

Efficiency Enhancement by Root Cause Analysis Through Rework Data

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Executive Summary

Alliance Compressors' line two output is currently at 90%, but the goal is at 98%. This project aims to achieve that goal by utilizing root cause analysis, the 5S method, and ergonomics to redesign the line two rework station, and then later to address the root causes of compressor failures. This redesigned line two rework station will prevent workers from having to turn all the way around for simple tasks, stop working to refer to a repair manual, starting a shift without proper tools, and have to work with tools in inconvenient, uncomfortable positions. This will allow more compressors to be repaired on a daily basis, directly leading to more daily output. After this design is implemented, the project will turn its focus toward ensuring that fewer compressors need repairs, by addressing manufacturing failures, such as machining errors, welding errors, and employee error.

Introduction

Alliance is a company which is a joint venture between Emerson Electric Company, Lennox International, and Trane. It is a manufacturing facility which supplies air conditioning compressors. The location of the manufacturing facility of Alliance is in Natchitoches, Louisiana. It has been recognized as Manufacturer of the Year by the Louisiana Association of Business and Industry in 2016.

Scroll Compressors

Scroll compressors power air conditioning units by creating a pressure system using concentric circles. It acts as a supercharger and as a vacuum pump for air conditioning units. Scroll compressors have two parts which are two scrolls where one is fixed and the other orbits it eccentrically without rotating. The way that the scroll compressors work is by trapping and pushing pockets of fluid in between the two scrolls toward the center of the two scrolls. When it finally reaches the center of the two scrolls, the fluid is then discharged out. Scroll compressors have become more popular due to being very reliable, highly efficient, and having low noise emissions [4].



Fig 1. Image of a scroll compressor. Photo courtesy of J&E Hall.

Problem Description

Currently, Alliance is producing 200 air conditioning compressors every hour. At 90% first pass yield, that means 20 compressors that are produced every hour are defective. Each compressor is worth approximately \$200, so even getting one more compressor repaired on a daily basis is earning a significant amount of profit.

The most common modes of failures in the compressors were identified as the following:

1. Upstream failures. These are failures that occur during the manufacturing process. These compressors are identified before the run test and are marked as not operating.
2. Discharge pressure failures. Compressors with discharge pressure failures do not produce the appropriate pressure during the run test.
3. Locked rotor failures. This failure occurs when something is wrong with the housing holding the compressor's scrolls, which then does not allow them to spin correctly.
4. Continuity failures. These are electrical failures. They are typically caused upstream when fuses are broken.

Root Cause Analysis

Root cause analysis is a method of investigating incidents that finds the root cause of the problem. Various incidents may appear to have different causes on the surface, but in actuality, all have the same root cause, such as poor employee qualifications or poor design[3]. In the study performed by Krupa and Meyers, they examined approximately 70 incidents spanning over eight years. Krupa and Myers stated that, "The client failed to address identified major root causes. The records demonstrated that even though the failure modes were different, the same root causes were identified[.]"

5S Method

The 5S method is part of Lean Manufacturing, which aims to improve the quality of products and customer service through the reduction of waste, time, and production costs. Implementing the 5S method is typically the first part of implementing Lean Manufacturing, because it serves as a good foundation[2]. The 5S Method is based off of five steps, based off of 5 Japanese words; these words and their English counterparts are:

1. Seiri (Sense of Tidiness)/Sort: All items that are not essential are removed.
2. Seiton (Sense of Orderliness)/Set in Order: The essential items are relocated to defined areas and are readily available to all employees
3. Seiso (Sense of Cleanliness)/Shine: What to clean, when to clean, and who will clean is determined.
4. Seiketsu (Sense of Standardization)/Stabilize: Practices are standardized across the organization.
5. Shitsuke (Sense of Self-Discipline)/Sustain: The former four phases are maintained through self-discipline and control.

Ergonomics

Ergonomics is the process of designing the workplace where the worker's capabilities and limitations are taken into account. The workplace is designed or rearranged to where it will be more comfortable and less straining for the worker whenever they are performing their tasks. This method is used not only for the health and well-being of the workers but for also the increase of productivity. Ergonomics has the ability to drastically increase productivity and performance with little cost [1].



Fig 2. Image of an ergonomic keyboard. Photo courtesy of Alamy Stock Photo.

Methodology

Certain procedures were followed to ensure that the project was completed well and on time. Following is a list of the procedures that were followed for this project:

1. Take a tour of Alliance to better understand the rework station and its functionality.
2. Observe the work station by taking notes and pictures of the work station.
3. Analyze the data given on what errors occur at the station.
4. Compare the line one and line two rework stations to determine if the line one station has any advantages.
5. Present data given by Alliance to assemble what tools are used more often than others.
6. Design an area to place tools based on failure mode and how frequently they are used.

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Experimental Design

The group currently has two experimental designs. This is because of the conflict between what are the best design choices based off of root cause analysis, the 5S method, and ergonomics and the constraints of not taking up too much space and not causing too much disturbance to the current facility layout.



Fig 3. Photograph of Alliance's line two rework station.

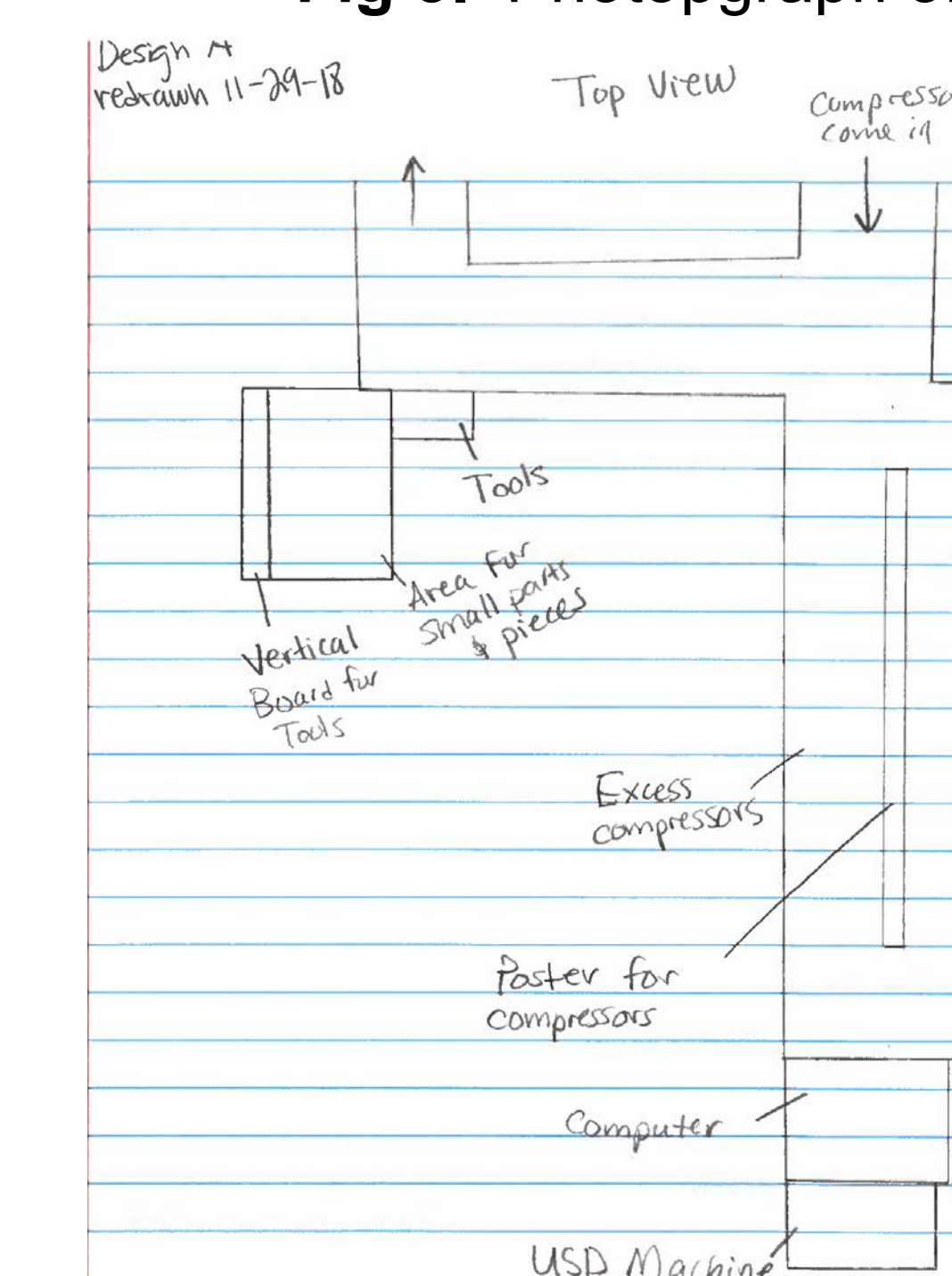


Fig 4. Concept Design A.

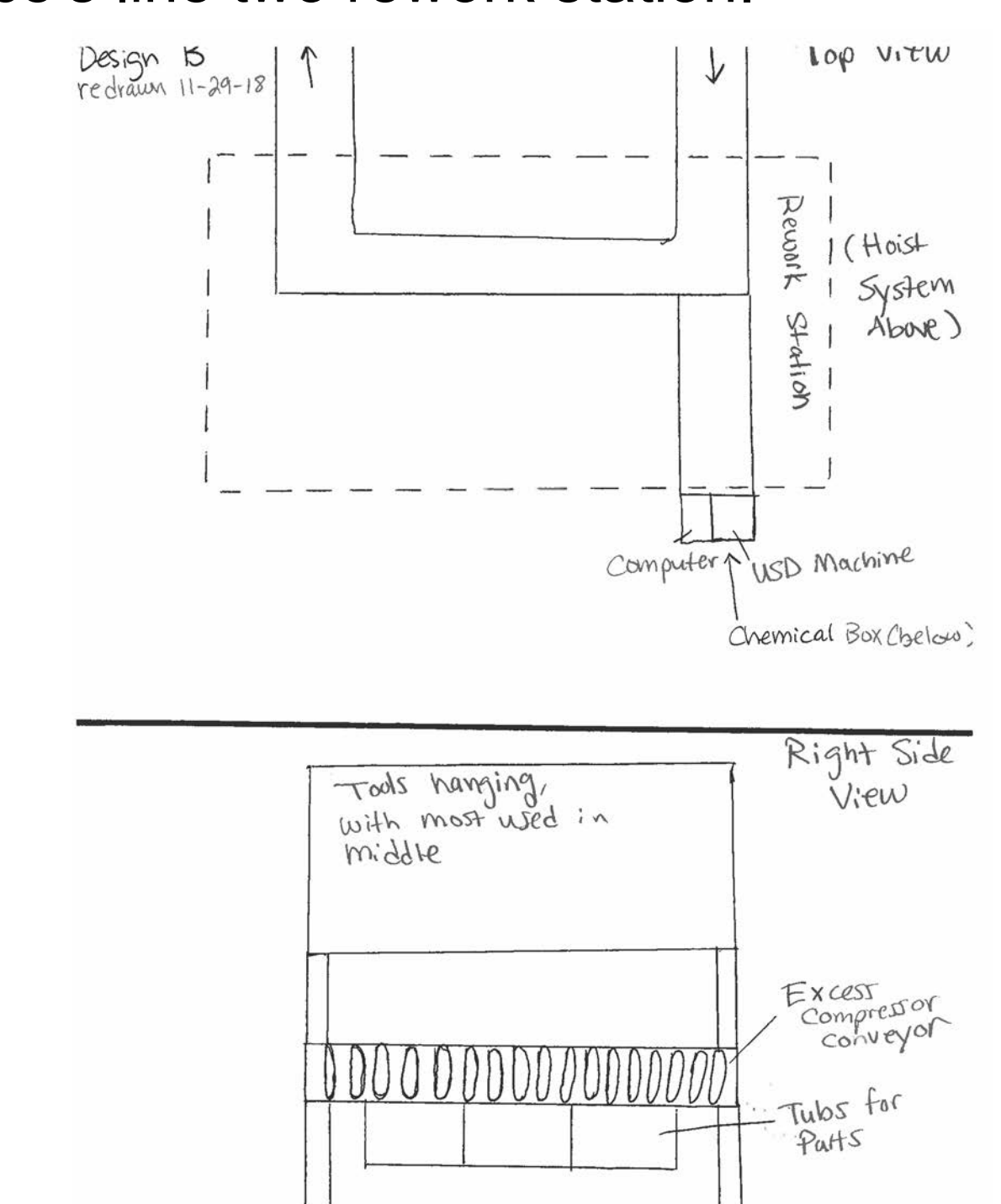


Fig 5. Concept Design B.

Future Work

Currently, there are not any results, as the design has not yet been implemented. Moving forward, the design will hopefully be implemented. Hopefully, the changes that this project implements will cause an increase in repair speeds, output, and profit. Our future work will primarily focus on improving the upstream sources that cause the compressors to be repaired. These sources of error include machining and welding errors, as well as employee error.

References

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