MAKING MODERN LIVING POSSIBLE

Danfoss Turbocor
Magnet Insertion Process

Team 5

April 22, 2014

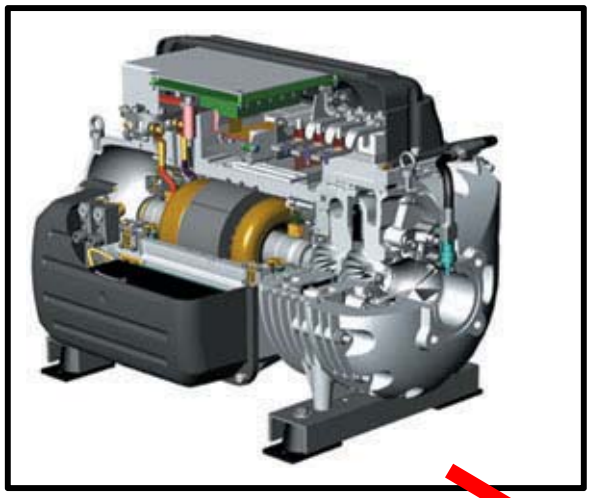
Team Leader: Jaro Volny
Coordinator/Financial Advisor: Henry Ferree
Webmaster: Timothy Blum

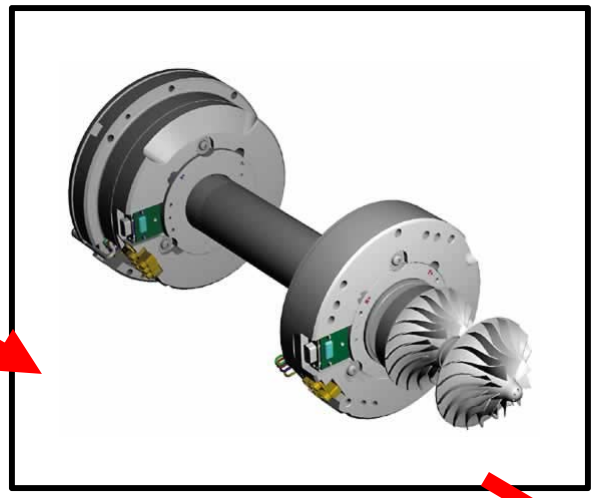
Mentor: Dr. Simone Hruda
Liaison Engineer: Paul Lulgjuraj

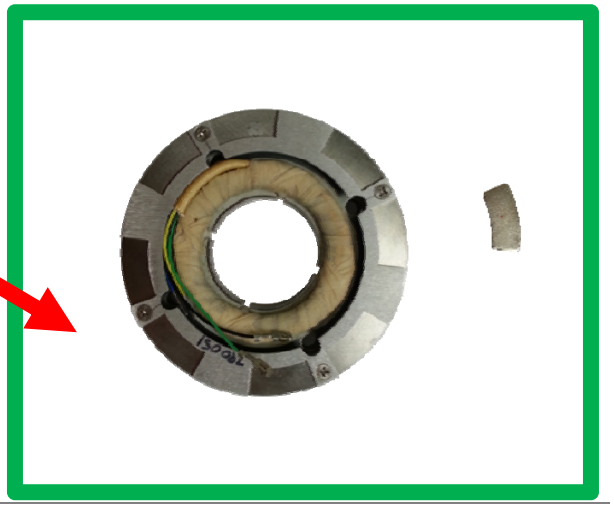
Agenda

- 1. Fall Review
- 2. System Design and Function
- 3. Materials and Budget
- 4. Machining, Design for Manufacturing
- 5. Accomplishments and Setbacks
- 6. Gantt Chart and Future Work

Project Overview





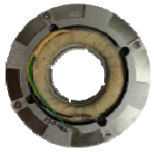


Project Overview

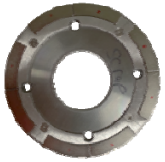
- Problem Statement:
  - "There is a need for an ergonomic and efficient magnet insertion process for properly placing magnets on axial bearings."

- Addressing sponsor needs
  - Polarity: ensuring magnets are not inserted improperly
  - Quality: Improperly placed magnets wastes time, money and productivity
  - Ergonomics: technician skill and time devoted to assembling bearings

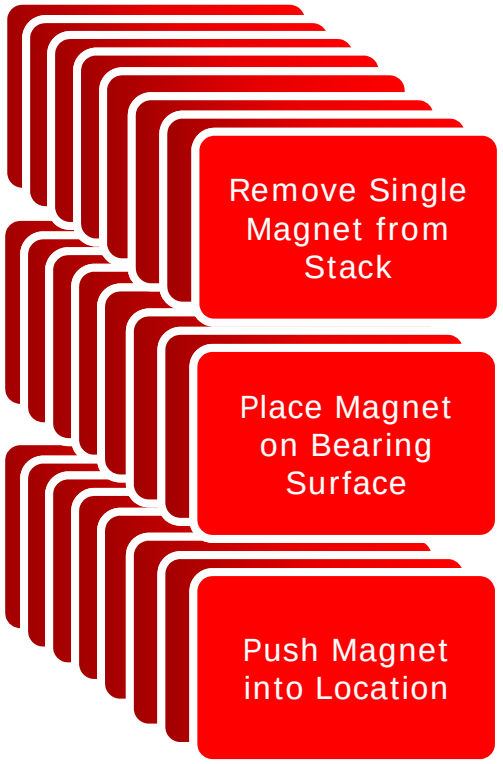
Process Breakdown



Twin



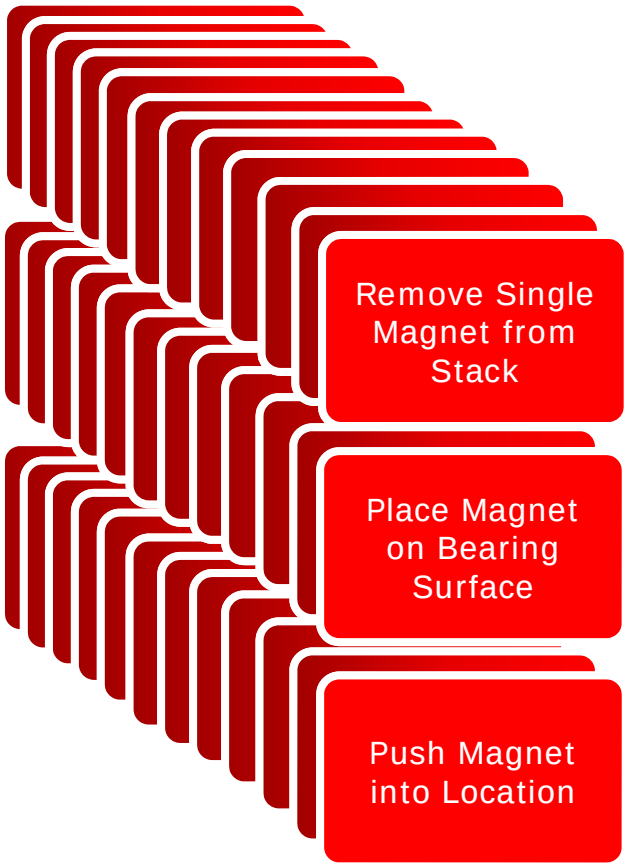
Small



x8

24 operator steps

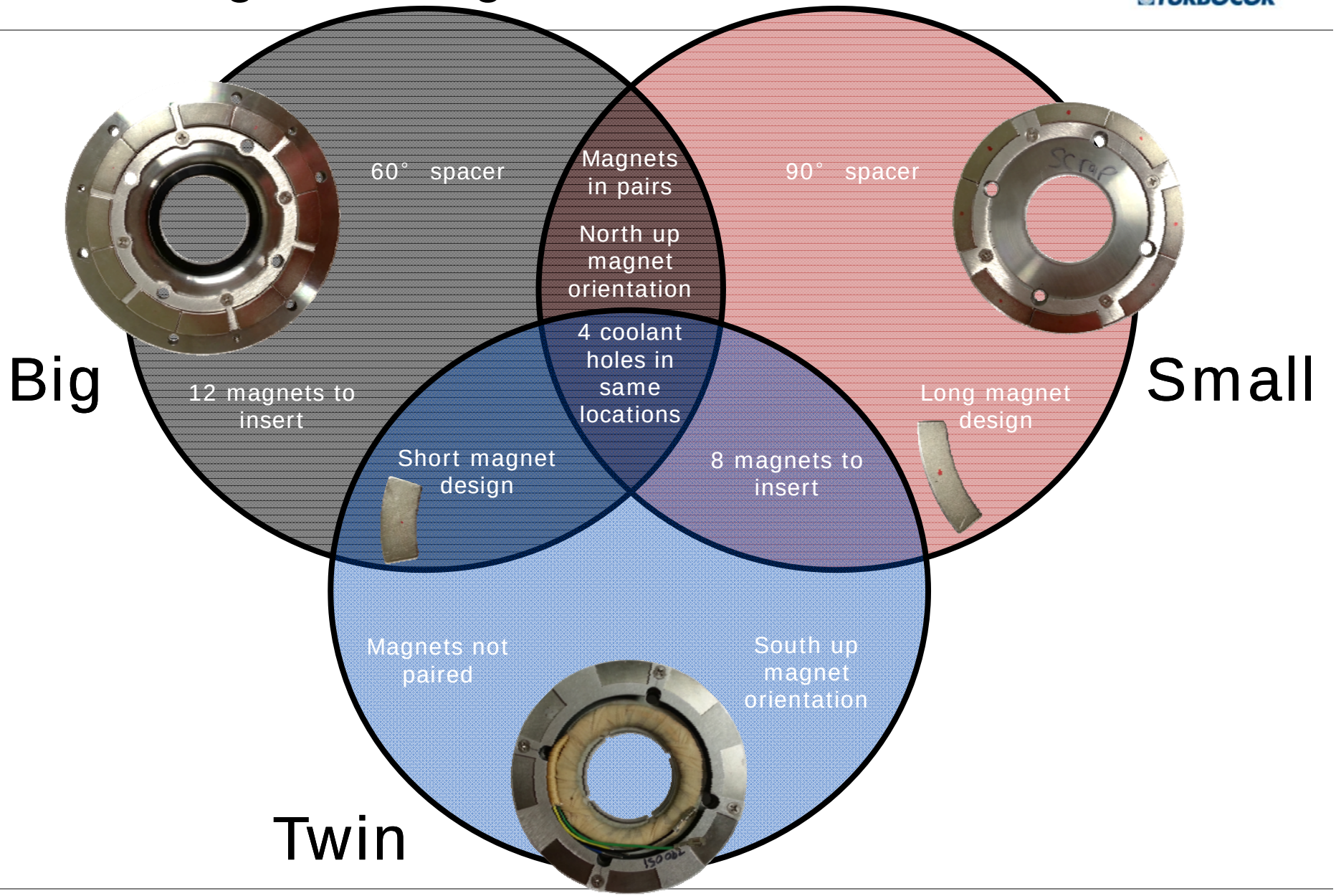
Big



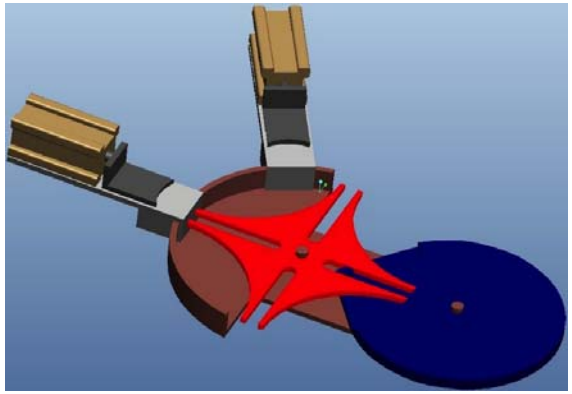
x12

36 operator steps

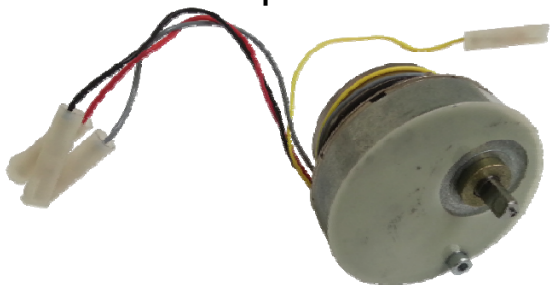
Bearing and Magnet Review



Fall Semester Highlights

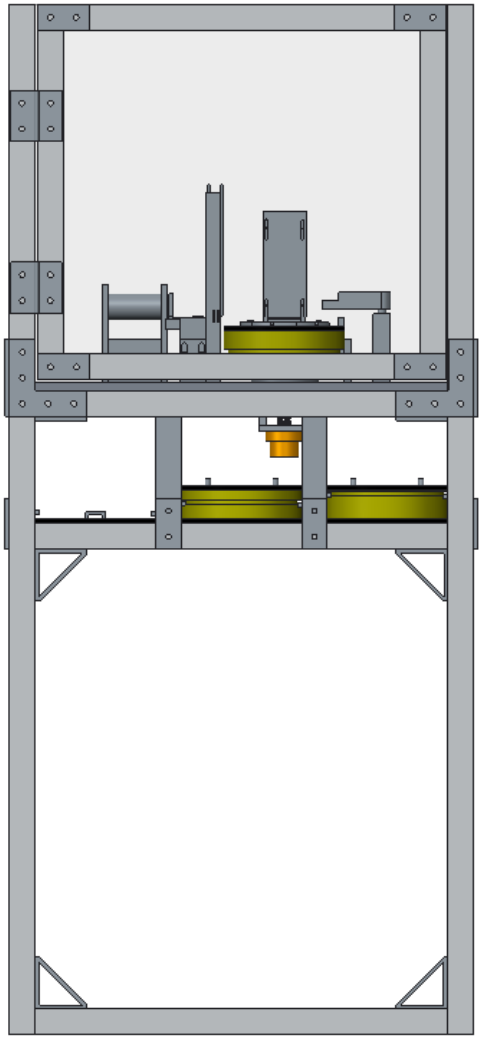


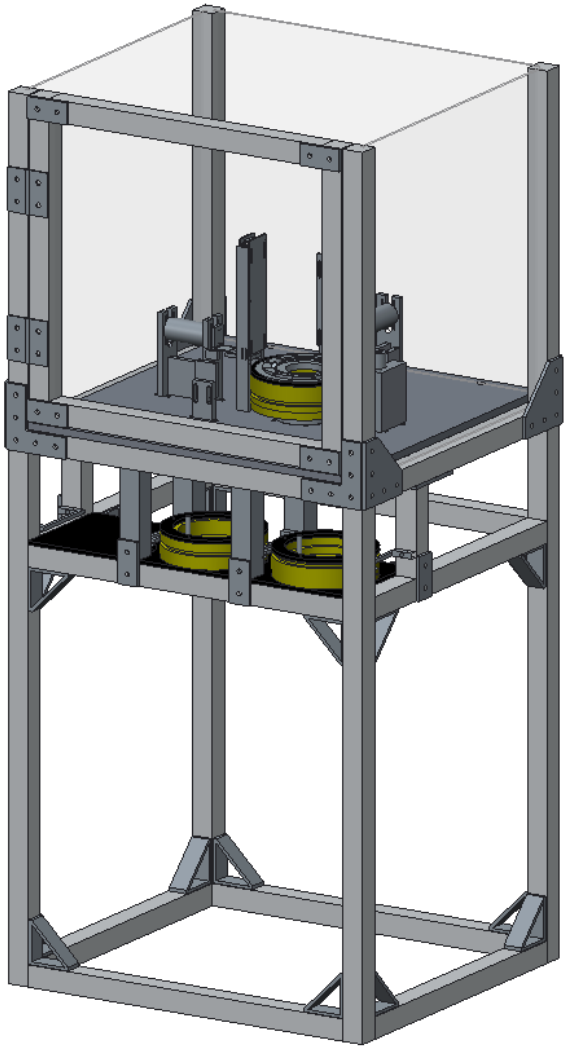
- Determined key areas of importance:
  - Indexing
  - Insertion
  - Polarity
- Generated concepts and moved forward with Geneva Mechanism
- **Scope changed**: issues with mechanism if bearings changed
- Design changed to automated process with use of a programmable stepper motor



Final Mechanical Design – Full Assembly

- Total height: 5 feet
- Will stand at operating height of 3-4 feet

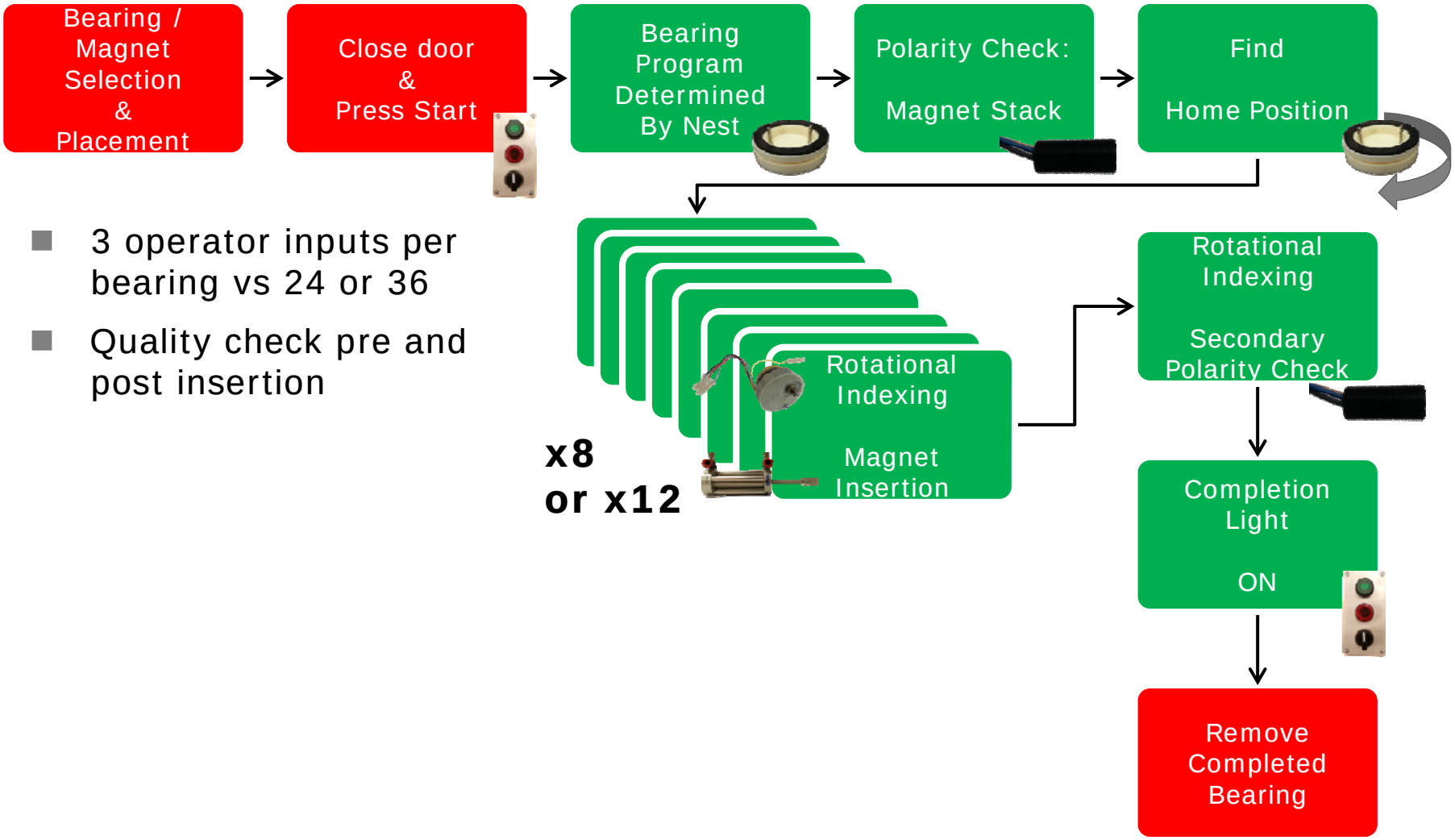




Advantages to Automated Process

Operator Step

Automated Step

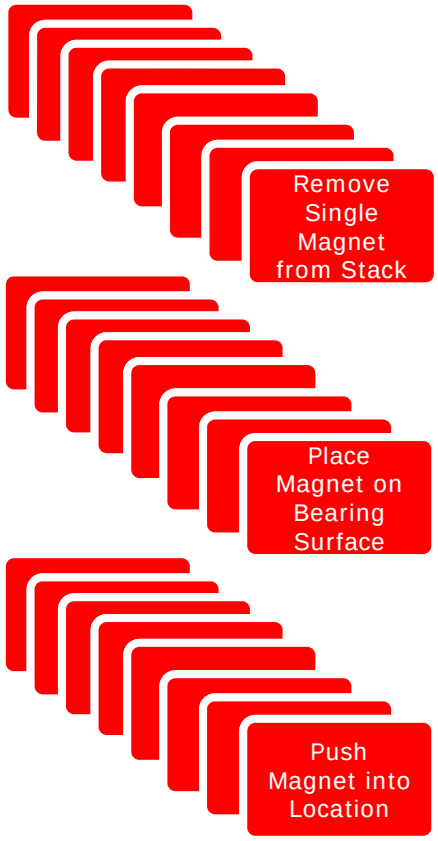


- 3 operator inputs per bearing vs 24 or 36
- Quality check pre and post insertion

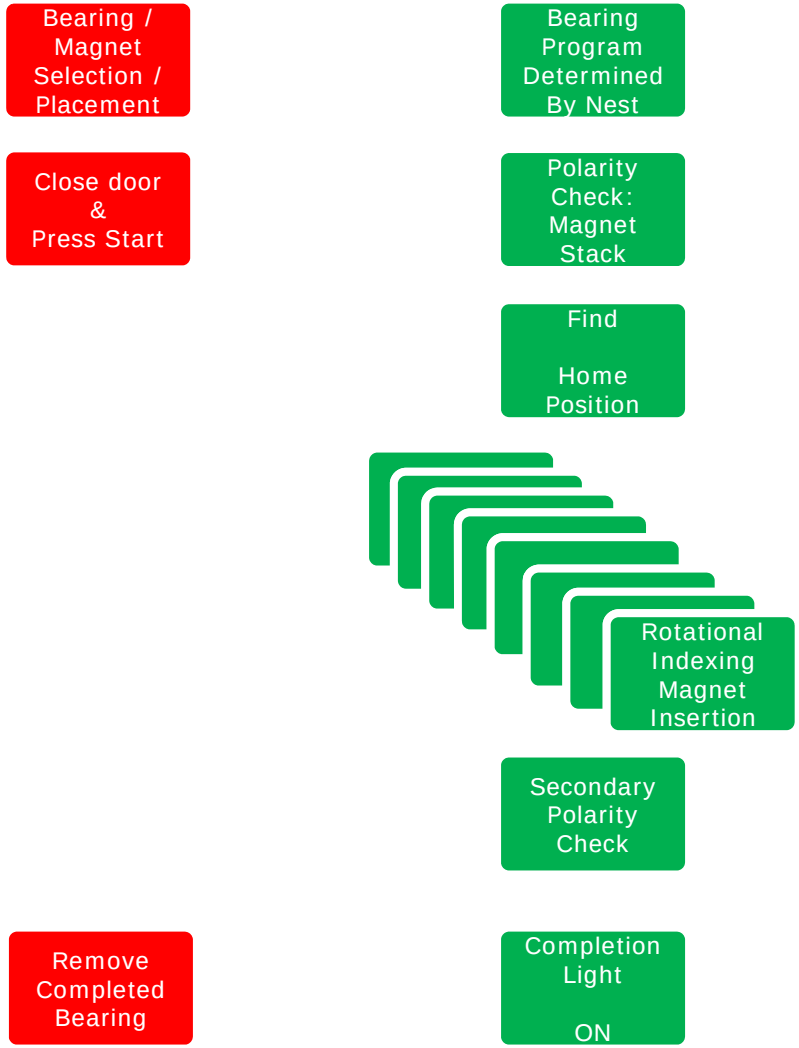
Process Comparison

Operator Step
Automated Step

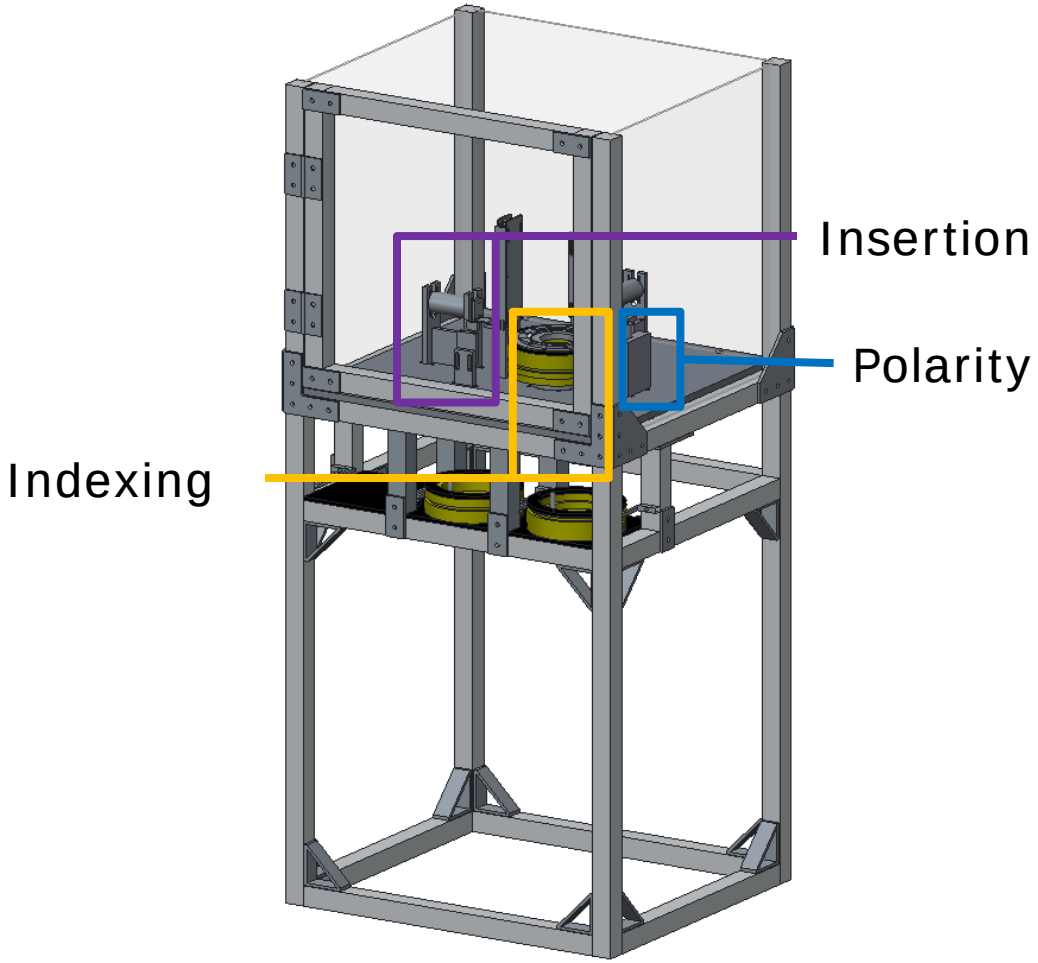
Currently: 24 to 36 operator steps



Goal: 3 operator steps



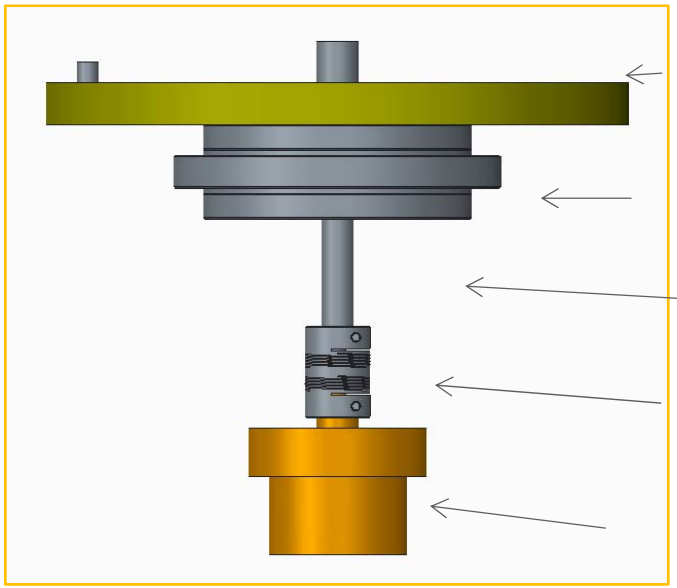
Mechanical Design - Basics



Mechanical Design - Basics

Indexing

Pin to Drive Nest



Connecting plate

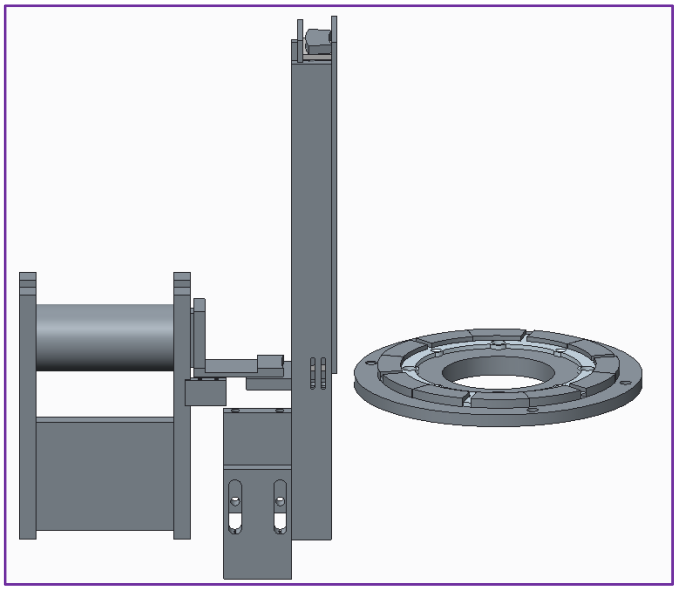
Plain Bearing Turntable

Shaft

Flexible Coupler

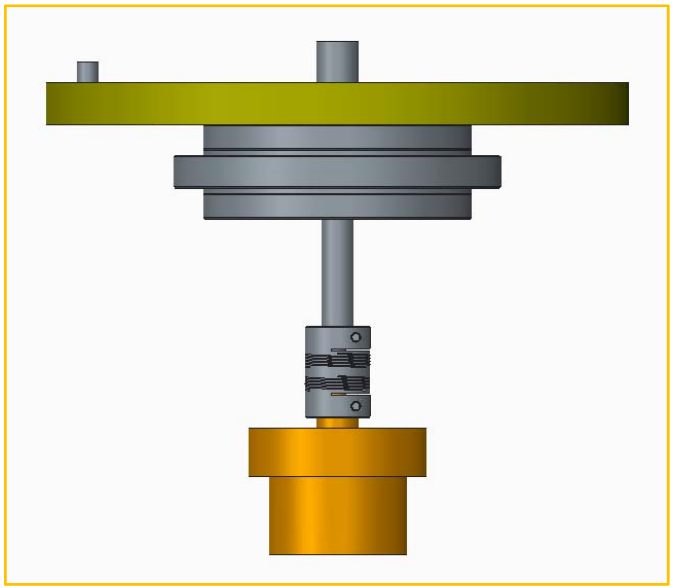
Stepper motor

Insertion

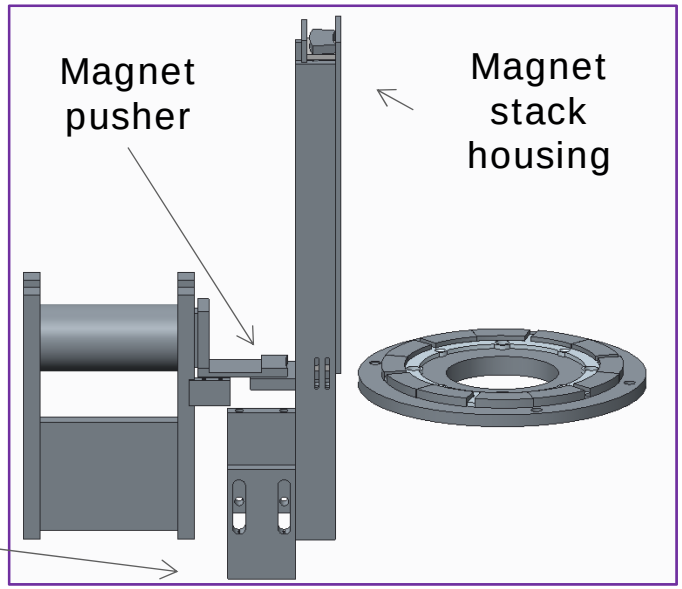


Mechanical Design - Basics

Indexing

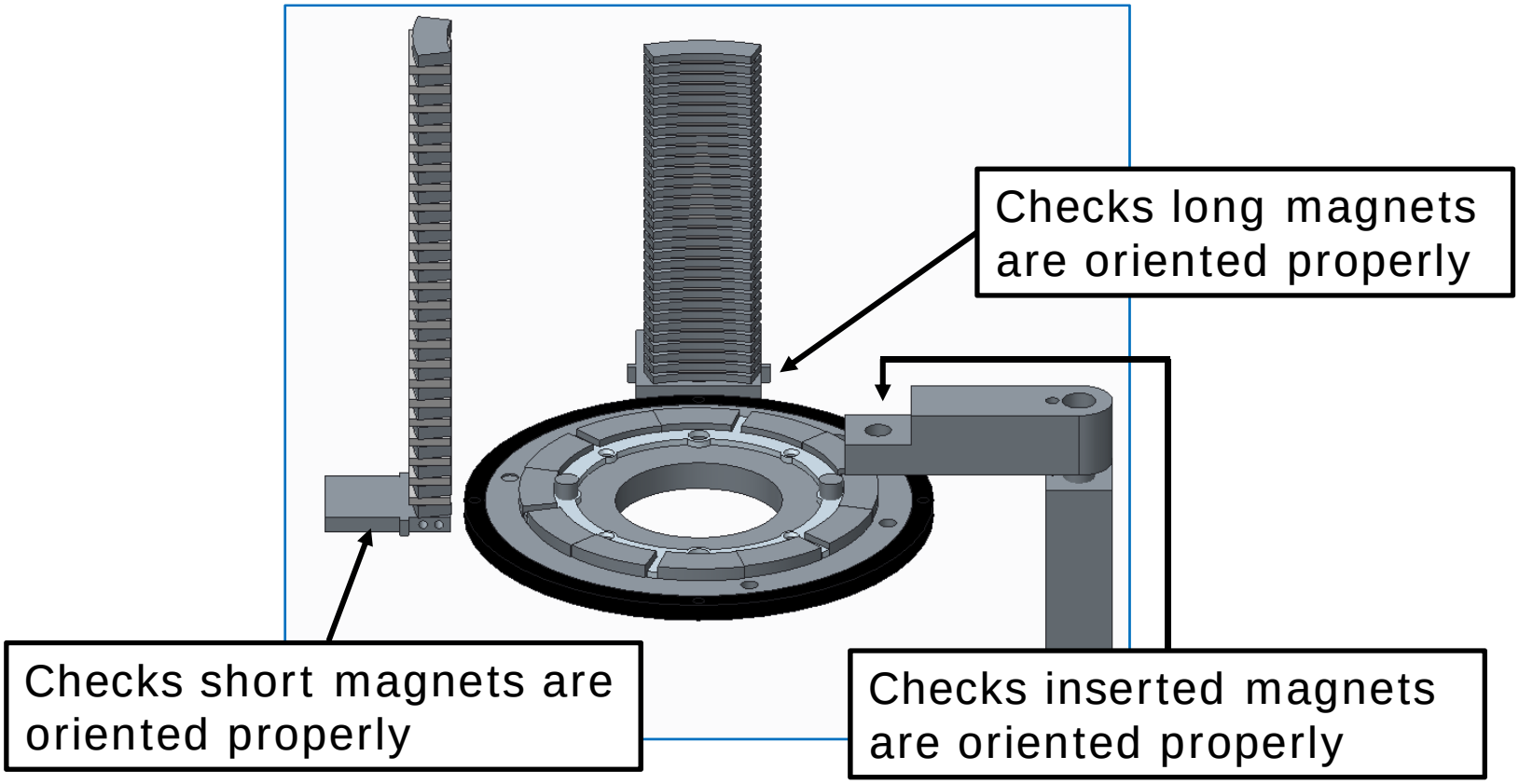


Insertion



Polarity

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



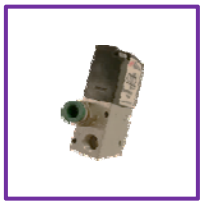
Communication Between Systems

Electronics & Logic

System	Part	Voltage (V)
Indexing	Motor Driver	5
	Stepper Motor	12
Insertion	Actuator NPN Switches	24
	Solenoid Valves	24
Polarity	Polarity Sensors	24
Function	MicroDragon	5
	Proximity Switches	5
	Push Buttons	5
	Magnetic Sensor	24

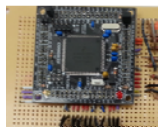
5V

12V



24V

24V



5V

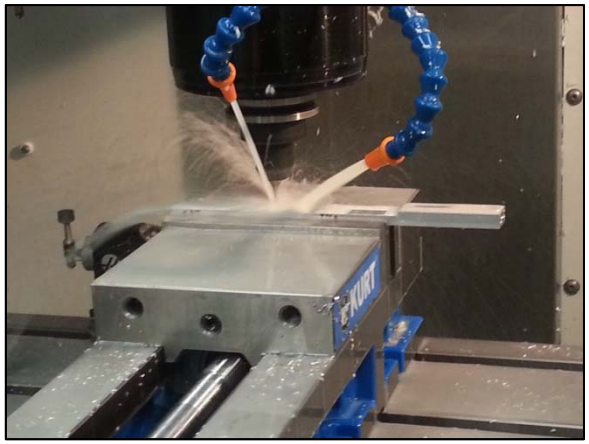
24V

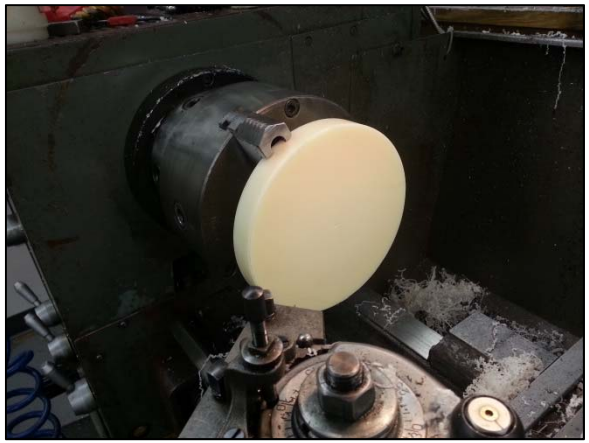
Material List and Budget

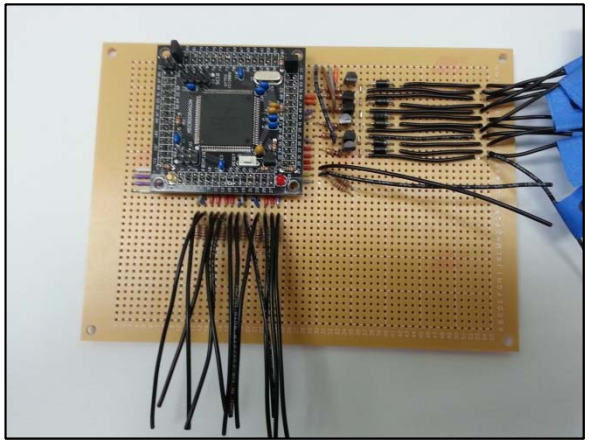
Items	Cost
Frame	$807
Raw Material	$660
Pneumatics	$395
Electronics & Logic	$322
Hardware	$284
Remaining	$32

$2,468 of $2,500

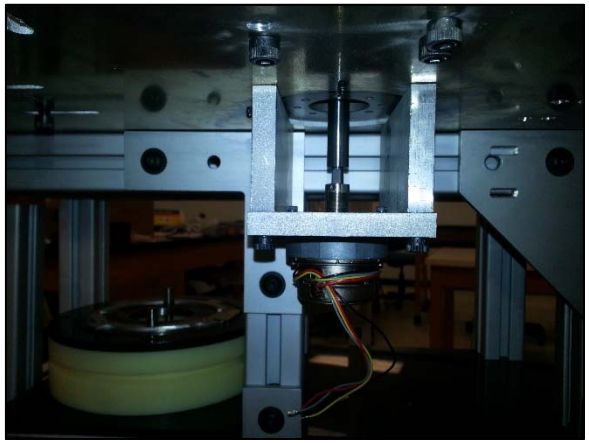
Machining and Assembly

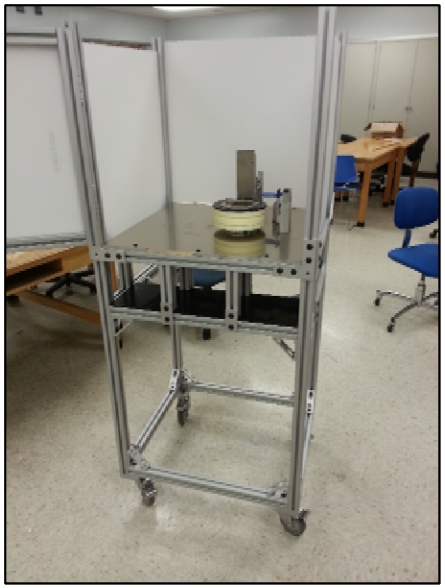


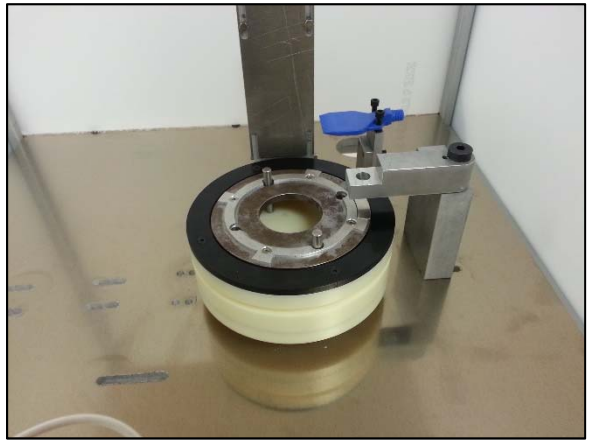




Machining and Assembly

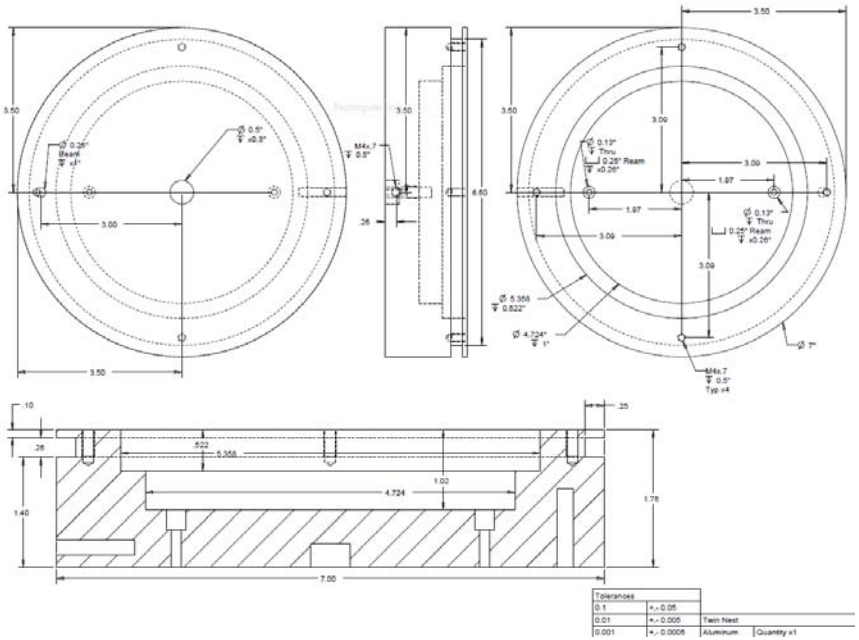






Design For Manufacturing

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



Incorporation of Studies

Classes		Uses
• Intro to Electrical Engineering	=	➢ Understanding electrical circuits
• Mechatronics	=	➢ Programming logic board, sensor data resolution
• Mechanical Systems II	=	➢ CAD assembly, mechanisms, motor torques
• Engineering Design Methods	=	➢ Design process
• Mechanical Engineering Tools	=	➢ Machining parts, making drawings using Creo
• Intro to Mechanical Engineering	=	➢ Understanding forces in machine

Accomplishments

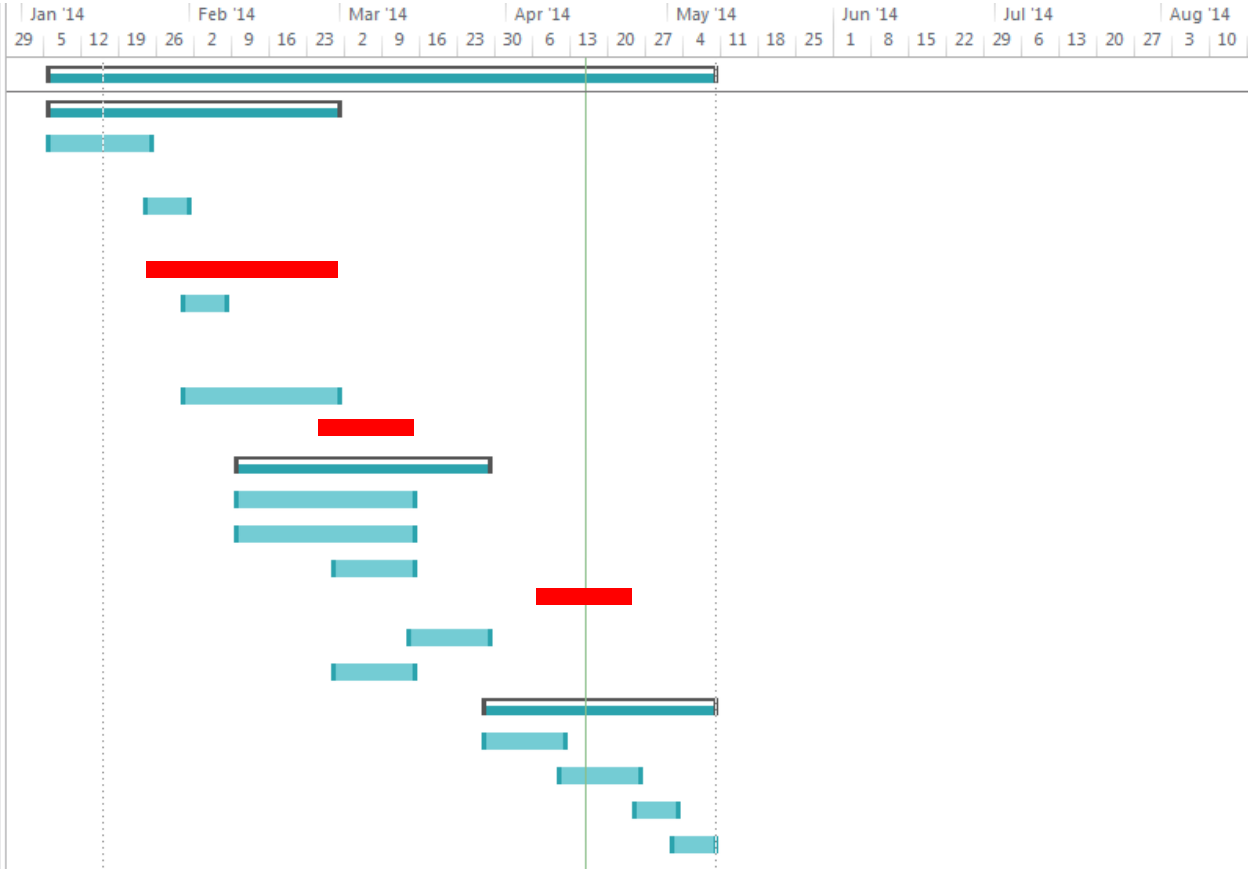
- Developed a theoretical process and prototype that
  - Reduces operator input
  - Increases ergonomics by eliminating manual steps
  - Increases quality by ensuring proper magnet orientation
  - Potentially increases technician productivity with spare time between bearings
  - Establishes reliability through documentation

Challenges/Setbacks

- Concept change from fall to spring
  - Mechanical system to fully automated
- Novice experience in programming
  - Building electrical circuits
  - Pneumatics
- Customer design changes
  - Drawing revisions
- Procurement delay
- Machining delay

Gantt Chart

	Task Name	Duration	Start	Finish
1	**Spring Timeline**	**90 days**	**Mon 1/6/14**	**Fri 5/9/14**
2	**Detailed Design**	**40 days**	**Mon 1/6/14**	**Fri 2/28/14**
3	Mechanical Design	15 days	Mon 1/6/14	Fri 1/24/14
4	Drawings to Turbocor	6 days	Fri 1/24/14	Fri 1/31/14
5				
6	Budget and Material Review	6 days	Fri 1/31/14	Fri 2/7/14
7	Procurement	21 days	Fri 1/31/14	Fri 2/28/14
8				
9	**Fabrication/Assem**	**35 days**	**Mon 2/10/14**	**Fri 3/28/14**
10	Electrical Design	25 days	Mon 2/10/14	Fri 3/14/14
11	Programming	25 days	Mon 2/10/14	Fri 3/14/14
12	Machining Parts	11 days	Fri 2/28/14	Fri 3/14/14
13				
14	Assembly	11 days	Fri 3/14/14	Fri 3/28/14
15	Pneumatics	11 days	Fri 2/28/14	Fri 3/14/14
16	**Validation**	**31 days**	**Fri 3/28/14**	**Fri 5/9/14**
17	Tuning and Setu	11 days	Fri 3/28/14	Fri 4/11/14
18	Testing	11 days	Fri 4/11/14	Fri 4/25/14
19	Rework	6 days	Fri 4/25/14	Fri 5/2/14
20	Testing	6 days	Fri 5/2/14	Fri 5/9/14



Updated Gantt Chart

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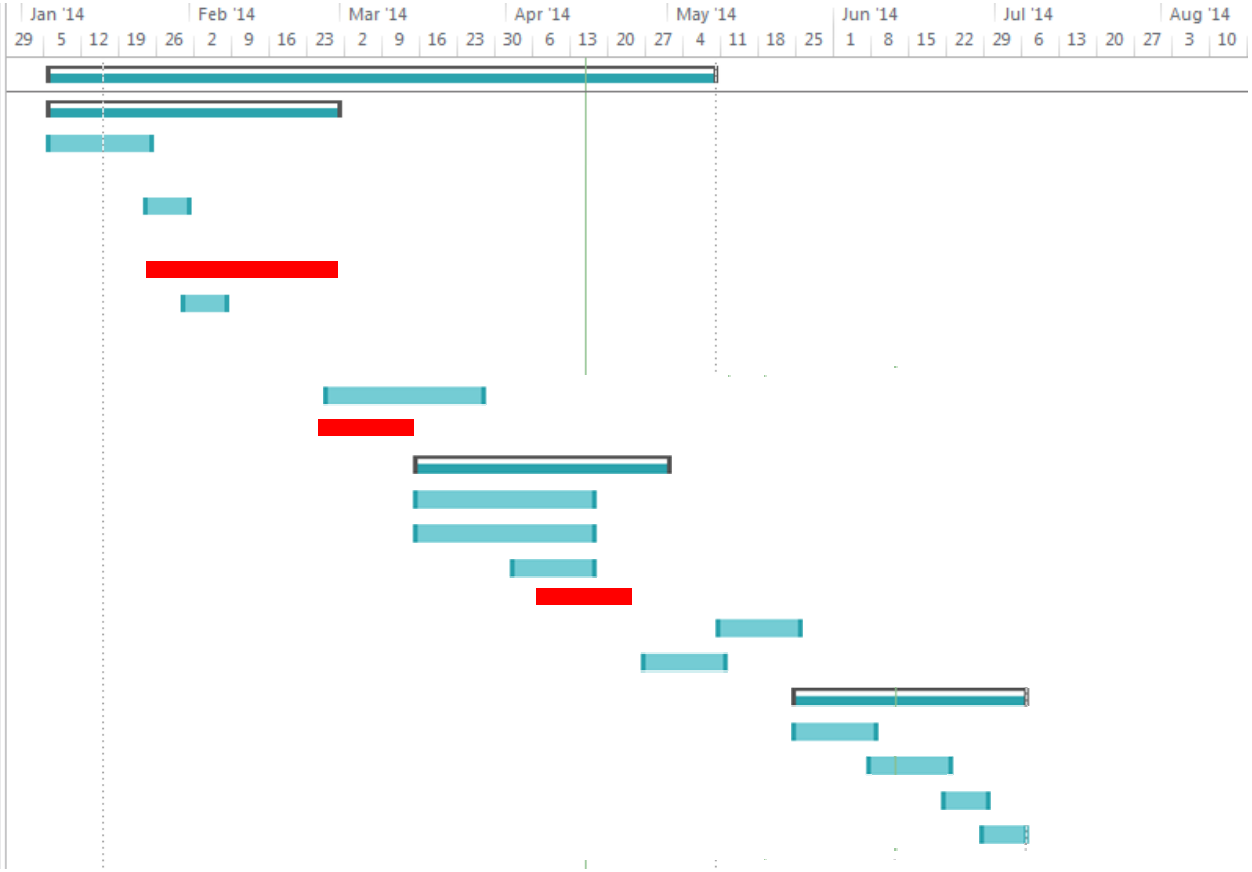
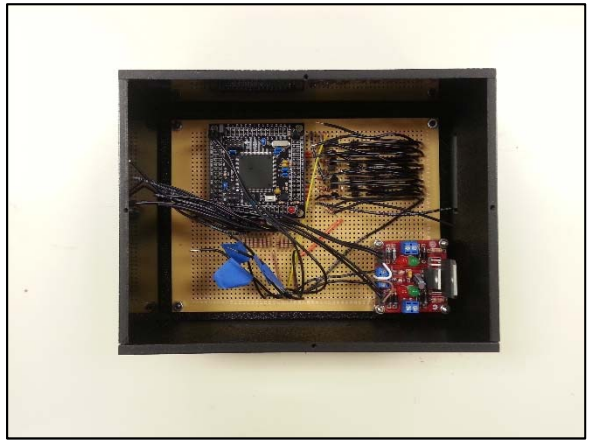


Future Work

- Implement programming
- Pneumatic and sensor logic
- Buttons, switches & emergency stop
- PLC implementation

Power supply



Logic board

Questions, Comments, Suggestions, Advice

Thanks to our sponsors:

Danfoss Turbocor

William Bilbow
Thad Larson
Kevin Lohman
Paul Lulgjuraj
Chuck Wesley

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Dr. Chiang Shih

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