AUTOMATION AND AESTHETICS: THE TRADEOFFS OF ROBOTIC PERFECTION AND HUMAN CRAFTSMANSHIP IN GUITARS

A Research Paper submitted to the Department of Engineering and Society

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

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Carson Peters

Spring 2025

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

MC Forelle, Department of Engineering and Society

Introduction

In the factories at Taylor Guitars, robots carry out around 90 percent of manufacturing tasks, while human artisans take care of the remaining 10 percent of work that cannot be accomplished with machines. Tyler Robertson, a robotics engineer in the factory, claims that although robots have enabled the work that they do by hand to become more refined and specialized, there will always be detail work that humans perform much better than machines (Weber, 2023). Across nearly every industry, the rise of automation has reshaped the landscape of production. Machines perform tasks that once required the hands of skilled laborers, leading to improvements in manufacturing speed, cost, and quality. However, the increasing usage of automation in the manufacturing industry raises questions about the roles of people in the making process. Is something lost when machines replace people in the creative or manual parts of production? How do these changes impact the humans who interact with these technologies?

Guitar manufacturing provides an interesting case study through which to examine these questions, as the guitar is a unique type of manufactured good. Guitars are both functional tools used to produce music as well as expressive artifacts with cultural and artistic significance. For some, they can be cultural symbols, reflections of personal identity, or artistic creations. For others, they are simply an instrument, used to practice or perform music for personal or professional purposes. They may be mass-produced in a factory using robotic tools or handcrafted by a skilled guitar maker, called a luthier. The way a guitar is created can impact how it is valued and used. They must meet practical demands of playability, tone quality, and durability, which are affected by the precision and consistency of manufacturing methods. These opposing values make guitar production a fitting investigation for analyzing the tensions between automation, craftsmanship, and the human experience.

After the 1950s, guitar production in Western markets shifted dramatically away from small workshops and towards large manufacturers such as Fender, Gibson, and Martin, correlated with improvements in manufacturing technology and a surge in demand for instruments (Dudley, 2014). These companies were the leaders in industrializing guitar production, incorporating tools like CNC routers and sanding robots. As computer and robotic technologies improved, companies like Taylor began using robots to assist with fine detail tasks, to the point that computers and machines carried a majority of the work in production. At the same time, there was and is a growing appreciation for handcrafted guitars in the Classical and boutique markets, where luthiers deliver personal craftsmanship and customizability (Dudley, 2014).

The contrast between automation and human craftsmanship raises important questions about the role of human labor in an increasingly mechanized world. It reveals how technological choices influence broader social and economic dynamics. This tension is highly evident in the guitar industry, where traditional luthiers and large-scale manufacturers take vastly different approaches to production. This paper examines how automation has transformed guitar manufacturing, exploring its effects on production efficiency, product quality, consumer perception, and the role of human workers in the process. I defend the thesis that an individual's role in the production of guitars as a buyer, business owner, or laborer determines the unique ways humans are impacted by and value automation technology. An examination of how different stakeholders assign value to mass-produced and handcrafted instruments reveals a conflict of interest in the choice of the process by which these instruments are manufactured. By analyzing the adoption of automation in the guitar industry, I hope to highlight broader trends in the impact that widespread automation has on manufacturing and human life.

Literature Review

The intersection of automation technology and the human experience has been the subject of several researchers. Current research focuses more on the economics surrounding the impact of automated manufacturing on the job market, and on the experience of human workers in environments using this technology. This literature review finds two differing consensuses on the impact of automation technology on the human job market, and evidence that automation improves the control and creativity of workers and designers have in the making process.

Some scholars argue that automation will reduce the number of human jobs. The automation and digitization of the workforce led to job loss, making certain basic human abilities obsolete. The widespread use of powerful computers has led to job losses, particularly among middle-skilled workers whose jobs consist of repetitive tasks like information processing and the operation of equipment (Lee et al., 2024). This job loss can be counteracted by training to upskill human laborers so they can work other jobs (Eng & Liu, 2024, p.192). Further, in cases where humans work to oversee robotic production, not only can the automation of jobs result in loss of employment, but humans also lose the opportunity to learn the skill of making the products themselves. The automation of assembly work may limit such workers' promotion to managerial positions by preventing them from gaining useful practical knowledge (Lee et al., 2024). Reduced opportunities to acquire new skills at work have negative impacts on the future employability of human workers, making them prone to joblessness in cases where their work becomes fully automated.

An opposing stance argues that although disruptive, automative technologies have positive influences on the human job market, even creating new jobs. The advent of automation in the workforce gives humans opportunities to utilize other skills that cannot be replaced by

computers and robots. Humans do not lose jobs, but the requirements of the new jobs are different. Abilities such as abstract intelligence, social intelligence, and decision-making are difficult to automate, making jobs that use these skills more resistant to changes due to improving technology (Lee et al., 2024). This means these skills are highly important, to the point that vocational training for workers whose jobs are at risk of automation may be necessary to develop these skills to prepare them for other roles (Lee et al., 2024). Some authors are more dramatic about the impact of automation on the human work experience, stating that humans will have to adapt to a new world to survive. Loku & Loku (2025) reference authors Martin Ford, Erik Brynjolfsson and Andrew McAfee, Stan Neilson, and Jerry Kaplan, synthesizing their position that technology has intrinsic goodness, but is incapable of rendering human beings obsolete. They suggest that "the only way to avoid an epochal catastrophe is to redesign our societies" such that humans take on a new role in a world dominated by technology (Loku & Loku, 2025, p. 89). Automation in manufacturing has a variety of impacts on the human job market, in some cases replacing or relocating workers, and in other cases providing opportunities for better jobs.

Other research focuses on how automated manufacturing affects the workflow of the people working alongside it. The consensus is that the use of automation and digital tools removes tedious work from the design and manufacturing processes, enabling workers to operate with more control and freedom. This line of research asserts that automation is a tool used to help streamline the human creative and manufacturing process. By saving human time and energy, it enables people to focus on higher-level problems while machines take care of the menial tasks, making room for creative thinking and innovation (Bruns & Long Lingo, 2024). There is so much work that goes into the design process that workers can become overwhelmed

with the minutia necessary to finalize the product. A reduction in the tedious, repetitive, detail-oriented, and expertise-based work reduces the barriers faced by creative thinkers to bring projects to completion, meaning producers can focus on creativity in their designs, producing unique and quality products (Bruns & Long Lingo, 2024). One manufacturer of robots for use in guitar production agrees that automation does not remove the capacity for human creativity, but allows humans to focus on higher-level problems, giving workers more time and freedom to perfect their products. Adaptec Solutions (2024) recognizes that "robots, while incredibly advanced, cannot replicate human thought processes", yet they "complement human labor, particularly, in tasks deemed 'dull, dirty, and dangerous.'" They found that automation "enhance(s) [manufacturing] processes, freeing up human resources for more creative and complex initiatives" (Adaptec Solutions, 2024). The use of automation technology allows human workers to meet specifications more exactly, increasing the quality of their work without increasing the time spent on it. This statement is motivated by a desire to improve sales by painting robots in a positive light, but other research with neutral motivation supports this claim.

While existing research agrees that automation impacts the people involved in manufacturing, scholars have not yet adequately considered the values of the actors involved and how they view the instrument. My analysis of automated guitar manufacturing technologies draws on Ontological Pluralism, which is the idea that "different scientific interests and values lead to different but equally valid ontologies" (Ludwig & Ruphy, 2024). Different parties may view a single artifact with alternative modes of existence, and there is no uncontested and objectively correct interpretation of the artifact (Ludwig & Ruphy, 2024). Using this framework allows me to analyze guitars as they are viewed by different people, taking on different meanings based on the values of the beholder.

Methods

To perform my analysis, I treat my topic as a case study, examining the automation in the guitar industry to provide insight into trends in the impacts of automation more generally. To limit the scope of the project, I focus on developments in the Western guitar industry between 1950 and the present. I examine research studies, firsthand accounts from professional guitar makers, and accounts from companies that build automation technology specific to guitar production. The use of these media provides a glimpse into the roles of multiple actors who interact with manufacturing technologies.

Analysis

For customers, the manufacturing process is important because it plays a role in their purchasing decisions. Customers take the manufacturing process of a guitar into account when making a purchase. Buyers of electric guitars care about the brand identity and heritage value of the guitar, indicating value in the manufacturing process (Oe & Yamaoka, 2023). “Heritage value” means the value of the instruments when they are sold to secondhand buyers. Unlike many products that are built with planned obsolescence, guitars are built to last, meaning they can have a series of owners, and there is a strong market for secondhand guitars. “Brand identity” deals with the public perception of the instruments in the context of the company that builds them, including associations with popular artists who use the instruments. Although some electric guitars have features that augment the user’s talent, these more abstract forms of value take precedence over functional attributes when making guitar selection decisions (Oe & Yamaoka, 2023).

These findings suggest that when compared to the quality or specific features of the instrument, guitar buyers give higher importance to the maker of the guitar and how it retains its

value over time. This reveals “the importance of cultural and emotional elements in consumers' decisions regarding electric guitar purchases”, indicating that customers care less about the actual product than other social factors they associate with it (Oe & Yamaoka, 2023, p. 36). Thus, as viewed through the lens of ontological pluralism, the guitar exists not only as a product, but as an entity with popularity and social context that influence purchasing decisions. To qualify this point, this study did not explicitly examine how manufacturing processes impact customer behavior. As the authors state, the way the brand is perceived and customer loyalty to a brand image are the major drivers in consumers’ decisions. However, the way the instruments are built is an element of consumers’ perception of the product, and part of the reason brand identity exists is due to the quality of the instrument. The importance of brand identity and heritage value to consumers indicates that the method of manufacturing plays a significant role in the buyer’s decision.

Not only do customers care about the social context of their instruments, but Classical guitarists in particular care deeply about how their instruments are made, preferentially buying from master craftsmen who hand-make the guitars. Luthiers, as they are called, operate on a smaller level than larger manufacturers, and can correspond with their customers and establish a personal relationship. They can learn about the customers’ desires and tailor the instrument to meet the specific needs of the customer. A luthier himself, Edgeworth (2024) says that working at a smaller output scale allows luthiers to pay attention to the characteristics of each wood piece and treat them differently. Buyers of Classical guitars care about the intricacies of the physical details and the way the wood is treated, matters which can be handled only with hand craftsmanship. Due to the mass-production scale of factories, each guitar is built the same, regardless of the variations in the wood. Factories must adopt priorities such as production speed

and limiting returns or repairs, which align with some customers. However, Classical guitarists may want a more delicate or detailed guitar, such as using a French polish finish on the wood (Edgeworth, 2024).

Interestingly, this contrasts with electric guitars, which need less manufacturing effort to produce good sound and aesthetics, and for which factory guitars are popular since the priorities of the factory align with those of the players (Edgeworth, 2024). Edgeworth (2004) claims that the craftsmanship, sound, and collaboration between the maker and guitarist lead to the preference for handmade instruments among Classical guitarists. Elements of the instrument, such as the decorative rosette around the sound hole, give each handmade guitar a unique look that cannot be achieved in a factory. He also states that the quality of workmanship is better among master craftsmen than among factory workers, comparing a handmade guitar to a well-crafted warrior's sword. Classical guitarists need an instrument of such a quality that it will not limit their abilities "soundwise, visually, or due to functional issues such as neck shape or intonation" (Edgeworth, 2024). Here, it appears that guitars may be viewed in different ways by different people. Factories and casual users treat them as a product, while small production luthiers and Classical musicians treat them as a piece of art. The values of the maker inform the manufacturing decisions, which affect the customers' purchasing decisions.

We can further examine the values of the producers of guitars to evaluate why they choose their production methods. The businesses producing goods select manufacturing techniques to save time and money. One of the primary reasons that businesses choose to automate production is to save time on tedious tasks. A study examined which qualities determine whether a job can be automated, determining that "… the occupational characteristics with low potential for automation were art, decision-making, assisting and caring for others and

working in cramped spaces, while those with high potential for automation involved repeating the same tasks" (Lee et al., 2024). This idea is further refined to recognize that a factory worker's job may have several types of activities, some repetitive and some creative, meaning that "the potential for automation varies among different activities within a job" (Lee et al., 2024). In manufacturing, there is need for both creative thinking and repetitive actions, revealing that while some elements of the manufacturing process can be automated, others may not be so easily. The predictability of a work environment also contributes to the potential for automation, which is higher for environments with fixed layouts and routine work activities such as manufacturing (Lee et al., 2024). This means that in manufacturing, the layout of a factory can determine whether a job is possible to automate. An efficient layout where there is easy access to each machine or step in the process makes automation more possible.

Writing about the integration of automation within the factory at Taylor Guitars, Weber (2023) states that "implementing automation in a factory that relies heavily on manual assembly processes and traditional building methods can be challenging." Most companies, specifically factories capable of mass production, value financial matters above all else, and automation is one way to improve profitability. The main reason a manufacturing firm will choose to automate production is "the desire to enhance profitability…increasing quantity of output, increasing the quality of the manufactured product and moving up the value-added chain with a view to reaping a greater share of the profits associated with the product sales" (Sharif & Huang, 2019, p. 250). One way they can reach this goal is by automating, which is cost-effective and makes products of consistent quality in a timely manner (Loku & Loku, 2025). Conclusively, factories value financial gain, which comes with increased output and consistent quality, both of which can be attained through automated processes.

Automation of production affects the factory workers as well. The humans making the goods experience increased safety and changes in job focus as a result of automation technology. This is because automation increases worker safety. In discussing the automation of the factory at Taylor Guitars, Roberston says, “Ergonomics was the No. 1 reason why we implemented buffing robots. It’s also why we plan to soon start using some robots for sanding. We also hope to deploy some collaborative robots in the future” (Weber, 2023). The worker experience was a leading reason for the choice to automate, as it made the job more human-oriented. Automation also reduces the areas of production requiring human involvement. At Taylor, Robertson noted that some things “don’t make financial or engineering sense to do with automation”, which is why Taylor “will never adopt a 100 percent automation and there will always be detail work that humans perform much better” (Weber, 2023). Not every part of guitar production can be automated, so human workers focus on the parts that cannot be done by machine. Humans control the robots; the robots just execute the work. At some factories in the Sharif & Huang study (2019), “the process [of implementing automation technology] seems to have treated workers as a liability to be dispensed with”, while at others, “the workers became critical components of the manufacturing process” (Sharif & Huang, 2019, p. 246). In the later factories, the workers who had been employed to manage the production line were moved to quality control. None of the workers lost their jobs. In the former, all the workers were laid off. This is a side effect of competition, as “the only way to make money in such a cut-throat market environment is to lower your labour costs by upgrading your production” (Sharif & Huang, 2019, p. 244). Automation had the potential to improve the workflow of the factory workers, but it was the decision of the factory owners that changed the outcome of their employment.

Conclusion

In his study of art in an increasingly mechanized world, Benjamin (1935) recognizes that art is valued in two separate ways: the cult, which is the ceremonial value an object has simply for existing, and the exhibition, which is the aesthetic value given to an object based on how humans experience it. He argues that a part of humanity is lost when advances in technology allow for the duplication of artifacts, which divorces them from their traditional connection to ritual and uniqueness. In other words, when a guitar can be mass-produced by a machine, an element of the human spirit is missing (Benjamin, 1935). The automation of guitar manufacturing reflects broader trends in the relationship between technology and human labor. While factories implement automation to improve efficiency, reduce costs, and ensure consistent product quality, traditional luthiers prioritize craftsmanship, customization, and artistic expression. Consumers value guitars not only as musical instruments but as cultural artifacts, with brand identity and heritage playing a significant role in purchasing decisions. Automation reshapes the role of human workers, in some cases displacing them and in others allowing them to focus on more specialized, creative tasks.

Understanding the impacts of automative technology on human actors allows decision makers to approach the choice to automate more holistically, such that they can weigh the costs and benefits to the outcome they desire to achieve with their products. If quantity is valued over artisanal value, then automation is desirable. If a product carries more artistic or cultural value, then human work is needed to better achieve that goal. Future research could include consumer reports on satisfaction with a variety of products outside of guitars, and an analysis of products produced by new “dark factories” in China, which are completely automated and devoid of human workers, in comparison to more traditional factories before automation.

Ultimately, automation is adopted not simply because of its technological capabilities, but because the values and priorities of manufacturers, workers, and consumers give it a viable place in the market. Viewing these dynamics through the lens of ontological pluralism reveals that guitars are more than just products, but they exist within a network of cultural, economic, and social meanings that influence how they are made and valued. As automation continues to evolve, its role in guitar production will depend on how industry leaders choose to balance efficiency with artistry, tradition with innovation, and mechanization with human touch. Because there is value in guitars both as practical instruments and as artistic and cultural artifacts, both large-scale automated processes and small-scale artisanship must coexist to bring both of these values to the consumer market. Art is important, and guitars fulfill an artistic purpose both with the sound they produce and their visual aesthetic, regardless of the way they are made. For this reason, humans may continue to have a role in manufacturing despite the prevalence of automative technology.

Works Cited

Adaptec Solutions. (2024, April 9). Human Touch in Guitar Hardware Automation. *Human Touch in Guitar Hardware Automation*. https://adaptecsolutions.com/human-touch-in-guitar-hardware-automation/

Benjamin, W. (1935). *The Work of Art in the Age of Mechanical Reproduction*.

Bruns, H. C., & Long Lingo, E. (2024). Tedious Work: Developing Novel Outcomes with Digitization in the Arts and Sciences. *Administrative Science Quarterly*, *69*(1), 39–79. https://doi.org/10.1177/00018392231208190

Dudley, K. (2014). *Guitar Makers: The Endurance of Artisanal Values in North America.* United Kingdom: University of Chicago Press.

Edgeworth, M. (2024, January 7). *What are handcrafted classical guitars and who are they for?* Handmade Classical Guitars UK. https://www.michaeledgeworthguitars.com/en/uk-classical-guitar-maker/am-i-ready-for-a-handmade-guitar

Eng, P. H., & Liu, R. L. (2024). Will Intelligent Technologies Replace Humans in the Future? An Exploratory Study for Likelihood of Intelligent Technologies to Replace Humans in the Future. In M. A. Al-Sharafi, M. Al-Emran, G. W.-H. Tan, & K.-B. Ooi (Eds.), *Current and Future Trends on Intelligent Technology Adoption: Volume 2* (pp. 171–202). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-61463-7_9

Lee, E., Kim, H., & Hong, S. (2024). A Network Analysis of the Relationship Between Automation and Job Characteristics. *Science, Technology and Society*, *29*(3), 478–496. https://doi.org/10.1177/09717218241265004

Loku, A., & Loku, N. (2025). Globalization, Automation, and the Future of Work: Examining the Impact of Technological Advancements on the Workforce. *Quality - Access to Success*, *26*(4), 88–96. https://doi.org/10.47750/QAS/26.204.10

Ludwig, D., & Ruphy, S. (2024). Scientific Pluralism. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Fall 2024). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/fall2024/entries/scientific-pluralism/

Oe, H., & Yamaoka, Y. (2023). Exploring socioeconomic factors for the sustainability of electric guitar brands: Focusing on traditional values and psychological attachment. *SocioEconomic Challenges*, *7*(4), 36–53. https://doi.org/10.21272/sec.7(4).36-53.2023

Sharif, N., & Huang, Y. (2019). Achieving Industrial Upgrading Through Automation in Dongguan, China. *Science, Technology and Society*, *24*(2), 237–253. https://doi.org/10.1177/0971721819841982

Weber, A. (2023, September 27). *Hand Craftsmanship Meets High Tech at Taylor Guitars*. ASSEMBLY. https://www.assemblymag.com/articles/98037-hand-craftsmanship-meets-high-tech-at-taylor-guitars