**Thesis Portfolio**

# Design and Construction of a Ferrofluid Kinetic Art Clock

(Technical Report)

# Evolution and Societal Fears of Robotic Manufacturing

(STS Research Paper)

An Undergraduate Thesis

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## Sociotechnical Synthesis

The technical project and research paper presented in this portfolio both relate to the automation of a process through the use of advanced technology. The technical project focuses on designing a clock that utilizes ferrofluid and moving permanent magnets to display the time. The research paper focuses on the evolution and social impacts of automation technology in the United States. The technology used to control the movements of the clock is the same technology that is used when automating a robot to produce a car. While a clock may not have the same societal impact that the automation of the manufacturing industry has, both are examples of automating a process. The clock is designed to function on its own without human input indefinitely in the same way robots are being utilized in all sectors of manufacturing to increase speed and quality while reducing costs. A clock is just a small example of the capabilities automating technology has to change how society functions.

The technical project involves creating a piece of kinetic art that also functions as a digital clock. The clock is designed to be displayed on the second floor of the Mechanical and Aerospace Engineering building. The clock has the same functions as any other digital clock, such as the ability to display time in the traditional format and the ability to be reset to account for daylight savings or loss of power. However, the time is displayed by moving ferrofluid into the shape of digits. Ferrofluid contains nano sized iron particles suspended in a fluid. When this liquid is in the vicinity of a magnetic field, it becomes magnetized and reacts and moves. In order to orient the ferrofluid into the shape of clock digits, moving permanent magnets are used. The movements of these magnets are accomplished through the use of an RC servo motor which either pulls the magnet away from the clock face to turn that segment off or pushes it forward to turn that segment on. Each digit of the clock utilizes seven permanent magnets which, when

certain segments are turned on or off, can display all the digits from 0 to 9. A microcontroller, the Parallax Propeller chip, is used to control the movements of the motors and magnets. Additionally, the microcontroller has the ability to keep time, accurate to plus or minus two seconds after one year.

The STS research paper covers the societal impact of automated robotics in manufacturing within the United States. Over time, Americans have developed a strong fear of automation because of a possible robot revolution. A recent CNN article states that robots will take over 20 million United States manufacturing jobs by the year 2030 (Tappe, 2019). Manufacturing jobs account for nearly 8.6% of all jobs in the United States (Amadeo, 2019). This data suggests a change to complete robotic automation would have a large societal and economic impact for many years to come. This paper answers the following questions: What is the evolution of automated robotic manufacturing, what are the societal fears, and what are the possible alternatives to this technology? In order to answer these questions, a historical case study of the progression of the Ford Motor Company's use of robots is used. Additionally, documentary research is used to collect and organize various articles and research studies. Actor network theory and network analysis are used to determine the various actor-networks involved in robotic manufacturing and their different interactions. Ulrich Beck's theory of a risk society is also used to determine how fear and public perception affect the decisions of different entities in the United States (2000). This research offers insight into the use of robots in manufacturing and how this technology affects society as a whole. Furthermore, this research highlights some new automation alternatives in the manufacturing industry in the United States.

While both projects were important on their own, when done simultaneously, they became even more valuable. Conducting research on the societal impacts of automation in the

United States while simultaneously working on designing an automated clock, facilitated reflection on how automation has changed the world in the past few decades. The clock is just a small example of the capabilities of computer and robotic automation. By researching how automation has changed the manufacturing sector, it becomes obvious how impactful this technology can be. In contrast, working on the clock showed just how difficult completely automating a process is. Even though a clock is a fairly simple machine, it took hundreds of man hours to design and build. This project helps put into perspective the difficulty engineers face when designing automated systems, especially when discussing systems capable of completing complex challenges such as building a car from start to finish. Overall, completing both the technical project and STS research paper simultaneously increased the value of each individual project. This added value is due to the inherent connection between the social and technical dimensions of engineering.

Works Cited

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