Electric Skateboard Regenerative Braking
Ethics Document

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Summary:
The electric skateboard has exponentially increased in popularity, quality, and capability in recent years, proving itself valuable to everyone from college commuters to professional racers. While there are many great electric skateboard brands out there, we believe there is still significant room for improvement. First, most electric boards with regenerative braking don't allow the rider to brake when the battery is full (bad for starting a commute down a hill) or when too much current is generated (bad for really steep hills). Our team seeks to resolve this issue by designing an electronics system that will redirect the excess current under braking away from the main battery.

The next issue concerns the trucks (which control steering sensitivity). Normally, a rider has to manually adjust the skateboard trucks. If the trucks are loose, the board will be highly maneuverable at low speeds, but will be incredibly unstable at high speeds. Conversely, if the trucks are tight, the board will be stable at high speeds, but hard to maneuver at low speeds. Our team seeks to resolve this by developing a system that will autonomously adjust the trucks while riding according to the speed of the board or input of the rider.

Our project is broken down into two separate but equally important parts. We will be building two prototype boards. One board will primarily focus on the entrepreneurial aspect of our project. Existing parts will be bought where available so that the focus of the board can be on the regenerative braking capabilities as well as the automatic adaptive truck system. We will be focusing on making this board as competitively viable as possible, while putting considerable effort into an easy to install, separate system which will control the truck adjustment.

For the second board, we will be using a larger board itself, and the primary focus will be to build as much from scratch as possible. We plan to learn as much as possible by building from the ground up. This should allow us to better understand the power system, the motors, and the speed controller. This means we will be building an open source ESC that suits our purposes as well as designing the controller. The first board will use a prebuilt ESC as well as a controller so that we will be able to focus more heavily on the improvements, while the second board will be focused on learning.

Why is This Project Important:
While electric boarding is thrilling and practical, it can be very dangerous. In 2012 alone, 5 people in the US and Canada died from electric skateboarding accidents. Furthermore, many riders have been seriously injured from the inability to brake down hills and from improper steering sensitivity in the trucks. This project, if implemented well, has the potential to vastly improve the safety of electric boards by addressing the above problems, which could literally save lives.

Volkswagen Scandal:
Starting in 2004, legislation started being created increasing the restrictions on the amount of nitrogen based pollution cars could emit. Diesel cars were more heavily affected since they produce approximately 20 times the amount of emissions of nitrogen oxide compared to non diesel cars. The current catalytic converter technology was not advanced enough to compensate for this amount of emissions. By 2007, Volkswagen announced that they would be suspending sales of their current diesel lines until they could figure out how to meet these new standards. By 2008 they announced their new line of Clean Diesel cars, which sold very well and won multiple environmental awards and tax breaks.

In September of 2015, the United States Environmental Protection Agency issued a violation of the Clean Air Act to Volkswagen. Volkswagen had intentionally programmed their Clean Diesel engines to deliberately reduce emissions by 40 times the normal amount when going through laboratory emissions testing. They immediately claimed that it was due to technical problems, but after being confronted with evidence of their deceitful practice and threatened by the EPA to withhold certification on their 2016 line of diesels, they eventually admitted to intentionally creating the software. The company has reportedly suffered over $30 billion in fines to date along with a prison sentences for multiple of the Volkswagen executives in charge of the emissions department.

The majority of the ethical dilemma occured within the Volkswagen company. The public simply believed they were driving environmental award winning diesel vehicles, and the emission regulators had an obligation to reduce the overall amount of pollution cars were creating. The executive level of Volkswagen faced a multi-agent dilemma. When the company suspended sales of their diesel lines, they were under a large amount of pressure to quickly create a solution to their high emissions. If they were unable to come up with a solution quickly, they would have no choice but to start laying off their employees. They also faced the moral dilemma of upholding their commitment to adhering to the environmental regulations created to reduce the amount of pollution in the air. The company conveniently chose the option that aligned with making the most money, and ironically had to lay off over 30,000 employees amidst their proceeding scandal consequences anyways.

The employees of Volkswagen also suffered from a prohibition ethical dilemma. Once the decision to falsify the emission testings were made, there would be many opportunities for a whistleblower to reveal the plan to the public. Whistleblowing is a classic engineering ethical dilemma in which the duty of the engineer is to report relevant authorities of their employer's failure to comply with rules and regulations, especially when public health and safety is involved. While it is uncertain how many employees would know about the deceit in order to install the software in the vehicles, it is clear that the Volkswagen company most definitely would have terminated any employee to betray them. Not all employees would suffer from this ethical dilemma, but the ones with the knowledge of the deception would have to choose between keeping their jobs or lying for their employer.

Although rules, regulations, and fines are great at establishing and enforcing environmental standards for the greater wellbeing, it does not solve the ethical dilemma faced by the executives and employees of Volkswagen. The Volkswagan scandal was most likely to be prevented by the employees who created and installed the emission cheating software into the vehicles. To alleviate their ethical dilemma and to prevent a similar situation from occurring in the future, rules could be put in place to protect employees who whistle blow on their employer. A stipend could be granted to any employee who loses their job as a result of bringing to light any illegal actions created by their employer, or it might even be desirable to go as far as offering a reward for such exposure. However, whistleblowing by professional engineers often results in the courts siding with the engineer, and overrules any duties or confidentiality to their employers. Therefore, it could be concluded that a majority of companies as a whole place profits above many moral standards, so it would be in the best interest to impose heavy fines as repercussions and try to strip the companies power over being able to cover up such a scandal.

There have been several consequential actions already taken as a result of the Volkswagen emissions scandal. One indirect consequence was that immediately preceding the news of the scandal, Volkswagen's stock dropped by approximately 40 percent. Between fines in numerous countries, vehicle callbacks, and compensations, Volkswagen allegedly spent over $30 billion dollars as a result of the scandal. One peer review study also estimated there were approximately 59 deaths caused by the pollution of the diesel vehicles in the United States alone. Although several engineers have been identified as knowingly designing and installing the software, only a few parties have been criminally charged. James Robert Lang, an engineer who helped create the system, admitted that there were several other employees who were responsible for the creation and installation of the software. The ethical dilemma and the matter of correcting the situation becomes much more complicated with the addition of potential and uncertain casualties as a result of the pollution. More arrests could be made for anyone who knowingly worked on the system that caused these potential deaths, although it may be hard to prove mal intent over ignorance. Historically, convictions of executives and engineers has not affected the stock price of Volkswagen. Lastly, Volkswagan could be made to directly offset both their environmental impact of their scandal as well as the negative impact of the public's health by creating carbon credits and by providing a public health service, instead of solely paying fines which might end up in another company or politician's pocket. It could even be argued that such repercussions would be beneficial to stockholders.

Regenerative Braking Electric Skateboard Ethics:

The largest area of ethics in which our senior design project is concerned is the area of safety and welfare of any of the users of our project. The team has put considerable effort into determining the safety requirement for the project, and will complete several rounds of testing throughout the project. When creating a personal electric vehicle capable of traveling over 30 miles per hour, the largest element of safety involved is the stability and reliability of the transportation. It is important that we provide proper safety gear when testing the project ourselves as well as to anyone outside the team testing the project as well. It is also crucial that all braking and stability features are thoroughly tested before anyone rides the eclectic skateboard. Smooth acceleration and braking are essential basic safety features so that the rider will not be thrown from the board. The brakes must also remain nearly perfectly reliable to allow the rider to come to a complete stop. And finally, in the event of a critical failure, it is imperative that the system completely shuts off automatically so as to not get stuck accelerating.

Safety must also be highly prioritized during the assembly and production process of our project. In particular, the lithium ion battery cells which will be manually spot welded together pose a potential fire hazard, and will be stored in a public setting. This provides an additional ethical safety requirement to verify the integrity of this battery system. Lithium ion batteries are usually highly tested and considered very safe. Most problems occur in extreme temperatures or when the cells are damaged which can pose a potential fire hazard. Lithium ion battery fires are classified as class B flammable liquid fires, and as such, can be extinguished by a type ABC or BC fire extinguisher, but cannot be extinguished using a type D. Sand and water are also effective at extinguishing lithium ion fires. As such, a proper fire extinguisher will be present for all assembly and testing needs.

As an entrepreneurship project, our team must also uphold the ethical areas that come with running a business and selling products, even if there are currently no plans to sell the project. As part of the project, customer outreach must be completed, market research must be conducted, and a business plan must be created as if the project has the desired outcome of becoming a publicly sold product. This means that we need to adhere to engineering ethics of only interacting with the public in a truthful and objective manner.

Alongside working with members of the public comes working with several advisors and supervising professionals, whether they specialize in an area of engineering or in business. These advisors should be treated as employers or clients, as they are the ones providing guidance and direction to our project. As

clients, it is our responsibility to treat them with respect and act in a professional manner when working with them on our project.