

# Danfoss Turbocor **Magnet Insertion Process**



www.turbocor.com Jaro Volny

Mentor:

Webmaster:

Liaison Engineer:

**Timothy Blum** 

Dr. Simone Hruda Paul Lulgjuraj

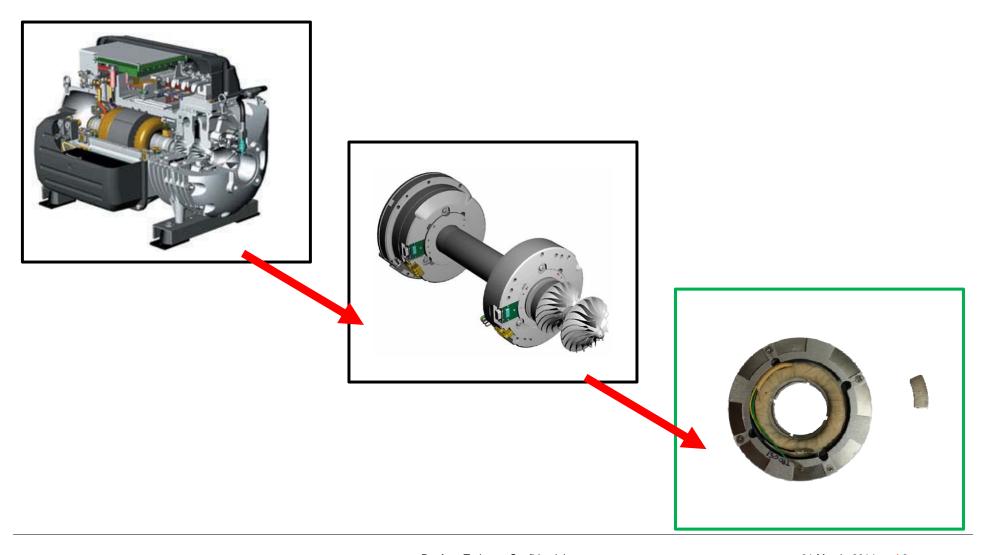


# Agenda

- 1. Project Overview and Background
- 2. Bearing and Magnet Review
- 3. Machine Overview
- 4. Electronics and Logic Selection
- 5. Operational Flow
- 6. Material List and Budget
- 7. Schedule and Future Plans



# **Project Overview**





#### **Project Overview**

#### Problem Statement:

"There is a need for an ergonomic and efficient magnet insertion process for properly placing magnets on axial bearings."

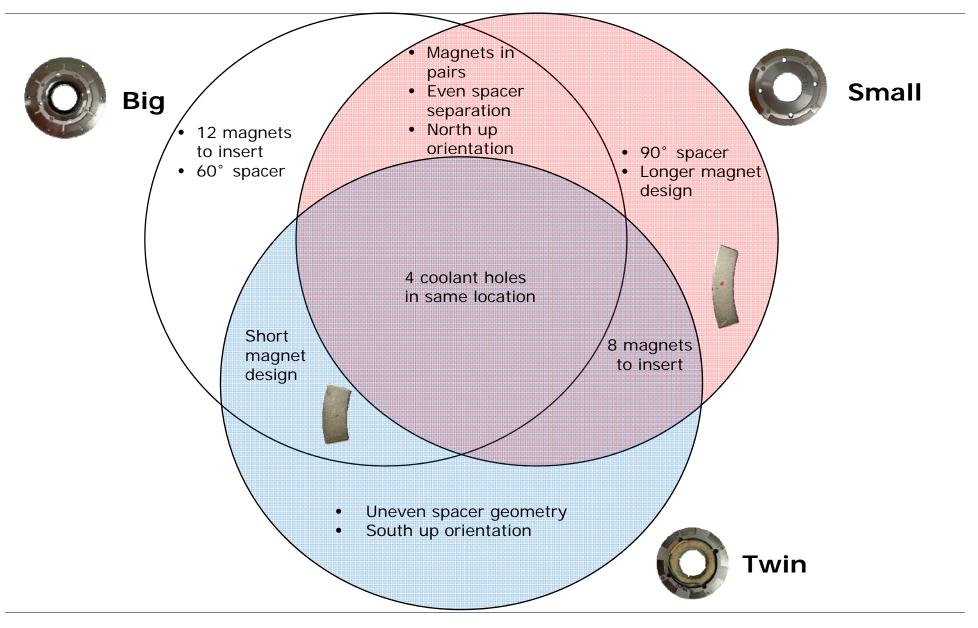
#### Project Scope:

- Currently a technician inserts the magnets manually
- Issues with quality, operator fatigue, operator downtime

Henry Ferree Danfoss Turbocor Confidential 31 March, 2014 4

# Bearing and Magnet Review







#### Fall Semester Highlights

- Determined key areas of importance:
  - Indexing
  - Insertion
  - Polarity
- Generated concepts and moved forward with Geneva Mechanism
- Scope changed: issues with mechanism if bearings changed

Design changed to automated process with use of a programmable

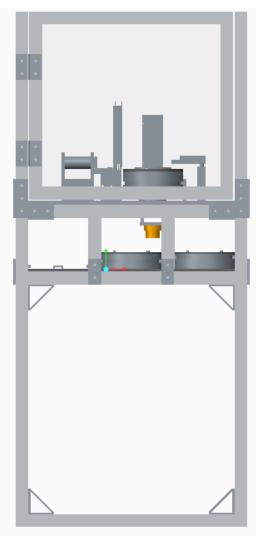
stepper motor

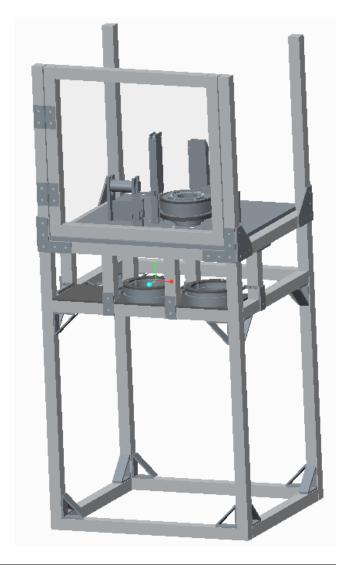
Timothy Blum Danfoss Turbocor Confidential 31 March, 2014 | 6



### Finalizing Design – Full Assembly

- Total height: 5 feet
- Will stand at operating height of 3 feet
- Not pictured:
  - Side enclosures
  - Door handle
  - Electronic mounting
  - Locking casters

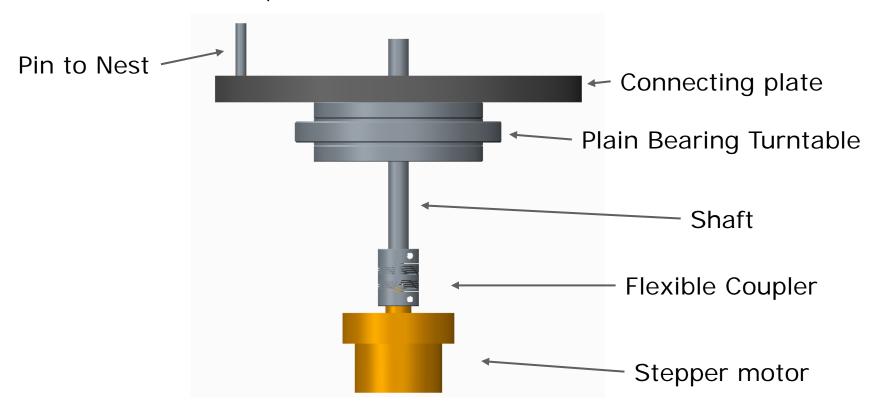






### Finalizing Design - Indexing

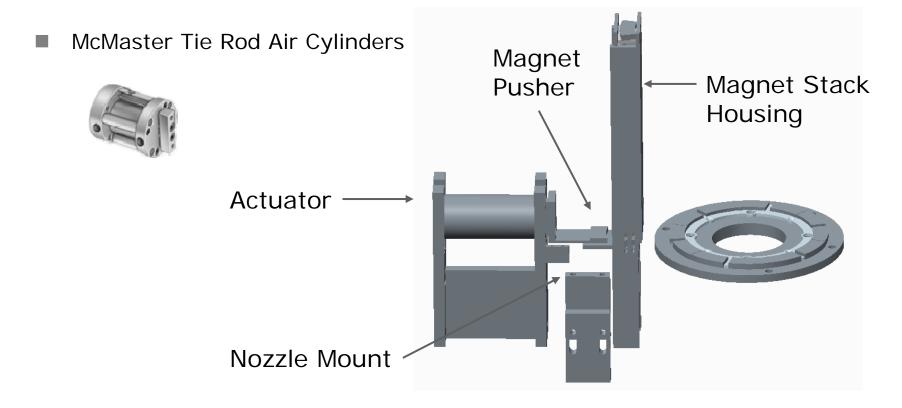
- Accomplished by stepper motor controlled with DragonBoard
  - Code structure is completed





#### Finalizing Design - Insertion

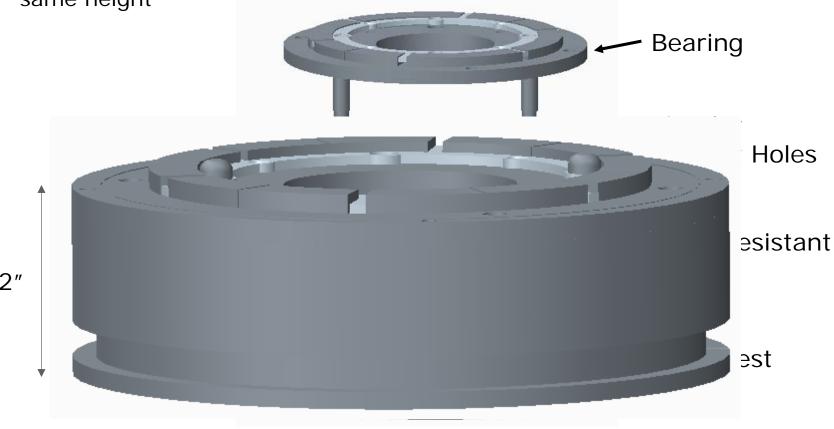
- Pneumatic actuators controlled by solenoid valves
  - Solenoid valves controlled by Dragonboard used to trigger actuator stroke





### Finalizing Design - Insertion

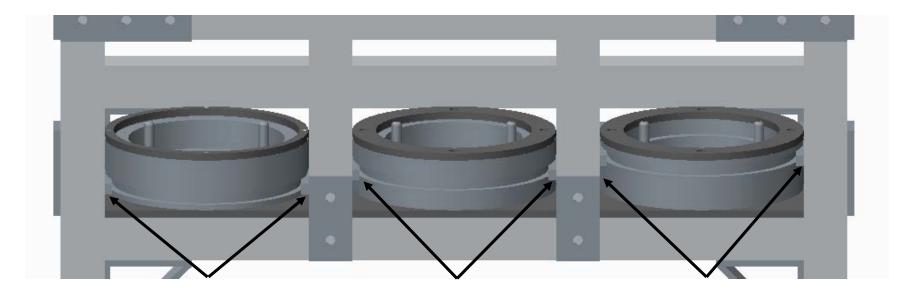
"Nests" were designed to ensure different bearing thickness reach the same height





# Finalizing Design – Frame Nest Housings

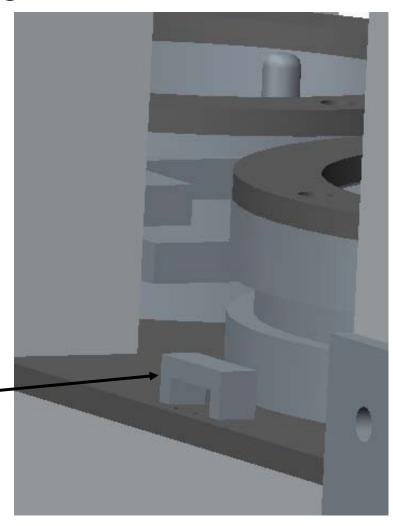
- Nests have keyed slots that are unique to their bearing
- Allows Dragonboard to determine which nest has been removed via limit switches and only runs that bearings insertion program



Keyed slots



### Finalizing Design – Frame Nest Housings

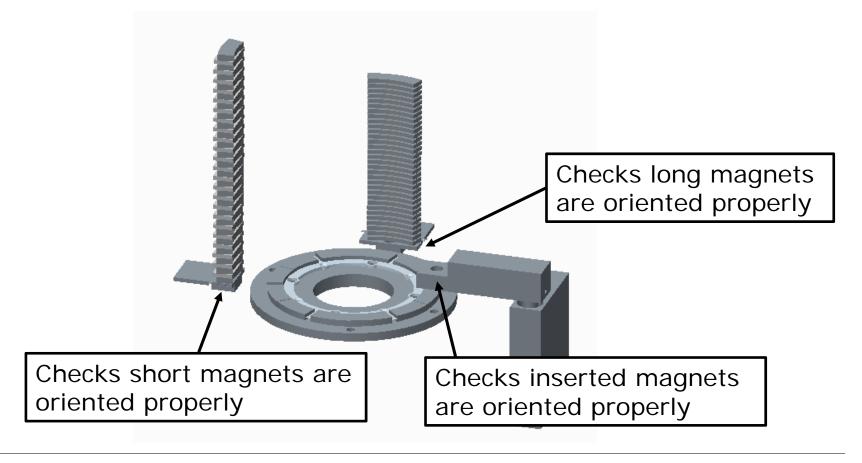


Sensor housing protects limit switch used to determine whether nest is present



### Finalizing Design - Polarity

Polarity will be checked by sensors resting over the magnet area



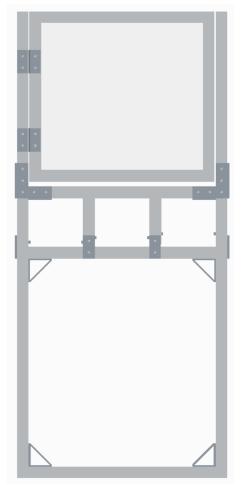


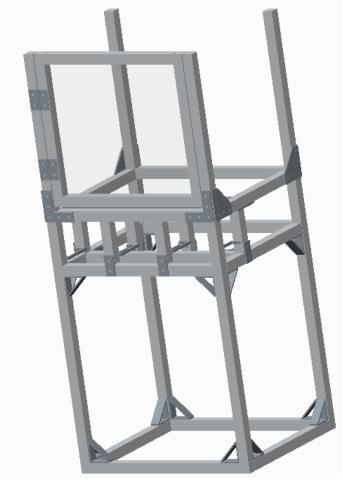
# Finalizing Design - Frame

Stand Alone Structure

■ Vendor: 80/20









#### Sensors

- 1. Limit switches:
  - Nest presence (x3)
  - Door closure (x1)



- 2. Polarity sensor
  - Check magnet polarity before and after insertion (x3)



- 3. Magnetic sensor to detect nest home position
  - Finds ferrous material place inside nest (x1)



#### **Basic Operational Flow**



Rotational Indexing: **Bearing Selection** & Magnet Insertion **Placement** Close Door Rotational Indexing: Find & Secondary Polarity Check **Home Position Press Start** Polarity Check: **Completion Light** ON Magnet Stack



#### Potential Challenges/Risks

- DragonBoard voltage requirements and communication with switches
  - 5V, 12V and 24V involved
- Stepping the motor
  - Code completed and works
  - Doesn't simulate real operation loads and requirements
- Sensor compatibility and data quality
- Rejecting the spacer from magnet stack
- Machining nests to tight tolerances
- Lack of experience with pneumatic and electrical diagrams
- Attempted to eliminate operator error
  - More issues may arise in assembly

Henry Ferree Danfoss Turbocor Confidential 31 March, 2014 17



### Material List and Budget

- Most parts ready to order
- Some items still need finalizing
- Most lead times are known
- Budget increased from 2000 to 2500
- In house items drastically reduce bottom line cost

#	Item	Quantity	Price	Vendor	Part #	Lead Time
1	80/20	1	\$664.05	8020		1 week
2	Aluminum Baseplate	1	\$316.94	Misumi	L-PNLNM-609.5-609.5-12	4-8 days
	Plain Bearing					
3	Turntable	1	\$215.27	McMaster Carr	8700K1	1 week
4	Nest Material	1	\$162.60	McMaster Carr	1610T73	1 week
5	Actuators	2	\$139.74	McMaster Carr	5036K12	1 week
-	3/8 Aluminum Sheet	1		McMaster Carr	89155K28	1 week
-	DC Solid State PNP		,			
7	Switch	2	\$104.00	McMaster Carr	4211K302	1 week
8	Polarity Checker	3	\$72.75	Allied Electronics	720207637	3-4 days
-	Rubber Tubing	1	\$67.50	Festo	567948	7-10 days
10	Control Box	1	\$59.38	Allied Electronics	70066992	3-4 days
	ABS Plastic for Nest					
11	Surface	1	\$49.74	McMaster Carr	8586K471	1 week
	Precision Adjust Air					
12	Flow Control Valves	2	\$47.56	McMaster Carr	4076K23	1 week
13	Air Nozzle	2	\$36.00	McMaster Carr	5329K63	1 week
14	Magnetic Sensor	1	\$35.35	Automation Direct	PFM1-AP-3H	In stock, Atlanta
15	Proximity Sensor	16	\$17.44	Mouser	101-61-05-033ST-Q-EV	Ships now
16	1/8 Aluminum Sheet	1	\$14.82	Online Metals		1 week
17	Wear Resistant Steel	1	\$6.94	McMaster Carr	8116K38	1 week
18	10 mm Aluminum rod	1	\$6.89	McMaster Carr	4634T16	1 week
19	3 position switch	1	\$5.99	Auber Instruments	SW5	Ships USPS
						Ţ
-	Dragonboard	1		EVBplus.com		1 week
$\vdash$	Motor Driver	1		EVBplus.com		1 week
-	Wiring/Electronics	1	,	Unknown		
23	Power Supply	1	\$99.00	Automation Direct	PSM24-090S	In stock, Atlanta
		,			·	

1 Motor
2 Flexible Coupling
3 Pneumatic Hoses
4 Machining
5 Buttons/Switches
6 Dinrail
7 Triple Regulator
8 Solenoid Switches

**TOTAL** 

\$2,370.21



#### Status of Procurement

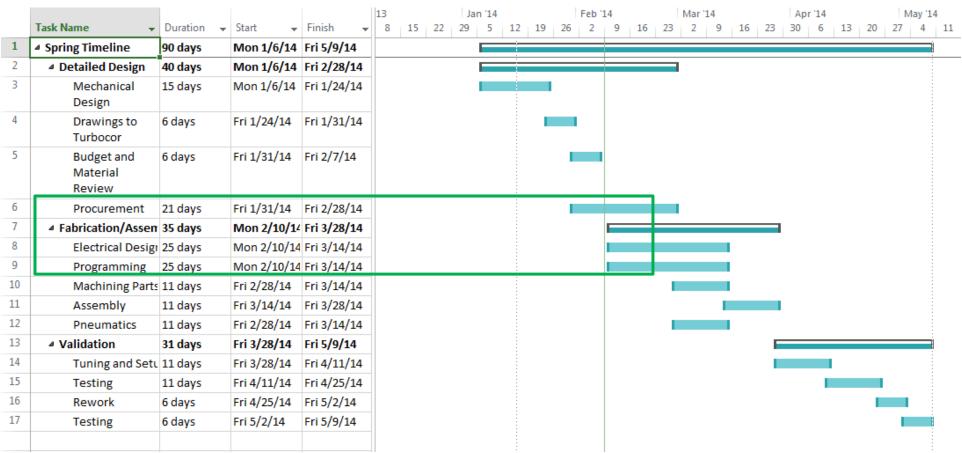
In process of filling out Purchase Requisition forms and will be ordering parts soon

Vendor: MdWaster-Carr		DATE:			5-Feb-14		
		_					
		CAPITA	1				
		CURRENCY: USD					•
Contact		CORRENCY:				030	
	NOTE: THIS IS NOT A PURCHASE	ORDER AND CANNOT BE	ISSUEL	то suppu	æ		
TURBOCOR P/N	DESCRIPTION	VENDOR P/N	QTY	UNIT	TOTAL PRICE	PROJECT NUMBER	ACCOUNT
1714	Plain Bearing Turntable		1	\$ 215.27		. TOWNERY	TOWNER
	Aluminum Rod 7" Diameter, 6" Long		1	\$ 162.60			
	Aluminum Sheet 3/8" Thick, 18" x 18			\$ 123.25			
	Nonrotating Aluminum Tie Rod Air C		_	\$ 69.87	_		
	30 VDC, PNP Switch for Air Cylinder		_	\$ 52.00			
	ABS Plastic Sheet 1/4" Thick, 24" x 2		1	\$ 49.74			
	Air Blowoff Nazzle, 1/4" Connection	5329KB3	2	\$ 17.75	\$ 35.50		
	Air Regulator for Double-Acting Cylin	nc 4964K23	2	\$ 26.72	\$ 53.44		
	Wear Resistant A2 Tool Steel, 9mm		- 1	\$ 14.40			
	Aluminum Rod, 10 mm Diameter, δ	L4634T16	1	\$ 6.89	\$ 6.89		
							<u> </u>
	FREIGHT	: A) PREPAID (included)		1			
		B) PREPAID & CHARGE		1			
		C) COLLECT		1			
		D) FIXED AMOUNT		amount		1	
				TOTAL	\$ 904.83	]	
Special instru							
See attached	spreadsheet with links to items for ea	ach vendor.					
repared by:	KEVIN LOHMAN					(Print name)	)
approved by:			( Manager )				
pproved by:		( Director )					



#### **Gantt Chart**

#### Fabrication and assembling phase about to begin



Timothy Blum Danfoss Turbocor Confidential 31 March, 2014 20



# Questions, Comments, Suggestions, Advice

Timothy Blum Danfoss Turbocor Confidential 31 March, 2014 21

