.decimal Proton Therapy Device Manager

Team Number: 14

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Abstract

This team is working on automating the loading procedure for .decimal's proton therapy apertures. Currently, this process is carried out by a technician, which delays treatment time. .decimal expressed the desire to reduce patient treatment time and improve the technicians' work conditions. In carrying out this process, the need for accuracy and efficiency in loading apertures is critical to successful implementation of an automation procedure. A means of sensing and choosing the correct aperture needs to be developed along with a safe loading/unloading procedure. This team has met with their .decimal representative and toured the UF Health Proton Center where the device is to be implemented. Additionally, the team has toured the .decimal facility to develop an understanding of the .decimal work ethic and the project's direction. The team has also met with their advisor, Dr. Clark, and gained an understanding of the project's scope. The next step for this team is to brainstorm potential design ideas and select the best one for initial prototype development.

1 Introduction

Proton therapy is currently being used as a cancer treatment when traditional radiation methods would cause too much damage. Proton therapy relies on a large cyclotron to accelerate protons to a desired speed, a 'snout' then directs those protons towards the patient's tumor. However, this beam of protons still has the potential to radiate a large region surrounding the tumor. To remedy this, .decimal manufactures brass apertures to focus and shape the proton beam in three dimensions. The current setup relies on a nurse to navigate through a maze of radiation shielding walls and exchange the final brass aperture which shapes the proton beam's cross section. These pieces weigh around 30 lbs and need to be changed five times per patient, for each position of the snout. This process increases strain on the technician and the patient as treatment time is delayed; as a result, the chance of patient movement increases which greatly affects the accuracy and effectiveness of the treatment. The goal for .decimal, and this senior design team, is to reduce treatment time and improve the accuracy of proton therapy treatment.

2 Project Definition

2.1 Background research

Our specific project has not been executed by any other companies, universities, or individuals. The University of Florida is in the process of brainstorming a scaffolding device that will be used to load and unload the apertures. There is no literature on their research. The two systems will be developed in parallel in the coming year.

Much can be learned by observing automation devices and mechanisms that are currently on the market. Manufacturing factories utilize these types of technologies daily. Many of these ideas can be adapted to meet the needs of our project. SMD Machinery Inc. manufactures high end metal fabrication systems for a variety of applications. Their Astes4 is a plate sheet sorting, stacking, and labeling system for plasma and laser cutting machines (http://smdmachinery.com/astes4).[xx] It utilizes a 2.5 axis sorting system that uses geometric coordinates to locate and pick up sheet metal. Inductors turn a series of magnets "on" in order to pick up the sheet and turns the magnets "off" to stack the sheet. The machine can pick up plates as large as 15,000 kg! [1]

ZenRobotics Recycler is the first robotic waste sorting system in the world (http://zenrobotics.com/zenrobotics-recycler/zenrobotics-recycler/).[**] The robotic recycles also uses a 2.5 axis system to laser scan and locate scrap. Scrap garbage travels via a conveyor belt. Once the scrap has been located, a robotic claw lowers down on the z-axis and clasps the garbage. The scrap is then sorted into a bin. The process is then repeated. [2]

CD labels are pressed using a 2 degree of freedom robotic arm, Figure 1. The nozzle of the robot is equipped with a vacuum system on the output link. A vacuum pump is cycled on and off in order to pickup and drop off the CDs. The crank arm pivots through 180 deg of motion and is powered by a servo motor.[3]

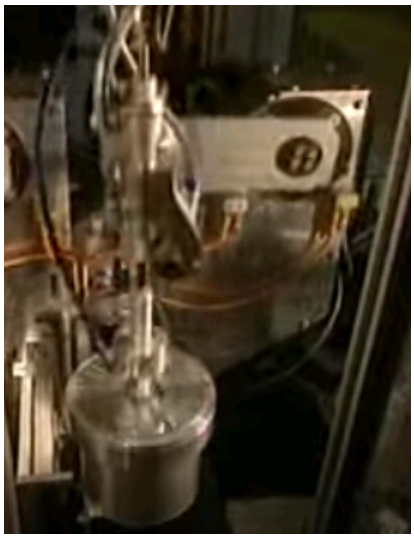


Figure 1: CD sorting robot.[3]

A 1962 Rockola Princess jukebox using a unique storage and sorting system, Figure 2. The system has 2 degrees of freedom.[4] The vinyl records are stored in a vertical fashion on a rotating wheel. After the user selects their song, the wheel rotates until the correct album is selected. A mechanical clasp then grabs the record while rotating and spinning the record onto a turntable.

Figure 2. 1962 Rockola Princess jukebox[4]

2.2 Need Statement

The sponsor for this project is .decimal. .decimal is a medical device manufacturing company in North Orlando. They manufacture patient specific devices for various types of cancer treatments including proton, photon, and electron beam treatment. The need that they have expressed to the senior design team has been that the apertures, or patient specific devices, take too long to load into a Mevion S250 Proton Therapy System. For the technician to come into the room, the machine must be off and then they have to navigate through a long hallway before getting to the treatment room. Also the apertures can be up to 25 pounds and the technicians have complained about having to lift the heavy apertures repeatedly throughout the therapy session.

It takes too long and too much effort for a technician to load and unload apertures during a patient's treatment.

2.3 Goal Statement & Objectives

Goal Statement: Provide proof of concept by developing a functioning scaled model of an automation device that will load and unload .decimal's apertures and range compensator relative to the nozzle of the Mevion S250.

Objectives:

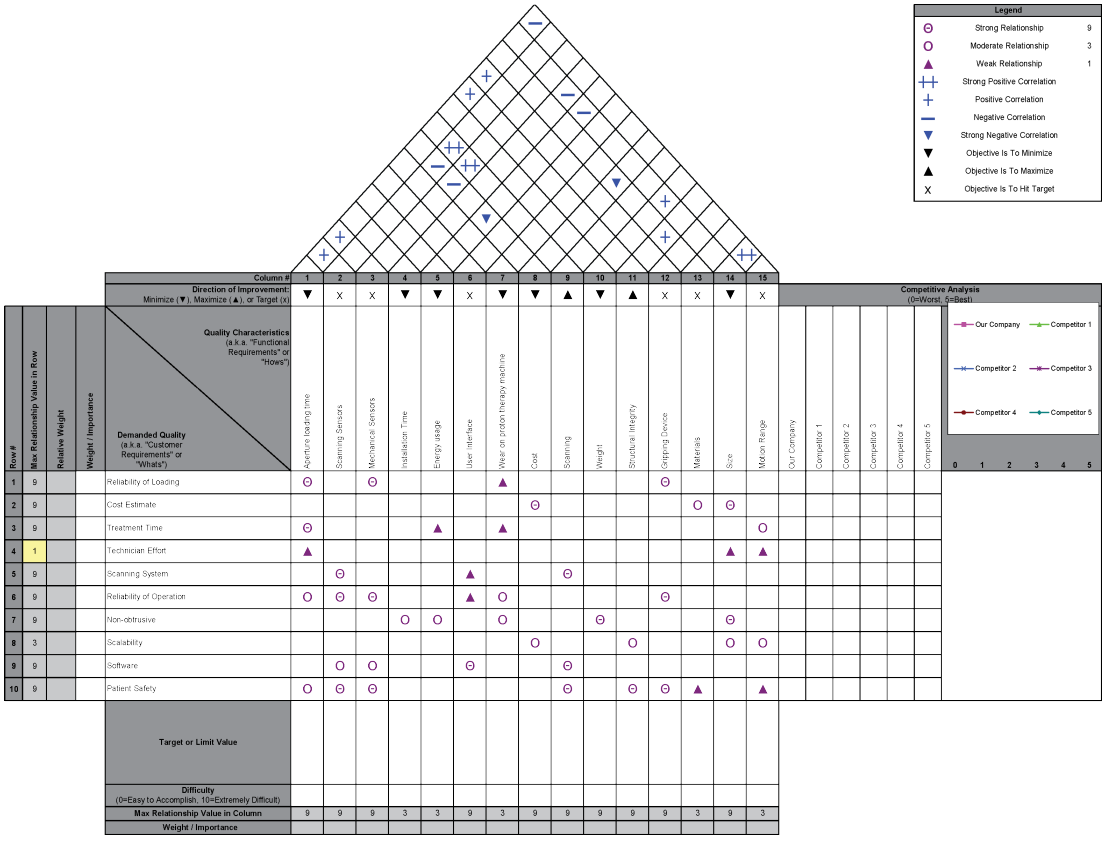
- Decrease the time a patient is in the treatment room
- Eliminate manual process for technician

2.4 Constraints

- Automation device must lift up to 30 lbs.
- Automation device must not interfere with proton beam or the patient couch
- Automation device must scan apertures to identify patient specific aperture
- Automation device must be installed in the same room as the Mevion S250
- Automation device must load apertures and range compensator
- Automation device must unload apertures and range compensator

Below in Table 1 is a House of Quality, which helped determined which customer requirements and engineering characteristics will be focused on when developing the design and final deliverables.

Table 1. House of Quality for .decimal Proton Therapy Device Manager



2.5 Methodology

The team plans on spending a week or two brainstorming and narrowing down possibilities. Then, the team will create a few rough prototypes made out of cardboard or foam to create a general proof of concept before finalizing designs and ordering parts. By December, the goal is to have an initial prototype. From there, further improvements and refinement can be made during the spring semester as the group prepares for the final deliverable.

2.6 Schedule

In Figure 3 is the Gantt chart developed for the schedule of this project for the spring semester. We plan to have one, very basic prototype built in mid- October and then our first major prototype built by the beginning of December. This will allow the team to utilize the Spring semester to refine the design and take the necessary measures to correct the design to make it the best it can be.

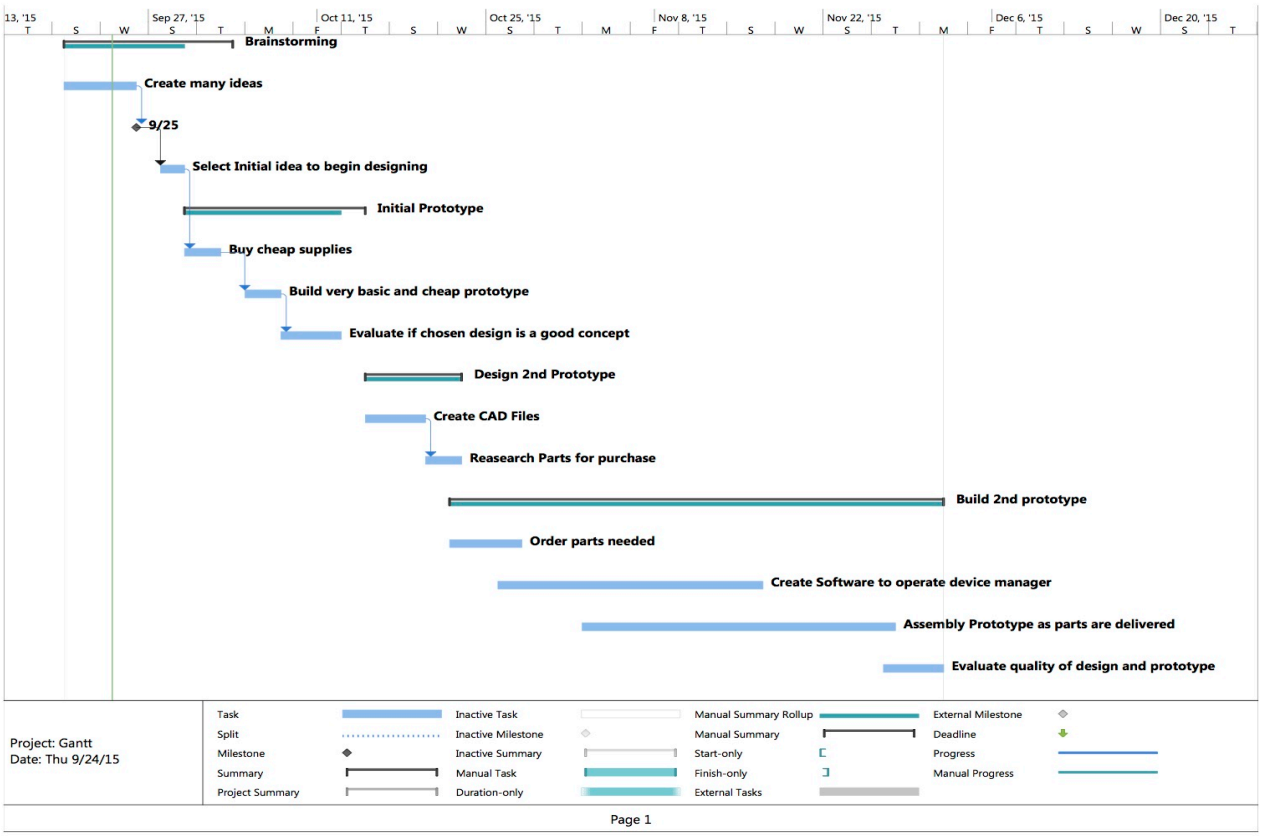


Figure 3: Project Gantt Chart

3 Conclusion

Team 14 has been assigned the task of designing an automated device to load and unload 25 lb. brass apertures for the Mevion S250 Proton Therapy System. The project is being sponsored by .decimal in Central Florida. Currently, the procedure for loading and unloading brass apertures in proton therapy treatment is time consuming and labor intensive. Creating an automated device will reduce the patient's time in the therapy room, which greatly improves the patient's well-being and therapy experience. Additionally, technicians will be relieved of tedious manual labor. The team is currently in the brainstorming phase of the design process. The first step being background research. A house of quality has been made to aid the planning process. A Gantt Chart has also been made to illustrate project start and end dates. The next step in the process is to continue brainstorming and doing background research. The development of several rough prototypes over the next couple of weeks are next on the list, as well as creating a website and preparing the next deliverable.

4 References

[1] Astes4 Explained. SMD Machinery Inc. Web. 22 Sept 2015. <http://smdmachinery.com/astes4/Astes4-Explained>

[2] Zen Robotics. Web. 22 Sept 2015. <http://zenrobotics.com/zenrobotics-recycler/zenrobotics-recycler>

[3] How It's Made: Compact Disks. YouTube. Web. 22 Sept 2015. <https://www.youtube.com/watch?v=ut_40U0t9pU>

[4] Rockola Princss Jukebox 1962 in Action. YouTube. Web. 22 Sept 2015. <https://www.youtube.com/watch?v=xoUwyj9zP3E>