Restated Project Scope and Project Plan

Team 5

High Speed Motor Test Rig

Members:

Jack Pullo jap12c

Alexander Jurko adj13c

Jonathan De La Rosa jgd12

Fehintoluwa Aponinuola fehintoluwa1.aponinu

Faculty Advisor

Dr. Patrick Hollis

Sponsor

Danfoss Turbocor

Instructor

Dr. Shih

01/27/2017

Table of Contents

Table of Figures

ABSTRACT

Team 5 has completed a design for the motor test rig system and it has been approved by the sponsor, Danfoss Turbocor. Two of the three proposed components needed for the design have been approved and are currently in the process of being purchased. The approved components are the laser alignment tool and the double-flex disc couplings. The third component that was not approved is the torque transducer. This was not approved because the price of this piece of equipment is very high and the lead time is upwards of ten weeks (out of stock). Instead of purchasing the transducer, Team 5 has been given the additional task of designing and implementing a "mock transducer" with a ball bearing system to verify the practicality of the design. By incorporating this mock transducer, it will hopefully eliminate most of the axial vibrations caused by the compressors fighting, and improve performance of the motor test rig.

1. Problem Statement

Danfoss Turbocor is a leader in compression technology, but does not have a system to analyze the performance of their compressors when they run at high speeds. Turbocor achieves high efficiency in their compressors through a combination of magnetic bearings, which use magnetic fields to create a contact-free system between the shaft and bearings, allowing high speeds (up to 40,000 rpm), and variable-speed centrifugal compression, which allows the use of the compressor at the rotation required for the highest quality performance.

2. Project Scope

Danfoss Turbocor requires a motor test rig that is capable of measuring efficiency and torque loads more accurately while utilizing little power consumption. The senior design team that was tasked with this project last year was able to create a design that ran at low speeds. Last year's team designed an adjustable frame that allowed the ability to change the position of the two compressors placed on it during the process of alignment. They designed a system with a flexible coupler to connect the internal shaft of the compressor to an external shaft, which accounted for a certain amount of misalignment, but that caused problems later on in their project.

Although Turbocor's compressors have rotation speeds that range from 13,000 rpm to 40,000 rpm, for safety reasons, Team 5 has been tasked with designing a test rig that can withstand rotations of up to 10,000 rpm, and, instead of incorporating a Torque transducer in the test rig, they have been asked to design a mock transducer, to prove our proposed design. Having such a wide range for rotation will result in misalignment between the shafts that the coupler is connected with. Improvements are expected to be made from the design that was presented last year; this includes adjusting the current coupler or using a different coupler, incorporating a mock torque transducer to the rig itself and trying to fix the alignment issues that occurred last year through the use of a laser alignment tool.

3. Methodology

Team 5 has been designing throughout both semesters, and now with an approved design and clear parameters set, the goals of this semester are clear. Meeting with the sponsor weekly along with Dr. Hollis, the faculty advisor for the team, the goal for this project has transitioned from reaching a high rpm in the system to proving the theory of adding a rigid component that will prevent vibrations between the compressors. This will in turn result in a higher rpm later on down the line, without the compressors oscillating and shutting down at high speeds.

Safety is a priority for Team 5, and with the mock transducer being designed this must be kept at the forefront of every iteration. For equipment, there are specifications listing maximum rpm, torque load, etc. However, with this new part that will be designed and implemented from scratch, the team must research and get approval from supervisors before manufacturing in the machine shop. Therefore, the team will begin the design on SolidWorks with supervision from Dr. Hollis to implement a design that will safely be integrated to the system with low risk and still perform its task at hand.

4. Challenges/Constraints

One of the challenges that the team faces this semester was to have the parts selected approved by the sponsor. The chosen design that the team sent over winter break was approved initially and the only thing left was to get the parts approved. The team had three parts that needed approval: the SKF 31 laser alignment system, double flex couplers, and the TMHS 310 torque transducer. As of the latest meeting with the sponsor, all but one of the parts were approved. The sponsor rejected the TMHS 310 torque transducer for purchasing. This was a huge setback for the team due to the fact that the team was relying on getting the torque transducer approved. Although it wasn't approved, the sponsor wants the team to create a mock torque transducer in order to prove the theory of why it’s needed for the motor test rig.

The challenge for this spring semester will be in making a mock torque transducer to input into the motor test rig. An idea that the sponsor mentioned would be having a shaft go through some ball bearings in order to mimic it properly. Depending on the quality of the finished product would determine how much of an effect the mock transducer would play in the motor test rig when running. The team will meet with the sponsor's FEA analysis expert to talk about what effects the mock transducer could potentially bring to the table in the design overall. This will be occurring while the other parts are being shipped to be assembled. It is imperative that the mock transducer be fully built by the time the last part arrives in order to start assembly as fast as possible.

5. Deliverables and Schedule

This spring semester's Gant Chart, as seen in the figure below, will start off with the requesting for quotes/purchasing parts and FEA analysis with the specialist at Danfoss Turbocor. The team will have until the end of January to have the quotes for the parts that were approved and give them to the sponsor for ordering. The team will also be meeting with the FEA specialist from Turbocor for approximately 3 weeks to discuss analysis done on the motor test rig. While that is occurring, the team will also be designing a mock torque transducer that would be incorporated into the motor test rig in order to prove the theories that the team had at the beginning of the fall semester for a total of 4 weeks. The team has put a time of four weeks for all the parts that were approved to be shipped over starting around the 26th of January. The team would then have 3 weeks to assemble and test the motor test rig while having 10 days on top of that for assessing issues and researching a solution for said issues starting on February 23rd. Improving the design will have a time of approximately three weeks before showcasing the final design in the middle of April. While all of this is going on, the team will be report writing and analyzing everything that is being done this semester.

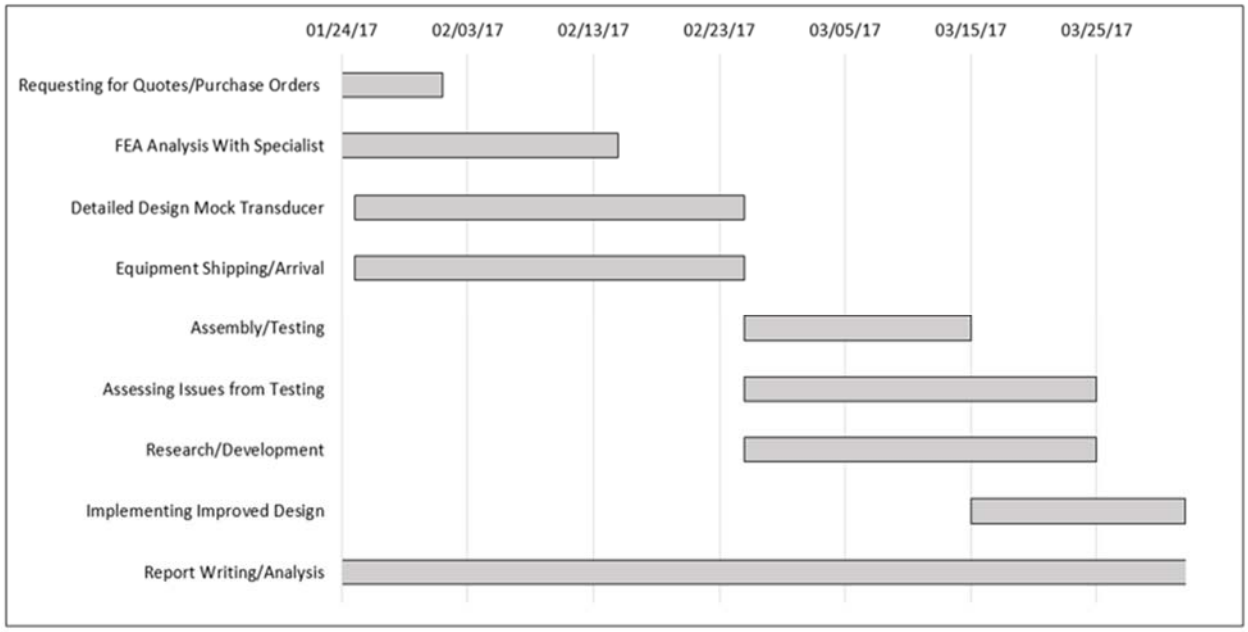

Figure 1 Gantt Chart

6. Conclusion

Team 5 is proud that their design was approved by the sponsor, and is excited to be working on the mock transducer design. This will hopefully prove the validity of their design when they begin actual testing. It was understandable that the sponsor didn't want to purchase the torque transducer due to the price and lead time, however the design would be easier to implement with one available. The team is looking forward to completing the project and beginning to start testing once the equipment and components arrive. The team will be executing different design steps when the equipment arrives, including a test of the laser alignment tool to get used to its software and capabilities. The next step will be to test with just a shaft between the two couplings (not mounted). Last step of the design will be to mount the mock transducer to the frame and see if it limits the vibrations and can run at relatively high speeds.

References

1. http://eng.fsu.edu/me/senior_design/2016/team04/Final%20Report%20-%20Team%204.pdf