

Thesis Project Portfolio

Focused Testing: Importance Within Project Management
(Technical Report)

Ethics of Differential Experience in Web and App Development
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Department of Computer Science

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Sociotechnical Synthesis

For the technical report I relate my experience as an intern for a California based tech company that maintains a job finding service. My task was to integrate the website's homepage with a A/B testing API produced by the company. The details of the modifications made to the API and homepage are contained inside, as well as my overall experience and view of courses that helped prepare me for the experience.

Tying into this is the research paper on the effects that techniques like A/B testing have on society. It explores some of the types of techniques and how they are viewed by the public. It also discusses the effects they can have on the individuals exposed, and how society is adapting to the advent of such technologies. It also examines these technologies and their impact through the technological determinism framework. As a software engineer at a firm that utilizes some of these things it is especially important to think about the effects that decisions can have on the people impacted.

Focused Testing: Importance Within Project Management

A Technical Report submitted to the Department of Computer Science

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University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Ifeoluwapo Adetunji

Spring, 2022

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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

Rosanne Vrugtman, Department of Computer Science

Focused Testing: Importance Within Project Management

CS4991 Capstone Report, 2022

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ABSTRACT

A San Francisco based job-finding service, wanted to improve locale-based A/B testing on its homepage. This would normally require significant engineering work by developers. So, an existing service was coopted instead. I modified a backend API and repackaging of data to sync established behavior with the emerging one. I also led a schema creation meeting with the project team for utilization in the API database. Afterwards, a fellow intern and I updated the homepage to create and send information to the API for utilization.

The project stalled on a deeper problem with locale data creation. However, we made immense progress on the homepage's adaptability. Important future steps include robust testing for the service, as well as improvements in data creation for the homepage.

1. INTRODUCTION

Homepages are the face of a website, the first introduction to the service it is providing. As expected, companies put a lot of time and effort in researching the effectiveness of their homepages and the different outcomes of consumers visiting. As a service, growth in other parts of the world

were especially imperative to this company. Coordinating metric data, schedules, and engineering hours for every individual change was lowering efficiency in testing. However, it is difficult to find and train new engineers to make locale-based changes for the various global headquarters. Even more so to expect to teach the business management teams in these areas the complicated processes of A/B testing. Some outside applications like Optimizely and crazyegg are used for these purposes, but the flexibility of an inbuilt system led the project managers to seek an internal solution to this problem.

A/B testing is a research methodology in which two different types of information on a website are shown at random to visitors. Metrics can be taken on the activity of users to see which of the versions is preferred, informing decision making by project managers. It is especially useful in the case of a job-finding service, as different cultures value aspects of job searching differently. Thus, the company had great interest in testing different combinations of the homepage.

An intern and I were tasked with bridging a middle ground using a preexisting in-house API that has a user interface for the creation

of A/B tests. I had to create a link between the in-house API and the existing homepage backend. I also needed to set a schema for the data and update the API's image storage capabilities.

2. RELATED WORKS

A/B testing is of increased relevance within larger companies in recent years. Companies are increasingly analyzing customer behavior to increase clicks, sales, and engagement. As Christian (2012) explains, “[Google] engineers ran their first A/B test on February 27, 2000... In 2011 the company ran more than 7,000 A/B tests on its search algorithm.” This has led to the creation of a new industry supporting less technologically-focused companies in this niche.

Optimizely is one such company, selling A/B testing capabilities and metric tracking. They also offer web personalization and data analysis tools. Crazyegg is another example, offering site launches and analyzing customer behavior. Their plans include larger datasets and tracking program. Interestingly, Barack Obama's campaign utilized A/B testing in 2007 to drive engagement with the politician and analyze what voters wanted from the candidate.

3. PROCESS DESIGN

The main objective of the internship was to connect only the homepage to the pre-existing API. I was tasked with creating a plan, document, and implementation of this connection and then presenting the results to my team.

3.1 API MODIFICATIONS

The first step I needed to complete was creating a standardized method for adding and accessing different aspects of the homepage. The SQL database referred to different parts of the page and their elements with a schema. As I had previously taken a course in Database Systems, this was a familiar environment for me to work in.

Each individual part or “module” of the homepage would be customizable. They could also be placed in different orders as well, something that was previously hard coded into each variation. I worked closely with a senior engineer on the API side to formulate a schema that captured all the aspects we desired to be modifiable and proposed the implementation to the project leads.

After manager approval the next task I undertook was to implement image file storage in the API, as it had previously not included permanent image storing. I considered multiple options with the team and started a development plan including one option and submitted it for approval. However, the originally-planned method for image storage was not compliant with the requirements of the API as it could not display the image publicly onto an external website, which was critical to the security of the source images used. I made the modifications necessary to accommodate the image hosting, and then proceeded to work on the second half of the project.

3.2 HOMEPAGE BACKEND

The backend of the homepage needed to be able to gather the data from the API and relay it to the frontend in order to display the different versions. Courses such as Software Development Methods and its advanced

version were of great value as the development process was the same scrum method used there. Earlier exposure to the development cycle helped me to adjust to the faster pace of the professional environment.

The API would be referenced by the homepage backend and resulting data would be carried along to the homepage constructing class. I created a mock of the data to begin in order to facilitate testing by the frontend intern and then implemented the actual version. I had made good progress when a missing creator class for the locale data stalled development. As the project was not meant to be fully completed due to the time constraints, a solution was not reached in the time before my departure from the project. However, the test data and the approval of my management at least showed the results of my overarching work.

4. RESULTS

The schema I created with my senior engineer mentor was the basis of the integration of two internal products at a large software development company. My design of the resulting backend implementation also displayed a missing link in the backend's processes. The original problem of A/B testing in different locations had a solution one step closer to completion, with the reduced engineering effort of an intern as opposed to trained team members.

5. Conclusion

A/B testing has widespread support across the various software engineering firms at this point. It plays a vital role in increasing

the efficiency of web sites and apps and understanding customer preferences. In my case, it was the main focus of my project during my internship and an area I had not previously heard of or thought much about. However, this is a very regular part of the software development process for the companies that employ new graduates.

This internship started a larger project for the company in bringing all pages under compliance with a new vision of ease of access to powerful tools by computer science laymen. A similar approach is used as the basis of companies and shows how valued such tools are. As the original creators of these pages did not see the future value of such a system and had hardcoded them, additional manhours were used for the conversion.

6. Future Work

As I was not able to finish the project, it is very likely still in development or recently finished. This includes the testing and bug fixing of the originally intended functions as well as proposed added functionality such as being able to run multiple A/B tests within one testing frame. Another area of expansion includes visual representations of the resulting web page when changing the form for the test.

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Ethics of Differential Experience in Web and App Development

STS Research Paper

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Department of Computer Science

Introduction

Software developers creating services can struggle with understanding the affects the changes they make can have on the users they serve. In order to remedy this problem A/B testing (also known as split testing or bucket testing) has been a solution used in order to rigorously test the impact of changes made. A/B testing in development is a research method in which different versions of a page or app are shown at random to users. This allows data and performance metrics to be collected and analyzed to improve decision-making on user experiences. When correctly utilized A/B testing can be a huge boon for companies and individuals, boosting user interaction, traffic, and sales. This is just one of many examples of data personalization techniques. These techniques use the data collected on individuals to create different experiences for users of web services. However, extensions of these practices can lead to personalized pricing and ads, radicalization via personalized content, and drastically increased screen times and influence by social media.

I argue that differential experience, while effective for marketing and engagement, can have harmful consequences on the users and the ethical concerns that should be considered when companies can change the information that is displayed to consumers. In order to argue this point, the framework of technological determinism is used to explain the effects on society that changes in the way web pages and applications personalize experiences.

Personalized Pricing and Ads

Price discrimination is a practice based around the use of data on consumers to change the prices presented for products. A famous example of this practice in the app space was the pricing of Tinder Plus for the dating app Tinder. By utilizing self-reported information (age), Tinder would charge people over the age of 29 twice as much as other users. As Germain (2022) argues, “It’s unfair because consumers don’t know that it’s happening ... They’re playing the game by rules that you don’t know about and have not agreed to because they’re doing it without your knowledge.” The practice has become more widespread in recent years, as companies use any means necessary to increase profits and increase margins. This is despite the majority sentiment that there is no ethical way that a company can use the data of their consumers (Koetsier 2019). Going even further, seven in ten Americans opposed personalized pricing with about half saying that they “strongly” opposed it.

In the case of ZipRecruiter (a job-finding firm for companies) that was originally charging a flat rate of \$99, simply randomizing the price from a range of \$19 to \$399 was enough to increase profits by 14% (Wallheimer 2018). But when they switched to using data provided by consumers to decide prices using an individualized algorithm, profit increased by 84%. ZipRecruiter made no changes to their business’ services to justify a price hike or discount, however the price discrimination model allowed them to appeal to all types of consumers by effectively determining how much they would be willing to spend. This is essentially the same business model monopolies can employ to reap maximum profit.

On the other hand, ads have for a long time been based around past actions and data collected on users. If you shop for something on Google, it feels almost inevitable that you will

see an ad for similar or even the same products in the future. A case of this taken to its extreme was Cambridge Analytica and other companies using Facebook data to send targeted ads and create profiles on millions of US voters (Metcalf 2018). The exact amount of value gained through these models, but it is impossible to deny the power social media can have in influencing people's decisions. Being able to track simply how a person shops can tell you about their economic situation, hobbies, and even tendencies like if a person is an impulse buyer or likes to splurge on big purchases.

Using Online Data to Radicalize

Many people nowadays reference the extreme difference in views in the United States as a symptom of the two-party state. However, a large part of it could be social media's effects in pushing ever extreme content based on previous viewing habits. As Roose (2019) explains about one such ex-radicalized person, "In the video, he told the story of how, as a liberal college dropout struggling to find his place in the world, he had gotten sucked into a vortex of far-right politics on YouTube." A large part of this radicalization comes from the algorithms that YouTube and other sites use to try and increase screen times and gain more ad revenue. In order to keep you engaged, they find related types of content in a constant stream. Slowly as consumers explore, it becomes the new normal and the algorithm has led them to consume content in that niche more regularly. This can lead to desensitization to the previous content and increased polarity in political views. 64% of Americans feel that social media has negatively affected the US, citing "misinformation and the hate and harassment" as some issues that raise concern (Auxier 2021).

It's important to note that this effect is not limited to just a person's political views. Even pseudo-science and general misinformation can easily be disseminated and impact users' opinions. As Germani and Biller-Andorno (2021) demonstrated by collecting Twitter data, "[For pro-vaccine users], we identified only one large influencer in the pro-vaccination web (the World Health Organization) ... [For anti-vaccine users] we identified 14 large influencers, with the largest one being former US President Donald Trump." By tracking twitter engagement, a profile could be similarly made to understand communities of people and take advantage of certain traits people of those communities have. Especially powerful are "echo chambers" which Ward (2021) describes as, "...a bubble called, "Echo chambers" where we are surrounded by like-minded individuals who reinforce our own existing views rather than being challenged by different views." It becomes much harder to try and change the views of an individual who is steeped in an environment that reaffirms their beliefs consistently.

A large portion of this activity is happening behind the scenes for consumers, who largely are not even aware of the scope and scale of data being collected on them and their personal choices and interests. Of course, there is the terms and conditions of these sites, but those are rarely made in a readable form for consumers and are largely ignored by users. As Schwab (2019) describes, "when it's not done in a transparent, responsible way, A/B testing can leverage the worst impulses of human psychology to convince you to click on something. When it comes to political content, for instance, that kind of sensationalizing contributes to political polarization." Whether or not that is the fault of the consumer for engaging with a service they don't understand is more understandable when a vast majority of people you know or are even just

acquainted with use them. It can cause a large social pressure to be on these platforms simply to interact with friends and feel accepted. That is not even mentioning that simply using sites or apps with poor or exploitable security can easily lead to complete loss of data privacy through no fault of one's own.

The Effect on Self

It is important for these companies to sell something to you, and a big part of that is certain lifestyles, goals, and images. Someone who follows a lot of athletes or is otherwise more attuned to fitness influences may find themselves getting recommended workout plans, health supplements, and other fitness related products or influencers. These can impact one's own view of themselves, seeing people live a life that they feel is better than theirs, and being recommended ways to make their lives like theirs, while not realizing that only a perfect glimpse is shown to the audience. In one study based on Instagram account posts with different tags, looking at fitness accounts led to lowered self-compassion compared to viewing inspirational posts or looking at both equally (Oakes 2019). While the long-term effects of social media use are not as well understood, it does seem that some caution should be taken with the content pushed towards impressionable users.

In general, to the owners and boards of these companies, getting you to use your phone or computer for as long as possible on their platforms is money in their pockets. Dolliver (2020) lays out the increase in screen time for ages 5-17 has risen on average 1.5 hours on school days. And with research linking screen times with worse sleep, depressive symptoms, and poorer

quality of life (Stiglic & Viner 2019) these trends could be harmful indicators of what is to come. As the struggle for user's time and money intensifies, tailoring a person's content is a perfect way to keep them engaged for as long as possible. Generally, restriction methods are implemented at a slower pace as opposed to the arms race corporations partake in.

Through the Lens of Technological Determinism

Technological determinism is the theory that technology progresses due to inherent efficiency and molds the societal structure around itself rather than technology being influenced by culture and society. It also posits that technologies attempt to self-preserve themselves by organizing society to develop further. In this section, the progression of the internet, algorithmic learning, and data personalization will be put explained using the framework of technological determinism.

The advents of the internet, Web 2.0, artificial intelligence, and machine learning have created many major firms. Companies have quickly exploited them for all manners of purposes. The invention of the internet as a technology is completely neutral, as it could be (and is) used for any purpose under the sun. It has significantly increased globalization as communities across the world can now regularly contact one another. It could also be said that it has significantly added to the intense increase in fuel consumption by the collective human race. It hosts social media sites on the normal web, people's wedding photos in the cloud, and criminal organizations in its underbelly.

Most importantly though is that personalized content has changed the way society interacts with the internet. Gone are the days of sending a letter or email to keep in touch, how about sharing a funny video that showed up on the timeline instead? You can read a book and get recommended a different one people with similar tastes enjoy. People have grown comfortable with their data being used to let companies sell to them more effectively, so long as it means convenience in their lives. Gazdik (2017) elaborates, “Forty-three percent of U.S. consumers are more likely to shop with companies that always personalize experiences, as long as their trust isn’t compromised. Nearly a third (31%) say they would find great value in services that intuitively learn about their needs over time to customize product, service or content recommendations.” However, the most important factor was trust, as 92% said it was extremely important that privacy is protected. But is this privacy being rigorously defended like the companies say it is?

Some of the largest news stories in the 21st century have been pertaining to the data of users being breached, misused, or illegally collected. In an age where refraining from using technology is almost impossible, the way it shapes society is of utmost importance. Tailored content online has in some ways elevated the need for higher technological literacy. Being able to understand why certain content is being pushed to an individual is becoming a skill that many young people are gaining with increased pace. Online etiquette in recent years has drastically changed, with kids growing up with a phone in hand and a personal computer at home. People have grown increasingly comfortable with using the internet for anything and everything. Very

rarely is a person fully aware of the extent of the data being collected on them, and even less so how it can be manipulated.

Society is currently adapting alongside these technologies with little input from political or social entities. People's social lives are increasingly being conducted online on websites that curate content for them, goods and services are bought from online vendors that advertise based on suspected preferences, and leisure is spent watching and reading from various media outlets eager to increase screen time by pushing whatever will catch viewers eyes. Effectively exploiting these tactics on consumers has become a valuable professional trait, while learning and understanding them to avoid manipulation has become a priority for individuals. These trends will likely only increase as the personalization of data becomes more developed.

Conclusion

In conclusion, it is important to understand the complexity of using user data for things such as personalized ads and pricing. While these things can be net positives for companies, the users show overwhelming dissatisfaction at these practices. Even the act of using these systems can lead to unfavorable outcomes like diminished self-worth and doom scrolling for the consumers. Data personalization can provide its practitioners significant power over the users of their services. Should these private entities have the ability to control their consumers to such high degrees? No matter the answer, it is of interest to society to understand the effects that this control has.

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**Sustainable Implementation Of Autonomous Vehicles Into Cities
(Technical Paper)**

**Addressing The Societal Effects From Autonomous Vehicles
(STS Paper)**

A Thesis Prospectus Submitted to the
Faculty of the School of Engineering and Applied Science
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In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Science

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Fall, 2021

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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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Problem Introduction

The invention of the automobile may be one of the most impactful inventions in the modern era. The drastically decreased travel times paired with the ability to continuously drive without breaks for as long as the driver can stay alert has allowed the connection of communities that were previously unreachable by horse and buggy in a timely manner. That is not to say that there were no downsides to its advent. According to the National Highway Traffic Safety Administration, more than 35,000 deaths happen nationwide due to motor vehicle-related accidents (NHTSA, n.p.). It also contributes over 100 billion gallons of fuel per year to humanity's increasing emissions problem. Unexpectedly contrary to its intended purpose, it has also increased travel times in some of the biggest cities in the world, as Americans alone spent about 7 billion collective hours wasted due to traffic in 2014 (NHTSA, n.p.). But as car ownership continues to approach full saturation are there safer, more affordable, more efficient, or environmentally conscious options?

In the US, with its sprawling suburbs and highway systems, the answer is generally “no”. American public transit “consistently have lower ridership levels, fewer service hours and longer waits between trains” than every comparable European or Asian country (Stromberg, 2015). Lack of strong transportation infrastructure combined with the artificial size of communities caused by American's rapid adoption of cars has led to some of the least pedestrian-friendly places in the world. This is quite a large problem as current estimates suggest that this status quo could be costing the US anywhere in the range of \$700 billion and \$2 trillion per year between accidents, fuel, productivity lost, and traffic congestion (Zhang, 2014). Thus, the autonomous vehicle (AV)

has been a topic of interest for some time. However, it's important to understand the difference between autonomous and automated vehicles. Contrary to an automated vehicle, autonomous vehicles do not require artificial aids, such as rails or magnetic strips to follow on a set path. They are able to go anywhere without driver assistance. While automated vehicles are quite common, the fully autonomous vehicle is still undergoing development. Thus, it's the goal of this paper to explore a possible plan for the safe and efficient implementation of autonomous vehicles, while addressing society's response to the adoption and safety of AVs.

Painless integration plan for autonomous vehicles

Automated guideway transit (AGT) systems have existed for quite some time, with one of its most recent applications being the Vancouver SkyTrain. Its impact on the region has seen the area grow faster than the regional average. AGTs utilize many functions that a future with AVs should also include. The AGT vehicles communicate with one another in order to create schedules and prevent collisions. They service large portions of the populace and even pay for themselves over time. However, these systems run on rails and set destinations, which severely limits its possible expansion as new infrastructure must be developed in order to serve larger populations. Currently self-driving cars use radar, cameras and lidar, which are quite expensive solutions, are not as adaptable to changing weather conditions, and can fail when other drivers make unexpected decisions (Ramsay, 2021). Couple this with the fact that as much as 95% of vehicle fatalities are caused by human error (Badger, 2015), and it's easy to dismiss AVs as only being useful when all cars on the road are autonomous. There are also not many current plans for

the utilization of infrastructure to accommodate AVs. For example, there are no comprehensive federal level regulations for the testing, safety, and use of autonomous vehicles. This leads to a comparatively one-sided effort on behalf of automakers to create “safe” AVs before attempting to have them in use at all.

My proposed solution to an initial integration of autonomous vehicles takes a page out of the book of AGTs by having special lanes spread throughout cities that are specifically tailored for AVs to follow with minimal interference from human-operated vehicles. City governments can gradually connect these AVs with their traffic systems in order to improve safety. As most cars in these lanes would also be AVs, vehicle to vehicle communication could also be implemented to mimic the scheduling of AGTs (Pyper, 2014). Special lane markings and traffic signs that are more noticeable to lidar or could even interact with AVs through vehicle to infrastructure communication would further help integrate these vehicles (Litman, 2021). This would not only encourage individual use of AVs, but could lead to the faster adoption of government use AVs such as buses or taxis for public use. Since labor is a majority of transit operating costs, transit could transition towards employing a larger number of smaller vehicles with more flexible routes. More vehicles would require more pilots for safety, creating job possibilities. The funds from the increased throughput could help make cities money from fares.

Parking space used could also be reduced as AVs could run more continuously, however, parking areas would likely not be eliminated as quick and efficient pickups for passengers would be a problem otherwise. Perhaps in the distant future it may even be appropriate to slowly curb human-driving due to its inherent danger in comparison to AVs. Overall, this is a plan for the

beginnings of active implementation within society. With proper foresight and planning the implementation of AVs can be a much more painless endeavor earlier on in their lifespan as an innovation, just as AGTs have.

Addressing Social Impacts of Widespread Autonomous Vehicle

Just as electric vehicles have experienced a relatively slow adoption in the United States, AVs will continue to experience higher cultural and organizational acceptance as innovation continues. Unlike electric vehicles, however, there is currently skepticism around the safety and efficacy of AVs. This is partly due to the short amount of time that self-driving cars have been available or even tested publicly. Another possible cause is the purposefully inaccurate depictions of self-driving vehicles in advertisements (Ramsay, 2017). The language that automakers use in order to sell cars frequently does not line up with the actual capabilities of the AVs themselves. An example given is the Mercedes-Benz E-Class sporting a slogan, “Introducing a self-driving car from a very self-driven company.” However, the car did not have self-driving capabilities at all and in fact could only brake, in-lane correct, and park by itself. This leads to overestimating the capabilities of the vehicle, leading to inattention while at the wheel. As a precaution automakers should be strongly policed on their wording considering levels of automation in their vehicles if this concern is to be addressed.

Even when largely integrated into society, how will driverless cars change social activity? Driverless cars could lead to less car ownership as the convenience eliminates the need for personal vehicles. Calling a taxi that arrives in minutes and gets you to your destination in a

cheap, timely, and safe manner could encourage people to drop their keys for apps and public transit memberships. Alternatively it could also lead to a large increase in car ownership, since owning a car would be much more convenient, possibly allowing you to send your car to other places to pick people up or charge at home (Badger, 2015). Children could be picked up from school by their parents while they stay at work or a secretary could remotely call their executive's vehicle, with no need for a chauffeur. Overall, it is hard to predict what type of changes society will make regarding car ownership. A lot of the change will be dependent on how effectively governments implement AVs into their transit infrastructure.

AV cars seem to have uncertain effects on cities as urban sprawl seems to increase, but counter pressures like reduced land for parking can lead to more condensed cities (Larson & Zhao, 2019). To remedy these possible problems, it is important for municipalities to reclaim parking spaces for more businesses or housing. In order to encourage forgoing a vehicle, it's possible that like the subway systems of now, price subsidized use of AV transportation could lead to decreased levels of car ownership as getting around without owning a car would be cheap, easy, and effective. It's most pertinent for these to be affordable and convenient for consumers, subsequently expanding public transportation use. Thus these initiatives will be partly funded by the local and federal government, ensuring sufficient price controls. With more government-issued AVs serving as taxis and bus services, jobs can be retained, or even created, for people to watch the road and prevent accidents.

In the short term it is more important to increase awareness of safety precautions while operating autonomous vehicles. Thus, it is important to look towards previous safety campaigns

in the past to understand what is most effective at influencing people's behavior. It has been shown that comparing masks to wearing a seat-belt, helmet, or possibly condoms lead to higher positive response to the message than simply telling people the benefits or simply warning them (Wittenberg, 2020). Campaigns towards increased awareness of alertness while being driven autonomously should include messages about preexisting illegal driving practices, such as phone usage and distracted driving. This will help form a culture shift towards realizing that an autonomous vehicle does not mean a vehicle that can drive free of all supervision. As a side effect, whether or not a specific AV is "safe" will be just as important as whether or not the driver is safely operating the vehicle.

Conclusion

In conclusion, autonomous vehicles have the potential to be enormously beneficial to society with proper planning and implementation. It is of utmost importance that governments work together with automakers to not only test the safety of AVs but to also provide infrastructure for a less painful integration. With proper implementation AVs could lower emissions, traffic congestion, and car ownership while increasing safety on roads for pedestrians and drivers, travel accessibility for disabled and elderly people and density of cities. Through proper use of awareness programs, the stigma towards AVs can be reduced and public perception will shift away from the perceived infallibility of systems created through fallible means. I will develop and analyze a series of protocols and supportive infrastructural projects to assist in enabling autonomous vehicles to start doing good in American communities as painlessly as possible.

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