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Secretary Elaine L. Chao  
U.S. Secretary of Transportation  
United States Government  
1200 New Jersey Ave, SE  
Washington, DC 20590  
United States

Subject: **Autonomous Swarm Networks: Increasing Traffic Safety**

Dear Secretary Chao;

This report was written to show the importance of new technologies and government regulations to create a safer traffic culture in America. This was written on 12/2/2019 at Clark Community College by student Matthew Walker under authority from Shannon Kelley.

This report shows how laws affecting the implementation of technology reduce deaths specifically seatbelts and automatic braking. Students at the University of Michigan are establishing a testbed for autonomous vehicle technologies showing how safe and reliable A.I. truly is. With new A.I. program thinking developed with swarm technologies the safety will increase even more. The intent would be to have Trans-American Universal Automated Car Network.

I'd like to thank the students and researchers whose work I was able to reference to show that these changes will increase safety. I'd like to thank you for taking the time to read this report and please don't hesitate to respond with any questions.

Sincerely,

Matthew Walker

**Autonomous Swarm Networks: Increasing Traffic Safety**

For

Elaine Chao

U.S. Secretary of Transportation

United States Government

1200 New Jersey Ave, SE

By

Matthew Walker

Clark Community College

Vancouver, WA

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## Abstract

Today in America traffic safety hasn't improved much the death toll per year has stayed pretty consistent, this report analyzes trends in Americas past regarding automotive safety technologies and government regulations/new laws and how together they shape the change in traffic deaths from 1972- now. By researching new Autonomous technologies being developed in M-City an autonomous vehicle network at University of Michigan that was built to test and run a live autonomous vehicle network and swarm technologies at Qinghai University that would allow the vehicle to move and think as one. This report shows that new regulations across America, first affecting city centers and high pedestrian areas then the highway network, using these technologies would reduce traffic deaths even further getting close to the zero point and removing traffic anxiety from society. This report also analyzes public opinion trends regarding autonomous vehicle technology and their roles in our lives. The solution outlined would solve traffic deaths with a Trans-American universal automated car network.

## Introduction

This report discusses traffic safety. Every year more than 30,000 people die every year in traffic altercations (Evans 1501). This is a high number that could be prevented. In 1972, the year of the highest traffic deaths 54,589 people died (Evans 1501). In the 47 years since the deaths have decreased by only 45% less than 1% per year (Evans 1). This decrease in deaths is due to vehicle technology improvements — seat belts, crumple zones, airbag systems, and radar/auto-braking — by removing some of the responsibility from the driver and evolving into a safer space to be in. What technologies can be applied to the current generation of vehicles to reduce this number further? Scientific studies on bees, ants, birds, and fish analyzing how they move in massive swarms without collisions and adapting dynamically to their changing surroundings. Autonomous vehicle companies can then apply this thinking and mathematical model to autonomous networked vehicle systems these would reduce traffic deaths significantly.

## Background

Regulations and vehicle technology have been the main contributing factors to the decrease in traffic deaths from the period of 1972 to 2019. The most significant is the introduction of drinking and driving regulations. Car design has also implemented new standards in technology to make vehicles safer for users and pedestrians. Namely radar auto braking and auto lane correct technology. This has shown a decrease in minor accidents. This report shows that by allowing further regulations and technology advancements this number can be lowered to essentially zero. This report utilizes data from many university studies to analyze this question and determine the best solution.

## Statement of Issue

This report analyzes if an autonomous vehicle network would decrease the number of overall traffic deaths.

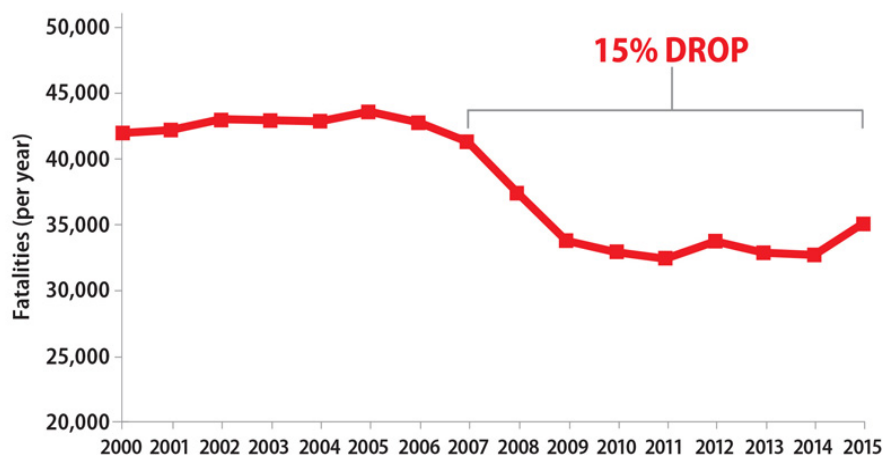
## Traffic Deaths

Roads and city centers are a part of everyday life but are also dangerous claiming the lives of more than 30,000 people each year, which is 90 people per day (Evans 1). The highest number of Traffic Fatalities in the United States was at 54,589 reached in 1972 (Evans 1). From the outset government and auto companies have been unknowingly working together to reduce traffic deaths. Today the average is around 30,000 not a significant decrease from that 55,000 number (Evans 1). This analysis will probe the effectiveness of these regulation/technology changes. Showing that regulations using new mandatory technology will reduce fatality rates even further.

## Regulations/Technology

As new technology is created it allows for new regulations to be placed to increase the safety of drivers and pedestrians. Seatbelts are a prime example. The first lap belt was invented in 1955, the shoulder belt came in 1959 (Kennerly 156). The technology existed but automakers were not using it until it was made mandatory in 1964 for all new American cars to have a lap belt (Kennerly 156). The reason is cost. Surveys at the time were showing about 10% usage by drivers. In 1984 New York passed the first mandatory seat belt law by 1996 all states had seat belt laws in place (Kennerly 156). This shows that even though safer technologies are available unless there are rules forcing change people will continue with their habits.

Figure 1- Showing the change in traffic deaths 2000-2015 in America



Source: Center for Disease Control and Prevention, *Motor Vehicle Injuries*, Motor vehicle-related deaths decreased between 2007 – 2015, Dec. 14<sup>th</sup> 2017  
<https://www.cdc.gov/winnablebattles/report/motor.html>

Automatic Braking is a new technology that has been introduced on a few luxury brands and make automobiles dramatically safer. Volvo sold the first vehicle using this in 2009 (Kennerly 155). This technology uses radar and a simple logic circuit connected to braking systems and if an object gets too close it stops the car. These reactions are faster than that of human reaction times thus increasing safety. This is costly for manufacturers to install the required components so not many accessible vehicles have the technology. Legislation has been passed that all new cars produced will have to have these automated systems in place by 2022 (Kennerly 160). Again, showing that technology comes first then regulation is needed to implement this change to the masses as companies are trying to save money. Figure 1 shows the decrease in traffic deaths since 2007. Showing a correlation between autonomous vehicle technologies and decrease in traffic deaths

## Autonomous Detection

Currently there is one type of autonomous vehicle detection. That uses block detection methods. Wherein a vehicle uses ultrasonic radar, millimeter wave radar, LiDAR (Light Detection and Ranging), and cameras to detect, analyze, and classify objects in its vision path (Meng 1). Vehicles are programmed to do this on an individual basis. As in the vehicles don't communicate with each other and react to the world the way a human driver does having a cause effect relationship with no prewarning. To increase accuracy companies and universities working on this technology have only one option and that is to increase the amount of data that can be analyzed by these A.I. driving programs. They do this by putting lots of hours into their prototype vehicles and running simulation software to increase the learning potential of the A.I. Students at Qinghai University demonstrated a new block detection method that increases the accuracy of current methods. Their model takes a few extra milliseconds to learn a new 'object' but its accuracy after it has the knowledge is greater (Meng 9).

## Swarm Networking

This is a new technology being developed at Massachusetts Institute of Technology Swarm networks work the way that flocking birds and schooling fish self-organize into complex lattice systems that don't interfere with each other and react to environmental changes seemingly as one (Chamanbaz 2). Applying this technology with already established block detection methods would allow a dynamic shift in autonomous driving. To enable swarming there must be distributed communication and decentralized decision-making meaning that the machines must have a clear way of communication with their neighbors and each machine is capable of making decisions without an overseer directing the machines (Chamanbaz 2). The team at M.I.T. ran a multitude of tests and using their leader-follower algorithm showed that the swarm self-assembled into a lattice network while simultaneously moving forward at the rate established by the leader (Chamanbaz 10). M-City is another project at M.I.T where students have built a city center and a shuttle network to show the feasibility of autonomous mass transport (Peng 1). The project is increasing the data available for the A.I. networks and creating more robust safer algorithms and increasing public opinion.

## U.S.A. Policy/ Regulations

Currently there is a regulatory battle happening on the federal and state level. The debate is over who is responsible in the event of a crash and who owns the vehicle the manufacturer or the passenger (Harris 599). Autonomous Vehicles add a level of complexity as vehicles are now making moral life and death decisions and that makes people nervous. The biggest concern being the vehicle being confused by unexpected

situations (McGinnis 31). The idea of ownership must also be addressed if the vehicle is autonomous who is paying for the car who owns it and what taxes are being paid. Autonomous vehicles have the potential to remove millions from the tax stream by removing the need for licensing, registration, and traffic tickets (Ratner 10).

## Popular Opinion

When asked about using a self-driving car the emotion that people rated highest is anticipation at 64% (Popescu 121). 57% of Americans think self-driving cars will be safe (McGinnis 30). States are creating conditions where an autonomous vehicle's may be permitted to operate without an operator having a driver's license (Brock 44).

## Limitations

The data gathered is an only a small representation of American demographics. There needs to be more public opinion surveys to show the differences in feeling amongst socioeconomic platforms.

## Solution/Recommendations

To solve the problem of traffic deaths a network of autonomous vehicles that utilized swarm artificial intelligence to communicate between vehicles would allow the car system to react as a singular unit to its surroundings. The way a school of fish move as one to avoid a predator or a flock of birds parting around a tree without colliding with each other. To allow this network to exist first implement new regulations on the existing road systems. An agency would have to control the American road network to allow for consistent regulations across all cities. Ideally all city centers and major freeways would be a part of the network and would work like an individualized public transport system. There would be many types of vehicles on a pay scale. Free buses would run at all times also an advanced scheduled private vehicle would be available for free. A membership would be established so an on-demand vehicle would be available for families and people who don't like the idea of scheduling in advance their vehicle time. A premium membership could allow priority vehicles to moves faster through traffic and have vehicles on standby for emergencies. The ownership of the vehicle would be under the same agency and would also build and maintain the vehicles. Once this network is established a permitting system will be implemented to allow non networked vehicles to be allowed on to the networked roads under the condition that a transmitter/receiver be attached so the rest of the network can avoid the human driver creating a safety buffer.

The first steps to implementing this solution would be too first remove human drivers from city centers and create small autonomous vehicle networks in the heavily foot trafficked areas to increase public opinion and awareness of the technology. Then acquiring the



regulations to change laws on the highways would not meet as much resistance. If we do not do anything about this then traffic safety will be a source of constant stress for people and losing the lives of 30,000 or more loved ones isn't worth it.

## Conclusion

This report outlines how in the past new technologies along with government regulations increase the safety of automobile passengers. It then demonstrates that by allowing the adoption of an autonomous swarm network of vehicles with strict highway and city center restrictions would reduce this number to a negligent amount. This matters for the safety of the human lives involved and the mental states of all who participate in our society. Growing up without traffic fear would lower anxiety. Changing public perception about autonomous technology allowing wide spread regulation changes easier to vote through. By reading this you can now see the importance of government in regulating the safety of its people and the direction we must push our technology and road regulations. To catalyze an autonomous car movement and implement the Trans-American Universal Automated Car Network.

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