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Final Written Thesis
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The Necessity of a Solution on Future Road Confusion - Autonomous Vehicles

Introduction

According to the ASIRT, driving has always been a significant issue for human death as *nearly 1.25 million people die in road crashes each year, on average 3,287 deaths a day*. The industry has come up with several potential solutions to the issue but frequently failed because of human errors. The NHTSA also claims that both unconscious physical and psychological mistakes are from humans, not from the machine. Between now and 2050, the road would be full of confusion as the manual cars and autonomous cars would be there at the same time. *The Driverless era will indeed come, however, as long as the whole world does not get rid of the old cars and change them to full Autonomous vehicles in a day or so on the road, the danger still exists*. I assume there will be a “transition period” when people slowly recognize autonomous cars to be a trend and move on. But we have to prepare and be aware of this period because the pedestrians and drivers would not know which car and who to trust on the road, in other words, people would not know exactly if the other person is driving or not. Addressing this issue, I will be designing an urban environment of the transition period on a 3d modeled urban environment to display how the communication design and technology work. It is a speculative design that suggests a solution to the road confusion when the world is transitioning to the Autonomous technology on the road in the near future, especially to the drivers who are interested in investing in the Autonomous industry. Throughout the project, I'd like to address the problem of future Autonomous vehicles' interaction with each other on the road. Which car is partially Autonomous, fully Autonomous, or none?

Contextual

Based on the technical research, I had an interview with the automobile industry expert Parrish Hannah, the founder of *movotiv*. Mr. Hannah mentioned that the driver's distraction was the major issue of why autonomous vehicles became the solution.¹ The human errors were too broad and wide for the researchers to consider. Among all the distractions, he claimed that the most dangerous act that people risk to do was texting because it distracts not only your physical hand, but also your mind. The situation depends on the content of the texts, for instance, if the text told the driver about a serious issue, he/she will definitely get distracted no matter what. Then the text becomes a matter as it will cause dangerous situations by blinding the drivers' awareness.

¹ Hannah, Parrish. A Founder of company Movotiv. Expert Interview. Nov 18th ,2019

Tesla and Uber emphasize AI and machine learning technology to be embedded in their self-driving car projects. They focus on technology to make sure not to harm people. I asked how the current industry's aim is on future cars and roads. Mr. Hannah answered the question without a doubt that the industry declared the solution to every problem on the road to be the driverless cars and Driving Monitoring system. The conversation gave me an insight of thinking about the road confusion, considering every case of the scenario such as what if people cannot afford to buy the updated cars? Or what if people own different Autonomous vehicle models?

Why? Human Behavior When Driving

The text, *Recent Trends in Driver Safety Monitoring Systems: State of the Art and Challenges* by Arief Koesdwiady states the human errors mostly occur when the drivers are waiting, similar to Mr. Hannah's claim. Situations like traffic congestion, or waiting for the pedestrian. They are normally looking at their phone or doing outside activities while waiting for the moment. This causes the drivers to lose instant attention to the front and the sides, causing accidents.

“In addition, in terms of complexity, distraction may also be partitioned into three levels: simple, moderate, and complex. However, crash risk due to distracted driving is affected not only by the types of distraction or the complexity levels but also by the frequency and duration of the distracting actions. In other words, frequent simple distractions may have similar effects as complex distractions. Subsequently, certain distraction activities can be categorized into two or more distraction types. For example, text messaging can be considered as visual, manual, and cognitive distraction since the activity involves the driver's vision, hands, and mind.”²

The Association for Safe International Road Travel indicates that *nearly 1.3 million people die in road crashes every year, with on average 3,287 deaths a day*. According to the United Nations, more than half of the world's population lives in cities. It is obvious to see what will happen in the future on the road. Following figure suggests how the human errors occur:

² Koesdwiady, Arief, Ridha Soua, Fakhreddine Karray, and Mohamed S. Kamel. “Recent Trends in Driver Safety Monitoring Systems: State of the Art and Challenges.” *IEEE Transactions on Vehicular Technology* 66, no. 6 (2017): 4550–63. <https://doi.org/10.1109/tvt.2016.2631604>.

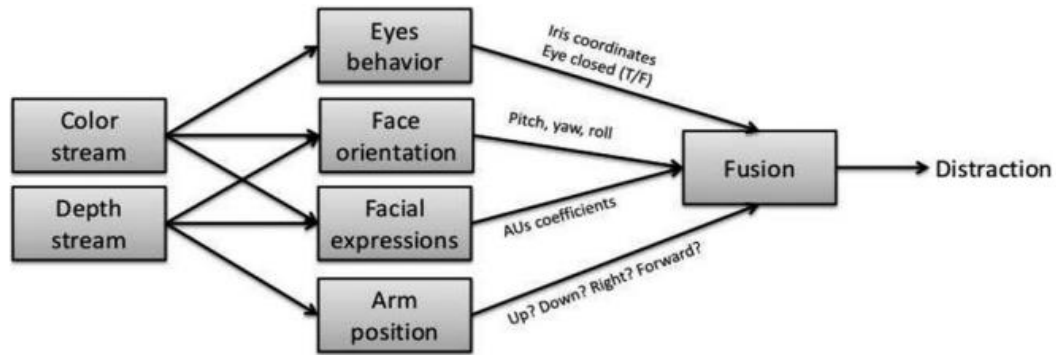


Fig. 4. Context-aware driver status assessment systems [18].

Imagine how the transition period would be. Current research shows how dangerous the roads are. *What if a full Autonomous driver trusts his vehicle and is not aware of the road situation while there are manual or partial Autonomous drivers at the intersection?*

How? Industry's Approach to the Solution

Arief Koesdwiady's text strongly suggests the Driver Safety Monitoring Systems which is basically about autonomous technology as a solution. The article demonstrates potential possibilities of how the vehicle and the driver will change due to the smart city development as the city will then require to know all the traffic systems and nodes. She suggests the Driver Safety Monitoring System to be the major key to solve the casualties on the road by gradually putting a computer on wheels, the self-driving will gradually disappear with the advent of utilized Internet Cars.³ The theme of this article directly suggests a solution, although it is somewhat futuristic, an autonomous car connected to the city traffic nodes, to the issues of car accidents and pedestrian danger. As the Driver Safety Monitoring Systems describes how the shift of the whole road system will improve the situation, the process of solving the issue becomes too complicated. The text focuses on the system, society, and current rule, suggesting a utilitarian road in the future, however, it does not show how individuals can have benefits. Restricting the road with technology would improve the safety aspects on the road, however, this is only an assumption of driverless cars on the road and drivers becoming a rider.

We certainly cannot cover all the potential victims of the accidents today because there will still be people who drive or walk the road when they are drunk, high, aroused, sleepy, etc and this issue will continue in the future as long as human drives. If we cannot control our emotions, we are not able to solve the solution at all even though we have a monitoring system in smart cities. Therefore, in order to avoid distraction, restriction of laws on the road is inevitable. Then what could be the laws? From the reading, my inspiration was "What if unifying the road

³ Koesdwiady, Arief, Ridha Soua, Fakhreddine Karray, and Mohamed S. Kamel. "Recent Trends in Driver Safety Monitoring Systems: State of the Art and Challenges."

system globally?” I thought if the world and the automobile companies share the same color, symbol, sign, or even sound of the autonomous vehicle, it will be easier for pedestrians and other drivers to communicate easily, to know what to avoid and what to trust. For instance, a triangle shaped symbol on the exterior of the car means that the driver is in full autonomous mode.

Where Are We Headed?

Mike & Maaïke’s *Autonobile* project⁴ which suggests a scenario that people will no longer have to drive and the driverless culture will be the trend, as if the assumption was the ultimate solution.



Autonobile

Rebutting the idea, I believe that autonomous technology will not solve the human error issues in the near future. It will take time, and we will encounter a lot of problems to fully implement them into our society, same happened in the past when engineers worked on to create “horseless” carriers. The *Autonobile* project has inspired me to think of the scenario of the future road. It helped me think about the process of the whole hype, instead of the result as what Mike and Maaïke did. The result, full autonomous vehicle, seems the ultimate solution however, we should understand the sacrifice and loss we have to pay in order to achieve. It gave me an opportunity to think about how the world will be changing its vehicles.

I would also like to talk about the *Bus Rapid Transports* project by designer Emanuel Papageorgiou. The whole project demonstrates a potential University of Michigan Ann Arbor Campus Transportation system; there are newly designed transportation hubs, vehicles, and routes of the university, suggesting a new approach to the current state.

⁴ Mike and Maaïke. “The End of Driving: Introduce the Autonobile.” n.d. Core77. Accessed November 18, 2019. <https://www.core77.com/posts/13908/The-End-of-Driving-Mike-and-Maaïke-introduce-the-Autonobile>.

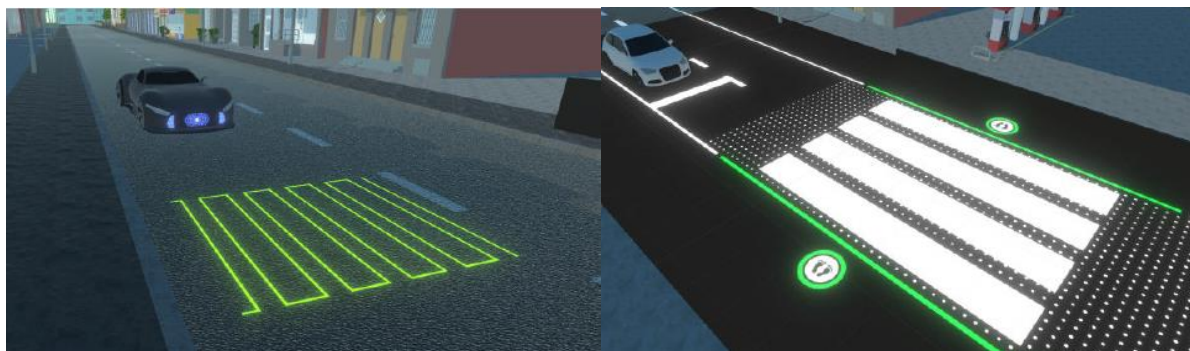
⁵ Papageorgiou, Emanuel. Cooper Hewitt Smithsonian Design Museum, *The Road Ahead: Reimagining Mobility Exhibition*. U of M. 12. 14. 2018 - 03. 31. 2019



The Road Ahead: Reimagining Mobility

I was inspired by the whole *system* he created for the project and how he displayed them. I realized that the infographics of the whole concept helps the audience to understand the artist's idea much better. His approach with sketches, maps, and how it will work has deeply influenced my project to be more informative and concise on the explanation of the future road confusion. I will be creating a specific city intersection with the interactive cars to explain the situation I'd like to solve throughout the project.

Löcken introduces the idea of “interaction and communication” in his text at the environment on the road. He makes an assumption of how pedestrians would be limited to communicate and interact with the drivers on the spaces such as crosswalks. Andreas uses Unity and Unreal Engine to create an environment where he shows all the User Test cases in 6 kinds of scenarios he assumed. He explores the scenario with the Oculus to generate a "realistic" experience for the users.



“The setup in which the display concepts were evaluated. Participants were instructed to cross the street without right of way in front of an automated vehicle, whenever it felt safe. The walkable area was about 9 x 2 m, and allowed the participant to cross the road completely. Left: what the pedestrian saw in virtual reality, here, with the F015 concept. Right: the real world.”⁶

The whole project observed effects on safety, trust, and user experience. A good concept displays information on the street, uses unambiguous signals (e.g., green lights) and has high visibility.

The examples that Löcken shows with Virtual Reality are cars showing driver’s emotion with emojis, LED strips, Sound alerts, etc at the crosswalk. The authors of the paper describe how “display” is the key to communicate with pedestrians. From the inspiration, I have realized that the method he suggests could also be the key to the communication between drivers on the road who are in different cars. How do we recognize if the driver is driving or not? Full Autonomous vehicles might have a unique appearance as a lot of engineers have excluded unnecessary parts such as side mirrors. I have figured out that the key to communication is visual; the fastest and clearest way to deliver a message to the opponent with color, symbol, a simple shape, and etc.

Arriving to Road Confusion (Methodology)

Basic Concept

I had to shift the gears during the process of elaborating on my project, "Road Confusion." My concept was to display the User Experience and Interface of the Road Confusion in the future "inside the car." I've been working on the inside car interfaces by the autonomous levels. I've set up a scenario that in the future, the definition and concept of the autonomous levels will become more solid and defined; a scenario that when Fully, Partially Autonomous, and Manually cars are driven by people at the same time. This will cause a serious confusion on the road. This project is about the road confusion that would occur in the near future due to the advent of Autonomous Vehicles on the road. It suggests a potential solution to this issue and shows how the drivers and pedestrians will react to it.

Ideation

During the first semester of IP, I've focused most of my time on "how the users will interact with the car." If the users could manually control the autonomous level, then we could

⁶ Löcken, Andreas, Carmen Golling, and Andreas Riener. 2019. "How Should Automated Vehicles Interact with Pedestrians?: A Comparative Analysis of Interaction Concepts in Virtual Reality." In *Proceedings of the 11th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, 262–274. AutomotiveUI '19. New York, NY, USA

maximize users' driving experience on the road in 2050. Initially, I focused on the interior UI of the future cars.



Dashboard UI Design For each Level Cars - Dec. 2019

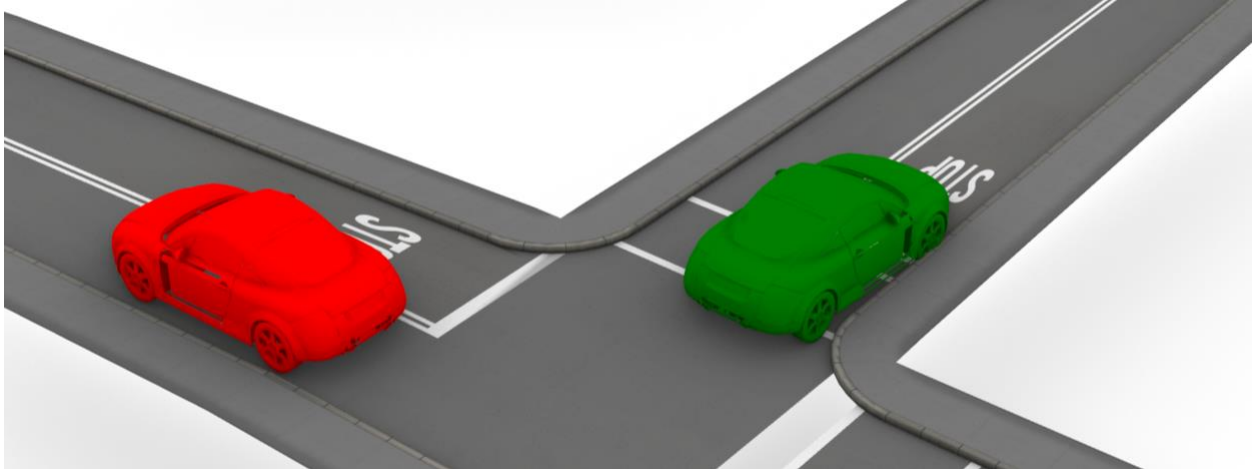
As the project went forward, I realized that I've lost track because I was designing a future car, not investigating the future road confusion. My idea was to portray how the roads in the future will have a problem, mixed with different car types and cause chaos to the drivers and pedestrians. But, this was targeting an individual having a better driving experience overall. Thus, I had to change my plans and go back from the start.



Car Exterior Prototype - Dec. 2019

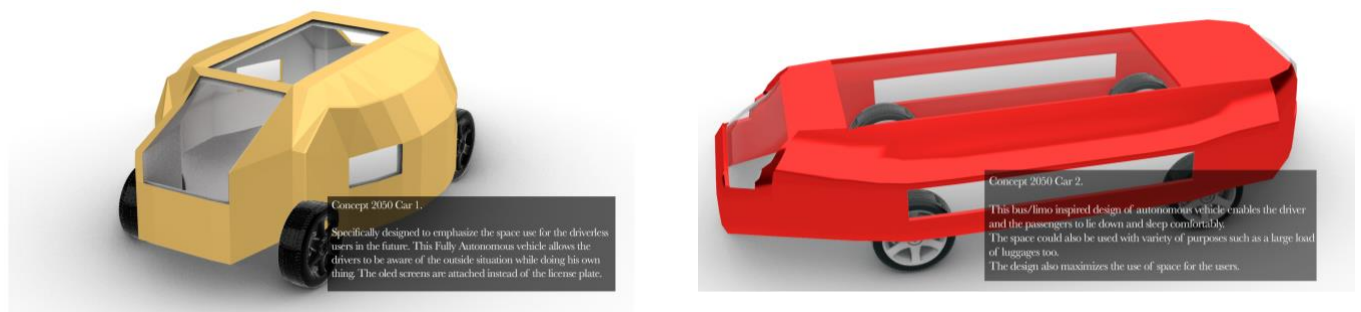
Prototypes

My focus changed from the individual's experience to the public; I decided to move on with the concept of the exterior of an Autonomous vehicle. **How can I design a method to communicate visually on the road at a glance?**



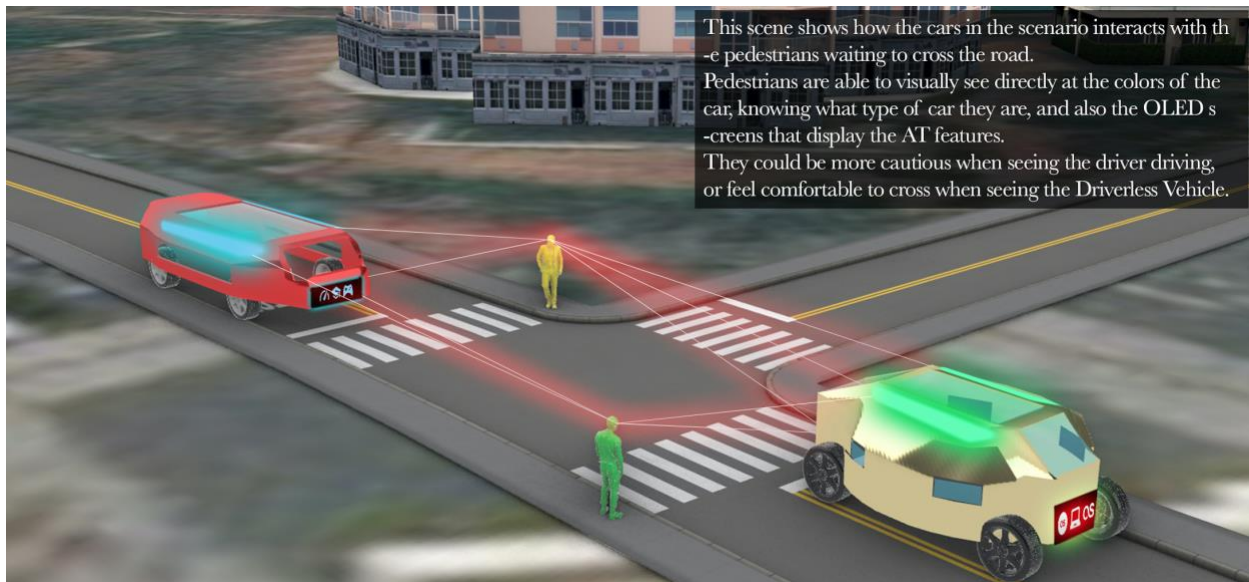
Car to Car Interaction Prototype - Jan. 2020

Instead of the User Interface design, I lean toward more on the environmental design of an Urban space such as Intersection area with a lot of cars, traffics, and pedestrians, where interactions occur the most. I specifically built an area where there is a huge mall, many residentials, and a lake, assuming that the population flow would be high because of the entertainment, resting area, etc.



Concept 2050 Car 1 and 2 Made by Rhino - Jan. 2020

Here, I wanted to set up a situation or a scenario where the audience can look at my project physically, interact with the 3D modeled car and see how the drivers and pedestrians, drivers and the other drivers communicate visually at a glance.



User Scenario, Drivers and Pedestrians Interaction - Feb. 2020

Visual Narratives

The futuristic designed car has three functions which are LED color, OLED displaying screen. LED is to notify the others of the type of vehicle whether it is manually driven or not. An OLED screen is to show what kind of autonomous feature the driver is currently using. For instance, the OLED screen will show that the driver is currently watching a movie and he has set up a one-lane feature with 50mph limit speed on his car. The function is enabled when a car is approaching nearby. If not, it will display the regular license plate. By these methods, I wanted to suggest a solution to the road confusion in the future to the users and make them aware of the scenario.

Throughout the process, I've learned that interaction is not simple. At first, I only thought about the interactions between the drivers on the road. However, not only the drivers but also the pedestrians were the ones who interacted with the vehicles. Therefore, I realized that the visual communications on the vehicles must have a design that could both deliver messages to the pedestrians and the cars at the same time, considering their locations. What if the person is on the left? What about the car behind you? Considering all these questions, I located the visual interactions at the place where it could be effective, but not lose the visual aesthetics as a car.

Creative Work

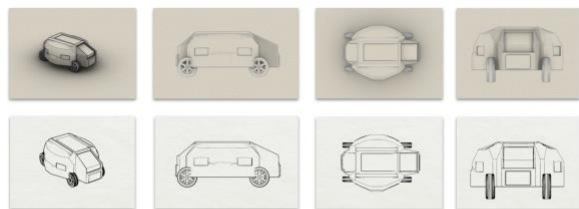
BFA Exhibition

Title : *2050s Road Confusion*

Medium : 3D Modeling (Rhino), Rendering (Vray), User Experience, Graphic Design

2050 Future Concept Car

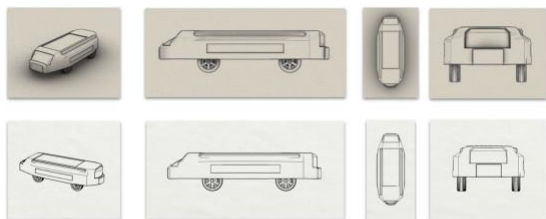
For the 2050 Future Concept Car, I specifically designed a vehicle that could interact with other cars and pedestrians. It simply has LED display lights depending on the car type. For instance, the designed car shown below is partially autonomous, so it has a blue LED light on its top facing both the left and right sides. It glows during the night time to make sure it could be seen in any circumstances and also from different angles. The reason why Manual Car has only the LED light is that it does not own any Autonomous features. I am including Manual Cars (even though 2050) because there will be drivers who want to enjoy driving. I am not excluding any targeted users in this scenario. Partially autonomous cars and fully autonomous cars have similar functions because drivers have less attention on the road compared to the Manual drivers and also considering the technological software that would be embedded in the Manual cars. They both have OLED screens, replacing the license plate and showing the autonomous features that are being used. It also has a vibration motor on the seats to notify if any different type of car is approaching.



2050s Concept Car
Partially Autonomous



2050s Concept Car- Partially Autonomous



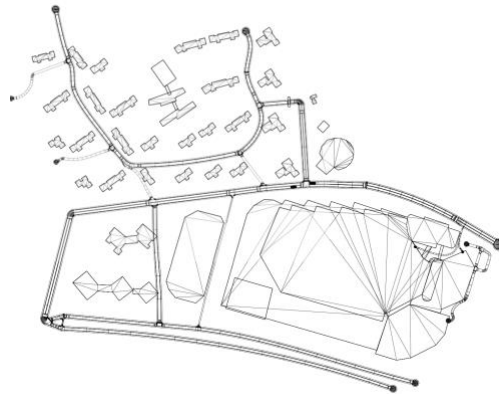
2050s Concept Car
Fully Autonomous



2050s Concept Car- Fully Autonomous

Urban Development - Intersection

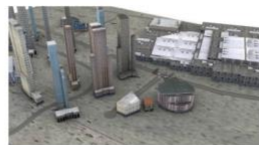
I had to create an Urban environment to have a place where the audience could be more convinced about the idea of this project. Where would it be the most confusing area? I had five key elements added on the road which are a huge mall, residential, parking building, crosswalks, and traffic on the intersection. These factors create a busy population flow on both drivers and pedestrians during the daytime. I intended this to have space where interactions could occur the most.



2050s Urban Plan, Top View



2050s Concept Urban
How Intersection Road was built



2050s Urban Design

Car Interactions

The LED Color Lights on top of the vehicle to make sure any people at different types of vehicles at any angle are capable of seeing it; this is placed at the top of the vehicles, considering

the height of the pedestrians and the eye height of the drivers; the place is visible in any circumstances. The OLED screen replaced the license plate on the front and back of the vehicle because when I interviewed Dr. Paul Green, he claimed that the license plate would soon disappear and I agreed with him too. Instead of adding the screen at the body of the car, which will become a bad visual aesthetics, I placed it at the license plate where it would be natural. A vibration motor alerts the driver on the seat if any other type of car is approaching by detecting the light of the car. However, the same type of car, you wouldn't have to worry. If a full AT car meets a Manual driver, then the driver must be aware of the outside situation just in case for any possibilities. Finally, all the interactions will be detected by the color sensor; I coded it as if the color sensor detects a "different" light which apparently be coded differently depending on the type of a car, then it reacts. If not, nothing happens.





2050s Car Interaction, Partially vs Fully.

Conclusion

The Corona Pandemic had changed my whole plan for the IP project. It was initially creating a physical interaction where the audiences could physically play with the made models; however, I shifted my gears and approached the project more digitally. I invested most of my time elaborating the 3d models and rendering them, in order to have a more realistic presentation on the exhibition. The Pandemic has taught me a valuable lesson. I've learned that a designer would always be in a position where he/she has to make a decision quickly with confidence. During the Pandemic, I had a lot of options with my project. It took me days and nights to make a decision. One decision that was the hardest would be *excluding the Arduino work* from my project. I knew that I've put a lot of effort and work into it, however, the produced work did not match the style of the digital work I did. The limitations were also a big problem, because I did not have a proper equipment and space to create a high-quality animation video of the physical artwork. Thus, I've excluded the work from my exhibition.

Throughout the process, I've learned a lot of important things as a designer. First of all, I realized that getting feedback and critiques from a variety of people were important during the project development process. As a designer, we have our targeted audiences and potential customers, thus we have to consider what they value the most when designing a product or a

system. Other people with different professions helped me a lot to fulfill what is needed on the project, for instance, when I was having a hard time where to locate the LED and oled screen, the feedback and critiques made me consider the pedestrian's eye direction and their physical height.

The IP experience has changed my standards as a designer. The most valuable experience I had would be interacting with different people in a variety of professions and talking to them about my work. The IP course provided me an opportunity to get out of my zone, a place I had my perception and prejudice where I felt comfortable, and challenge myself to a new field of work.

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