

# Danfoss Turbocor Magnet Insertion Process



Team 5

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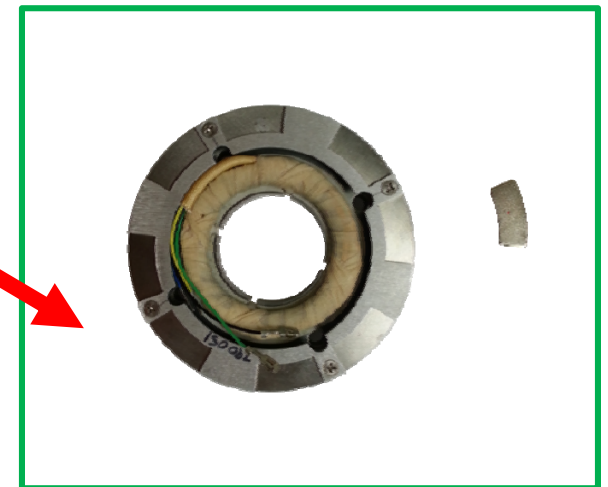
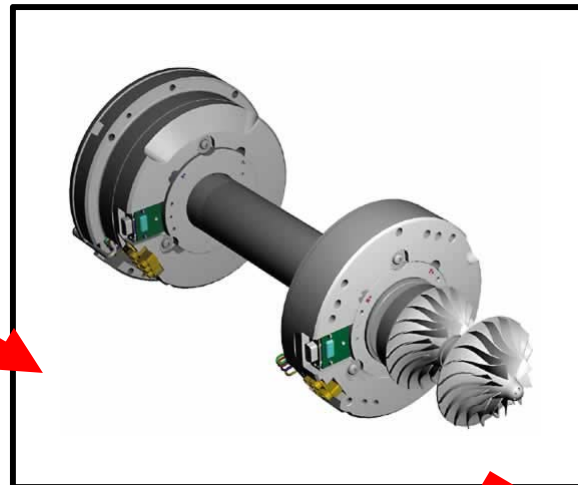
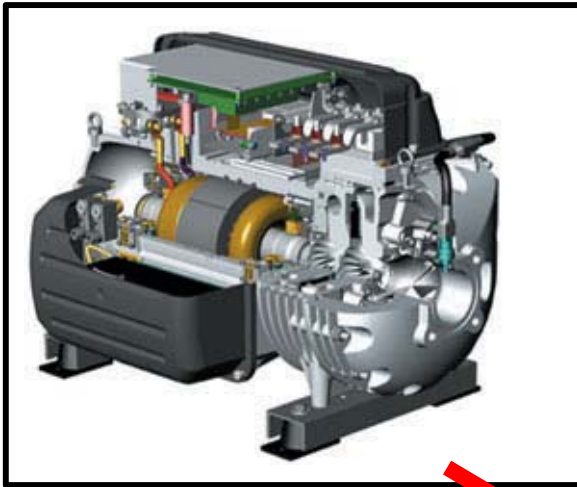
Dr. Simone Hruda  
Paul Lulgjuraj

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# 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, Future Plans and Summary

# Project Overview



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## Project Overview

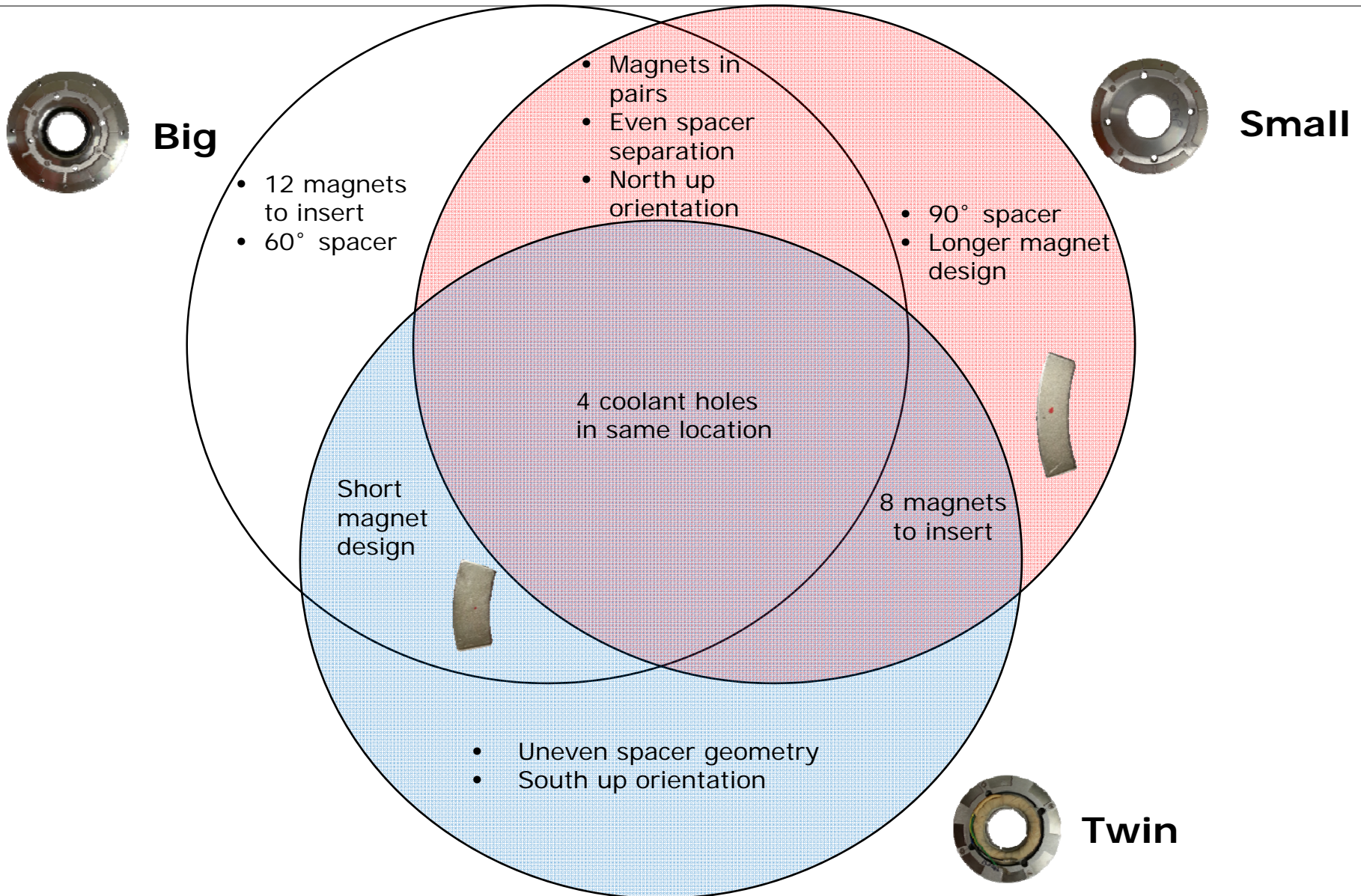
- Problem Statement:

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

- Project Scope:

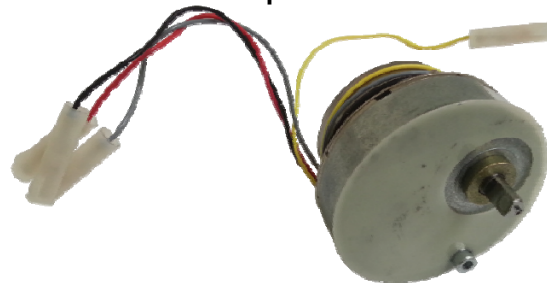
- Currently a technician inserts the magnets manually
- Issues with quality, operator fatigue, operator downtime

# Bearing and Magnet Review



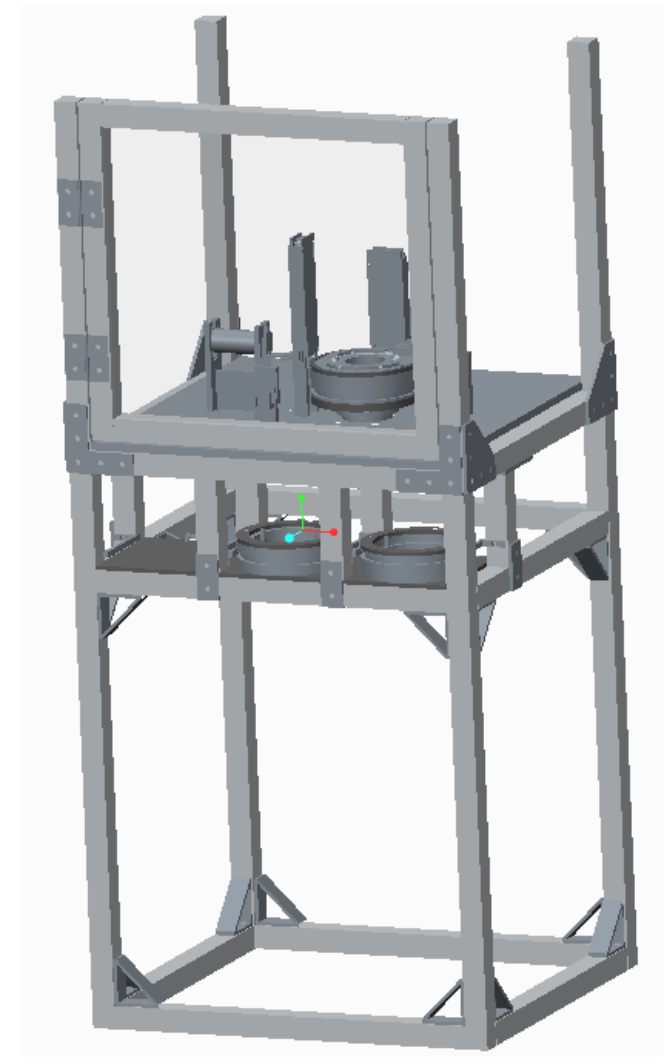
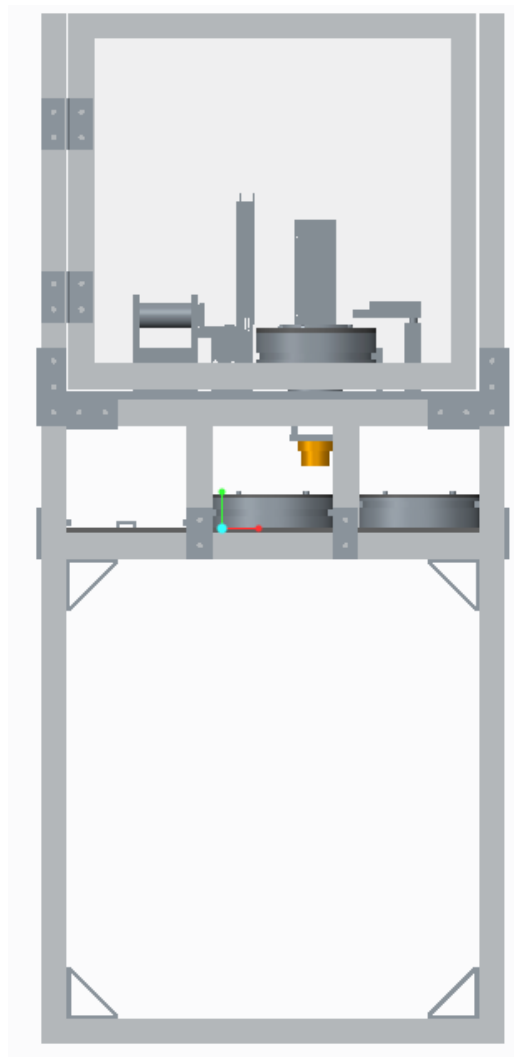
## Fall Semester Highlights

- 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



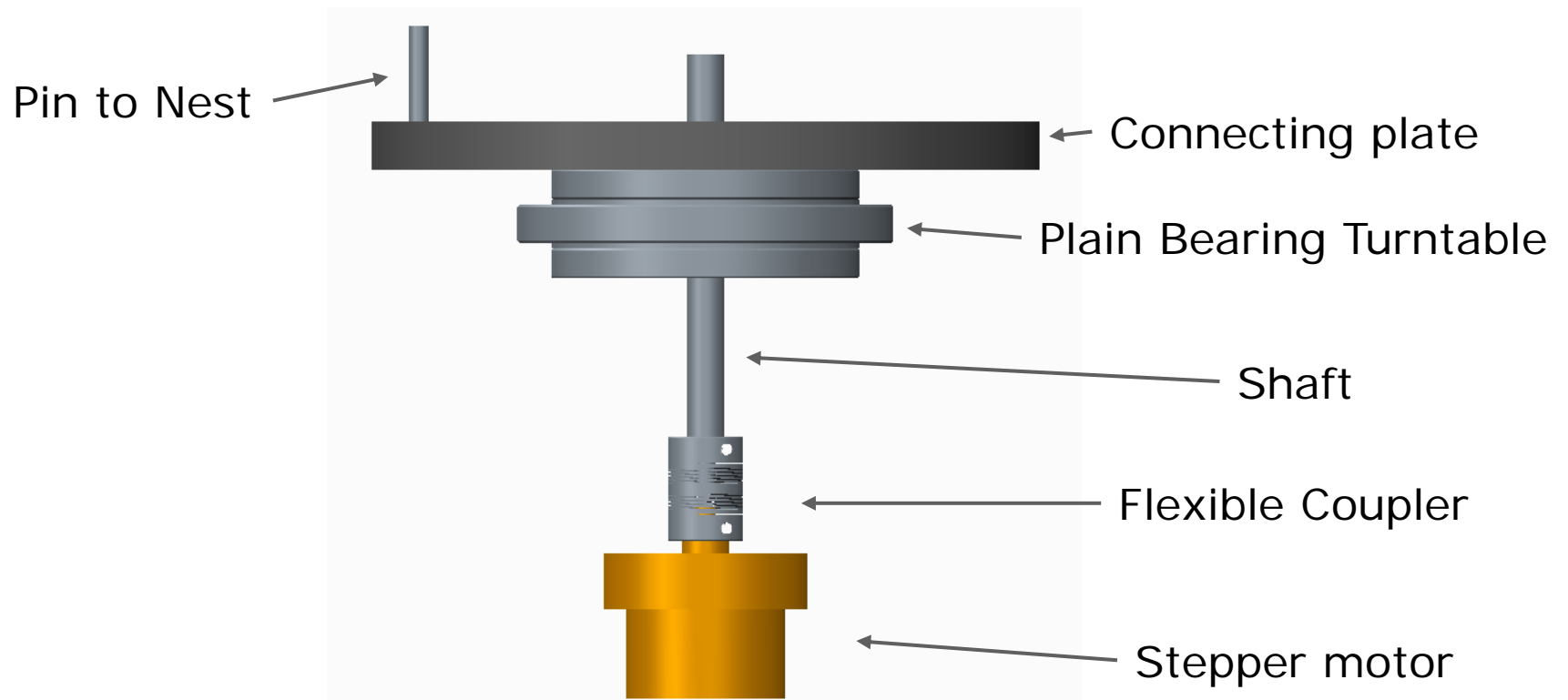
## Finalizing Design – Full Assembly

- Total height: 5 feet
- Will stand at operating height of 3 feet
- Some items not pictured



## Finalizing Design - Indexing

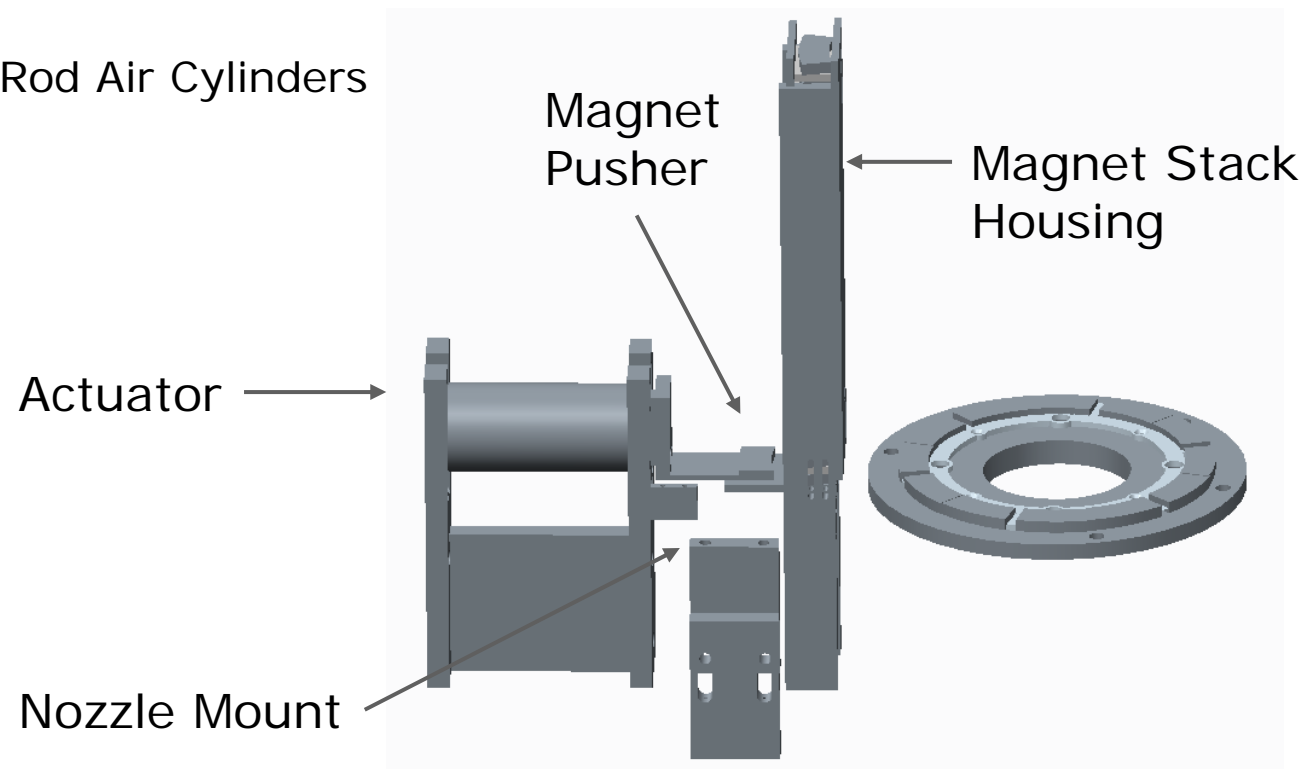
- Accomplished by stepper motor controlled with DragonBoard
  - Code structure is completed





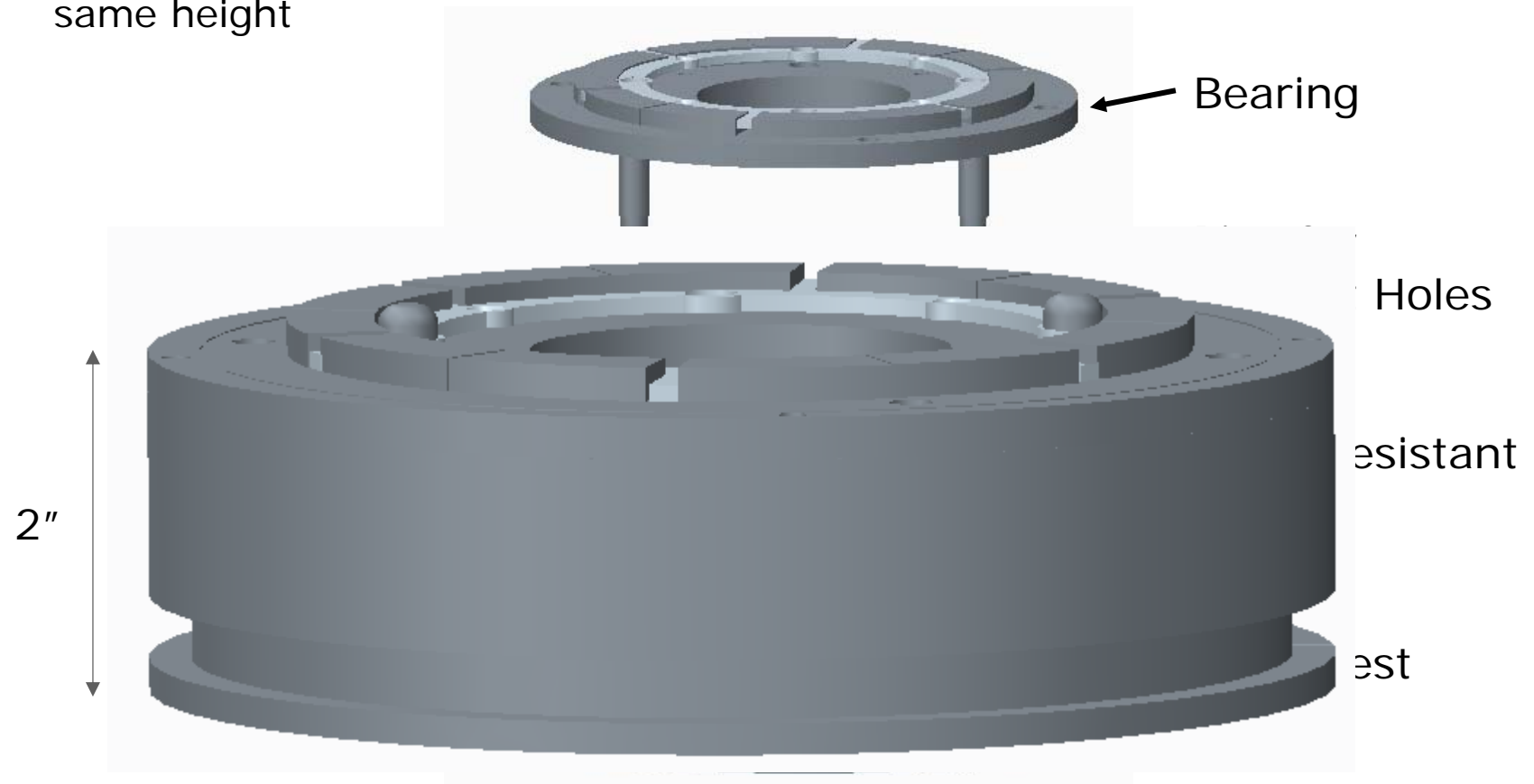
## Finalizing Design - Insertion

- Pneumatic actuators controlled by solenoid valves
  - Solenoid valves controlled by Dragonboard used to trigger actuator stroke
- McMaster Tie Rod Air Cylinders



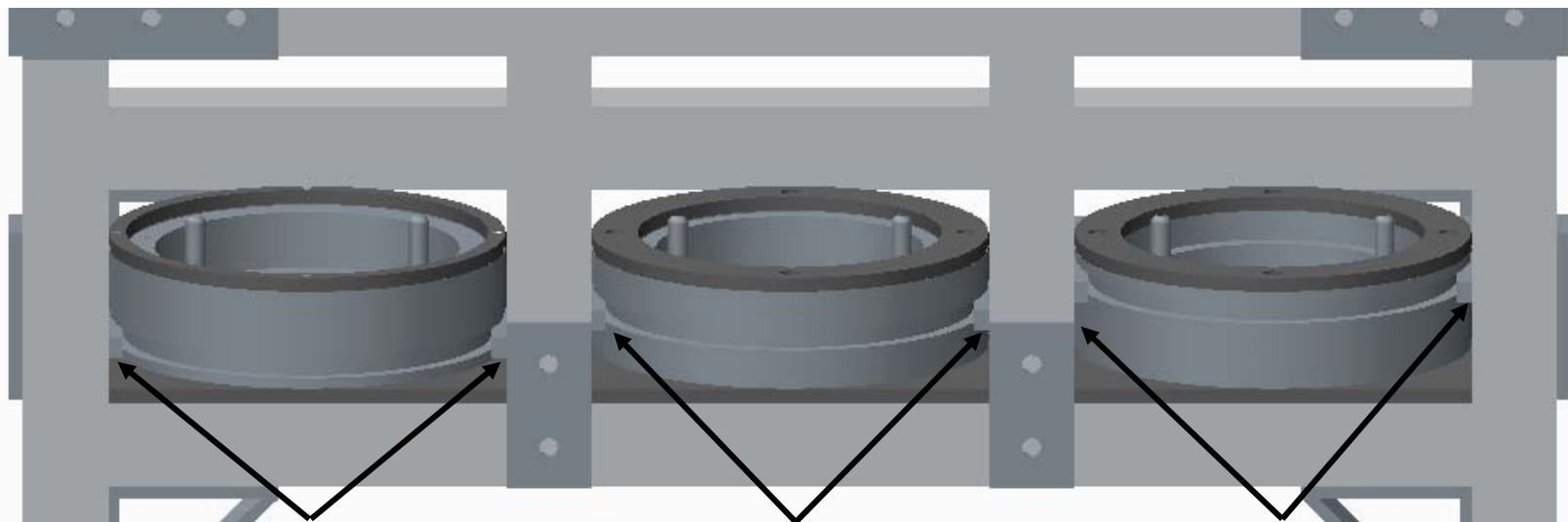
## Finalizing Design - Insertion

- “Nests” were designed to ensure different bearing thickness reach the same height



## Finalizing Design – Frame Nest Housings

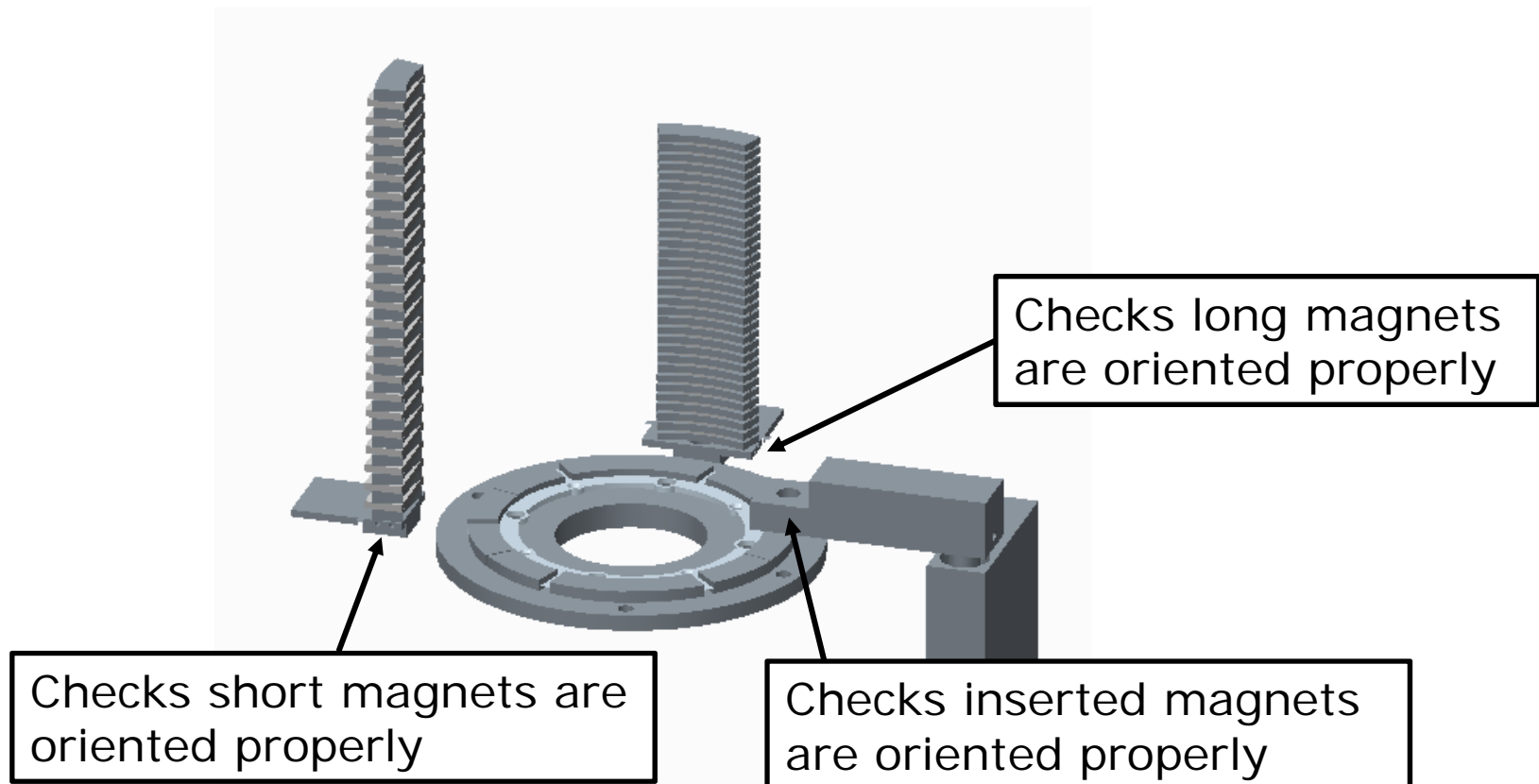
- Nests have keyed slots that are unique to their bearing
- Allows Dragonboard to determine which nest has been removed via limit switches and only runs that bearings insertion program



Keyed slots

## Finalizing Design - Polarity

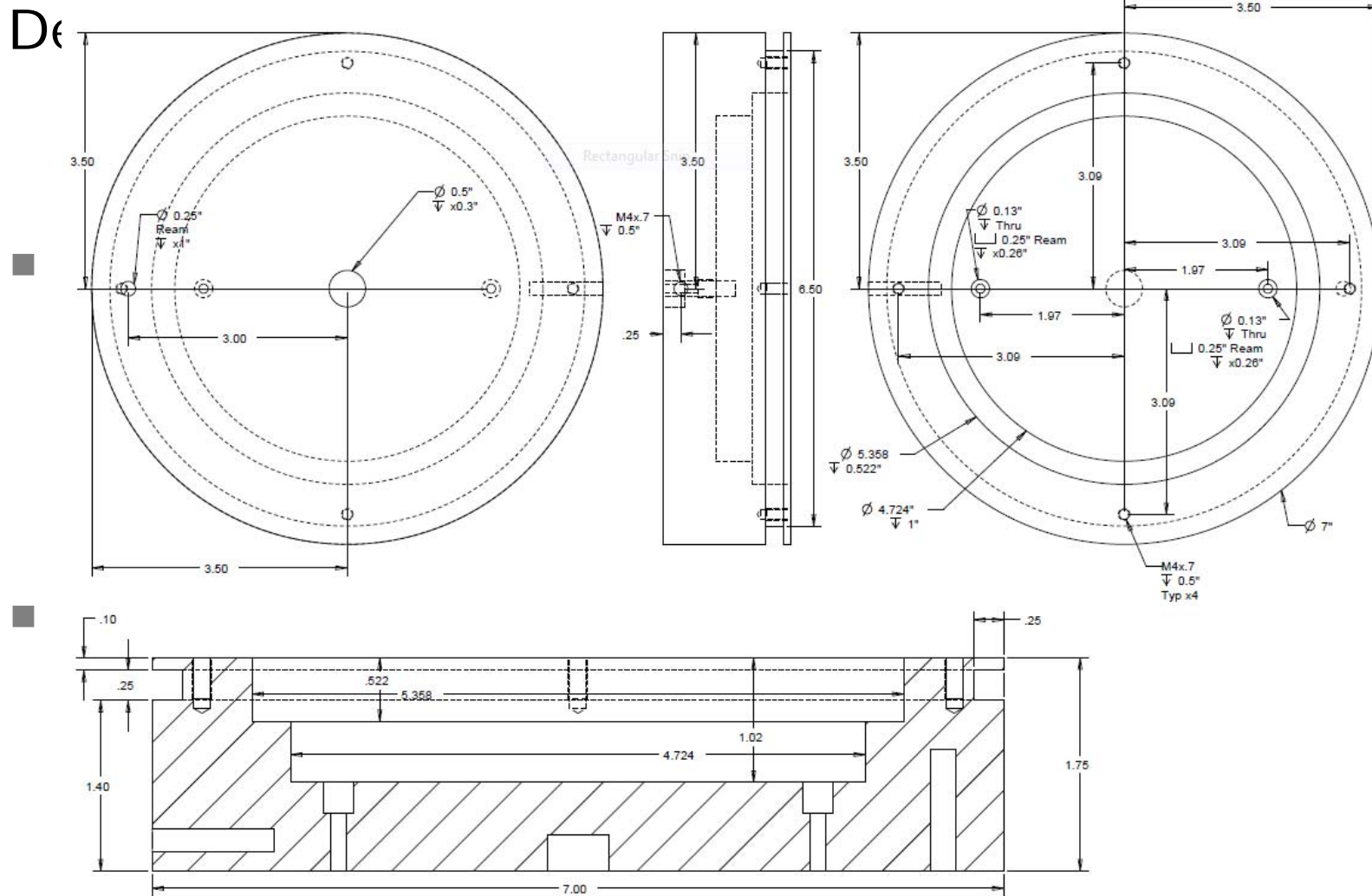
- Polarity will be checked by sensors resting over the magnet area



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# Design For Manufacturing

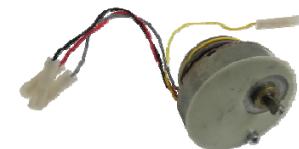
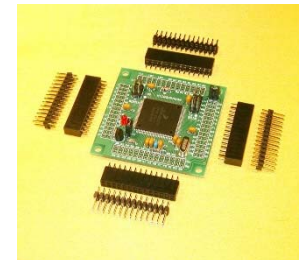
- Iterations
  - Dimensioning and tolerancing
  - Standard sizes for taps and reams
- Finalize drawings for parts



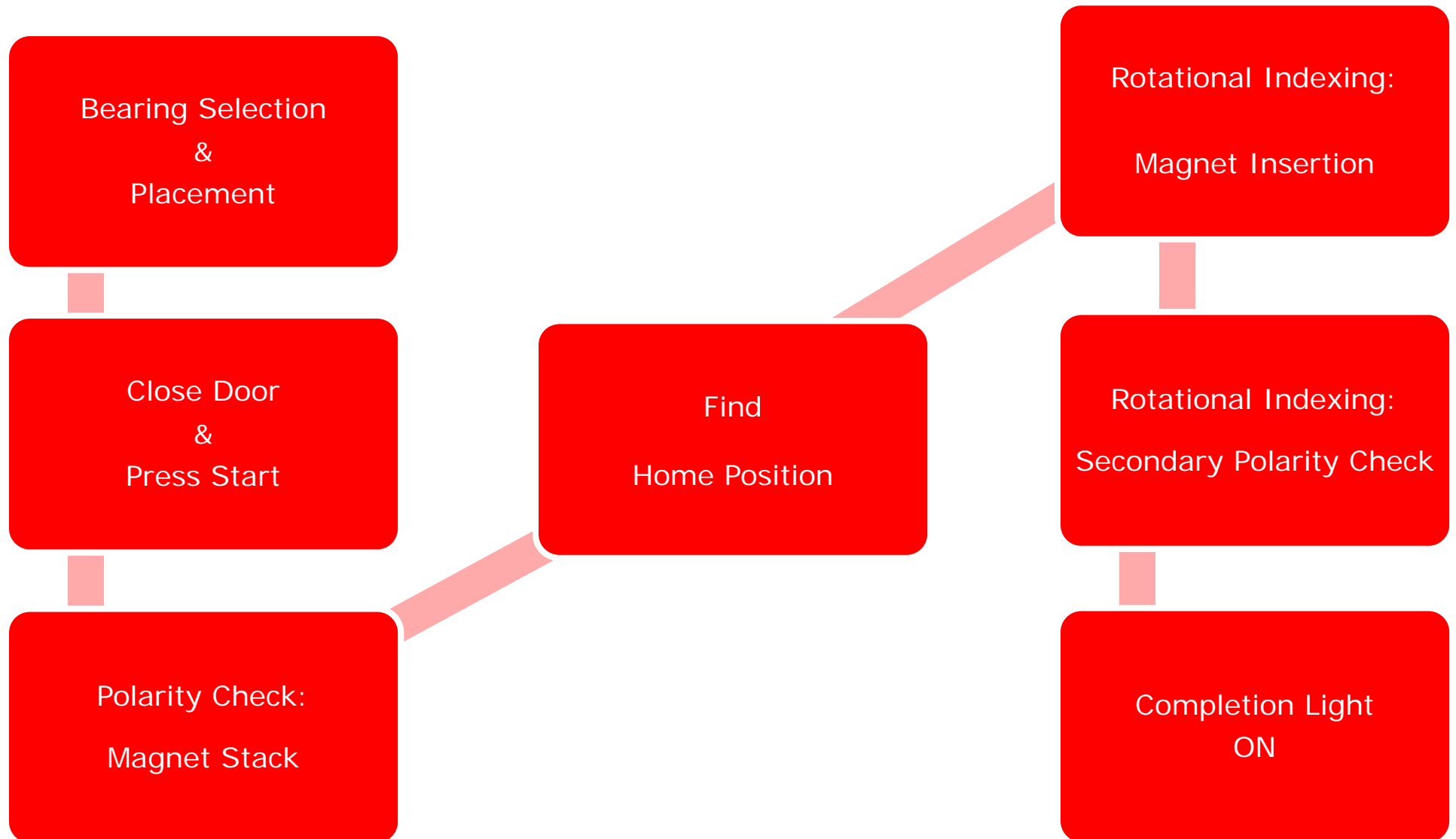
Tolerances			
0.1	+/- 0.05		
0.01	+/- 0.005	Twin Nest	
0.001	+/- 0.0005	Aluminum	Quantity x1

# Electronics

- 1. Sensors
  - Polarity Sensor
  - Limit Switch
  - Magnetic Sensor
  
- 2. Dragonboard
  - MicroDragon
  - Protoboard
  - Inputs: Pull up resistors
  - Outputs: Relays
    - Resistors, transistors, diodes
  
- 3. Motor
  - Motor driver



# Basic Operational Flow





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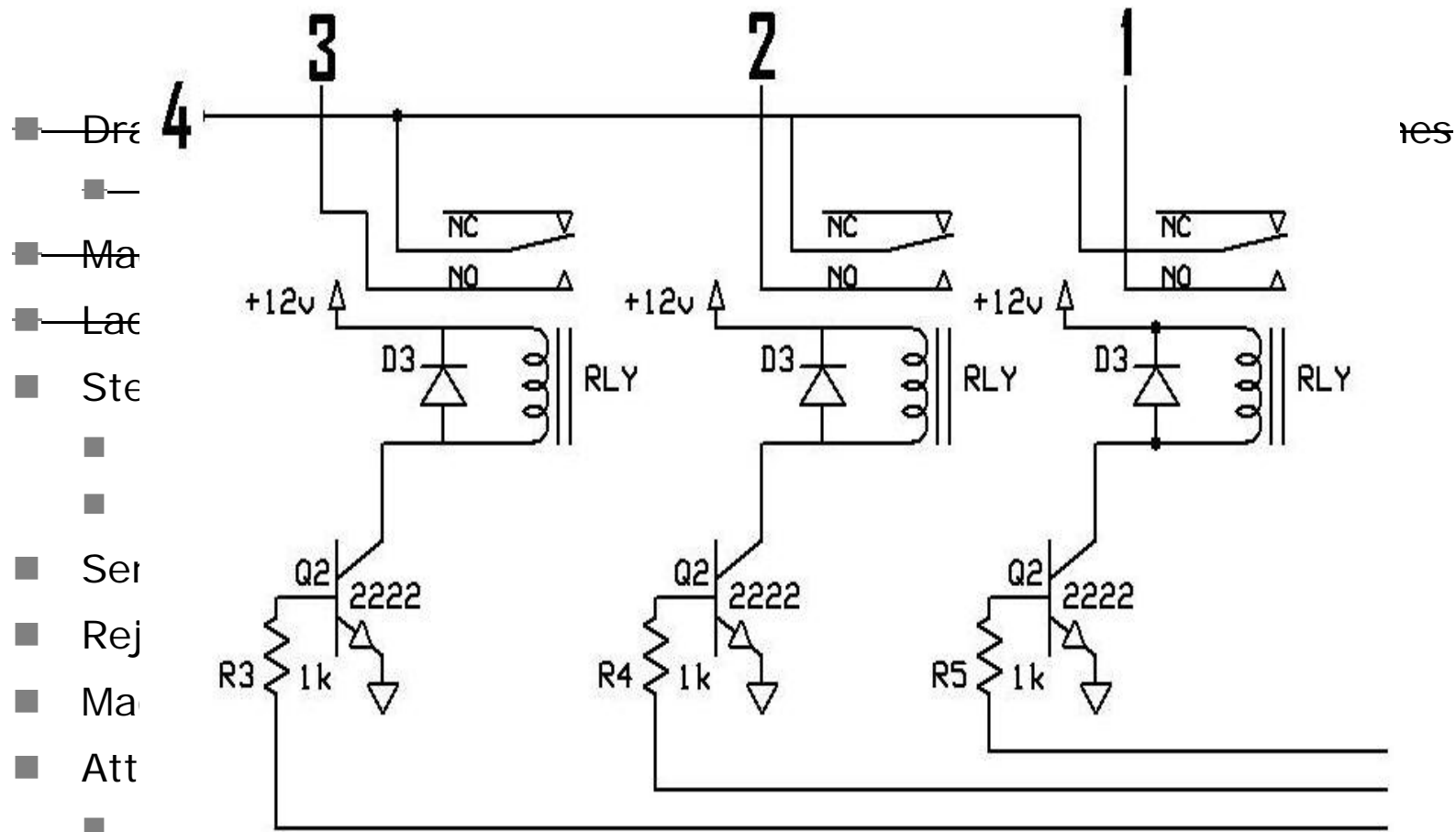
## Potential Challenges/Risks

- DragonBoard voltage requirements and communication with switches
  - 5V, 12V and 24V involved
- Machining nests to tight tolerances
- Lack of experience with pneumatic and electrical diagrams
- 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
- Attempted to eliminate operator error
  - More issues may arise in assembly

## Potential Challenges/Risks

- ~~DragonBoard voltage requirements and communication with switches~~
  - ~~5V, 12V and 24V involved~~
- ~~Machining nests to tight tolerances~~
- ~~Lack of experience with pneumatic and electrical diagrams~~
- 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 no longer in house
- Attempted to eliminate operator error
  - More issues may arise in assembly

# Potential Challenges/Risks



# Material List and Budget

- Changes to budget since last presentation
- In house items
- Status of Procurement:
  - All items received except:
    - Dragonboard
    - Automation Direct

#	Item	Quantity	Price	Vendor	Part #
1	80/20	1	\$806.87	8020	
2	Aluminum Baseplate	1	\$316.94	Misumi	L-PNLNM-609.5-609.5-12
3	Plain Bearing Turntable	1	\$215.27	McMaster Carr	8700K1
4	Nest Material	1	\$155.34	McMaster Carr	85035k71
5	Actuators	2	\$139.74	McMaster Carr	5036K12
6	3/8 Aluminum Sheet	1	\$123.25	McMaster Carr	89155K28
7	DC Solid State NPN Switch	2	\$104.00	McMaster Carr	4211K302
8	Polarity Checker	3	\$72.75	Allied Electronics	720207637
9	Rubber Tubing	1	\$67.50	Festo	567948
10	Power Supply	1	\$64.92	DigiKey	454-1203-ND
11	Dragonboard	1	\$55.00	EVBplus.com	DVB-009 SM
12	ABS Plastic for Nest Surface	1	\$49.74	McMaster Carr	8586K471
13	Precision Adjust Air Flow Control Valves	2	\$47.56	McMaster Carr	4076K23
14	Magnetic Sensor	1	\$42.50	Automation Direct	PFM1-BN-1H
15	Air Nozzle	2	\$36.00	McMaster Carr	5329K63
16	Plug Tap 15/32" - 32	1	\$35.44	McMaster Carr	2595A237
17	Dowel Pins	1	\$27.02	McMaster Carr	8116K38
18	Alpha Wire	1	\$21.47	Allied Electronics	70136541
19	Motor Driver	1	\$18.95	Robot Shop	RR-Sho-24
20	Proximity Sensor	16	\$17.44	Mouser	101-61-05-0335T-Q-EV
21	1/8 Aluminum Sheet	1	\$14.82	Online Metals	
22	Control Box	1	\$11.50	Automation Direct	SA108-40SI
23	Proto Board	1	\$8.02	Allied Electronics	70012509
24	3 position switch	1	\$5.99	Auber Instruments	SW3
25	Ball Plunger	1	\$3.62	McMaster Carr	3408A73
26	Transistor	7	\$2.59	DigiKey	1026-STSA851-CHP
27	Shoulder Bolt	1	\$2.32	McMaster Carr	91259A712
28	Diode	7	\$0.77	DigiKey	1N4001-TPMSCT-ND
29	Resistor	7	\$0.56	DigiKey	CF14JT1K00CT-ND

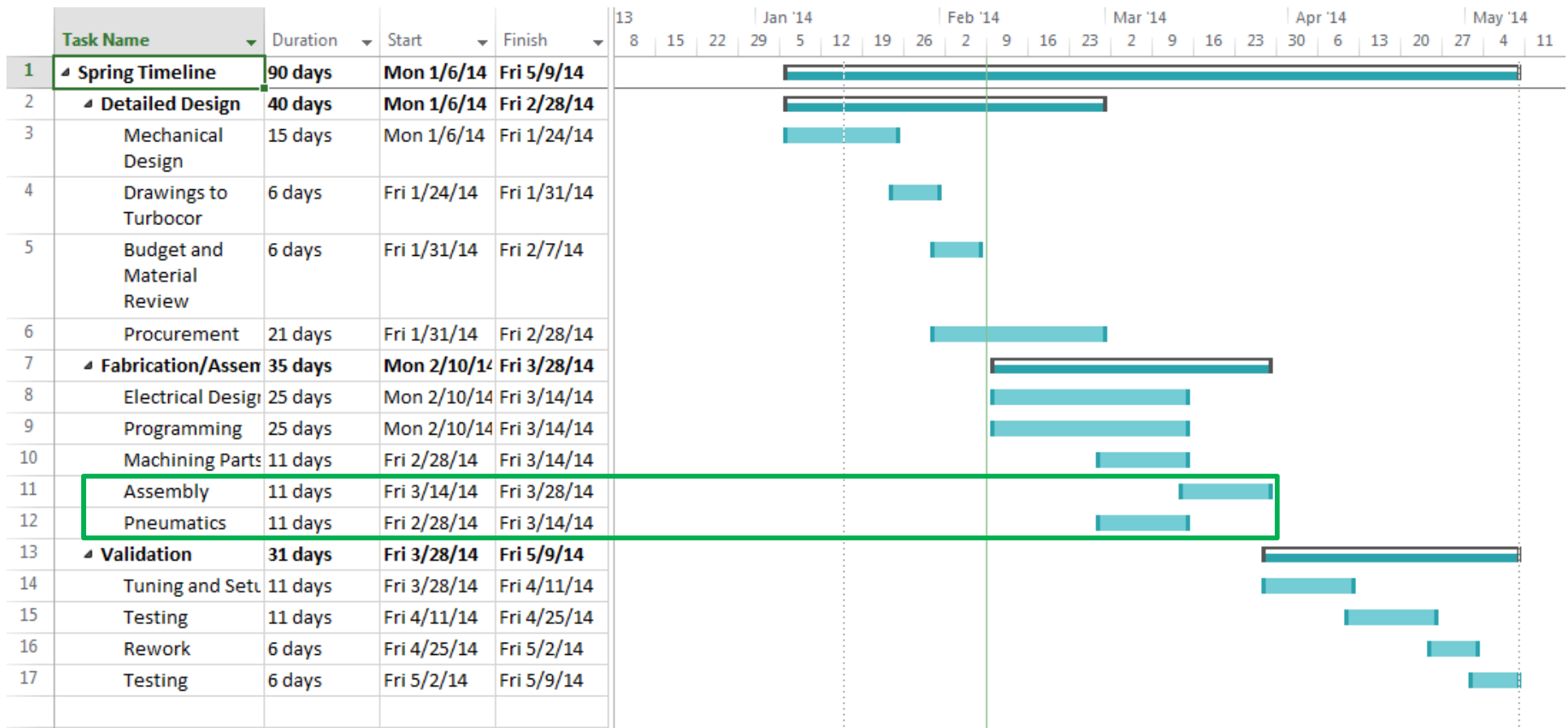


1	Motor
2	Flexible Coupling
3	Pneumatic Hoses
4	Machining
5	Buttons/Switches
6	Dinrail
7	Triple Regulator
8	Solenoid Switches

TOTAL	\$2,467.89
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# Gantt Chart

■ Fabrication and assembling phase about to begin



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# Summary

- Major changes
  - Fall:
    - Changed from mechanical system to mechatronic system
  - Spring:
    - Electronics
    - Drawings
    - Machining resources
- Most parts are received, assembly and machining phase beginning
- Future
  - Troubleshoot and rework
  - Instruction Manual

# Questions, Comments, Suggestions, Advice