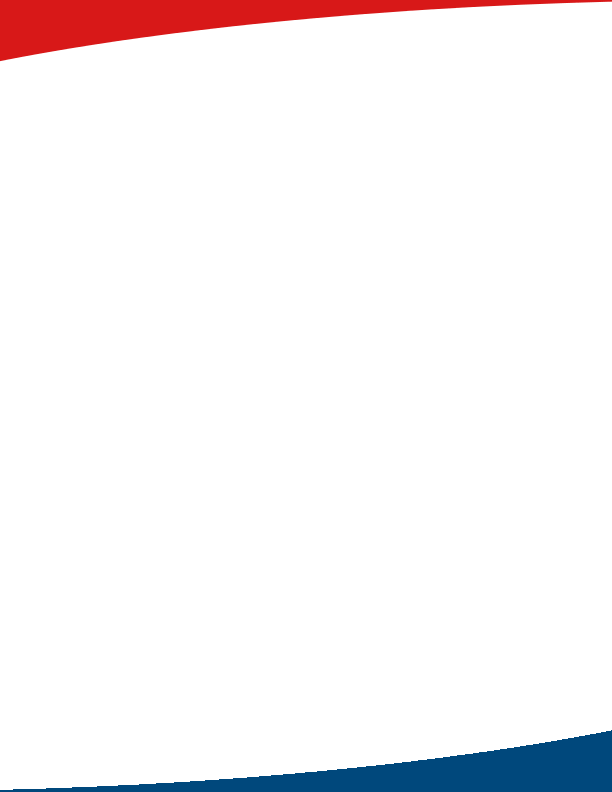
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**Team 5 - Magnet Insertion Process**

**Restated Scope and Project Plan**

**January 17, 2014**

**EML 4551 Senior Design Spring 2014**

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**Brief work statement, project scope, major goals and objectives**

A review of the project problem statement, solution and goals is detailed here. To begin, the team’s sponsor is Danfoss Turbocor, whose manufacturing facilities are located in Tallahassee, Florida. Turbocor specializes in oil free centrifugal compressors which feature a levitating shaft and magnetic bearings. The team’s focus is not on the function of the compressors as a whole but rather the magnetic bearings that are placed axially on the shaft. The bearings require preparation steps before being fit into the compressor: bolting on an aluminum spacer to the bearing face and placing the magnets around the edges of the spacer.

At the present time, these preparation steps are being completed manually by a technician. Turbocor has a table complete with bearings, spacers and magnets in their warehouse. At this station, the technician manually bolts the spacer to the bearing and hand places the magnets onto the bearing. This current process has some notable disadvantages. First, the technician is locked to the workstation for a long period of time to assemble the bearings with their magnets. Second, the magnets involved are quite strong and brittle and can jump out of the hands of even the most experienced technician. The strength of the magnets also make them difficult to place with ease. With many bearings per day and 6 to 8 magnets to place per bearing, it is plain to see these difficulties can lead to bodily injury by pinching the technician’s fingers or causing long term fatigue. For these reasons, Turbocor turned to the team for analysis and solutions to this process.

Initially, the team chose a mechanical Geneva driven system to assist the technician. This system would feature two different machines to account for the two different sized bearings. The technician would merely have to turn a crank while the system indexed the bearing to the proper magnet locations and a pneumatic actuator would push the magnet onto the surface. Midway through the development, the sponsor issued some design changes. The mechanical system would not be able to compensate for future bearing geometry changes. The primary disadvantage to the Geneva system is that it can only index in specific intervals. If the bearing intervals changed, the system would be rendered useless. For this reason, Turbocor suggested use of a programmable stepper motor. This allows for more rotational freedom for indexing the bearing and also allows for a more automated process.

Following these changes, the team’s project scope and design changed quite drastically from a mechanical systems approach to a mechatronic approach. At the conclusion of the Fall semester, the team was working to finalize the mechanical aspects of the design before tackling any programming or electronic aspects of the machine.

By the end of the Spring, the team plans to present to Danfoss Turbocor a safe, stand alone machine with an enclosed work area. The machine will serve to eliminate as much technician input as possible. The technician should only have to place a bearing in a nest, place the intended magnets to be inserted into a holder and press a start button. The magnets should then be placed with proper orientation and the technician can remove a fully assembled bearing from the station. This will open up more time for the technician while at the same time ensuring quality assembly of the bearings.

**Any modifications or changes since last fall final report**

Since the final Fall report, the team has continued to complete mechanical aspects of the system, specifically the issues with pushing a single magnet from a magnet stack and onto the bearing surface. Other considerations include overall layout of the machine components and creating nests with unique features to each bearing.

**Any midterm corrections requested by sponsor or by team that could affect project duration/direction**

The midterm corrections by the sponsor to change the project to a mechatronic system affected the materials and resources needed. These changes added many items to the budget. Originally, basic raw materials were needed, now many electronic components are included, such as wiring, logic boards and sensors, which drove up the bottom line cost. The programming aspect is also demanding for a team of three people and assistance may be needed to achieve proper function of the machine. With all changes established, the project is still anticipated to be complete by May 2014.

**Any newly developed or unanticipated issues or concerns**

Many unanticipated issues are expected when it comes to the electronics and programming aspects of the design. The majority of the time for the Spring is devoted to design review and testing of the system. However, procurement for parts has not yet begun as the mechanical design is still being finalized. The procurement phase, if not started soon, could begin to remove time from testing and fixing bugs. It is crucial that the mechanics and materials be sorted out soon so that there is ample time left at the middle and end of the semester to adjust.

**Any updates on procurement, milestones and their impact on project schedule**

The current project budget is outlined to the left. The bottom line has two different values, one being a subtotal without Turbocor’s assistance, the other being the actual estimated cost of the project. Many values are estimates, such as the 80/20 cost and wiring, electronics and din rail mount. Still, this budget yields an initial idea of what the team and sponsor can expect. One item to note is that the automated magnet insertion machine Turbocor had built years ago that is no longer in service was estimated to cost $50,000, while this system comes in at a drastically lower value. Turbocor’s initial budget was discussed to be around $2,000. This value is still being negotiated with Turbocor management. Additionally, the costs will change as the team finalizes the design and materials needed.

As for procurement, not much is known. The team and sponsor have not yet met as of the due date of this report. Procurement could drastically impact the timeline of the project, especially if there are long lead times on crucial parts and pieces. The team is in contact with the structural and enclosure manufacturer 80/20. Turbocor is a longtime customer with the vendors McMaster car and Automation Direct, so the impact of procurement and shipping times should be better understood as more information is gathered.

**2014 Gantt Chart**

The team’s revisited Gantt chart is shown below. This will be updated as the semester progresses.

