

**Autonomous Chess Robot
(Technical Project)**

**An Examination of the Right to Repair Movement
(STS Research Paper)**

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Engineering

By
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Fall, 2022

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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.

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Introduction

My technical project is an autonomous chess robot. The goal is to have a robot that can play an intelligent game of chess against a human opponent by physically manipulating the pieces on a board. It will be able to read the current state of the board and react to the moves its human opponent makes. My STS (Science, Technology, and Society) project is entirely separate and unrelated to my technical project. I will be researching the right to repair movement in the United States. I will be paying special attention to the power dynamics of repairing smartphones and laptops.

As it stands, original equipment manufacturers (OEM) have little to no incentive to make their devices repairable, in fact they are incentivized to do the opposite. As customer demand for new electronics year after year has waned, these manufacturers have turned to other means of maintaining their profit margins, one of which is to make it as difficult as possible to repair a device in hopes that the customer will simply buy a new one (Svensson-Hoglund et al., 2021). This flies in the face of the culture of tinkering and the innovations that accompany it.

Currently, there is a war waging between consumers and repair businesses against the manufacturers of these devices over if and how their devices can be repaired. Ultimately, they are fighting over a philosophical and legal question: who owns these devices? If the person(s) who purchased the device own them, then surely they should be able to modify them how they see fit. If they are prevented from doing so by the seller of the device, especially retroactively, do they own their device or are they merely renting it? In an economy that is increasingly fascinated with subscriptions for use of products, this is an especially salient question.

To answer these questions, I will be examining the history of the right to repair movement and the legislation it has produced or failed to produce in order to determine what a piece of legislation would look like that both respects the intellectual property of the OEMs and allows independent repair

technicians or customers to easily repair their devices. This examination will be a synthesis of existing literature and legal texts to culminate in a final thesis paper.

Technical Project

My technical project is to build, test, and verify an autonomous chess-playing robot capable of playing an intelligent game against a human opponent. This involves designing a mechanical system capable of manipulating the pieces, and creating a printed circuit board (PCB) that interfaces with a microcontroller to control the motors on the robot and the sensors necessary for reading the state of the board and ensuring safe operation. The overall system diagram can be seen in Figure 1.

To accomplish this, my group uses an electromagnet attached to a rack and a pinion-powered lifting mechanism that attaches to an overhead gantry system to pick up and place down the pieces. The mechanics are powered by three stepper motors connected to a custom PCB. The PCB connects a microcontroller, which controls the motors and monitors the various sensors, and a Raspberry Pi which calculates the robot's moves, and powers all the motors and sensors. To detect where each piece is, an array of magnetically activated switches is embedded beneath the chessboard. These switches will close in the presence of a magnetic field, so by attaching a magnet to the bottom of each chess piece a binary representation of which squares contain pieces can be obtained. The pieces are tracked from the start of the game thus tying each square with a piece to a specific piece. This project covers large areas of mechanical, electrical, and computer engineering. It is not intended to have a large impact on society, but rather to hone and demonstrate my group's abilities as engineers.

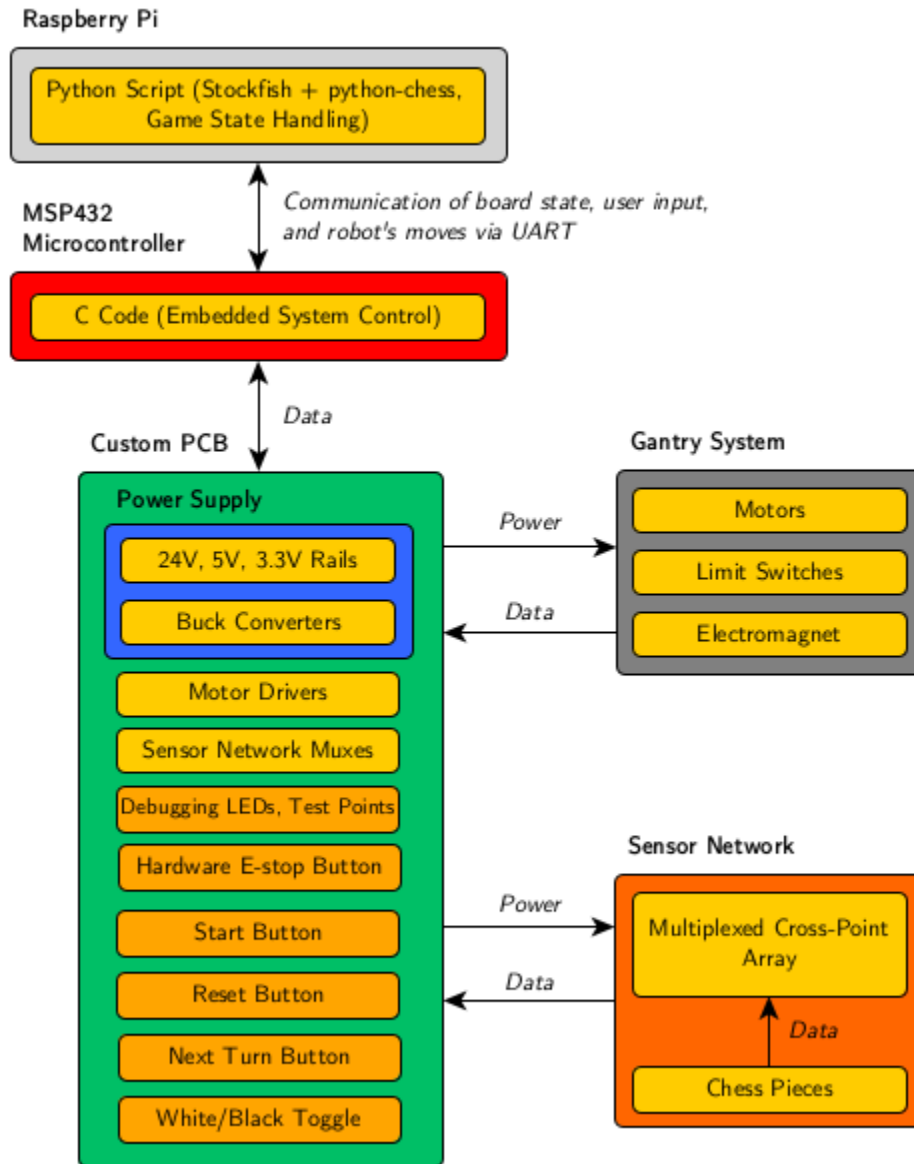


Figure 1: Technical Project System Overview Courtesy of Keenan Alchaar

STS Project

My research focuses on the right to repair movement in the United States. I seek to explain what precipitated the movement, the mechanics of device repair, and how legislation could be crafted to facilitate repair without removing intellectual property rights. The principal actors in this dance are the device manufacturers, consumers, repair businesses, and government regulators, both legislative and

executive. The original equipment manufacturers (OEM), companies like Apple and Samsung, are in the best position to influence the other actors. Since they make the devices, none of this would exist without them and this grants them the ability to control the flow of information about their devices. As the designers of these devices they are the sole holders of the documentation detailing how, if at all, their devices can be repaired. OEMs are not required to provide these documents to the public, nor are they required to provide means of accessing the software locks that prevent modification of their devices by their owners (Svensson-Hoglund et al., 2021). Thus, the supply of knowledge for effective repairs is cut off at the source. Simultaneously, these OEMs are often very large entities with a great deal of influence over the governments that may seek to rein them in. The consumers are technically the largest and most powerful group, without their dollars the manufacturers could not survive, but they are not organized into a single group and so their piecemeal efforts are largely ineffective at causing real change. The repair businesses are likely the best positioned to push back against the manufacturers as they are relatively organized and economically incentivized to improve the state of repair in the industry. However, their only means of doing so are through grassroots activity and by convincing legislatures to pass legislation benefiting the right to repair. As for the legislatures themselves, while they do have the power to write a right to repair into law, with some exceptions they have mostly lain dormant on this issue. Currently, electronics are covered under an intricate web of patent, trademark, and copyright law. Most of the physical parts and their designs are covered under patent law, which restricts the ability of anyone other than the OEMs or their deputies to create spare parts or substitutions. Trademarks are generally used in the commercialization and marketing of parts. Copyright generally applies to the software running on these devices, software that is increasingly relevant to the repair of the device. The most relevant law in this arena is the Digital Millennium Copyright Act (DMCA) which updated copyright for the internet era (Bello & Aufderheide, 2020; Svensson-Hoglund et al., 2021)

At this time, I do not have a specific STS framework for this research, but actor network theory (ANT) would probably be the best suited. However, unless a very specific device is selected to study, an act that would remove much of the history and wider impacts of the movement, the actors would have to be rather broad. Most of the research for this project will be done during the Fall 2022 semester, before actually writing the final thesis paper during the first half of the Spring 2023 semester.

Key Texts

An excellent starting point for digging into the history of the right to repair movement is *The Right to Repair, the Right to Tinker, and the Right to Innovate* by M. Hatta. While the author focuses on how the ideas from the right to repair movement could affect Japan, nearly all of the events discussed occurred in the United States or relate to US law. It explores several landmark legal cases and outlines how modern trends in engineering interact with copyright law (Hatta, 2020).

This leads directly to the landmark copyright law for the internet age: the Digital Millennium Copyright Act (DMCA). This fairly controversial piece of legislation effectively restricts any tinkering with another's software. Since essentially every modern device has a microchip and is mostly controlled by software, this significantly restricts anyone trying to repair that device. The paper *The DMCA, Database Protection, and Right to Repair: The Long Tail of Public Interest Activism in the First Digital Copyright Decade* by Bryan Bello and Patricia Aufderheide explores how the DMCA came to be. Although this is a somewhat biased source, as they mostly focus on the efforts of the Digital Future Coalition (DFC) which was opposed to much of the bill, it does have a fairly detailed explanation of what protections were included and why (Bello & Aufderheide, 2020).

In a similar vein, *Intellectual Property Law and the Right to Repair* by Leah Chan Grinvald and Ofer Tur-Sinai shines some light on the more intricate depths of intellectual property law in the US. This is a very detailed examination of the current state of copyright and other intellectual property protections with a focus on how right to repair would disrupt them. The authors look for a way to create legislation that prevents manufacturers from restricting their customers' ability to repair their own devices while at the same time being able to retain strong intellectual property protections on their creations (Grinvald & Tur-Sinai, 2019).

Lastly, *Consumer Perceptions of the Right to Repair* by Aaron Perzanowski asks the question of how many people care enough to go through the relative inconvenience of getting their device repaired instead of simply purchasing a new one. Perzanowski surveyed the consumers of popular commercial electronics about their expectations of their devices. He also does a fine job of detailing the measures manufacturers go to restrict the repair of their devices and their measures to dissuade consumers from even trying to repair their devices in the first place. (Perzanowski, 2021)

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