Thesis Project Portfolio

Motion of the Spheres: Constructing a Compact Mechatronic Orrery

(Technical Report)

Automation Machining and its Effects on Blue-Collar Workers

(STS Research Paper)

An Undergraduate Thesis

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Samuel John Montante

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Department of Mechanical Engineering

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Sociotechnical Synthesis

As a mechanical engineer, I have taken multiple courses that have helped my design, development, and engineering skills. One of these courses has been the most influential in my young engineering career, this course being mechatronics. Mechatronics engineering is the combination of mechanical, electrical, and computer science engineering to breathe life into systems, allowing them to operate such that they can function without the need for human interaction. This also acts as the link connecting my research paper and my technical capstone completed during my final year in college. Mechatronics is a fascinating field such that it can be applied to almost every scenario imaginable. In the case of my technical project, mechatronics was used to create a form of kinetic art. This art piece is an orrery that is designed to be hung from the ceiling in the mechanical building, allowing human interaction. As mechatronics is used to create art forms, it is also used in common machinery and appliances. Automatic sinks, dishwashers, and A/C units can all be considered mechatronic systems. Often, mechatronic systems are used in manufacturing design to allow less user interface and more precision in quantity manufacturing. This became the focus in my investigative thesis paper as it is noted that there have been negative mental health effects seen from workers using these systems. My thesis then questions how these devices have been designed that have caused these mental health problems.

The technical capstone that was completed was the creation of a mechatronic orrery. The purpose of creating a mechatronic orrery is to demonstrate in a unique and fun way, the positions of the earth and moon, relative to the sun. This project creates a more aesthetically pleasing and accurate model of the earth, moon, and sun while educating people on the seasons, moon phases, eclipses and so on. The orrery is rapidly prototyped using laser cutting acrylic material as well as

3D-printing ABS plastic. This system consists of multiple motors and induction proximity sensors, as well as two microcontrollers to help process the data of the positions and run the motors.

The final design consists of a sun and an earth and moon that rotates around the sun. The sun itself is not a traditional sun in that it will be more aesthetically pleasing rather than an accurate representation. However, the sun will contain a lighting fixture that will shine light on the earth as well as the moon. As the earth rotates, the light will show how the seasons are made relative to the earth's atmosphere. As the light shines on the moon, it will show a rough estimation of how the phases of the moon are created. There will also be an electronic display that will show the phase of the moon as well as the date and the position of the earth. The orrery will have two modes. One mode is where the orrery will rotate on its own at a constant space, showing how the earth and moon are revolving around each other and the sun. The second mode will involve the user input in which a user can put in a date, and the orrery will automatically rotate to show the earth and moon's position at that time. It will also be able to indicate the next eclipse, as well as other events regarding the lunar cycle. Note that this is still an ongoing project, and it is hoped that after an explicit technical report it will be able to be completed with these visions in mind.

The thesis completed focused on how the design of certain manufacturing machinery has led to the decrease in mental health that is seen in the blue-collar workforce. To investigate this issue, I researched a specific case in manufacturing: CNC machine integration. By analyzing the CNC machine, it could be seen how this device was developed and introduced into manufacturing. By using Woolgar's configuring the user framework, I presented that this technology could be analyzed to determine how it was written to interact with the user

specifically. It could then be determined if there is evidence to determine if there were any design characteristics that would affect the mental health of these blue-collar workers in manufacturing.

I used UVA's digital library to gather sources regarding the history of CNC machines as well as their implementation into the manufacturing field. It was also used to find studies, statistics, and other methods of supporting evidence to use in the paper. This knowledge was combined with the technical STS framework used to analyze the case. The conclusion highlights that the lack of consideration in the initial implementation of CNC machines into manufacturing is a cause of the increase mental health dealt with in the manufacturing industry. It is the lack of consideration that is causing these mental stresses, and if more consideration is added to the implementation process there could be a positive increase seen in the mental health of these workers.

Being able to complete both projects at the same time proved to be important as a young engineer and designer. As I was researching these negative mental health effects experienced by workers, it made me question my own designs for the capstone as well as anything I design going forward. During the design process, I found myself questioning the motives of each design making sure that they remained pure and true to their task. By completing these projects side-by-side, I found the goal is to be able to design an object that will positively leave an impact on its surroundings as well as the actors that it will be using the technology. The object should be able to go through changes with the social climate as well as be able to be redesigned to adapt the relevance of its task.