

Thesis Project Portfolio

Portative Pipe Organ

(Technical Report)

The Impact of Automation on the Manufacturing Industry

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

In 1785, a pioneer in the field of automation, Oliver Evans, created the first completely automated industrial process - an automatic flour mill that occupied a whole building. Almost 250 years later, we have managed to create transistors that are just around 70 nanometers wide. Automation is following a similar path. Every year, there are more machines that automate routine jobs, often making the product or process optimized, safer and cheaper. This fact has intimidated millions of workers, economists, and engineers around the world, as it is hard to predict how automation will affect the future of labor as we know it. For these reasons, it is important to educate US citizens about the impacts of automation as well as familiarize ourselves with the current progress for our jobs do not become obsolete.

My technical capstone consisted of creating an automated pipe organ. The pipe organ is a combination of a piano and a flute, using the keyboard keys and the pedalboard to activate valves that allow air to escape from the wind box and make resonance with the pipe walls, producing harmonics that produce different tones. For our capstone to be a true engineering challenge, we decided to create an automated system that was not only responsible for the movement of the valves, to produce sound, but also the intake of air for the entire system. The pipe organ was made of six different systems that all acted together to create sound: the drive mechanism consisted of a motor that would power the bellows using a scotch yoke mechanism; the bellow box was responsible for the air intake in the push and pull motion of the system; the air conduct box redirected the air coming from the four different vents into a singular output; the pressure regulator maintained constant air pressure in the wind box to ensure that pipes speak at the desired pitch and volume wind box; the wind box was were all the solenoids rested waiting to be activated by the MIDI signals sent from the Arduino; and lastly, the 24 custom 3D printed flues which covered two octaves (from C3 to C5). The main goal of the automated pipe organ was to educate the public, especially the young ones, by familiarizing themselves with the power of automation. For this

reason, the product was designed with the end goal of being donated to the Discovery Museum in Charlottesville, Virginia, for students all around the community to interact and learn from it.

My sociotechnical thesis focused on analyzing the impact of automation, specifically in the manufacturing industry in the United States, as well as the role that the United States has played in advancing the progress of automation from an ethical perspective and following the responsible innovation framework conceptualized by Jack Stilgoe, Richard Owen, and Phil Macnaghten. My paper discusses that automation will make millions of jobs obsolete as well as will create millions of new jobs that we have never seen before, but it is essential to ask ourselves for whom will those jobs be created. The sociotechnical thesis will analyze automation through four dimensions – anticipation, reflexivity, inclusion, and responsiveness – and will conclude if the ethical progress of automation is responsible, who are the main stakeholders that benefit from automation, and who gets hurt the most. Most importantly, it will highlight that education will be the answer to combat the current pace of automation.

The combination of both projects has allowed me to have a greater perspective as I continue my path as a Mechanical Engineer. Throughout the next couple of years, I will come to make important decisions, and by working simultaneously on these projects I have come to understand that every decision has very different outcomes for different groups of people, whether those are divided by race, socioeconomic class, or just the work field. Automation will forever change the manufacturing field. As engineers, we often see technological progress as a positive, but we must realize the effect on people's lives.