

AUTOMATION OF A FORMULA SAE CLUTCH
UNDERSTANDING THE REASONS BEHIND UNIVERSAL DESIGN

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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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Reasons Behind Universal Design and its Application in FSAE

Universal design is the engineering and design process in which a product is designed with the intent for all people to be able to use it. An example of this is the design of a door that has an automatic opener for handicap access. Due to the fact that universal design is not a widely accepted design process, many sectors of industry do not design universally usable products. One of the most major culprits of this is the automotive industry, specifically in the design of manual transmissions. One of the limiting factors for universal design in a car is the manual transmission. This type of transmission requires the use of a clutch pedal, which adds a third pedal to the car and requires a large force to operate it, usually 25-75 pounds of force (Zhang 2012). Currently manual transmission cars are becoming a novelty luxury item that only true car guys purchase. Automatic transmissions have taken over the industry since their creation due to ease of use and smoothness (Wheals, 2002). However, manual transmissions are quite a bit better in most categories. Manuals are much cheaper to manufacture and service when compared to other types of transmissions. They also are much better at transmitting power and preventing parasitic loss, which is the loss of power due to internal friction, and makes them the top choice of transmissions for performance car enthusiasts (Beckman, 2019). Because of these unique conditions, most people would not consider universally designing a clutch for a manual transmission to be an issue because they would just suggest that people who could not operate a clutch simply buy an automatic transmission. This suggestion would work, but unfortunately it's one that leads towards the further disenfranchisement of people with disabilities. The disenfranchisement comes from the fact that people with disabilities should be able to have the same options as everyone else. As manual transmissions become the standard for the cheapest transportation available as well as the top choice for performance enthusiasts, people with

disabilities should not be relegated to an automatic transmission just because of an automaker's lack of universal design.

Automated Clutch System for FSAE Car

The function of a clutch is to engage and disengage an engine or drive unit from a drive system. This is accomplished by using a pressure plate which imparts force on a friction disk. This force causes friction between the flywheel and friction plate in order to transmit torque and rotation through the assembly. The force required to disengage this spring is extremely high, usually between 1000 and 3000 pounds. In order to make the clutch a usable part, the force is helped by mechanical advantage so that the force is reduced down to between 25 and 75 lbs. This allows the driver to control a large force and allow the clutch to slip while it engages in order to start moving from a stop. The clutch must be used when starting and stopping the vehicle as well as in between each gear change. The destabilizing condition that my work addresses is that manual transmissions are spreading from a common option on vehicles to the fringes of the industry. The vehicles equipped with manual transmissions are either the cheapest vehicles made or the manual transmission is a luxury option for purists. Manual transmissions are much cheaper to produce and fix as well as being a simpler design which makes them more durable. “Manuals are still found on less expensive cars. — the transmissions themselves are cheap to build and easy to fix. There are also some performance car brands that stock at least some of their cars with manuals to please the purists” (Roberto, 2020). At the other end of the spectrum manual transmissions are more desirable in performance oriented vehicles as they have a lot less parasitic loss of power due to friction. Due to the nature of an automatic transmission, it is prone to slipping and power loss. As a result, most professional racers use a manual transmission as it provides more control over the car. Currently, manual transmissions are on the decline in average

cars and are only found in the fringes of the market as performance and economically based cars (Ulitskaya 2021). Some cars are only offered with a manual transmission due to the nature of the vehicle. “Predictably, the three-pedal holdouts proffer stick shifts either as a cost-saving feature on affordable trim levels or a purist’s choice among performance cars” (Ulitskaya, 2021). The trend for removal of the clutch and shift to automatic transmission has been growing in popularity in recent years. “In the past four years alone, the percentage of new U.S. vehicles sold each year with manual transmissions has slipped from 19.9 percent to 12.2 percent, according to industry consulting firm AutoPacific in Tustin, Calif” (Rechtin, 2000). The technical work being done at UVA closely parallels work done by the University of Michigan. The University of Virginia’s approach will work because of the simplicity of the design and the engineering behind it as shown in figure 1. The challenges faced by our design team will be due to the design portion of the process as well as being able to find components that work for the application and are within the budget. The deliverable will be a system that activates the clutch of a manual transmission with the push of an electronic button.

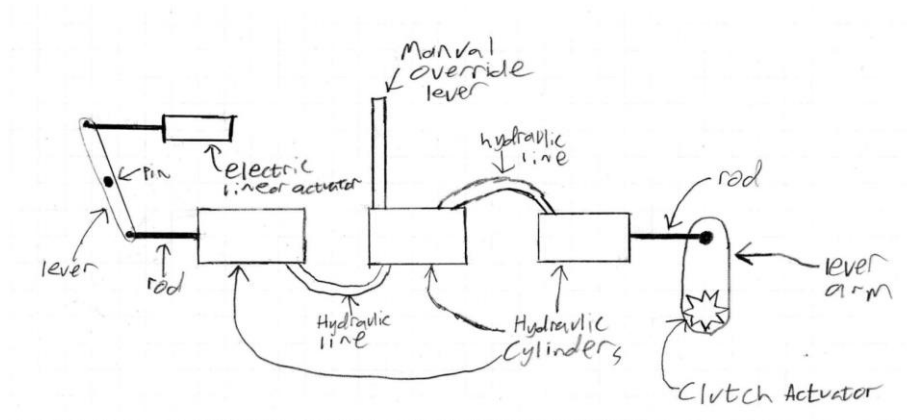


Figure 1: Design of the universal clutch actuator to be build by students at the University of Virginia

What Causes Universal Design in Engineering

Universal design is the process of engineering and designing a product that is able to be used by everyone including fringe users. This engineering process has not been a major factor in design until recently (Williamson 2012). The usage of universal design is not just a random occurrence since it does require quite a bit more time and effort to design a product universally so it must be caused by something. Some products have started to be universally designed around the early 1990s. These products were mainly infrastructure. Around the early 1990s, civil engineers started to design buildings and streets with universal design. Examples of these designs range a lot but at the most basic end they include ramps at the end of crosswalks and automatic doors at the entrances of buildings. In the nation's current condition, there are quite a few destabilizing conditions that warrant the use of universal design. Currently “more than one billion people worldwide live with a disability that could inhibit their ability to access a building or infrastructure. Looking at mobility issues in the U.S. alone, there are about twice as many people with mobility disabilities as available wheelchair-accessible housing, according to a 2020 analysis by online realtor Apartment List” (Lowenkron, 2021). This very clearly illustrates the need for universal design to become a staple of engineering design. There are many more examples of this problem, especially closer to home. For example, the University of Virginia has a wide diversity of students and some of them have disabilities but the University still has not incorporated universal design into its infrastructure. Specifically, for a student at UVA who had a class in one of the historic buildings on grounds it was easy to see how big of a problem the lack of universal design was. In order for her to enter the building she had to open two doors in opposite directions all while trying to operate her wheelchair. She requested an automatic door opener, but because of the historic building she was asked to withdraw her request due to the fact

that pieces of the historic building would have to be replaced to install the automatic door (Dhyne, 2018). Another example of how there is a lack of universal design at UVA is brought by another student who uses a wheelchair who brought up the point that most people with disabilities cannot streak the lawn because there is no handicapable ramp connecting the different tiers of the lawn (Heuser, 2019). These students are just a sample of the stories that occur everyday due to the lack of universal design and also illustrate the consequences of not fixing the problem. On the other hand, there are examples of how universal design has positively affected infrastructure. In Sonoma California, a group of engineers has universally designed a small living community specifically for people with disabilities. The great success this community has shown is the exact reason why universal design is such a good way to design products and how it can positively affect the community. Another way of trying to frame the problem of why universal design is so lacking and what causes it is through Actor network theory. This is by placing the designing engineers as a set of actors along with people with disabilities as another set. Many networks between them exist but by analyzing all of the networks the one that is closest related to designing products specifically for people with disabilities will be the cause.

Deliverables

The deliverable of my technical work will be a system that can mount to an existing manual transmission and activate the clutch at the push of a button. The deliverable of my STS research will be a paper that explains the reasons behind the use of universal design and the factors that insight it that is well backed by numerous credible sources. I will also leave the STS research process with a better understanding of universal design and how to apply it to better include people with disabilities through universal design. When these deliverables are successful

it will allow for people with disabilities to have the ability to use a car not designed for them and will give them a better choice in vehicles. It will also help with teaching new engineers to design products using universal design which will continue to strengthen and impose the University of Virginia's core values of engineering.

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