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To what extent is the obstruction of repair done for profit by modern technology firms?

Abstract

This dissertation aims to research and provide a definitive answer to the question of whether modern technology is being purposefully designed to limit consumer access for independent repairs. To answer this, I have found and read several published academic papers which talk about the right to repair and several industry case studies which talk about repair laws, surveys and patents. I have also analysed legal analyses relevant to repair laws and a government report by the Federal Trade Commission to see a pattern in the specific methods and justifications manufacturers utilise to restrict consumers from repairing their own devices from home. The literature review and the discussion are structured in a similar manner by covering three sections which go over hardware restrictions such as proprietary screws, software restrictions such as part pairing protocols, and legal frameworks such as the Digital Millennium Copyright Act. Later in the discussion I cite specific devices like the ThinkPad P52 by Lenovo and the Steam Deck by Valve as some practical evidence that repairability does not have to come at the cost firms show it to be. My discussion also examines how the EU's approach compared to the US's proves that manufacturers can comply with repair friendly requirements when forced to by law, as seen when Apple was made to adopt USB type C charging across their products. The dissertation ends with the conclusion that the obstruction of repair is driven primarily by a business's profit motive due to manufacturers using tightly held hardware, software and legal barriers to force cycles of replacement and control the repair market rather than acting out of genuine technical necessity.

Introduction

The relationship between consumers and the technology they purchase has heavily shifted in recent decades. While technological advancement has accelerated, consumer rights to repair, modify, and maintain devices have by and large decreased. As we are given greater technology to use in our everyday life as consumers, such as AI and self driving cars, it is easy to admire how it makes our lives easier and more convenient.

From your phone being able to take professional grade photos and giving you the ability to contact anybody regardless of how far away they are, to the rapid spike in AI development in the last three years completely shifting how we view work, ethics and effort, technology is a modern day marvel. It benefits almost everybody in the world in one way or another. Any field of work whether it is medicine, engineering or transport has been improved by technology in some way.

Even looking locally, the device on which this dissertation is being read most likely serves as a valid example. This makes it important to archive and preserve this technology for future uses. However, lately companies have seemingly made it increasingly difficult for their customers to upgrade, repair and especially preserve the devices they paid for and "own".

To understand these barriers, I would like to define some terms and jargon for better understanding. **'Consumer control and ownership'** is the legal and practical ability to modify, repair, and modify the internal/external components of purchased devices without manufacturer permission. **'Restrictive hardware design'** refers to the physical manufacturing choices that either heavily prevent or complicate independent repair, including proprietary screws, non standardised components, serialized parts requiring manufacturer authentication, and integrated components such as charging ports that cannot be separated without damage. **'Restrictive software'** is the code responsible for detecting, restricting, or disabling device functionality when unauthorized repairs are detected. This can include firmware locks, part pairing protocols, and diagnostic software access being disabled. **'Obstruction of repair'** describes the combined effect of these hardware and software barriers in preventing consumers and independent technicians from repairing and maintaining devices. **'Profit motive'** refers to the strategies a business implements that are designed to control repairability and encourage premature replacement purchases.

An example context of the terms discussed above would be Apple blocking its "FaceID" function when its software detects an unauthorised screen replacement which otherwise without Apple’s interference would have worked like an official Apple screen with functional FaceID. Another well known case of Apple’s guard against third party repairs would be the introduction of their proprietary screw bit known as "The Pentalobe" in 2009 when it was first used on their flagship Macbook pro to secure its battery in place to prevent independent battery swaps. Apple claims these measures are not about profit. They argue

that proprietary screws ensure devices are opened correctly and that blocking unauthorised screens is necessary to protect a user's security and guarantee the quality of the repair.

This example creates two contrasting views. Is the obstruction of repair done as a form of strategy to control the market, or are these measures genuinely required for a device's security and performance?

This dissertation addresses the central question: to what extent is the obstruction of repair done for profit by modern technology firms? This question matters because it evaluates the boundaries of current consumer and company rights in the tech market and determines whether current repair restrictions are justified or if they represent anti consumer practices with environmental and economic consequences.

To effectively explore this question, the key terms defined above ensure my writing can be properly conveyed and understood by anyone regardless of their knowledge on repair.

This research matters to me personally because I am a firm believer in having the ability to preserve and maintain the technology I purchase and in my eyes rightfully own. Additionally because repair restrictions affect what consumers spend their income on (affecting the market) and because these restrictions directly lead to electronic waste generation, both of these cases cause harm and affect everyone, regardless of their opinion of repair rights. This dissertation will investigate the extent to which these measures affect consumers, technicians, and enthusiasts. It will argue for the corporate argument that these restrictions are necessary to counter any malicious activity, as well as examining against them and seeing whether these measures are genuinely required for safety or are primarily a strategy to control the repair and technology market.

Literature Review

Overview

To start evaluating my research question, "To what extent is the obstruction of repair driven by profit motives versus technical necessity?" it is vital to analyze the specific mechanisms and reasoning manufacturers use to potentially limit consumer control and ownership. This literature review is sectioned into three primary categories: Hardware, Software and Legal Frameworks. I would like to start by examining hardware restrictions as topics discussed in it are the foundation of other restrictive mediums and are necessary to understanding the physical barriers to independent repair which then directly connect to software restrictions which reveal the modern shift toward digital locks and part pairing protocols and their legality. By the end of this lit review, I hope to find and establish a pattern in the restrictions and design choices made by the firms that I can later discuss in detail in my following discussion. The limited amount of literature in this review is due to most of the sources I covered in my preparation and planning going over the same points and having a lot of overlapping ground between each other. The sources selected for this review were therefore chosen because each contributes a distinct approach such as technical reports, surveys and law analysis which, whilst they do come to a similar conclusion, obtain their evidence and arguments through completely different methods. I believe this variety in methodology strengthens the overall argument rather than simply repeating it.

1. Hardware Restrictions

1.1. The Shift from Modularity to Integration

Reports by the FTC and legal scholars have shown a clear historical shift from modular, user repairable products to integrated devices designed with inherent resistance, such as components being soldered onto a device's motherboard which would function just fine with alternative methods of attachment.[1] Although these appear to be minor engineering choices, they play a huge role in restricting devices and forcing repair works towards destructive disassembly.[2] The report by the FTC, labeled "Nixing the Fix: An FTC Report to Congress on Repair Restrictions", is a very significant and important piece of evidence to have, as it was submitted to Congress by government inquiry, meaning that it was held to very high standards of accuracy, formality, and evidence, making it reliable and trustworthy because of its authority and reason for being written. Where this report falls short is

[1] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), p. 18; Aaron Perzanowski, 'Consumer Perceptions of the Right to Repair', *Case Western Reserve University School of Law Case Research Paper Series*, no. 2020–25 (2020), pp. 6–7.
[2] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), p. 18-25.

unfortunately we are never explicitly told or given the names of the authors, which could be reason to doubt the report in some way, I doubt this is a significant enough reason to completely scrap and avoid the source. What would be a better reason of doubt is, as the report was reflecting what manufacturers chose to submit to the FTC, rather than the FTC doing their own investigation, it is highly unlikely that manufacturers would submit any incriminating or potentially negative information that would hurt their own position and would be self sabotage.

Simpson, a Doctor of Philosophy in the Indiana University, writes about historical context through a textual analysis of patent documents, documenting how even component choices which are often dismissed carry carefully planned design intentions that affect repairability and control over user modification. While Simpson's analysis is historical rather than practical or experienced, it is valuable for demonstrating that fastener choices are almost never accidental. I would like to note that his methodology of analyzing patent texts gives us the closest accurate record of true engineering intent. I must admit that reading a patent is not the same as speaking to an engineer or designer in person or being there for the procedure as patents are made to show a complete and formalized version of the process and product rather than the process of getting to it. Despite all of this, Simpson's work is very valuable as it is one of the few sources I am using that deal with the physical side of repair restrictions, which makes it particularly valuable to this review. His findings regarding Apple's Pentalobe Screw are also quite valuable even today as, as far as it is known, Apple is still using Pentalobe Screws on all of their iPhones, MacBook Pros and MacBook Airs.[3] For instance, he highlights that while the Phillips screw was designed for industrial efficiency, Apple's proprietary "pentalobe" screw was chosen "specifically because it was new, guaranteeing repair tools would be both rare and expensive."[4]

While it can be argued that each screw variant serves its own purpose, Simpson notes Apple's Pentalobe is designed not only to fasten but to seal.[5] Evidence indicates a shift from readily accessible screws and screwdriver heads to specialized proprietary fasteners, industrial adhesives and most damaging, soldered components.[6] Manufacturers employ these in almost all consumer technology, often citing cheaper cost and industrial grade durability for their reasoning.[7] However, this represents a fundamental change in design architecture which, while not starting as invasive, has paved a path that leads to damaged product longevity and worsened repair procedures for the end user.[8]

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[3] https://www.ifixit.com/Guide/iPhone+17+Pro+Battery+Replacement/199458, see Step 3.
[4] Grant Leyton Simpson, 'The Social, Textual Lives of Patents: The Phillips Screw and Driver', *Textual Cultures*, vol. 11, no. 1–2 (2017), p. 173.
[5] Simpson, 'The Social, Textual Lives of Patents', pp. 173–174.
[6] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), pp. 18–19.
[7] Federal Trade Commission, *Nixing the Fix*, p. 34; Aaron Perzanowski, 'Consumer Perceptions of the Right to Repair', *Case Western Reserve University School of Law Case Research Paper Series*, no. 2020–25 (2020), p. 6.
[8] Perzanowski, 'Consumer Perceptions of the Right to Repair', p. 3.

Lloveras et al., writing from the Postgrowth Innovation Lab, observe that modern consumer electronics feature glued in batteries and fused display panels along other vital components that make disassembly extremely difficult without damaging structural integrity.[9] On their official website, the PostGrowth Innovation Lab describes itself as a group working towards a transition away from what they would call "the exploitative economic model that exists today." This publicly and openly stated position means that the use of some of their terminology, such as hegemonic, to describe manufacturer behavior does come from a clear belief and ideology, rather than a neutral academic one. [10] This does not necessarily make their findings wrong or incompatible with my research, but it should be kept in mind that some of their framing for repair restrictions might align with their research goals. Their research suggests these are "hegemonic" strategies to maintain control.[11] The practical consequences of these choices are significant. Perzanowski, an American legal scholar at Case Western Reserve University, highlights through his published survey work that device makers such as Apple and John Deere have adopted strategies to reduce the independent repair of the products they sell.[12] Perzanowski's source is significant in this review because, unlike others, his work is survey-based and gives us first-hand data collected by a questionnaire which consumers were fully informed about and did on their own volition, giving us an accurate representation of their awareness. Although surveys can show us what consumers think and are aware of, they do not prove anything legal or practical to us, as just because a consumer thinks a restriction is unfair does not prove that the restriction is unnecessary from an engineering standpoint. The impracticality of even minor repairs is backed up by Ozturkcan's analysis of Apple's Self Service Repair program. Ozturkcan, publishing in the peer reviewed *Journal of Information Technology Teaching Cases*, notes that the program requires customers willing to repair their own phone to rent an industrial 79-pound (35.8 kg) repair kit containing specialized tools just to replace iPhone batteries weighing approximately 1.1 ounces (0.03 kg), effectively forcing them to rely on manufacturer controlled and authorized repair services.[13] I would like to evaluate Ozturkcan briefly by saying that although it is a source that provides us a lot of valuable information, it is not a study and is more of a teaching case, and is something that is meant to inform the readers. It is still peer-reviewed and reliable due to it being published in a journal, but it does have less depth as it does not go into the bigger picture of right to repair and its needs like other sources do.

The depth and extent of these barriers should not be underestimated. Manufacturers employ multiple overlapping strategies that work together to prevent independent repair.

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[9] Javier Lloveras et al., 'On "the Politics of Repair Beyond Repair": Radical Democracy and the Right to Repair Movement', *Journal of Business Ethics*, vol. 196 (2025), p. 332.
[10] https://postgrowth-lab.uvigo.es/about/
[11] Ibid.
[12] Aaron Perzanowski, 'Consumer Perceptions of the Right to Repair', *Case Western Reserve University School of Law Case Research Paper Series*, no. 2020–25 (2020), p. 3.
[13] Selcen Ozturkcan, 'The Right to Repair Movement: Sustainability and Consumer Rights', *Journal of Information Technology Teaching Cases*, vol. 14, no. 2 (2024), p. 221.

Industrial adhesives create permanent bonds that cannot be reversed without applying heat that risks damaging sensitive electronic or chemical components such as solder or batteries. Additionally, integrated circuit boards eliminate the possibility of homemade component level repair, requiring the replacement of entire boards even when only a single component has failed.

1.2. The Debate Over Intent and Necessity

A repeated argument exists in the sources regarding whether these design choices are due to unavoidable engineering trade offs or planned strategies to control repair markets. Manufacturers justify restrictive designs as necessary responses to consumer demand for smaller products and improved durability, while others argue they are done to serve profit driven business models designed to monopolize and control repair services.

This debate shows a major bottleneck in the existing research, being that there is a lack of independent, controlled studies that practically test manufacturer claims, with no published research verifying whether industrial adhesives represent the only method to achieve water resistance or if alternative repair friendly solutions exist. As a result, much of the literature relies on economic theory rather than technical validation.

However, one of the few practical analyses regarding engineering choices is Simpson's textual analysis of patent documents. Simpson's work provides important data into how documented design choices function as "instruments of power" that control consumer access.[14] By examining the actual patents, Simpson debunks the belief that the Phillips screw was intentionally designed to "cam out" to prevent damage. Instead, he shows the original patent explicitly states the design was intended to ensure "no tendency of the driver to cam out of the recess."[15] This source analysis is significant for proving that many anti repair choices are done purposefully because it demonstrates how hardware choices are carefully documented, legally protected mechanisms. As Simpson notes, specific fasteners act as "gatekeepers to the concrete internals of our technology," proving that restrictive designs are conscious and planned choices used to enforce control over production and repair rather than purely engineering necessities and lack of choice."[16]

I believe the primary cause for this lack of research is that independent researchers usually lack access to the proprietary design processes that would allow for definitive conclusions about whether repair hostile designs are necessary or chosen. For example, manufacturers claim that achieving consumer demands for durability and thinness requires design choices that unintentionally prevent simple repair.[17] However, the pattern of manufacturer behavior suggests that profit motives play a significant role. Perzanowski documents how companies

[14] Simpson, 'The Social, Textual Lives of Patents', p. 173.
[15] Simpson, 'The Social, Textual Lives of Patents', p. 200.
[16] Simpson, 'The Social, Textual Lives of Patents', p. 172.
[17] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), p. 34.

have adopted marketing strategies that emphasize incremental feature improvement to drive short upgrade cycles, implementing restrictions that extend beyond what is strictly necessary for durability.[18] The existence of products that successfully balance durability with repairability suggests that the trade-offs manufacturers claim are necessary may not be as major as presented. As Simpson notes, patents function as "instruments of power," establishing both manufacturing patterns and monopoly like control over production and modification.[19]

[18] Perzanowski, 'Consumer Perceptions of the Right to Repair', p. 4.
[19] Simpson, 'The Social, Textual Lives of Patents', p. 173.

2. Software Restrictions

2.1. Part Pairing

Beyond physical obstacles, software based restrictions represent perhaps the most complex tool for controlling repair. Lloveras et al. describe how manufacturers use firmware encryption and serial number pairing to create "digital locks" through a method called "part pairing," which requires a software handshake to authorize new components.[20]

The technical implementation follows a common logic: unique identifiers (serial numbers) are registered in the device's protected memory. When a component is replaced, the operating system checks whether the identifier is authorized. Without proper authentication, often requiring proprietary in-house manufacturer specific software, the device may lose functionality. The FTC notes that Apple has implemented systems where replacement screens or batteries will not function correctly unless checked by proprietary software, meaning even genuine components sourced from other devices may trigger persistent warnings.[21]

The scope of part pairing extends far beyond consumer electronics. A legal analysis by Kira Liu in the University of Chicago Business Law Review reveals that John Deere tractors require company owned software for basic diagnostics.[22] This is extremely vital when presented in agricultural contexts. For example, a farmer who could previously replace a sensor must now wait for an authorized technician to authenticate the part. Liu argues that this directly links aftermarket services to equipment sales and potentially violates antitrust laws.[23] This source provides both software and legal context, making the correlation that software locks are not just technical features but tools for economic control. Her analysis clearly frames the Deere ruling as a good development for right to repair movement. This means it should be seen as an analysis with a clear siding rather than a neutral one but I believe remains valuable due to its detailed explanations and angles given as to how the court handles a case of antitrust in a repair context.

2.2. Industry Justifications

The Federal Trade Commission's (FTC's) report, Nixing the Fix, discusses industry claims which state that unauthorized repairs pose significant safety risks. Manufacturers argue that part pairing ensures repair quality, prevents the installation of counterfeit components that might present fire risks, and protects proprietary algorithms.[24]

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[20] Lloveras et al., 'On "the Politics of Repair Beyond Repair"', p. 332.
[21] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), pp. 23.
[22] Kira Liu, 'Opening the Door to Right-to-Repair: Deere Co. and Its Implications', *The University of Chicago Business Law Review: Online Edition* (2024), p. 1.
[23] Ibid.
[24] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), pp. 23–27.

However, sources like Perzanowski and Mirr generally treat these justifications as excuses to protect a company's private business models rather than technical necessities. I would like to note that whilst Mirr's Article was published while he was still a student at the University of Iowa College of Law, it is still published regardless, meaning it did have to go through proper editorial review. However, the opening abstract immediately argues that Congress should adopt a federal right to repair legislation, showing us his exact views and not a neutral analysis. This, I believe, does not invalidate his arguments but his publication should be read as a case being made for the right to repair rather than from a neutral standpoint. The FTC report, which is highly reliable as a government inquiry utilizing required legal data found "scant evidence to support manufacturers' justifications for repair restrictions," noting that manufacturers provided no factual support for the claim that independent repairers pose greater safety risks.[25]

While counterfeit batteries have indeed caused fires, the sources suggest the safety argument is often unbalanced. Perzanowski notes that while batteries are naturally prone to failure, manufacturers use this to justify glue heavy designs that actually make safe replacement harder.[26] The question raised by this source is whether software locks represent an appropriate response to genuine safety concerns or an overly broad restriction serving primarily economic purposes.

[25] Ibid., p. 6.
[26] Perzanowski, 'Consumer Perceptions of the Right to Repair', p. 6.

3. Legal Frameworks

3.1. The DMCA and its Effect on Repair

The legal architecture enabling software-based repair restrictions in the United States is based primarily on copyright law. Mirr, writing in the Iowa Law Review, argues that the Digital Millennium Copyright Act's (DMCA) anti-circumvention laws legally prevent independent technicians from bypassing software locks.[27] This creates a legal paradox where, while consumers own the physical device, they may violate federal law by circumventing the software protections to repair it.

The DMCA, enacted in 1998 to combat digital piracy, has been expanded to include firmware controlling device operations. Mirr notes that manufacturers successfully argue that bypassing authentication systems constitutes illegal circumvention, extending copyright protection beyond its designed domain of preventing unauthorized copying to controlling product use.[28] This expansion creates concern about the law's competence and whether courts have appropriately considered the consequences for consumer ownership rights.

3.2. Intellectual Property and Patent Barriers

Simpson's analysis of patent related texts shows us the collaborative and economic nature of these documents, showing how patents serve as "social actors" connecting engineers, manufacturers, and legal frameworks.[29]

Additional legal complications arise because, as Law Professors Grinvald and Tur-Sinai write in the Fordham Law Review, requiring manufacturers to release repair manuals could create complications with existing trade secret and patent laws.[30] Similarly to Mirr, both Grinvald and Tur-Sinai have a stance towards the right to repair and are sympathetic and all for it. I believe, however, this is in no way a factor that should ruin the credibility of this source, as they go into uniquely covered trade secrets and are both law professors published in a respected journal. They highlight that manufacturers often claim repair manuals reveal proprietary manufacturing processes. This creates a pack of legal barriers where a device is simultaneously protected by copyright (software), patents (mechanisms), and trade secrets (diagnostics), making policy reform challenging as addressing one form of protection may leave others intact.

3.3. Evolving Policy

Despite these barriers, legal frameworks are shifting. Mirr documents that the U.S. Librarian of Congress now grants temporary DMCA exemptions for vehicle and phone repairs, though

[27] Nicholas A. Mirr, 'Defending the Right to Repair: An Argument for Federal Legislation Guaranteeing the Right to Repair', *Iowa Law Review*, vol. 105 (2020), p. 2407.
[28] Ibid., p. 2408.
[29] Simpson, 'The Social, Textual Lives of Patents', p. 188.
[30] Leah Chan Grinvald and Ofer Tur-Sinai, 'Intellectual Property Law and the Right to Repair', *Fordham Law Review*, vol. 88, no. 1 (2019), p. 122.

he argues these are insufficient because they do not cover the "trafficking" (distribution) of repair tools.[31]

On the state side, while many bills have stalled due to industry lobbying, a shift is happening. The FTC report notes that manufacturers exert significant political power by emphasizing safety risks to legislators.[32] However, the University of Chicago Business Law Review highlights the recent Deere & Co. judicial opinion as a potential “big win” for lawyers, suggesting a lower barrier for antitrust standing in repair cases.[33]

Internationally, the EU presents more progressive approaches. Priora and Alonso contrast the U.S. approach with the EU's Eco-Design Directive, which prioritizes environmental sustainability over strict IP enforcement.[34] While they note that balancing legitimate IP interests with repair rights remains a "legally grey area," the EU solution demonstrates that clearer legislative frameworks are achievable by setting in minimum requirements for product durability and repairability for the consumer which would force manufacturers to make spare parts and repair available for a certain product for a set number of years after the product leaves the market and to also make their products easy to disassemble with common consumer available tools. The fact that manufacturers are able to comply with these requirements in Europe while arguing a similar measure in the United States is impossible and unreasonable is a significant point of argument and discrepancy that I will return to later in my discussion.

As products become increasingly software defined, the questions raised by the right to repair movement become more pressing. The literature reviewed here suggests that current frameworks prioritize manufacturer control over consumer rights and environmental sustainability. The following discussion will utilize these perspectives to argue that establishing proper laws is of great importance so that future generations can benefit from accessible technology and reduced e-waste.

Discussion

To what extent is the obstruction of repair driven by profit motives versus technical necessity?

Original Equipment Manufacturers (OEMs), consistently argue that stopping people from fixing their devices is an unfortunate side effect of technical necessity. They claim that consumers demand safety, security, and durability which require devices to be sealed shut.

[31] Mirr, ‘Defending the Right to Repair’, p. 2409.
[32] Federal Trade Commission, *Nixing the Fix*, p. 6.
[33] Liu, ‘Opening the Door to Right-to-Repair’, p. 1.
[34] Giulia Priora and Francisco Lobão Alonso, ‘Repairing Products and EU IP Law: A Forthcoming Copyright Development?’, *Kluwer Copyright Blog*, 27 March 2024.

However, a look at the evidence suggests these justifications are often just convenient excuses to maintain economic control.

This discussion will, similarly to the literature review, be split into three sections and look at hardware design, software locking, and the use of legal frameworks. My argument will ultimately be that the obstruction of repair is driven primarily by profit motives. While some engineering factors like waterproofing are valid, the practical methods used to achieve them are often designed to exclude the user rather than simply solve an engineering problem.

1. Hardware and Design

Is it really "Technical Necessity"?

A major argument in the sources is that restrictive designs are engineering requirements forced by what consumers want. Manufacturers claim that to achieve water resistance and portability, components must be glued and densely integrated with each other.[35] This supposedly makes simple beginner repair impossible without destroying the device. However, when we look at other devices in the market, this argument falls apart.

1.1 The False Form Factor

The industry tries to present a simple yes or no choice. They suggest a device can either be modern and portable, or it can be repairable. Perzanowski documents how marketing strategies push further innovation such as a new design or form factor to drive short upgrade cycles.[36] This conditions consumers into viewing thinness and device aesthetics as the most important features, which works surprisingly efficiently as many consumers trust the firms to give them good hardware and do not usually think or care for long term device maintenance.[37]

The existence of devices such as the Lenovo ThinkPad series of laptops, specifically the P52, challenges the idea that modern performance requires unrepairable design. The P52 is notoriously heavy and big, but it is also an incredibly capable machine. It shows us that consumers are willing to accept a larger device if it delivers performance and serviceability. It allows users to swap RAM, storage, and batteries easily and maintain their machine in the long term. While it targets a different market than a thin tablet or MacBook, it proves that modularity does not stop a device from being high-performance.

A perhaps more modern and recognisable example of this would be the Steam Deck by Valve Software. It is a modern, handheld gaming computer that uses highly integrated all in

[35] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (May 2021), p. 33-34.
[36] Aaron Perzanowski, 'Consumer Perceptions of the Right to Repair', *Case Western Reserve University School of Law Case Research Paper Series*, no. 2020–25 (2020), p. 3.
[37] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (May 2021), p. 34-35.

one chips (APU's) similar to smartphones. Yet, unlike modern smartphones, it remains highly repairable. It is easy to disassemble thanks to Valve creating official public repair guides and videos and parts being readily available and sold at fair prices by the manufacturer 3 years after the device's release to the public.[38] If a handheld gaming device can be designed for repairability, the argument that smartphones must be glued shut for the sake of size is weak. It suggests that the extreme integration in mobile phones is a strategic choice to force obsolescence rather than an absolute engineering requirement.

1.2 The Waterproofing Trade-Off

A specific point of debate amongst the repair and engineering community worldwide is the use of industrial glue to make devices water resistant. Manufacturers argue this is a technical necessity. However, it is widely accepted the trade-off imposed on the informed consumer is not worth it.[39]

Protecting internal circuits from water is a valid goal and can be rationalised. Having a waterproof device, especially one you carry with yourself daily, is important, but the glue should not be so dense and hard that tampering with it during a repair risks ripping out vital components. I think it is fair to argue that if a device is dropped in water deep enough to breach the seals, the device is likely destroyed anyway. This makes the benefit of extreme waterproofing marginal compared to the certainty of the device becoming e-waste because the battery cannot be easily swapped and other components sourced.[40]

1.3 Historical Intent

If the engineering defense is weak, the historical context provided by Simpson reinforces the view that the attempt on consumer restriction is intentional.[41] Simpson's analysis of the Phillips screw patents reveals that the design was made for industrial production efficiency.[42] In contrast, Apple's adoption of the Pentalobe screw had no mechanical advantage. Its sole function was scarcity and uniqueness.[43] By using a screw that no consumer had a driver for, Apple had physically restricted access to the device their customer paid for and made them reliant on their service and ecosystem even further.

This context suggests that when manufacturers claim a specific design choice as a necessity, we as the consumer and end user should look into the reasoning more carefully to evaluate

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[38] https://www.ifixit.com/Device/Steam_Deck

[39] Perzanowski, Aaron, 'Consumer Perceptions of the Right to Repair', Case Western Reserve University School of Law, pp. 26-27.

[40] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (May 2021), p. 18.

[41] Grant Leyton Simpson, 'The Social, Textual Lives of Patents: The Phillips Screw and Driver', *Textual Cultures*, vol. 11, no. 1–2 (2017), p. 198-201.

[42] Grant Leyton Simpson, 'The Social, Textual Lives of Patents: The Phillips Screw and Driver', *Textual Cultures*, vol. 11, no. 1–2 (2017), p. 192, 198.

[43] Grant Leyton Simpson, 'The Social, Textual Lives of Patents: The Phillips Screw and Driver', *Textual Cultures*, vol. 11, no. 1–2 (2017), p. 173.

whether or not the product and its manufacturers are being honest about their reasoning and procedures and any alternative motives they may have. Just as the Pentalobe was a tool of exclusion, the soldering of storage to motherboards is often a tool of planned obsolescence being innovation disguised as efficiency. The FTC's report discusses how soldering components such as storage chips or RAM directly to a motherboard eliminates any possible individual part replacement at an average consumer's home using the tools at their disposal. Whilst it is possible to replace these soldered components, it is generally an extremely difficult and an unrealistic procedure to do for an average consumer.[44]

[44] Federal Trade Commission, *Nixing the Fix*, p. 18.

2. The Patronization of Safety and Security

Beyond hardware, manufacturers justify obstruction by claiming they are protecting safety and security.[45] This narrative relies on a childish view of the consumer. It treats the user like an infant who is too incompetent to handle their own property without getting themselves hurt or the technology damaged.

2.1 The “Exploding Battery”

A common argument from industry representatives is that unauthorized repair risks catastrophic failure, specifically regarding lithium-ion batteries, a standard and approved technology. They argue that untrained users will puncture these volatile components and cause fires.[46]

While lithium-ion batteries can be dangerous, the manufacturer’s response is overexaggerated. Other devices that run on lithium-ion batteries, like the ThinkPad P52, allow for safe replacement without needing any screwdrivers or tools aside from a user’s hand to flick a switch to release a battery’s latch for replacement with the whole process taking under 10 seconds from start to finish.

I have attached a visual example from Lenovo’s official hardware guide for better understanding and illustration below.

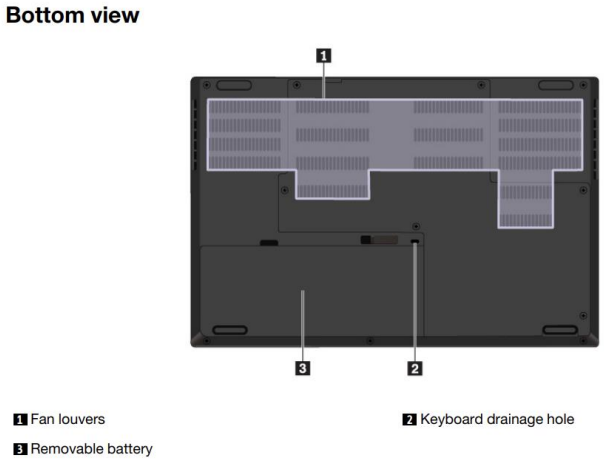

Figure 1 Bottom view of the Lenovo ThinkPad P52 showing the removable battery latch. Source: Lenovo, 'ThinkPad P52 Hardware Maintenance Manual' (2018)

Instead of designing the battery housing to be safer and easier to access, manufacturers bury the battery under cables and glue. This actually increases the danger of removal due to there being more fragile and intricate parts in the way of the removal that if handled incorrectly could potentially break a crucial connection in the device and require either a

[45] Federal Trade Commission, *Nixing the Fix*, p. 26, 30.
[46] Federal Trade Commission, *Nixing the Fix*, p. 26-27.

replacement cable/wire which may not always be available or a complete replacement of the device's main board.

Furthermore, the FTC report found "scant evidence" to support these safety claims.[47] Manufacturers failed to provide data showing that independent repair results in higher injury rates. This suggests the safety argument is largely a scare tactic. I believe that consumers should be warned and made aware of risks, but they should not be treated like infants who are incapable of unscrewing a screw and unplugging a wire. If safety were the true priority, manufacturers would release official guides on how to safely remove a battery like Valve and Lenovo rather than hiding behind a crafted narrative.[48] [49]

2.2 Competence and Data Privacy

The belittling of independent repair shops extends to issues of quality and data privacy. Industry representatives often claim that independent repairs damage the brand or risk user data.[50]

This argument ignores reality and is based solely on theory that can rarely ever be applied.[51] Independent repair shops are usually just as competent as authorized ones.[52] Solo shops might struggle only because big firms restrict their access to proprietary blueprints and tools. If an independent technician makes a mistake, it is often because they were denied the service manual that explains how to do it right, as proven by the FTCs report.

Regarding data privacy, the argument that authorized networks are inherently more secure is flawed. If a customer trusts a repair store with their tech, it is a given that they trust them with access. It is up to the consumer to be careful with their data, such as hiding crypto wallets or locking banking apps behind a passcode. Using privacy as an excuse to block hardware repair serves only to slander and control the service market.[53]

3. Software Locks and Assetization

Whilst hardware restrictions can theoretically be chalked up to engineering choices and pressure rather than profit driven incentives, this does not apply to software locks which often have built in and unmodifiable code that prevents certain seemingly harmless

[47] Federal Trade Commission, *Nixing the Fix: An FTC Report to Congress on Repair Restrictions* (Washington, DC: FTC, 2021), p. 6.
[48] https://www.youtube.com/watch?v=Dxnr2FAADAs
[49] https://support.lenovo.com/us/en/solutions/ht505031-parts-removal-and-replacement-videos-pcs-and-smart-devices
[50] Federal Trade Commission, *Nixing the Fix*, p. 32.
[51] Federal Trade Commission, *Nixing the Fix*, p. 30-31.
[52] Ibid.
[53] Federal Trade Commission, *Nixing the Fix*, p. 31.

software. Lloveras et al. describes this as a shift toward “assetization,” where the manufacturer keeps control over the device long after the sale.[54]

3.1 Part Pairing and the Murder of the Second Hand and Third Party Market

The most aggressive version of the murder of the second hand and third party market is part pairing. This links the serial number of a component to the motherboard in the factory. If a part is swapped without using proprietary software, the device breaks or displays warnings.

There is no technical necessity for this at all. A genuine screen from one iPhone is physically identical to the screen on another of the same model or one with equal specifications. Blocking it serves only to kill the second-hand market. By preventing the use of donor parts, manufacturers force repairers to buy new, expensive components directly from them, if they are even sold. This is a clear economic strategy to monopolize the supply chain and device lifespan.[55]

3.2 Performative Repair

In response to pressure from consumers, some manufacturers have introduced self-repair programs. Ozturkcan’s analysis of Apple’s Self Service Repair program highlights a critical issue in how firms tend to reply to repair related complaints or controversy. Apple’s program requires a consumer to rent a 35kg industrial toolkit just to replace a single small battery in their device.[56]

This solution is a double-edged sword in my opinion. Whilst it is a good toolkit for third party repair shops that need factory level precision, it is an otherwise unreasonable and unrealistic solution for the regular consumer who wishes to repair their own technology. It is a form of backhanded compliance designed to give consumers a response to their demands whilst also making repair look too intimidating so people give up, rather than a genuine attempt to help the user. This is evident by how a consumer who does their research will quickly find online guides by sites such as “iFixIt” providing extensive guides requiring minimal investment (Usually around 40 dollars with the battery and toolkit) explaining how to replace their own battery with simple tools and procedure.[57]

[54] Javier Lloveras et al., ‘On “the Politics of Repair Beyond Repair”: Radical Democracy and the Right to Repair Movement’, *Journal of Business Ethics*, vol. 196 (2025), p. 332.
[55] Ibid.
[56] Selcen Ozturkcan, ‘The Right to Repair Movement: Sustainability and Consumer Rights’, *Journal of Information Technology Teaching Cases*, vol. 14, no. 2 (2024), p. 221.
[57] https://www.ifixit.com/Guide

4. The Weaponization of Legal Frameworks

The final pillar of the manufacturer's strategy that I would like to cover is using the legal system to enforce these barriers. Innovation should be protected, but the current system is often abused.

4.1 The Digital Millennium Copyright Act Paradox

Mirr highlights the legal paradox created by the DMCA.[58] Consumers own the hardware, but the software is licensed. Manufacturers interpret bypassing software locks for repair as a copyright violation. This weaponizes IP law to control physical interactions with hardware. [59]

4.2 Intellectual Property and Trade Secrets

Grinvald and Tur-Sinai discuss how manufacturers label repair manuals as "trade secrets" to prevent their distribution.[60] As a result they are often withdrawn from consumer access and reserved for certified repair centres.

In my opinion a fair compromise would be a "Sunset Clause". It is reasonable for a company to protect cutting-edge technology for a new device to prevent immediate copying. However, this protection should not last forever. I believe that replacement batteries and instructions for installing them should be provided immediately as it is not rare for lithium ion batteries to come out defective shortly after being used for a short period in a device. In the case of device specific schematics and blueprints, I think it is fair to release them 3-5 years after a device's release as that is around the average time their support time in terms of software and replacement typically ends.

However, keeping this data secret for any longer contributes to e-waste.[61] By the time a device is three or four years old, the manufacturer may have moved on, yet independent repairers are still legally barred from fixing it. This confirms the legal stance is about forcing the obsolescence of older devices to drive new sales.

4.3 The European Counter

The effectiveness of regulation is shown by the difference between the US and EU markets. Priora and Alonso discuss the EU's Eco-Design Directive which is done to set minimum requirements for product durability and repairability across the European market. It requires

[58] Nicholas A. Mirr, 'Defending the Right to Repair: An Argument for Federal Legislation Guaranteeing the Right to Repair', *Iowa Law Review*, vol. 105 (2020), p. 2407-2409.
[59] Nicholas A. Mirr, 'Defending the Right to Repair: An Argument for Federal Legislation Guaranteeing the Right to Repair', *Iowa Law Review*, vol. 105 (2020), p. 2407.
[60] Leah Chan Grinvald and Ofer Tur-Sinai, 'Intellectual Property Law and the Right to Repair', *Fordham Law Review*, vol. 88 (2019), p. 122.
[61] Federal Trade Commission, *Nixing the Fix*, p. 41-42.

manufacturers to make spare parts available for a set number of years after a product is no longer sold. [62]The fact that manufacturers can comply with these regulations in Europe proves that the “technical necessities” cited in the US are choices. When forced by law, manufacturers will always find a way. A prime and relevant example of this would be when the EU forced Apple to add mandatory USB Type C options for charging to all their products for accessibility when prior to the regulations, Apple would use their proprietary magsafe or lightning ports for charging only. Another example of this is the EU's requirement to smartphone manufacturers was to make batteries in consumer hardware user replaceable by 2027, directly challenging the industry's claim that sealed batteries are a technical necessity.

[62] Giulia Priora and Francisco Lobão Alonso, ‘Repairing Products and EU IP Law: A Forthcoming Copyright Development?’, *Kluwer Copyright Blog*, 27 March 2024.

5. Conclusion

To answer my research question, the obstruction of repair is driven primarily by profit motives.

While some of the obstruction can be attributed to genuine engineering trends, these do not justify the entirety of restrictions. There is no engineering justification for part pairing and there is no safety justification for withholding repair manuals.

Throughout my research, as I have stated before, one of my largest bottlenecks and difficulties I had encountered was the lack of independent, practical and technical studies that test the manufacturer's claims. Most of the literature analysed and discussed in the EPQ was sourced and written from a legal or economical perspective. This unfortunately meant that I had very few practical engineering data that was published by any academic sources to definitively give a completely proven yes or no answer in an academic context. Because manufacturers keep design procedures hidden from the public, researchers are forced to rely on what the company publicly shows and answers regarding their technology and reasoning which is understandably rarely the complete picture. Unfortunately, without access to hard technical evidence, there is a significant gap in the field of the right to repair research field that future researchers should aim to address. Finally, my research focused primarily on consumer electronics and the legalities and reasoning in its restrictions and changes in the United States and the European Union. I believe that future research should investigate how repair restrictions can affect other industries and how it profits them, such as the agricultural industry, medical industry, and vehicular industry, where the consequence of being unable to repair modern essential equipment could be even more severe than in our everyday consumer devices.

Whilst we are on the right track with the rise of the right to repair movement and with the EU’s Eco directive program, we are still a long way off from an ideal and repairable market where the consumer would have easy access to their purchased and owned products. It is unfortunate and bleak that the wider implications of these findings suggest that without further intervention from government authority, the current trajectory may lead to a market where consumers own their devices in name only. The environmental cost of disposable technology will continue to grow, independent repair businesses will be forced out of the market, and consumers will have no choice but to accept manufacturer controlled service at manufacturer dictated prices.

Manufacturers want to force the cycle of replacement to drive sales. If this continues, independent repair will vanish. Corporations should be controlled, and their devices should be made for the people rather than just for profit. The device must belong to the buyer, not the builder.

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Evaluation

How far did you achieve what you set out to achieve?

In my dissertation, I set out to find a definitive and formally proven answer to the question of whether technology has truly gotten harder to repair independently and if so, whether this has been done on purpose by firms to squeeze money out of consumers. I would say given the time and resources I was allowed to use, I did find fairly solid evidence and evaluation that had been previously suspected and reported on the way that ease of repair to the consumer has indeed gotten worse in recent years and that proprietary tech has grown amongst big firms whose technology now hinges on it rather than on standardized and agreed upon solutions. I am relatively satisfied with this conclusion as it is something I personally agreed with and thought prior to writing my dissertation which made evaluating and discussing this view that much easier.

What were the limitations in your methodology/approach and how did they hold you back?

Unfortunately, this is not to say that my project is flawless, far from it. Due to the nature of my topic being electronic devices, my initial plan was to analyses and evaluate schematics of devices and their repairability 15 years ago and now, as well as using many repair stores testimonies regarding the right to repair as my evidence. This idea was very quickly shut down as they are not published academic pieces in any way and are more akin to personal complaints based on personal undocumented experience. Additionally, I was unfortunately heavily limited in the number of companies and pieces of documented electronics I could look into and formally analyse. I had also neglected and failed to consider looking into any sort of financial reports throughout companies' years to see if there was a pattern between when they would introduce proprietary technology into their products and if there would be a spike in their revenue. This, although a great idea, is one that I was notified of a little too late in my project and had to unfortunately pass up on. Thankfully I had underestimated just how much academic writing and reports there are on the right to repair and its many cases which saved my literature review and made me more confident in my choice of question.

What would you do differently if you were to redo the project?

If I were to redo the project I would definitely make sure to skim through some resources and evidence ahead of finalizing my question to ensure such a risk does not happen again, I would also love to have covered more studies and areas of the right to repair movement and hypothesize how it could affect the future of our devices and our control and ownership of them. However, due to my poor time management and planning ahead I was unable to discuss many points I wanted to and write them to a standard I would find acceptable and understandable.

What did you learn in terms of skills that will help you in the future?

In terms of skill, I taught myself proper formal research, time management and how to better structure my essays and thoughts. In all honesty, I learnt much more from taking EPQ and writing a dissertation than I thought I would and I can definitely see these skills helping me in phrasing myself in work, arguments, debates and how to better approach discussions. It also taught me the importance of sticking to a schedule and discipline because there would be multiple cases, I am ashamed to admit, where I would miss out on a week or two worth of activity log reports because I would forget or neglect in favour of doing other work, or I would concentrate too much on one section of the discussion or the literature review which really did not matter all that much in the bigger picture But would still cost me time and potentially neglect other more crucial parts of the literature review and the discussion, such as proper citation and evaluation. In the future I always planned to go into a role which would require me to research or develop something new or interesting, based on iterating previous attempts or ideas and by pursuing a project such as EPQ and writing my own dissertation with its own research based on my own conclusion that was backed up and proven by other sources really opened my eyes and reinforced my desire and want to go into such a position.