%	15 days																			4						-	
Bill Of Materials	0%	5 days																						h				
Turbocor Approval	0%	5 days																						•	Ъ			
Ordering	0%	5 days																										

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# **Conclusion & Future Work**



- Initial design has been decided upon
- Individual components (linear guide, motor connection, ball screw) need to be selected
- Dimensions and tolerances to be determined
- Final Design Review at Turbocor:
  - November 20<sup>th</sup>
- Spring Semester: Manufacturing and Testing

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## **Questions or Comments?**



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- For more information, see our website:
  - VTT Rotor: Back



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