The body of work in my portfolio pertains to technical discretion in the development of road safety measures, with my technical project involving an active approach to improving road safety and my research project discussing both an active and passive approach to addressing the same specific road safety concern. My research project explored the effect of virtual instruction during weather-related school closures in K-12 on the quality of a student's life, through that lens comparing an active technical approach, the implementation of online learning schedules, and a passive approach, the temporary cessation of instruction, to eliminating the need to drive in unsafe weather conditions. My technical project developed a trailer hitch attachment allowing motorized lateral movement of the hitch connection; the physical capability of the developed prototype was limited to improving trailer maneuverability by reducing turn radius, but there was an additional emphasis on the future improvement of trailer safety, with high powered versions of the device theoretically capable of mitigating trailer sway and thus pertaining to active improvement of road safety.

My technical project aimed to develop a trailer hitch attachment to address two issues with trailer operation. The first is maneuverability; attaching a trailer to a vehicle increases the vehicle's turn radius, making it more difficult to fit into tight spaces. The second is safety, with trailer sway, the motion induced oscillation of a trailer, causing 39,000 accidents annually in the U.S. The developed prototype of the attachment used a sensor to detect the angle between the truck and the trailer, which determined the lateral motion of the hitch, which was mounted by rollers to a beam and moved by a motor that took control input from the sensor. The sensor and actuator were designed to be powered directly by a typical truck, receiving power from a standard 7-pin output. The prototype was built with the same geometry on either connection end as a standard 2-inch-ball hitch, making it compatible with most small-scale trucks and trailers.

While the design of sensor mounting and motor-to-hitch-ball connection fell short of allowing the device to operate independently of user input, the motorized lateral motion of a small, unloaded trailer was successfully demonstrated and shown to reduce the turn radius of the vehicle. Sway mitigation was not physically addressed due to safety and feasibility concerns, but a simulation was developed that successfully demonstrated the theoretical capability of the device to mitigate sway.

Since schools' increased familiarity with virtual instruction during extended school closures due to COVID-19, it has become a go-to mode of continued learning during weather conditions prohibiting physical school attendance. My research project investigated the effect of this development on K-12 students' mental health, enrichment, and quality of education. I conducted literary research to understand the perspectives of key professionals like psychiatrists and school administrators. I conducted a survey among adults mostly of college age to build a representation of the student perspective on the value of the rest and specific experience provided by a spontaneous school closure and the perceived effect of adding online learning to this experience. I also interviewed Winchester Public Schools superintendent Jason Van Heukelum, who discussed the process of striking a balance between sympathy for the student experience and maintaining an emphasis on the urgency of learning. I concluded that weather-related school closures should not be fully replaced by remote learning but that a balance between traditional and remotely-engaged cancellations is ideal. I found that between teaching virtually on canceled school days and making up cancellations at the end of the school year, there is no clear educational advantage to either, but many school districts are ill-equipped to guarantee that e-learning poses no disadvantage to students with limited internet access.

While my technical project did not achieve all physical objectives, falling short in terms of system autonomy, it demonstrated efficacy in mitigating the focal issue of maneuverability. Further development of this technology should focus on tuning the actuation response to different steering patterns to optimize maneuverability improvement in variable circumstances. While the technology was shown in simulation to be capable of improving trailer sway, it is not expected for further development to yield a fully practical solution, as an implementation of adequate scale would be much more expensive than effective technologies that already exist for this purpose. Rather than a fully electronic approach, future development of sway mitigation technology might be more effective if focusing on variable activation of already available passive damping technologies. My research project was able to confirm that a balanced approach to teaching during school cancellations is likely ideal, but did not make much headway in determining the optimal distribution of that balance. Research into the balance should prioritize characterizing the preferences of students in a manner similar to but broader than my survey. Further research should also investigate the quality of virtual education in temporary formats.