Bi-directional Offset Lifting Bar

Deliverable # 3: Project Plan and Product Specification

Team 5

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Abstract

Having a swift plan of action for a design project of this caliber is paramount in completing the objective in a timely manner. The goal of this project is to implement a method to lift Danfoss Turbcor's next generation VTT compressor from the ground onto testing position, which utilizes the existing winch and gantry system. In order to accomplish this goal, Team 5 has met with Turbocor to consult with the engineers involved and to record dimensions and retain information needed in order to develop design solutions. With what is known thus far, Team 5 has concluded that the necessary features of their lifting bar design are not attainable in the budget of $1000. Thus, Team 5 plans to propose a new system of lifting, by increasing the height of the existing winch complimented by a redesigned gantry and trolley system.

1 Introduction

Danfoss Turbocor has asked Team 5 to devise a new method to lift their new compressor to the testing height using the existing winch and gantry system. This must be executed in a manner that is safe and reliable, but not require a new process to achieve the goal.

The current gantry system is designed to lift the compressor to a height at which was adequate for previous compressor models, but does not lift the new compressor to the appropriate height for testing. As a temporary solution, Turbocor has implemented the use of a manual chain hoist in order to lift the compressor to the appropriate height. This method is unsatisfactory, thus Turbocor has sought out alternative methods. Alternative methods must be analyzed to determine if the solutions are feasible, given the following constraints. Safety is the most important aspect due to the potential risk to human life and expensive equipment. The most challenging limitation is the working space of the room, which will be a deciding factor in choosing a concept. Also, due to the relatively small amount of sponsor funds, designs will be greatly limited.

2 Project Definition

2.1 Background research

"Danfoss Turbocor Compressors are transforming the commercial HVAC market with innovative technology that redefines lifetime operating costs for mid-range chiller and rooftop applications." *[1]*

Before every compressor is approved for distribution, it must be tested on a chiller rig to test for its efficiencies and performance. Turbocor now has a new line of compressors, the VTT line, which is much larger and operates at higher pressures than previous mdoels. Due to the high confidentiality of this compressor, background research has been obstructively difficult. The compressor at hand is shown below in Figure 1 and as a result of the high confidentiality of this new compressor, Figure 1 has been a primary source of information about the compressor. The gantry system and lifting bar are custom, thus there is no literature related to them.

Currently, Turbocor has implemented a temporary solution that requires the assistance of multiple mechanical engineers in order to manually lift the half-ton compressor over six feet to be installed on to the chiller testing rig. This procedure is hazardous and distracts the engineers from projects that require their attention. Team 5 has been asked to develop a solution in order to create a safer working condition and allow the compressor to be lifted in to place without the supervision of any more mechanical engineers than are necessary.

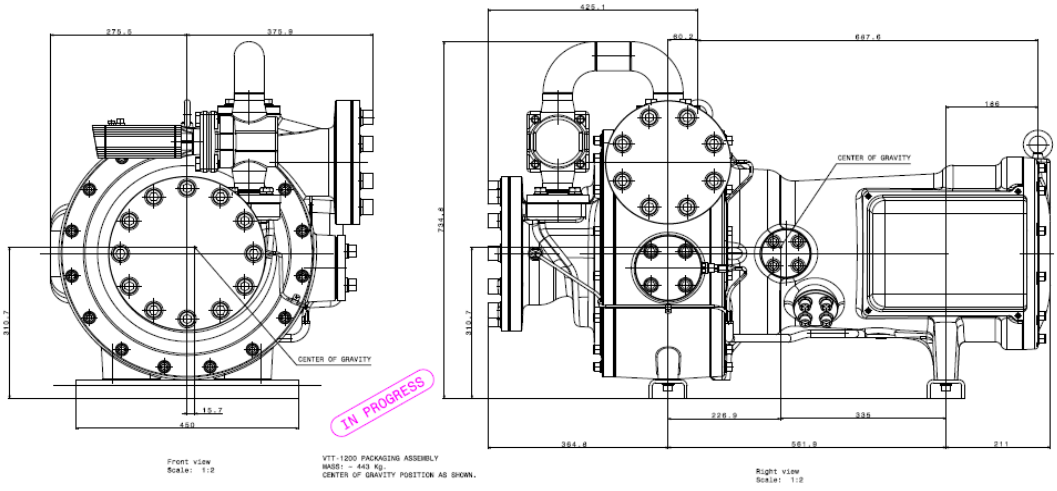

Figure 1 - Schematic of Turbocor's new VTT Compressor

2.2 Need Statement

Danfoss Turbocor requires that each half-ton compressor be tested on the chiller system to ensure quality control. Each time the new compressor is ready for testing, a mechanical engineer must employ the use of a manual chain hoist to lift and install the compressor onto the chiller system. Danfoss Turbocor has sponsored a team of 5 mechanical engineering students to solve this problem, which will have detrimental effects on manufacturing in the future. Currently, Team 5 is in the process of scheduling routine meetings with Turbocor in order to facilitate a cohesive relationship. During these meetings, Team 5 presented risk assessments, detailed specification, and a project timeline. After these documents were reviewed, Team 5 proposed an alternative design solution that does not implement the use of an Offset Lifting Bar, but does raise the compressor to a sufficient vertical distance.

"Currently, the lifting process requires too much manual labor and distracts an engineer from tasks that he could else wise be focusing on."

2.3 Goal Statement & Objectives

"A better lifting system must be designed and implemented in order to more easily install the compressor for testing."

Objectives:

- Increase lifting height of the compressor
- Must be able to adjust for a variation in center of gravity of the compressor being lifted
- Lifting system must be compatible with multiple compressors
- Minimize all safety risks involved with lifting a half ton compressor
- Design must not interfere with current production practices

3 Constraints

- Adjustable to ensure a level lift with a range of Center of Gravity
- Adjustable lifting hooks (dx = 18” to 38”)
- Meet OSHA Safety standards
- Primary load capacity: 1200 lb
- Maximum operating weight (unloaded): 500 lb
- <$1000 Provided by Danfoss Turbocor
- Limited access to the compressor and chiller due to confidentiality
- Extremely tight dimensions available for compressor/lifting arm movement

3.1 Design Specifications

Measurable design and engineering features important to the design, examples include: geometric dimensions and tolerances, load/ stress bearing capacity, both static and dynamic, needed power, weight, various modules and components and integration within the designed system.

- Load Capacity: 1 Ton
- Weight of assembly: <500 lbs.
- Rate of Lift: 4.8 – 14 ft/min
- Dimensions: TBD
- Bearing specification: TBD
- Machining tolerance: Hundredth
- Wheel size: TBD
- Material:
    - A36 Steel
    - Square Tubing
    - Grade 8 fasteners

This proposed pulley system will attach to the existing I-beam by use of a hoist trolley and uses all existing infrastructure to accomplish task. Due to costly and sensitive equipment located

below the compressor, it will likely not be possible to test and implement the system into the actual work environment until it has been deemed safe and stable. Consequently, it will be necessary to create a simulated test environment in which an equivalent load will be raised and lowered in order to confirm performance of the proposed design.

3.2 Performance Specification

The redesigned gantry and trolley will be a permanent implementation that allows Turbocor to safely lift and install all current and future compressors onto the chiller system for testing. To promote adaptability of the system, the redesigned lifting bar will have an adjustment to alter the bars point of lift in order to adjust for a variation in center of gravity. The engineered system will have the precision to adapt to every model compressor that Turbocor could possibly need to lift into position on the chiller system. Due to its simplicity, implementation and maintenance will be easy.

- Easily implemented and low maintenance costs
- Maintains horizontal position of compressor during lift and movement
- Bubble display indicates uneven lifting
- Allows lifting of all 3 compressor units
- Functions with existing 1-Ton electric hoist

4 Methodology

The first step in the project plan was to begin communication with Turbocor in order to facilitate a good working relationship. An initial meeting was scheduled on Wednesday, September 10, in order to discuss the preliminary constraints of the project and to visit the task at hand in person. We were allowed access to Chiller 3 system and were able to better understand the difficulty of the project. We then scheduled a meeting that Friday, September 12th, in order to take measurements of the chiller. Turbocor shut down testing for two hours to allow us to do so.

Since those two preliminary meetings, the team has met weekly in order to discuss possible design implementations, budgetary constraints, and formulate a project timeline. On Friday, September 26, the team met with the team Advisor, Dr. Hollis, in order to discuss the team's possible designs and for new design suggestions. Team 5 will continue to meet every Monday at 4:00 pm and on alternating Tuesdays with Dr. Gupta and Dr. Helzer. Starting the second week of October, Team 5 will meet with Turbocor bi-monthly in order to maintain strong communication and to meet Turbocor's desired deadlines.

During the meeting that took place the second week of October, a complete project plan and timeline was discussed with Turbocor. Team 5 also presented four preliminary design prototypes and received positive feedback. The team is approaching this issue abstractly and proposed to dismiss the design and implementation of an offset lifting bar, and instead introduce a redesigned lifting bar that will complement the new gantry system. This method will require a larger budget and Team 5 has requested more funding in order to do so. Upon approval from Turbocor, development of the design will begin.

4.1 Schedule

In order to ensure that Team 5 will meet required deadlines for the project, a project plan and schedule has been established. This project plan will be followed as closely as possible and when scheduling changes are necessary, the project plan will be updated. A visual of the current project plan can be viewed below, in Figure 2.

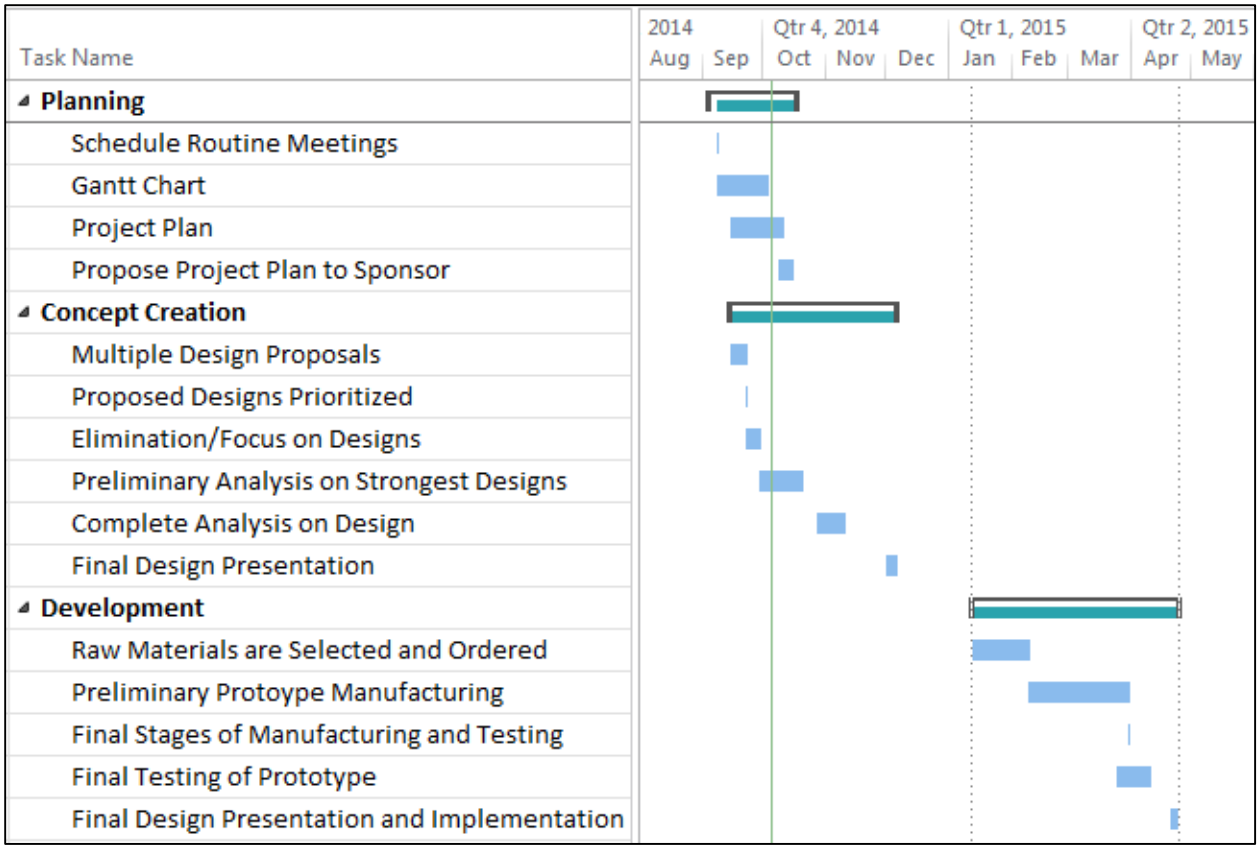

Figure 2. Gantt Chart

4.2 Resource Allocation

Devin Stubbs - As team leader, Devin is responsible for delegating roles to each team member and ensuring that clear progression of the project is being made. Devin will also be responsible for establishing a clear project plan and schedule. The majority of communication between Team 5 and the sponsor will be facilitated through Devin.

Luke Leelum – As the Treasurer of Team 5, Luke will be responsible for all budgetary actions related to the project. This will include, but not limited to, keeping the project within budget and/or requesting budgetary changes if necessary.

Coert Maraist - As Secretary, Coert is responsible for documenting the content of group and sponsor meetings to assure a clear understanding amongst the team. Coert will also make sure that all information is easily accessible and organized. It will be the Secretary's responsibility to ensure all deadlines are met for each deliverable, staff meeting, and sponsor meeting.

Yoel Bugin - As Head ME, Yoel will lead development, but must consult with the group as whole prior to making any significant changes. Once development is complete, Yoel will then oversee the manufacturing of the proposed design model.

Gabriel Omoniyi - As Webmaster, Gabriel will be responsible for the creation of the website in which team documents will be will be displayed. Additionally, Gabriel will be responsible for the updating of this website to ensure that all progress made by the team is transparent to the sponsor and advisors.

5 Conclusion

Turbocor is in need of a new lifting system in order to lift the new VTT compressor into place for chiller testing. The current design was sufficient for previous compressors, but is inadequate for the new design. Turbocor has requested that a new, offset lifting bar be designed and implemented with the current crane hoist in order to lift the compressor to the appropriate height. Team 5 will propose that in addition to a new lifting bar, the hoist will be raised by a new mounting bracket and redesigned gantry system for an increase in total vertical lift. The new proposed plan will be much more realistic of a solution due to its more simplistic nature.

6 References

[1] "OEM Customers." *Danfoss Turbocor Compressors Inc.* N.p., n.d. Web. 23 Sept. 2014.
[2] Lohman, Kevin. "Project 5 - DTC Bi-directional Lifting Bar." *Www.campus.fsu.edu*. Florida State University, 31 Aug. 2014. Web. 26 Sept. 2014.
[3] "Lifting Beams Design." *Lifting Beams Design*. N.p., n.d. Web. 26 Sept. 2014