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Supporting Long Lifespan Products with Modularity

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by

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Abstract

When designing with a material as permanent as plastic, extending the product lifespan is vital. Modularity is a great tool for increasing product lifespan by supporting ease of repair and user attachment. This project concerns game controllers and explores sustainability by using the inherent long lifespan of the video game space to support sustainability efforts and extend the time plastic is not in a landfill. User research for this project discovered that gamers held onto their gaming devices and still purchased retro hardware and software in secondary markets. It is proposed that a modular device would have a longer lifespan than a traditional controller and increase likelihood of a user repairing specific broken parts of a controller, rather than throwing the whole thing away.

Keywords: Product Modularity, Game Controllers, Long Product Lifespan, Ease of Repair, Sustainability

Introduction

Towards the end of the 20th century, modularity was implemented into multiple fields due to its ability to increase versatility (Russel, 2012). Modularity itself is "the use of common units to create product variants," with two examples of the major types being component sharing and bus modularities (Huang and Kusiak, 1998). *Component sharing modularity* is defined by using a standard component across different products, such as multiple power tools all using the same motor. *Bus modularity* is defined by a larger module with many like connection points that allow for many different modules to connect to it, such as an electronic board with standardized solder points (Pine, 2018). Benefits of modularity include the support of economies of scale, supporting the abilities for products and components to change and evolve, increasing product variety, and "ease of product diagnosis, maintenance, repair, and disposal," (Huang and Kusiak, 1998).

Ease of repair is a major contributor to product lifespan, especially with plastics, which cannot be recycled infinitely, where increasing product lifespan is vital (Holmes, 2021). Many factors can make plastic more difficult to recycle such as sorting and the removal of paints and coatings (Al-Salem et al, 2009). For this reason, product life spans are vital and can be argued to be very conducive to sustainability. A potential advantage of plastics in this regard is their permanence, with that aspect, coupled with other design features potentially being able to lead to products with very long lifespans. Plastics with long lifespans that can be reused are preferable to recyclable short lifespan single-use plastics in terms of sustainability, with it taking less energy and resources to reuse products than to recycle them (Siddique et al, 2008). These factors, long lifespan, and the traits associated with it- such as those afforded by modularity- including ease of repair and replacement, can strongly support sustainability.

Long lifespan can be supported by product categories, with some spaces supporting lifespan more than others. An example of this is gaming peripherals, with their associated consoles increasing in profit margins the longer they are on shelves. Due to these factors, consoles have one of the longest average lifespans among tech products (Taylor, 2015). In a survey I conducted with video game players on gaming focused Subreddits and Discord servers, it was shown that most players will attempt a DIY repair of their controllers when the item breaks, most commonly in the analog sticks. In addition, a large percentage either take it to a repair store or do something other than throwing it away such as putting it away in storage or putting it on a shelf as a nonfunctional memorabilia display piece, with just under 20% of polled gamers reporting they would throw away a broken controller. Additionally, interest in video games and their related paraphernalia lasts much longer than a given console's retail lifespan with 30% of polled gamers reporting that they are interested in and collect hardware and software for consoles such as 1985's Nintendo Entertainment System (NES), and another 30% reporting that collect for consoles as old as 1990's Super Nintendo Entertainment System (SNES). Out of the remaining 40%, only 4% reported only buying for the current hardware (at the time of writing Sony Playstation 5, Microsoft Xbox Series X, and Nintendo Switch) and 11% only play games on their personal computers. Out of these polled gamers, 70% also preferred using original hardware in regards to their controller, meaning they use the controllers that were released at the time of the console retail life by the console manufacturer and not any third-party reproduction products, supporting the long user usage lifespans of game controllers, with NES controllers from the late 1980's still being sought after and kept in circulation via specialty brick and mortar stores and online outlets. The long lifespans of the video game space greatly support a long product lifespan and this can be supported further with features that ease repair and thus will further extend the product lifespan. I propose the creation of a game controller that uses modularity to extend its durability and lifespan through ease of repair.

I did an analysis of major first-party controllers (Fig. 1) from the four most prominent console manufacturers, Nintendo, Sega, Sony, and Microsoft. Trends I analyzed for this chart

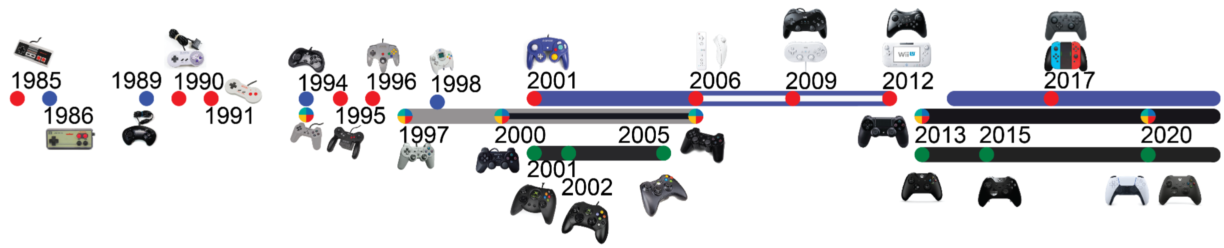

Figure 1

Timeline of United States Gamepad Release and Backwards Compatibility.

include: release date, time a controller is supported by a manufacturer as determined by compatibility with their main console at the market, console generation length, and correlating industry trends. Release date trends show that "handles" on controllers first appeared around 1994, with the original Sony Playstation controller being very similar in layout to a Nintendo SNES controller, with added handles. Following that, controllers became fairly standardized, for the most part including all the same input methods across manufacturers, until about 2006 when motion detection and gyroscope features became popular in-home consoles. In 2012 and 2013 touch interfaces also became popular, being integrated into Nintendo and Sony offerings around this time, respectively. In 2012 we also saw Nintendo begin to borrow ergonomic design cues from Microsoft offerings, with this trend progressing with Sony appearing to do the same in 2020 after staying fairly stagnant in silhouette since 1995.

Controller backward compatibility primarily began with the Sony Playstation 1 (PS1) and Playstation 2 (PS2) consoles using the same controller ports, and the PS2's ability to play PS1 games, and thus sported backward compatibility. An important note with this, however, is that PS1 controllers lacked dual analog sticks until a mid-generation revision, meaning that the pre-revision controllers were not compatible with games for the PS1 or PS2 that used analog sticks. Another major controller that kept its backward compatibility, despite the industry trend to move to USB controllers, was the Nintendo GameCube controller. The GameCube controller was compatible with the Nintendo Wii console due to that console having all the required ports, as well as the ability to play GameCube games. Interestingly, the GameCube controller lost compatibility with current Nintendo consoles until a USB adapter was released in the middle of the WiiU life cycle. This adapter is also compatible with the current console, the Nintendo Switch, and has given the GameCube controller the longest period, currently, of being supported by current hardware. Runners-up include the Sony Dualshock 4 and the Xbox One controller, which are backward compatible and brings us to the subject of longer console generations. Generations have been getting longer for the most part consistently, due to the aforementioned business model of selling expensive, powerful, hardware at a loss while profiting on software.

Problem Statement

How can we use modularity to encourage sustainability through repair and waste reduction in long lifespan products?

Project Overview

The initial stages of this project were focused on fitting modularity into an archetypal controller. Starting with a clay model of a traditional controller shape (Fig. 2), I moved onto

Figure 2

Early Iterations of The Controller Design.

sculpting and 3D printing other traditional controller shapes, taking inspiration from and amalgamating various designs from Nintendo, Sony, and Microsoft. Later on, these manufacturers would be used to benchmark what necessary features and input methods need to be incorporated into the final design. I chose the design seen in the center of Fig. 2 a traditional controller with room for modules, with the square shape being a placeholder at the time, but chosen due to having defined orientations (only being able to place it in four ways, every 90 degrees). This sparked a conversation with my program director which caused a change in design philosophy. To paraphrase Alex Lobos "[I was] currently designing from the shape inwards and ending with modularity, [I] should try designing from the modularity outwards." In other words, I should focus on the interactions of modularity first and let that define the shape.

The next iteration was a controller inspired by "bus modularity", with a central bus that held onto all of the modules that contained an input method. This design turned out to be the foundation that informed the direction in which this project would evolve. Issues with this design that needed to be resolved were the strengths of connections and the superfluous nature of the optional handles. These would be resolved with a peg system and a modular bus that could be changed in future iterations. What was carried over was the method and design philosophy of module construction. Modules were designed around standardized parts (component sharing modularity), with the construction method lending itself to ease of disassembly and repair. The

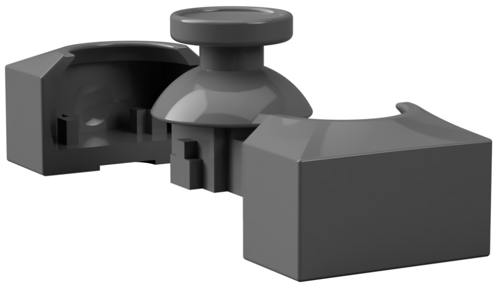

Figure 3

Assembly of the Thumbstick Module.

more “tech savvy” users would have the option of repairing their modules, with other users could opt to replace just the broken module and reduce the amount of waste produced because they did not have to replace an entire gamepad. Furthermore, if a user would be inclined, the method of assembly would lend itself to the easier separation of electronic waste and plastic waste.

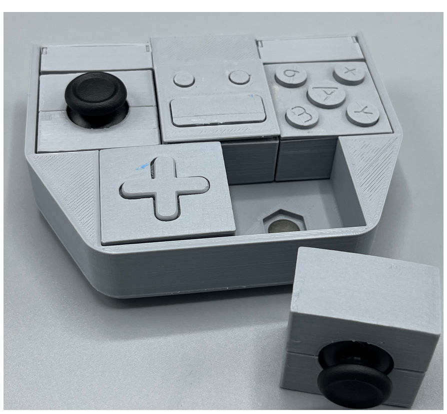

Figure 4

Penultimate Iteration.

The next iteration of the modular controller added more secure pegs, and a brim that stopped parts from moving during play and removed the handles. This design was then used for user testing.

Out of a group of 16 interviewees who were mostly gamers in their 20s, the most frequent answer for" number of controllers owned in the last five years" was two and six. These gamers primarily played using a controller. During the end of the life of their peripherals, most interviewed gamers would currently keep and sell their controllers after they are done using a given console, as opposed to throwing it away or giving it away, and would most likely throw away a broken controller, with the next most common answers being a tie between keeping a broken controller and repairing it themselves. Reception of the modular features of this controller was positive, with some of the negative feedback being that the controller was too "brick-like" (this was a small minority, with many believing that the "retro" shape was actually comfortable) and that some corners were hard. Overall receptions of the modular features were overwhelmingly positive, with some notable one-off comments being that everything had to be pulled apart to be disassembled and that some basic pragmatic features needed to be added such as up and down orientations for the modules, start and select buttons, a larger touch pad, different button layouts, and inputs for wired connections to the console or PC. Other important comments were that it was good for users with smaller hands, who are often neglected in this product space, that suggested configurations should be included in the retail package in the manual, and it would be good for different genres of games. One interviewee made a configuration they believed players of the platform fighter genre would love.

With this feedback in mind, I refined my model further into the final iteration (Fig. 5).

Figure 5

Final Iteration of Modular Gamepad.

This design features improvements informed by my user testing. These include giving the modules an up arrow so that they have defined orientations. This arrow would also double as an indicator light to confirm if the module is plugged in, which would also assist in troubleshooting a broken module. The defined orientations would, in addition to “left” and “right” indicators for the thumbsticks, would give the user options to invert controls with just a flip of the module and experiment more with the placement of inputs such as movement (left stick on most games) and camera control (right stick on most games). The top edge was also further rounded to give a more comfortable transition, and the start, select, and home buttons, in addition to a USB-C input were added to their own modules rather than being a part of the bus. The final product is a fully modular controller that is customizable for different players and genres, allowing for tweaks for comfort and increased performance. This design took into account feedback from user testing that further user feedback revealed to improve usability and comfort.

Conclusion

Modularity is an excellent tool that can be used to make a product more sustainable. From its ability to support streamlined manufacturing processes to its ability to aid in longer product lifespans, sustainability is a powerful way to design for lower environmental impact and stronger user experiences. Modularity can increase product lifespan through ease of repair, and with the permanence of plastic the products are made to last. This can be supported by products where it is advantageous for manufacturers to give a product a long retail life. An example of a product like this is video games, which are supported by users who support hardware long after a retailer stops, and who rarely throw paraphernalia in the trash. Backward compatibility is also a key feature to supporting hardware, with it also being vital to support new input methods in any controller a designer wants to have a longer lifespan.

The key to ending up at my final design was to “design from the modularity outward”. This meant that I had to stop focusing on making modularity fit into a traditional shape and let modularity define my shape. Once I did this, I was able to properly come to a form factor that allowed me to diagnose problems and use those problems to refine my design. User testing allowed me to find and diagnose more issues with the controller. My final design is focused on modular functionality, with a resulting retro shape and the ability to fully move modules and completely customize the configurations.

Further development of this project will include a retail model that allows the user to purchase each component separately, cardboard packaging that will double as storage for spare modules, paperwork that will have suggested configurations, and more module options in addition to the ones that are strictly necessary. These modules will include a stick design with extended levers for more precision, concave and convex sticks, and different button layouts. Other important considerations would be more options for modular buses, with different grips, sizes, and motion control features.

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