Part Handling and Processing of the 68K Blade

Define Phase

EIN 4890 – Senior Design – Fall 2011 Deliverable

Team # 5

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Abstract

TECT Power produces a range of components for clients including G.E., Pratt and Whitney, and Boeing. This project primarily focuses on 68K blades used in jets and some locomotive engines. Each blade requires a meticulous multi-stage process in order to be useable in their various applications. This project will focus on the ergonomic improvement and mechanical design for the processing and handling of 68K turbine blades. Prior to broaching, the blades weigh approximately 45 lbs and current handling methods require manual lifting to and from containers as well as milling machines. These methods lend themselves to a high risk of personal injury. The goal of this project is to develop a mechanism that is able to lift, carry and assist in loading the blades onto the various machining fixtures. Also, there is a need to redesign the manner in which these blades are received and oriented in their storage containers to better suit the proposed lifting procedure. To better understand what the customer is requesting, a few essential tools are utilized below. Assessments, such as the RULA worksheet, house of quality, threat/opportunity matrix and a voice of customer tree are used to clarify the customer's requirements. They also prioritize which technical attributes are most important to reaching the final goal. If the project is unsuccessful TECT Power could face significant costs in the form of downtime and disposal of scrap material.

1. Introduction

Turbine Engine and Components Technology (TECT) Power is based in Thomasville, Georgia. TECT Power products include: airfoil blades, airfoil vanes, diffusers, impellers, as well as a myriad of other components. TECT Power generates profit through the engineering and manufacturing of various turbine components used throughout a wide range of applications. . The primary focus of this project will be the 68k turbine blade which is used in engines GE, Pratt and Whitney, and Boeing. The 68k blade is difficult to process because of its unique size and shape. When the forging of the 68k blade is received, it weighs approximately 45 lbs and is transported through the plant using a variety of carts with no uniform design. The manual lifting required for the handling methods to and from containers as well as milling machines is a potentially problematic process that has an increasing need for improvement. TECT Power employs a select few individuals who meet the physical requirements necessary to manage these heavy blades across the facility and onto various fixtures. The issue with this process is that the techniques are taxing on the body resulting in high risk of injury. Consequently, if an employee experiences an injury that will prevent him or her from working, the broaching process of the blades may experience downtime. In addition to the profit loss of downtime, the resulting consequences which include hiring and training a new employee, places pressure on TECT Power to improve this procedure. After speaking with the sponsor of TECT, Ashok Patel, it has been concluded that a new process and/or mechanism is needed to eliminate manual lifting and improve transportation of the 68k blades. Once all the issues are clearly defined and weighed for importance, developing modifications to TECT Power’s current manufacturing methods of the 68k blades will begin.

2. Project Definition

2.1 Problem Statement

The 68K blades can be difficult to handle, weighing approximately 45 lbs, and the incorporation of bulky lifting mechanisms decreases the overall production efficiency. This project incorporates both the redesign of receiving methods in order to create a more efficient process as well as the design and fabrication of a new mechanism able to safely handle the blades through the multi-step manufacturing process.

2.2 Justification and Background

Our contact for this project is Ashok Patel, an industrial engineer at TECT Power. TECT Power produces numerous 68K blades meant for engine use. The manufacturing process for each one of these blades begins in the shipping and receiving center of the plant where the blades are contained in a packaging with sometimes variable orientations. The next stages of the process include the transition from receiving to broaching stations wherein the blades must be milled down before progression to 68K manufacturing line which holds even more stages of processing.

Each phase of this process involves direct interaction and, in most cases, vertical lifting and reorientation of the 45lb blades to maneuver them through the range of required positions as the blade is transferred from one station to the next. While handling these blades the carrier must step onto and off of elevated platforms as well as hold the blade in extended positions while it is attached into each machine. These processes present themselves as an increased risk for work related injury. To add to the danger, most of the milling machines require oil during operation. This increases the risk by adding a slippery surface to maneuver through while maintaining control of the blade. The assistance of traditional lifting devices, such as cranes and hoists, could be used, but they become cumbersome in the confines of the process line and increase the amount of time necessary for manufacturing each part.

2.3 Objectives

This project can be defined using two related, but individual objectives.

1. Redesign the receiving methods
    a. Redesign storage area (optional)
2. Design and fabricate a blade handling mechanism

Both objectives will be designed while keeping in mind the overall process requirements. The receiving methods should be designed as to allow the parts to be in an orientation which is best suited for placement on the mechanism. This mechanism will relocate the blade to each station while maintaining the optimal orientation for milling attachment. For the initial goals, the project is only addressing the first stages of manufacturing: receiving and broaching. The goals may be extended to include other processes depending on time constraints.

2.4 Methodology

In order to match the expectations set forth by our sponsor, our group will first become completely familiarized with the exact process occurring through the receiving and broaching procedures as well as the constraints given to the design. The group will determine what blade orientation is necessary for the majority of the processes and the methods used for receiving. We will interpret the voice of the customer using a house of quality and a threat/opportunity matrix. The next portion of design for each objective would be to brainstorm for initial design concepts.

For the mechanical design, the brainstorming session would be focused on mechanisms that would both allow for the robustness of handling the 45lb blade while demonstrating the versatility necessary to easily interact with the many types of machines available on the manufacturing lines. The receiving and efficiency concepts would be primarily devoted to how to modify the current methods for increased productivity and safety.

Once each brainstorming session is complete, the group will rank the designs based on the following criteria:

Mechanism Design:

- Injury prevention
- Ease of Implementation
- Design Capability
- Durability
- Cost

Process redesign:

- Injury prevention
- Efficiency of implementation
- Cost of Implementation

Also, both the mechanism design and the process redesign will be characterized based on the capability to implement with each other.

2.5 Constraints

The following constraints have been placed on our concept designs.

The Mechanical Design Must:

- Carry a minimum of 45lb
- Be able to extend the blade between 3-5 feet
- The device cannot exceed allowable path dimensions

The Process Redesign Must:

- Maintain or improve efficiency
- Not be operator exclusive
- Reduce time spent between machining

Both the mechanism design and the process redesign must cost a maximum of four thousand dollars.

2.6 Expected Results

This project, once completed, should have redesigned the receiving and processing method to allow for a more efficient procedure. The handling of the blades should be done by a mechanism that allows for the relocation, installation, and removal of 68K blades from the milling machines used in the broaching phases of manufacturing. The entire project should result in an increase in productivity and a reduction in risk of physical injury to TECT Power employees.

3. Team Organization

The team is comprised of five members, each of which was assigned a job title for the 68K blade handling process. Jason Newton is assigned the role of team leader who is responsible for assigning tasks, maintaining group collaboration, and ensuring all deadlines are met. Reginald Scott is assigned as team liaison who and is responsible for communicating the groups requirements to the TECT Power sponsors. The team liaison is also required to keep the advisors and sponsors well informed of the status of the project. Nadia Siddiqui is assigned the role of team organizer, who is responsible for coordinating meetings, keeping a meeting log, and maintaining all backup documents. Michael Brantley was assigned to be the team treasurer and is responsible for maintaining the budget, logging all financial transactions, and placing orders of materials. Ryan Ferm holds the role of team webmaster. The webmaster is responsible for developing and maintaining the project website with team information as well as frequent status updates on the project. A hierarchal diagram of the roles of each member and the primary contacts can be seen in Figure 3.1 below.

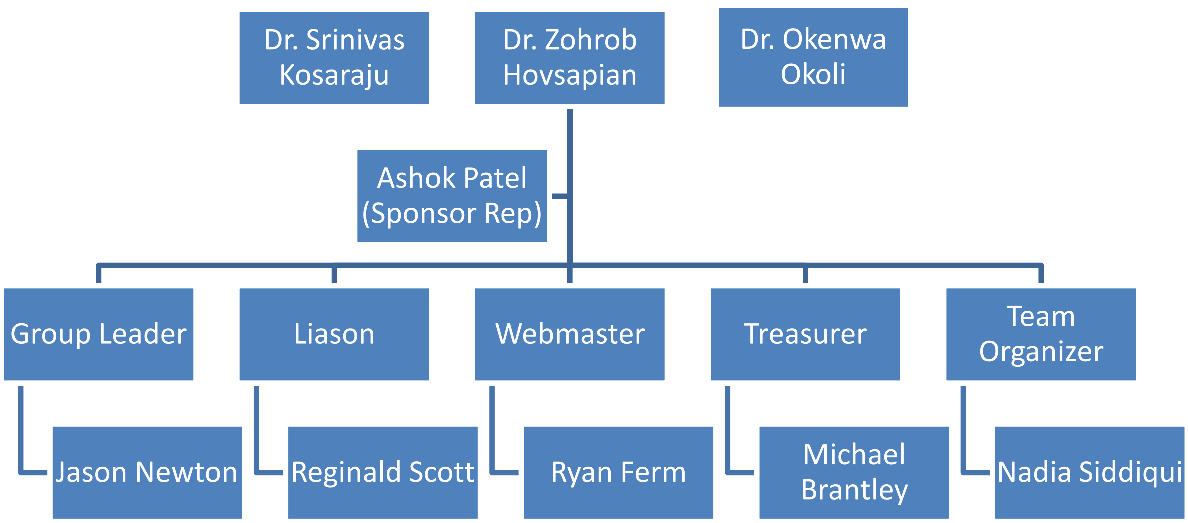

Figure 3.1: Organizational Team Chart

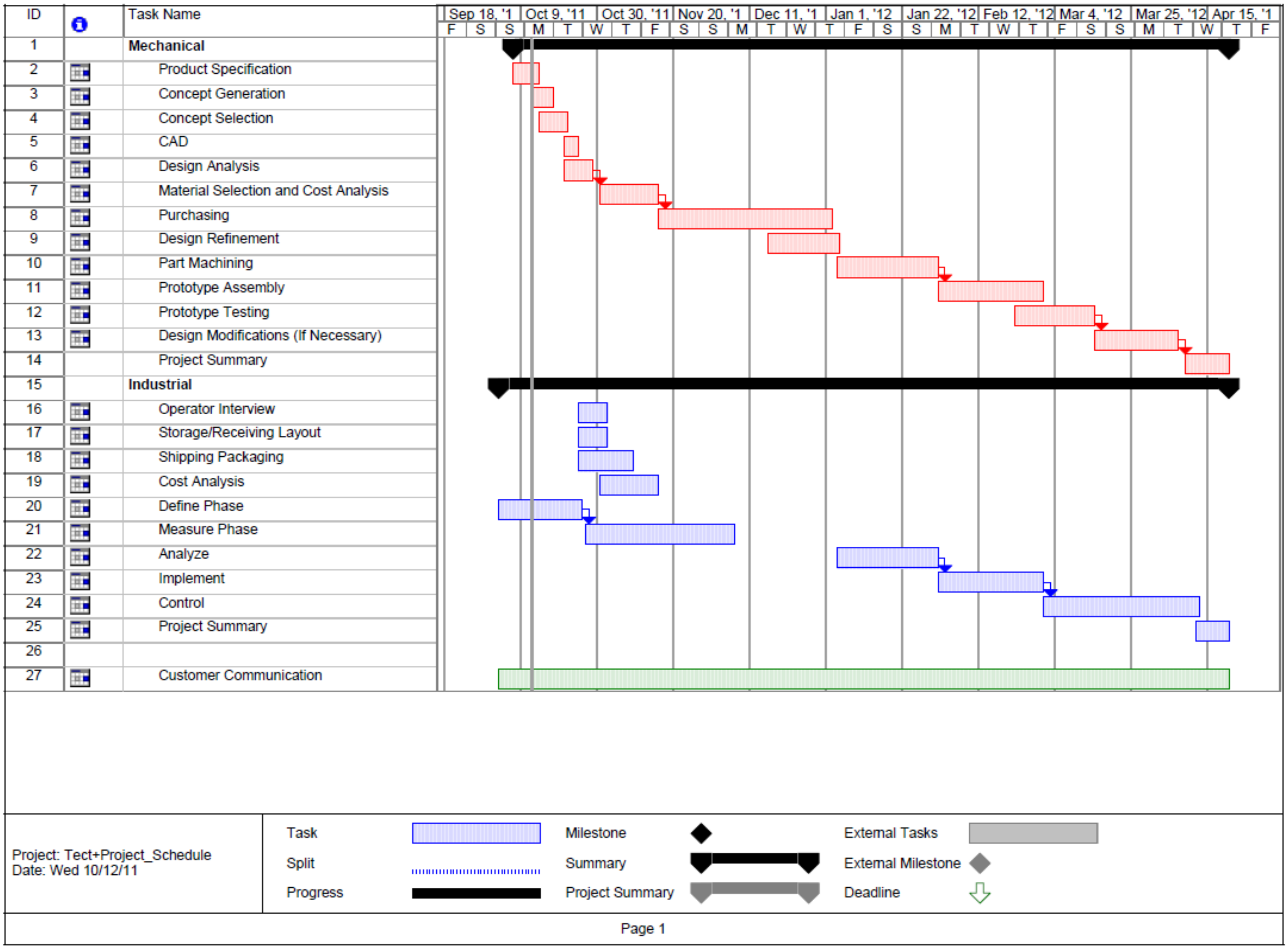

Figure 3.2: Project Timeline

4. Analysis of Customer Requirements

4.1 Threat/Opportunity Matrix

Due to the high risk of injury in the 68K blade handling process, there are many threats to the company if preventative steps are not taken. The opportunities relating to the improvement of the process is derived from the project objectives. A comparison is seen below that displays the possible short and long term outcomes if situation is left unchanged or action is taken.

	Threats	**Opportunity**
Short Term	**Short Term Threats:** loss of money through scrap, more down-time, longer set-up time	**Short Term Opportunities:** better quality turbine blades, better quality of life
Long Term	**Long Term Threats:** more work related injuries, reputation loss	**Long Term Opportunities:** greater profit, keep workers

Figure 4.1: Threat/Opportunity Matrix

4.2 Voice of Customer

Figure 4.2 depicts the subsidiary problem classifications that were revealed when optimizing the stated objectives. For example, the primary objective of reducing the amount of physical lifting fell under the larger category of reducing injury risk; subsequently, this category also includes making the process more ergonomic. Additional factors were uncovered when discussing the issues inherent in designing a mechanism. These factors include cost, quality, and ease of implementation, each of which branch into subcategories.

Figure 4.2: Voice of Customer Tree

<u>4.3 House of Quality</u>

In making the house of quality, customer and technical requirements are specified based on the voice of the customer. The relationship matrix between the two indicates the strength of association using a scale of 1, 3 or 9; the highest association would be rated a 9. To quantify the importance, a range of 1-5 is used, 1 being the lowest level for the customer requirements. The correlation matrix displays the effects of one category upon another, and their magnitude. After calculating the technical weights, it's easier to determine the highest level of importance.

In Figure 4.3, the results are displayed. The strongest relationships between customer and technical requirements have the highest technical weights and are therefore a priority. For example, minimizing the amount of lifting is strongly related to the range of height a device can achieve. With a technical weight of 45, these conditions must be placed before others. Illustrated in the correlation matrix are the positive and negative relationships among the technical requirements; additionally, it exhibits the desired direction of improvement. This is significant because challenges in this project are revealed. For instance, the strength and weight requirements have a positive correlation but oppose each other in direction of improvement; as a result, it is integral to find a way to optimize both requirements.

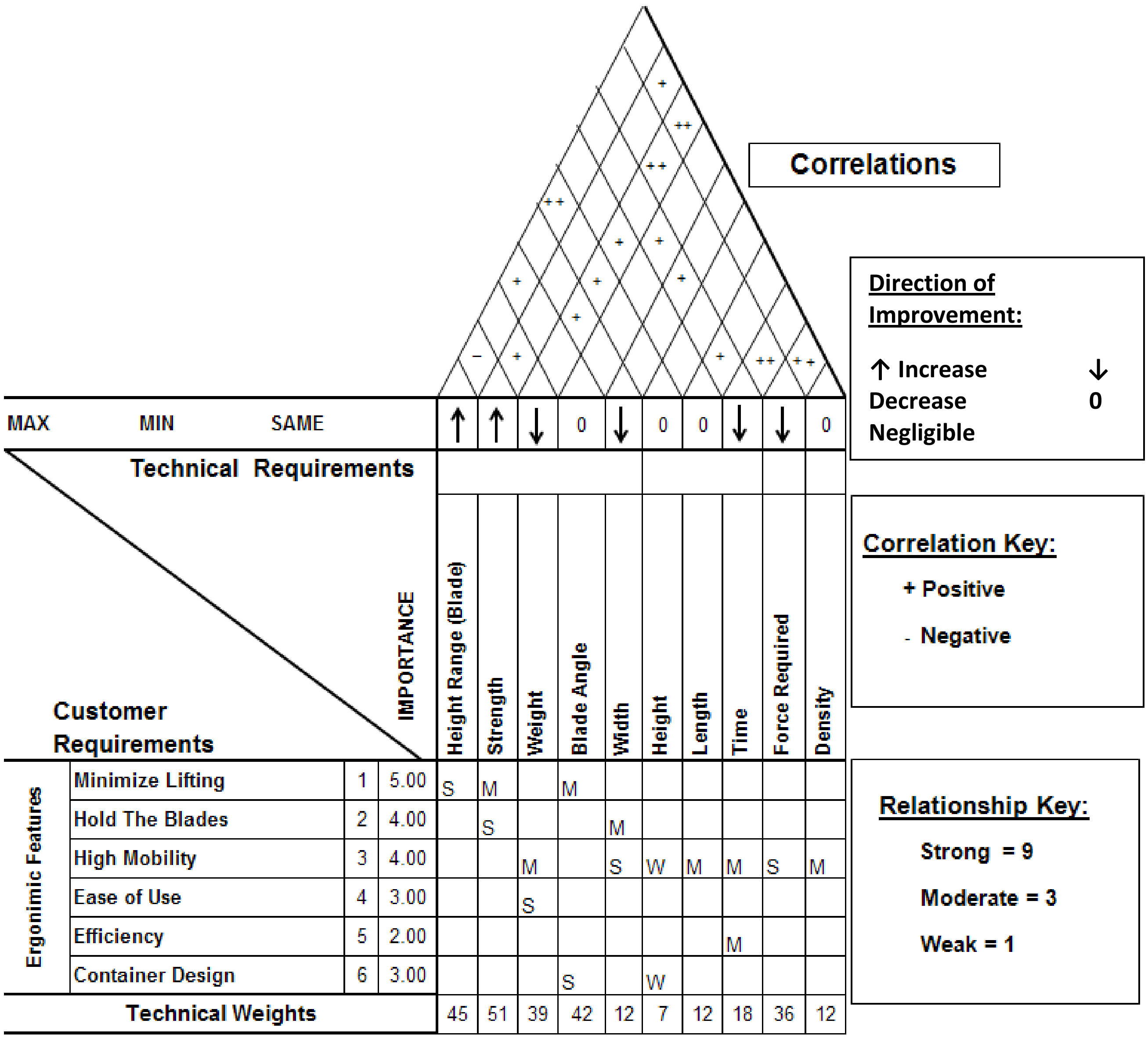

Figure 4.3: House of Quality

4.4 RULA Employee Assessment Worksheet

RULA, rapid upper limb assessment, is a tool that was developed to analyze work-related activities where upper limb disorders have been reported. It is a surveying method assesses the different postures and positions of the neck, trunk and arms in addition to the forces applied to the body during the operation. These forces are then ranked to determine the amount of action required in order to minimize the risk of injury to the operator. Specifically, a ranking of 1 indicates the operation is acceptable as is. The highest ranking, 7, suggests the operation should be investigated and changed immediately.

In the case of process handling 68k turbine blades, the maximum score was reached. This confirms the original assumption that there is a need for drastic improvement upon the current methods. The operator's body is subjected to many different positions considered hazardous in the long term. This is easily displayed through the use of a RULA Employee Assessment Worksheet in Figure 4.4.

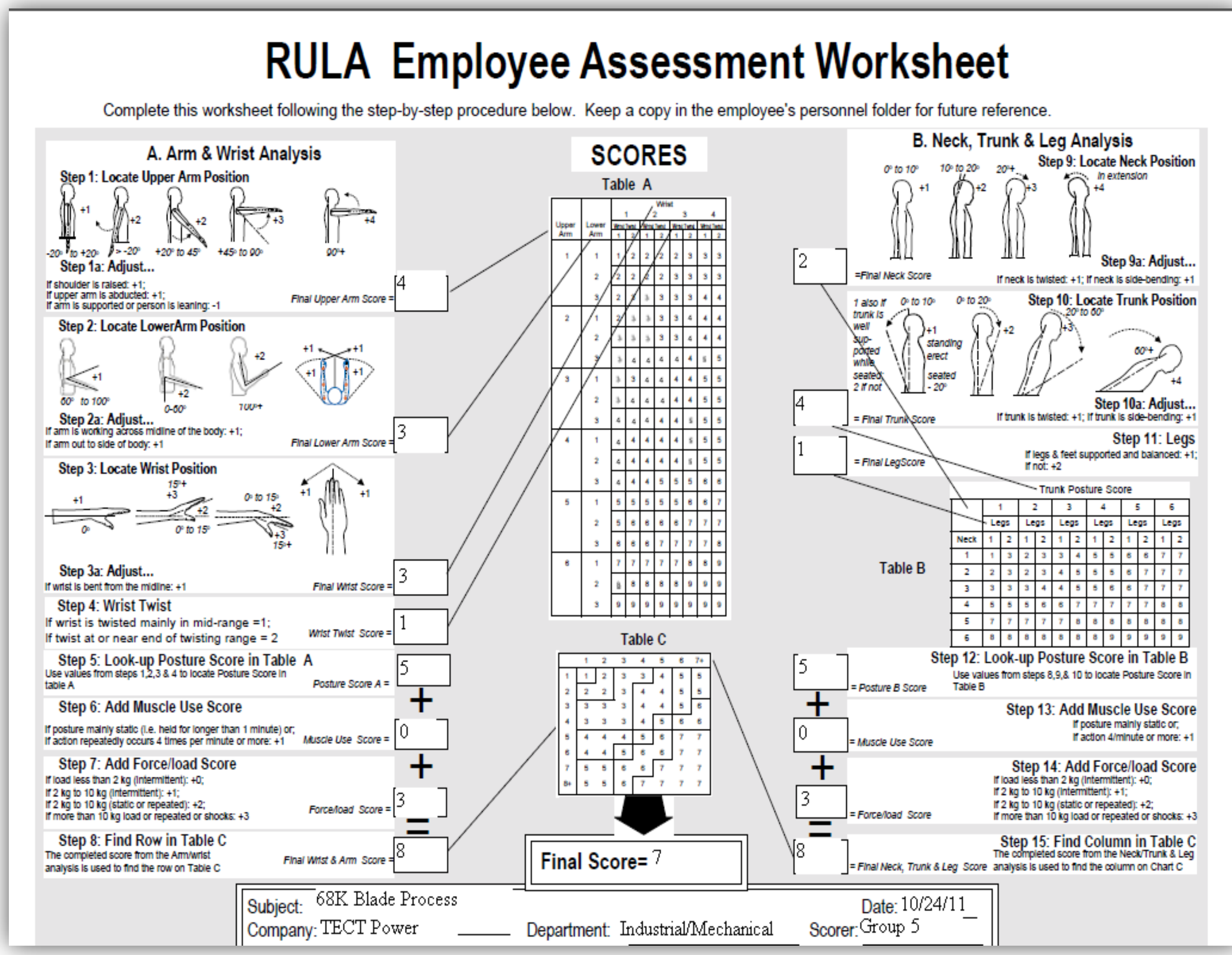

Figure 4.4 RULA Worksheet

5. Conclusion

In summary, the procedures involved in the handling/transport of the 68k turbine blades places TECT Power operators at a high level of risk for work-related injury. The target of this project is to reduce this risk by eliminating manual lifting by redesigning the receiving methods of the blades and possibly designing a mechanism to handle them while working around the constraints.

A few different methods are utilized to analyze this problem and interpret customer needs. To help narrow it down, a voice of customer tree is developed so that various areas of interest are depicted within the scope of the project. The house of quality is used as a way to demonstrate how all the customer and technical requirements relate; moreover, how these items are correlated and their affect on one another. It also calculates the level of importance of the technical requirements, which clarifies each requirement's priority. A tool that further defines the ergonomic issues is a RULA assessment sheet, the results of which are indicative of a level of risk. In this case, the level of risk is high and should change immediately.

With multiple ways to clearly define TECT Power's concern, concept solutions may be generated. From analysis of customer needs, it is understood what should be measured in the Measure phase, from DMAIC. Taking measurements of the 68k blade itself, the facility layout, the force on the body from lifting are just a few of the essential aspects of the next step.

6. References

1. McAtamney, Lynn, and E Nigel Corlett. "RULA: a survey method for the investigation of work-related upper limb disorders." Institute for Occupational Ergonomics, University of Nottingham, University Park, Nottingham NG7 2RD, UK, Vol 24 April 1993. Oct 2011.
2. "TECT." *TECT Power Scope*. N.p., 2011. Web. Oct 2011. <http://www.tectcorp.com/scope/tect-power/>.