

Construction Marking Robot



Team 19

Submission Date: September 25, 2015

Submitted To: Dr. Nikhil Gupta

Authors:

Christian Baez (cob11b@my.fsu.edu)

Justin Gibbs (jrg13f@my.fsu.edu)

Kelsey Howard (knh12d@my.fsu.edu)

Derrick Portis (dportis40@yahoo.com)

Brandon Roberts(bdr12@my.fsu.edu)

Table of Contents

Abstract.....
.....2

1

Introduction.....
.....3

2 Project

Definition.....4

2.1 Background
 research.....4

2.2 Need
 Statement.....5

2.3 Goal Statement &
 Objectives.....5

2.4
 Constraints.....
 5

2.5
 Methodology.....
 6

2.6
 Schedule.....
 6

3

Conclusion.....
.....7

4

References.....

.....7

Table of Figures

Figure 1. Gantt Chart of Team 19’s schedule.

Abstract

This deliverable seeks to express Team 19's process so far in terms of defining the project at hand, which includes a needs assessment. So far the team has defined the problem as being that surveying construction sites can be problematic due to miscommunication between contractors which leads to inaccuracies in the markings for the overall layout, additionally, the process is general is very time consuming. From there, the team has determined the goal to be to design and implement a "proof of concept" robot that will ultimately survey 100 square feet within a half inch margin of several layout plans. For the needs assessment, the team has chosen to focus primarily on communication with the sponsor with the end goal being the development of an in depth House of Quality and then eventually diving deeper into the Quality Function, Deployment process. From there, the team plans to move into the embodiment phase of design, keeping in mind what aspects of the design are deemed most important in correlation with the House of Quality.

1 Introduction

In this age where the inclusion of robotics in industrial settings has become increasingly prevalent, the construction industry stands as one of the last industries to take notice of the advantages robotic tools can offer. However, as the industry emerges from the recession, two observed trends have occurred: an increasing desire for higher efficiency and a hesitancy towards hiring new personnel to meet demand due to not knowing how long this boom in business will last. Due to this, Mark Winger, of PSBI, believes now is the time to introduce the application of robotics to the construction industry. Seeing that one of the most accident prone and time consuming areas of the construction process is that of the layout, Mark has tasked Team 19 with designing a “proof of concept” robot for the sake of marking of the preliminary layout of walls, electrical, HVAC, and water systems during the construction process.

2 Project Definition

2.1 Background research

The idea of a construction marking robot is a fairly recent idea in the construction industry. Currently there is research being done with the idea by companies such as Trimble and DPR, who are combining their specialities in GPS positioning products and construction to create an automated layout robot, or Laybot as they have termed it. This Laybot idea is similar to the group's construction marking robot in that it hopes to be able to mark multiple layouts on the ground, use downloaded 2D CAD files to input the layouts into the robot, and have communication with a robotic totaling station to ensure precise positioning¹.

Aside from the Laybot idea, there is also a patent for a construction marking robot by Joseph M. Prouty with Totalmark Technologies². While designed to perform the same function as both Team 19's design and the Laybot, the robot by Totalmark Technologies "is controlled via an included tablet pc which is accessible via the internet from anywhere in the world, so long as the job site has WiFi access³." It also is linked with a robotic totaling station to track position, and is able to function in complete darkness.

The differences between Team 19's design and the others is the plan of a different marking mechanism and different sensors on the robot. With the resources provided to the group, and the materials available, the final design for the construction robot is guaranteed to be different than the products currently being researched and produced by other companies.

Opposition to the project comes with the resistance to newer technology in the construction industry. There is a skeptical view of automated processes due to a lack of newer technology in the field, and a fear of robots taking job opportunities. The goal of this project is not to encourage the removal of jobs, but to increase efficiency in those jobs and provide a tool better equipped to help.

2.2 Need Statement

Surveying construction sites can be problematic. Communication between contractors that have to lay markings down arise, which can cause inaccuracy in the layout. Marking every floor by hand is time consuming. Productivity in construction is low and there needs to be a way to compensate for lack of hands. Team 19's sponsor, Mark Winger of PSBI, is asking for a "proof of concept" robot that will ultimately survey 100 square feet within a half inch margin of several layout plans. This project would help with efficient surveying and lessen the confusion and problems between contractors that have to work around one another.

"Since the recession, productivity in construction is too low"

2.3 Goal Statement & Objectives

"Design a 'proof of concept' high precision marking robot that will lay out the preliminary floor plan of a construction site"

Objectives:

- Must avoid obstacles
- Must generate error report if obstacles are encountered
- Must be able to mark <100 square feet
- Must use 2D CAD file as input
- Must be autonomous

2.4 Constraints

- The robot must be able to obtain its precise position in the room
- The robot must be able self navigate and avoid obstacles
- The robot must be able to mark on concrete the given floor lines

- All marking lines must be within a half inch accuracy from the floor plan
- The total cost must not exceed \$8,000
- The weight of the robot must be such that a single person could carry it

2.5 Methodology

For the Construction Marking Robot, Team 19 will implement a strategy focused around the preliminary design of the system similar to the one mentioned in *Engineering Design* by George Dieter. The team will be using a product development process known as Quality Function Deployment (QFD), which is a graphical, multistep process that creates relationships between key parameters throughout the entire design process. This tool will help focus the team's attention to satisfying the customers needs. One of the beginning steps of this process is constructing a House of Quality (HOQ), which is a design tool in the form of a relationship matrix which compares the customers needs to the engineering characteristics set by the design team. A preliminary HOQ for the Construction Marking Robot will be included in the next report. Once the system has been designed conceptually, the team will move into the embodiment phase of the design where more specific figures and values will be chosen. QFD is a very iterative and involved process which will make for a better final design.

2.6 Schedule

Team 19 will focus around the two Midterm Presentations and use them as milestones throughout the semester as self evaluation points in the design process. These milestones can be seen in Figure 1 and are denoted by the blue diamonds. The arrows on the gantt chart represent tasks that must be completed before other tasks, or predecessors. Knowing which tasks need to be completed before others provide the team with an idea of float, which is similar to lag, where it provides the team with a time padding in knowing which tasks can be started early and started or finished late.

Construction Marking Robot

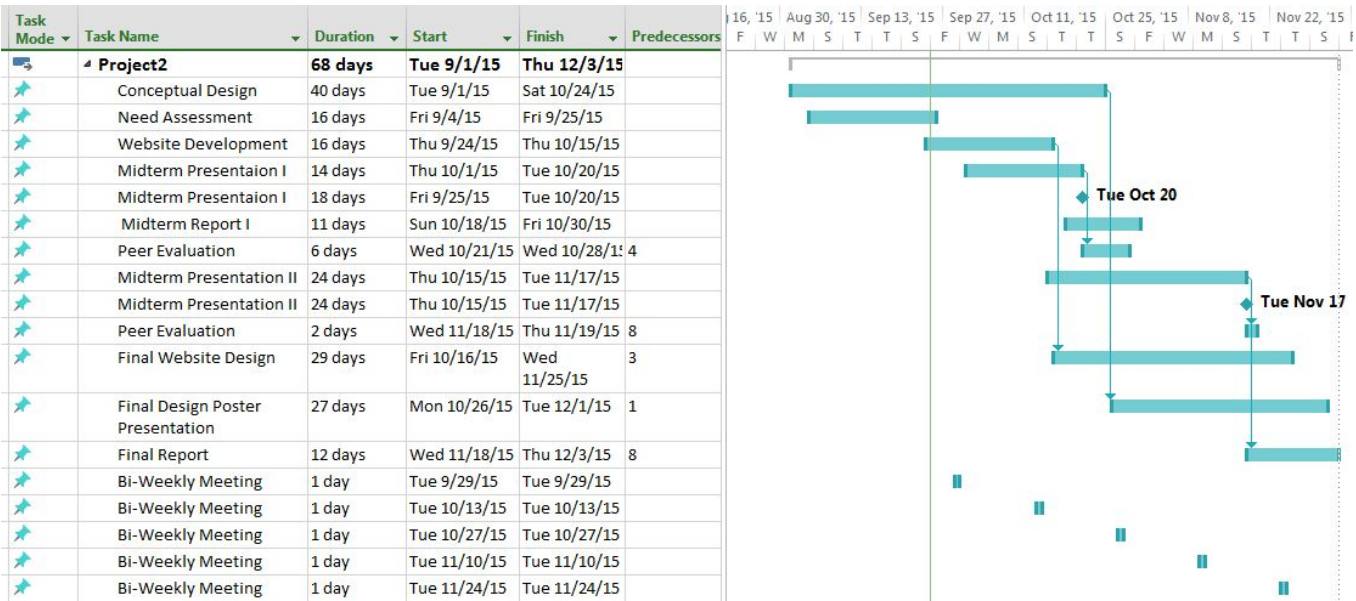


Figure 1. Team 19 Gantt chart schedule

3 Conclusion

This project is the start of advancements in technology in the construction industry. Designing a “proof of concept” construction marking robot that will survey 100 square feet can jump-start the construction project presented by Mark Winger of PSBI. The marking robot will mark all of the layouts will make the contractor's job simpler and more accurate than each subcontractor coming in and surveying one by one. Our end goal is eliminating confusion and increasing productivity in surveying while meeting our House of Quality.

4 References

- [1] "Project Lion - A DPR/Trimble Automated Layout Robot." *YouTube*. YouTube, 25 Apr. 2013. Web. 25 Sept. 2015.
- [2] Prouty, Joseph M. Robotic Construction Site Marking Apparatus. Joseph M. Prouty, assignee. Patent US 20130310971 A1. 21 Nov. 2013. Print.
- [3] "Construction Industry- Robotic Layout." *Totalmark Technologies*. N.p., n.d. Web. 25 Sept. 2015.