

Thesis Project Portfolio

Automated Guitar Robot

(Technical Report)

What We Can Learn from CHIPS and Science Act Of 2022: A Case Study of Domestic Semiconductor Manufacturing

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

(Executive Summary)

Combining Humans and Machines in the Right Way: A Sociotechnical Perspective on Integrating Automated Work

“The countries with the highest robot density have among the lowest unemployment rates.

Technology and humans combined in the right way will drive prosperity.”

– Ualrich Spiesshofer, ex-CEO, ABB

My technical and STS research focus on automation. In my technical project, I designed an automated system that can play diatonic guitar chords through plucking, strumming, and fretting the guitar strings. This automatic guitar robot shows a promise for promoting automation to perform any music without any flaws. Despite the benefits of automation, however, whether such an automatic guitar robot could threaten guitar musicians job opportunities promptly raises my concerns. This becomes clear with careful consideration of these autonomous machines from a sociotechnical systems perspective. Within the systems in which this robotics are designed to perform, several oppositional concerns could arise, but sociochemical system thinking provides a means of predicting and addressing them preemptively. To foster such thinking and understand this whole sociotechnical system, my attention was brought to a recent policy, the CHIPS and Science of 2022, which prompts domestic semiconductor manufacturers to create more jobs in

the U.S. and ensure domestic chip resilience; furthermore, my research developed a new system to address the concerns on job marketing while prompting automations.

My technical report includes both software and hardware. In software side, I programmed an interface in laptop that asks users to input any guitar diatonic chords or upload a music sheet. Consequently, the laptop sends the data to microcontroller, a small computer, via Bluetooth. Lastly, the microcontroller controls motors to simulate hand action such as plucking, plucking, or strumming strings on the guitar. My professor, who has been playing guitar for more than thirty years, even told me this robot plays better than him. Furthermore, this robot can learn any song in under three seconds and then performs flawlessly. Since I built this automatic robot in four months with a budget of \$500, it would be more surprised than usual does that any basic hand actions can be simulated by this robot with limited source and time. This realization makes me arise a concern – even such budget-limited machine can replace someone who has been into guitar for thirty years – what about the future for the guitar musicians? This question has extended to my STS research.

In seeking for an answer for automation, my STS research focuses on studying domestic chip manufacturing based on a recent bill – the CHIPS and Science Act of 2022. The bill appropriates \$54.2 billion for subsidies to build highly automatic plants in the U.S. In the beginning of my research, I highly doubt if such a bill can bring more than 500,000 jobs to the U.S. as the legislator promise. In addition to understanding the circumstance that impacts of automation, several fundings were summarized by following literature reviews that can shape the concerns of the domestic chip manufacturing “Global manufacturing scorecard: How the US compares to 18 other nations”, which provides me striking statics. The funding points out, in fact, many highly automatic chip manufacturers including Micron Technology, Global

Foundries, TSMC, and Intel, are hiring for more than 35,000 from oversea to fulfill the labor demand for who can operate the automated machine and improve their automation systems.

By the end of this STS Research, the most important take-away is how many new and additional jobs automations can bring to humans while trying to replace humans in certain ways as well. Although such automatic robotics may learn and play a song better than humans do, music is not simply pressing and plucking strings. Music is about setting a scene and communicating a feeling, and without a doubt, automation still requires humans to define them on how to express appropriate feeling. In the same way, development of automation in manufacturing can bring down the cost of labor and resources while creating many jobs for high-tech to operate and prompt the machines. Automation is a tool to bring people convenience, but how to define automation is still our job.