AUTONOMOUS TECHNOLOGY IN TRANSPORTATION

PRESCOUTER

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2017

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INTRODUCTION

For a number of years, the autonomous operation of vehicles, machinery, and other mechanics has seemed to be a thing of the distant future. In reality, technology today stands at a precipice: ahead lies a world full of driverless cars, autonomous public transport vehicles, and an exciting wealth of opportunities we are only beginning to realize. This autonomous land ahead, however, is only available with a great leap of faith- faith that autonomous systems are safe, capable, and robust. In time, most consumers will find that the leap of faith required is little more than a step, the next step in technological evolution.

This paper provides an overview of several facets of **autonomous technology** within the **transportation industry**. First, we examine the **technological developments** that led us here. Interestingly, the timeline begins several hundred years ago with da Vinci's Self-Propelled Cart (1480).

Next, we arrive at the present day with the development of **various facets of an autonomous system** making driverless vehicles a reality. These include system overrides, different types of detection mechanisms, traffic alerts, and more.

Technologies such as those described pose **ethical questions** as well as technical ones. For instance, how safe must an autonomous vehicle be to be "safe enough"? This and more is covered in the next section.

Not surprisingly, automation has begun to touch other vehicle types as well, including **aircraft**. We next delve into the **recent developments in aviation** making strides toward unmanned flights, which start in autopilot capability and push much farther ahead.

Finally, the two remaining sections of the paper turn our eyes toward **the road ahead**. What pieces of autonomous technology will **disrupt** the transportation industry? How quickly? What will the average person's commute look like in 20 years?

In assessing impact and reimagining what we can do with the technology at hand, you will have a glimpse into a truly **autonomous future**.

A TIMELINE SNAPSHOT OF AUTONOMOUS TECHNOLOGIES

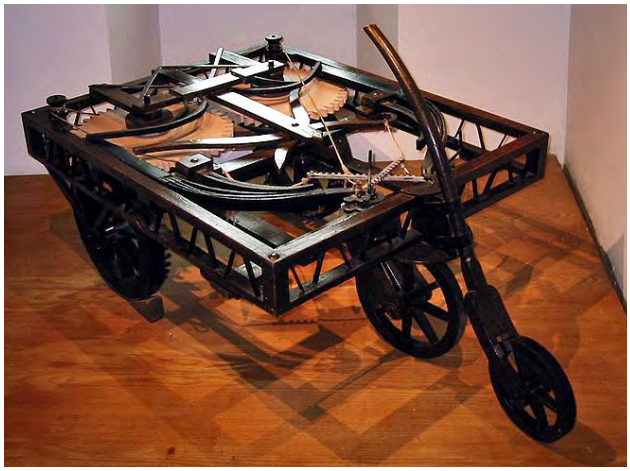
Adam Kimmel

Autonomous (or self-directed) technology is transforming industries ranging from automotive to insurance to healthcare. The opportunity to realize passive yet intelligent control is enabling innovation almost as fast as its creators can dream it up. However, the speed of advancement makes us wonder how the revolution started. The following is a timeline of the most important technologies that led to the advent of autonomous transportation.

Autonomous Propulsion

Leonardo da Vinci – *The Self-Propelled Cart, 1480*

The inventor prescribed a path for a self-propelled cart that was intended for use in the theater. Powered by high-tension spiral springs, the cart traveled along the path toward its intended destination. It also boasted a remotely-controlled handbrake. While the cart did not respond to external stimuli, the automotive community considers the cart one of the first automated mobile vehicles in history.



A self-propelled cart replica at museum Clos Lucé. *(Source: Wikipedia)*

Autopilot Gyroscopes

Wiley Post – *Mechanical Mike (air travel), 1933*

Sperry Gyroscope Co. developed a prototype autopilot for Post's flight around the world in 1933. It employed gyroscopes that were used to collect data from all three dimensions. This data was used to calculate the position and motion of the plane regardless of conditions, enabling

simultaneous flying and navigating. For that reason, gyroscopes have proven transformative in the development of autonomous vehicles, and are still used today.

Cruise Control

Ralph Teetor (Dana, Inc.), 1945-1958

German automotive engineer Ralph Teetor of Dana Corp. developed conceptualized cruise control while riding in his attorney's car. The rocking motion of acceleration and deceleration inspired him to develop a mechanical throttle to regulate the vehicle's speed. Development over the next decade led to commercialization of the technology that first autonomously regulated the speed of a car. Following commercialization, cruise control was first offered by GM on its 1959 Cadillac models.

Vehicle-Mounted Camera

James Adams and Les Earnest (Stanford Univ.) – *Stanford Cart, 1961-71*

Stanford University mechanical engineering graduate student James Adams built the cart to validate the assumption that a car could drive on the moon while being controlled on Earth. The original cart used a car battery to drive and a television camera on the top to navigate. An inherent lag in the timing of signal communication from Earth to the moon disproved the primary assumption of Adams's research. Five years later, Les Earnest proposed converting the cart into a road vehicle using video as its navigation. This new application employed a computer to control the cart based on images received through the video camera. The cart was one of the first instances that used a battery as the primary model of power, pairing electric drivetrains with autonomous driving.

Tsukuba Mechanical – *Passenger Vehicle, 1977*

Extending the work started by the Stanford Cart, Japanese firm Tsukuba fabricated a vehicle capable of traveling 20 miles per hour using two cameras attached to the outside of the car.

Dynamic Vision

Ernst Dickmanns – *VaMoR, 1987*

Like many key inventions that have led to autonomous cars, Dynamic Vision was born out of the aerospace industry. Dickmanns worked on space shuttle orbiter re-entry. When modifying the path to shuttle re-entry proved impractical due to the fragility of the spacecraft itself, Dickmanns transitioned his research to a remote sensor for Europe's first communications satellite. It was then that Daimler-Benz approached him to develop (among other things) an autonomous car to commemorate the centennial of their first car in 1886. Dickmanns and his team outfitted a five-tonne Mercedes van

with cameras and sensors to sense its environment and to process information.

The hurdle that Dickmanns finally cleared was eliminating the delay between information receipt, process, and response using computers that did not yet have the processing power of today's versions. His team developed a solution termed the "4D approach", with the fourth dimension being a predictive estimate of spatial positioning based on data from the other three. This shifted focus from the history of previously-captured images to areas of high contrast, or changes in color or density.

LIDAR, 1960s-present

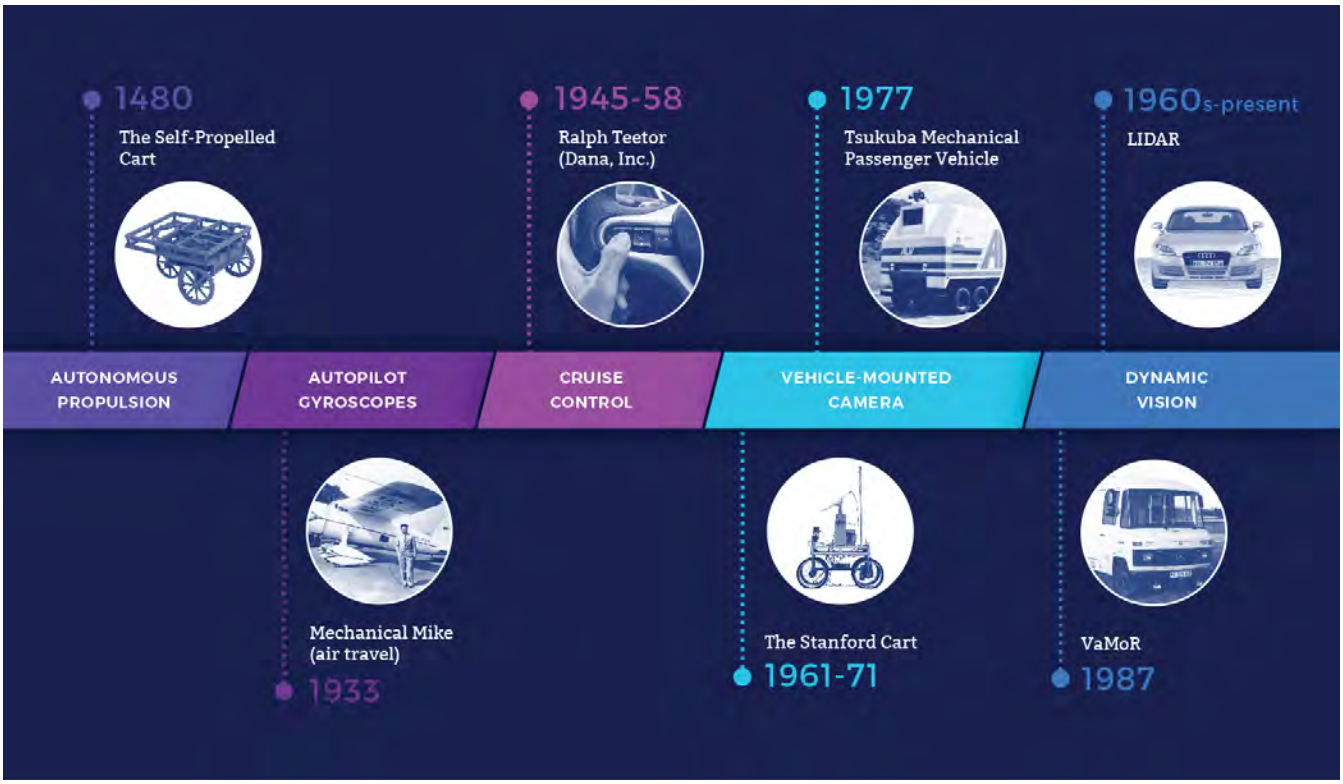
The wide scale use of lasers in the 1960s enabled the invention of LIDAR (light detection and ranging). Like its predecessors SONAR (sound detection and ranging) and RADAR (radio detection and ranging), LIDAR creates a three-dimensional map around the vehicle by sending laser pulses to a remote object. The map is created by measuring the time it takes the laser to return to the origin. It is this map that triggers the autonomous controls to respond in real time. Along with autonomous vehicles, LIDAR has had significant impacts in oceanic applications like storm surge, hydrodynamic and shoreline modeling. Its first application was space exploration, where it was used in the Apollo 15 mission to map the surface of the moon.

At its present stage of development for autonomous vehicles, the LIDAR box spins 360° continuously and has a depth perception accuracy within 2 cm. Most images of current autonomous vehicles include a LIDAR sensor that sits on the roof of the vehicle. Coupled with modern GPS systems, LIDAR represents the most enabling technology for the recent momentum in the autonomous vehicle industry.

The use of a battery to provide power and the inclusion of gyroscopes and lasers are largely responsible for the current state of autonomous vehicle industry. While significant technical challenges remain, such as external object discernment as an example, we are closer to self-driving cars than ever before due in large degree to these advanced technologies.

As shown in the timeline above, technology innovation is constantly pushing us past existing boundaries and paradigms. While inventions often take several years for widespread commercialization and adoption, they can also lead to the creation of new building blocks that can be used to build the next transformative

A LIDAR unit mounted to an autonomous car
(Source: Wikipedia)



platform. Just as the current autonomous technology was largely born out of the aerospace industry, new technology developed through commercialization of these vehicles may very well lead to innovation in a future industry we have not yet even considered.

ADAM KIMMEL

Adam is one of Prescouter's Global Scholars, as well as the Principal Writer at ASK Consulting Solutions, an engineering content writing and research consulting firm. He specializes in the alternative energy, transportation, consumer products, IT and healthcare IT industries. Adam earned a B.S. in Chemical Engineering from Penn State and an M.S. in Mechanical Engineering – Energy Systems from Marquette University. His master's thesis at Marquette defined new transport correlations for steam-methane reforming in non-adiabatic, process intensified catalytic reactors.

CAR TECHNOLOGIES OF THE FUTURE: MAKING THE ROADS SAFER

Amanda Elliott

There's a lot changing in the automotive industry. Most surprisingly, having a driver's license won't be a milestone in the future because our cars will be able to drive us.

As we take a hands-off approach to driving, will seat belts and airbags remain the car safety standard?

One thing is for certain, sensors and cameras will play a major role in car safety. We are going to look at 10 future car technologies to look forward to.

10 Future Car Technologies:

1. Animal detection

Road kill is a problem. In America, there are about 1.5 million car accidents every year from deer alone, according to AAA. With new car technology like radars and infrared cameras, the car will be able to detect animals and automatically apply the brakes.

Companies like Volvo, Audi, Ford and Mercedes-Benz are incorporating animal detection systems into their models for car safety.

2. Infra-red headlights

During bad weather like fog, snow and thunderstorms, driving conditions become more dangerous. To help drivers see further in poor driving conditions, car companies like Audi, Ford, BMW, and Toyota and turning to infrared headlights.

3. Remote vehicle shut down

Sometimes cars need to be shut down because of reckless driving or missed car payments. Remote vehicle shutdown will allow technology to shut down a car within a 50m radius. GM and Toyota are some of the car companies working on this technology.

With this technology, there are other logistics to consider like when to turn off a car. There is still

inertia and gravity in play and this technology could potentially disengage a car in mid-traffic.

Remote vehicle shutdown has already been installed in an estimated 2 million vehicles in 2014 in the United States alone, according to Cartrade.

4. Driver override system

While all cars might not be autonomous, they might be semi-autonomous. With the driver override system, the car will be able to apply the breaks even in some cases when a driver is accelerating. Car companies like Nissan, Volkswagen, Volvo and Toyota are investing in driver override systems.

5. Dynamic infrastructure alerts

Car companies are investing in this future car technology to connect with real-time infrastructure maps to monitor changing driving parameters and road conditions. This will be like Google Maps, but with more real-time data based on construction and traffic and hazards like potholes. Companies using dynamic infrastructure alerts include Toyota, GM and Mercedes-Benz.

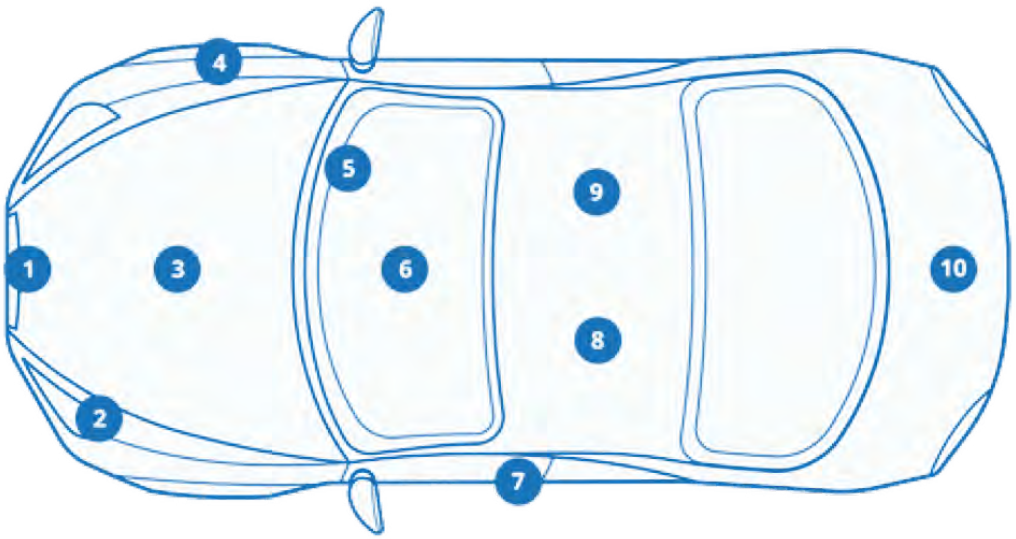
6. Augmented reality windshield

Augmented reality will play a large role in future technologies and it might start with the windshield on cars. While we use windshields to see the road, the car's dashboard might actually be part of the windshield to provide real-time data on speed, fuel, temperature and directions.

Companies like Jaguar, BMW, Ford and GM are investing in augmented reality windshields.

7. Biometric vehicle access

There's a more personalized driving experience coming in the future. Biometric vehicle access would take away your keys and put them literally in your hands. With this future car technology, drivers will be able to use their fingerprints to unlock their cars and even authenticate the driver.



It would also help with car theft, through this personal biometric tracking and authentication. Mitsubishi, Ford, Mercedes-Benz, and Volkswagan are some of the car companies currently investing.

8. Network-based traffic alerts

Traffic is one of the most challenging or boring parts to anyone's commutes. Well, what if you could send messages to other drivers on the road about current traffic conditions? With the network-based traffic alerts, drivers will be notified of congestion and will be able to re-route based on real-time data. According to Quoteme, the network-based traffic alerts will bring about a 97 percent increase in data traffic in the next 10 years.

Companies like GM, Volvo, and BMW are currently working on these car technology applications.

9. Autonomous cars

One of the most talked about trends is autonomous cars, especially with recent pilot programs by Uber for both passenger and commercial use.

In the United States, some states have already legalized self-driving cars. Lexus, Tesla, Mercedes-Benz and Ford have all started working on self-driving cars.

10. Active health monitoring

Active health monitoring technology might help health related accidents – like driving for too long or with low blood pressure or while intoxicated.

> *"The system will be able to detect if someone is having a cardiovascular issue, for example a heart attack, and could also be used to detect the symptoms of other conditions such as high blood pressure or electrolyte imbalances. This not only benefits the driver; but also could make the roads safer for all users."*
>
> **Dr. Achim Lindner, Ford Research Center medical officer**

Ford, Mercedes-Benz, and Lexus have started to work on this new car technology.

AMANDA ELLIOTT

Amanda Elliott is an experienced content curator and marketing campaign manager. She held the role of Marketing Coordinator and Journal Editor at PreScouter from 2016 to 2017. In her free time, Amanda interviews other Chicago startups in her blog, Windy City Cosmo.

RESPONSIBILITY IN THE AGE OF DRIVERLESS AUTOMATION

Justin Schaefer

Self-driving cars are coming, and they will almost undoubtedly be the predominant mode of transportation on our roads in the next few decades. The first driverless cars hit the streets in 2015, and already, they are beginning to boom in controlled areas. For instance, NuTonomy will be introducing driverless taxis to Singapore in 2018, and in 10 other cities around the world by 2020.

Industry Giants Taking on the Driverless Innovation Challenge

Major players in the car market such as Volvo, Ford, Tesla, GM, and even Google are all making great strides in driverless innovation. Google and Ford, for instance, agree that self-driving cars need to be fully autonomous rather than a hybrid human and robot driver, due to the fact that drivers start to trust the technology and stop paying attention. By literally handing over the wheel to robots, it becomes clear that new conversations and laws about safety and responsibility will need to be processed.

The US Energy Information Agency predicts that electric vehicles will make up 8 percent of the US market share by 2025, and we can expect those car models to have integrated self-driving systems as standard options relatively soon.

Even before that, however, aftermarket self-driving systems will be available for purchase and the combination of newer technology, price differences and varying efficacies of these systems will cause standardization or even legal issues (for instance the legal questions raised by the fatal Tesla accident in May of 2016).

Can Man and Machine 'Coexist' Safely on the Same Road?

During this period, when manually-driven and automatically driven cars of many different types and grades coexist on the same streets, an interaction between the two groups is bound to be less than cordial. Early on in their inception, driverless cars had higher accident rates than

regular cars, despite being touted as the ultimate in safe-driving features. The programming of these vehicles is simply not capable of dealing with the limitless, sometimes chaotic, variables seen on the road. It is then apparent that problems will arise when an algorithmically-driven car encounters the decidedly un-algorithmic driving style of humans.

For a portent of things to come, one need look only to your local freeway on-ramp, and the long-haul trucker that is trying to merge into traffic. Today, truckers in heavily congested areas routinely have to force themselves into a lane by slowly moving over and leaving it to the '4-wheelers' to stop in time or get out of the way. The reason this happens is that drivers choose not to let the truck in. It is safe to say that an automatically driven truck would not be programmed to merge somewhat forcefully. It is also safe to say that for every one person kind enough to slow down to allow the truck to merge, there are thirty people who have less charity in their hearts. So, our lamentable truck sits and waits, with traffic backing up until someone comes along to relieve the situation.

How Will Driverless Cars Make Decisions?

This is just one example. One thing we can all bet on is that there will be many more instances of uncharted robot-human interactions. The kinks in these systems will inevitably be worked out, and as machine learning and artificial intelligence begin to come into their own, the problems will become less common.

Before that happens, though, I believe that driving algorithms should be made public and the public should be trained on how driverless cars will react in any given situation. For example, the

ethical dilemma of whether a self-driving car will respond to prioritize the safety of a pedestrian or the driver is still up for consideration. But once that decision is made in the courts, people need to be aware of it so they can plan accordingly.

Will an out-of-control car on an icy road drift aimlessly and hope to regain traction, or will it work to get to the side of the road as quickly as possible to arrest its momentum? And what of the man walking his dog on the sidewalk that is hit when the car eventually hits that curb? If the vehicle is programmed to swerve immediately and forcefully, that dog walker should be aware that that is a real possibility. If the car is programmed to stop trying to correct and just drift until traction is restored, then the cars in front of it should be aware of that scenario. Either way, knowing what will happen in any given situation might not prevent accidents, but it might save lives by making other motorists and non-motorists more prepared.

Driverless cars and trucks are here, and as they are being tested, it is up to us to know how to react in situations that might be out of the car's control. It is up to the programmers to give us that information.

JUSTIN SCHAEFER

Justin received his PhD in Comparative Biomechanics and Functional Morphology from the University of California, Irvine. His dissertation research focused on describing and modelling the mechanical effects of morphological changes to serially repeated skeletal elements in sharks, stingrays and skates. During his studies, he also worked as an assistant professor of medicine at the UC Irvine School of Medicine. After a post-doctoral research/teaching fellowship at Brown University School of Medicine, he began a career as a medical educator teaching gross anatomy to medical students at schools such as UCLA and UCI. Justin then transferred to PreScouter as a Project Architect and left in 2017.

When not working, Justin enjoys teaching Martial Arts, working on his '71 Chevelle, rockhounding, spearfishing, and playing with his 5-year old son.

SELF-FLYING PLANES: A 'JETSONS' REALITY IS CLOSER THAN YOU THINK

Paula Hock

With recent buzz surrounding automation, most notably autonomous vehicles, the next question to ask is what comes next? For Boeing, the next step is self-flying planes, a step they may begin to take as early as next year.

Boeing's Recent Announcement

At the Paris Air Show held in June of 2017, Boeing's vice president for product development Mike Sinnett announced the company's vision for solving a foreseen shortage of pilots with **autonomous behavior**. He sees a need for over 40,000 commercial aircraft over the next 20 years to keep up with air travel demands. This, of course, would require approximately 600,000 more pilots, the training of which is an expensive and time-consuming process.

With Sinnett's interview comes Boeing's expectation to have in-flight tests by 2019. They anticipate a transition away from a required aviator for tactical operation in favor of an autonomous vehicle operation system. However, this can happen only when the technology can operate on the expected levels of safety, integrity, and availability as is currently provided.

Current Autonomous Technology

It should come as no surprise to note that a fair amount of autonomous systems already exist in aviation. Most commercial aircraft fly on auto-pilot throughout a high percentage of the flight. Radio navigation (VOR) and GPS are used together with auto-pilot for flight between waypoints. Even a variety of auto-landing systems exist to land an aircraft in low visibility conditions.

The gap between today's technology and the flying robots of the future (technologically speaking) lies in consistency and unified operations. In the case of autonomous vehicles, most experts agree that autonomous driving systems will reduce the US's annual 40,000 traffic death toll, a low expectation barrier for

incoming systems. In aviation, the number to beat is zero: no one has died in a jet crash in the U.S. since 2009. This is no small task.

Additionally, though Sinnett acknowledged that landing software could handle auto-takeoffs as well, no system has actually compiled all the systems together yet. This technology does need to undergo development to come to fruition.

The Future of Automated Flying

Boeing is certainly not the only company/research team in the development of automated flight technology. Teams in academia, the aviation industry, and government agencies alike have been working on various aspects of the technology for several years.

Successful tests have been performed to date, both for unmanned aerial vehicles (UAVs) and for manned/unmanned teaming. A researcher at Carnegie Mellon University's Robotics Institute has been working to develop smart UAVs with the capability of avoiding unanticipated objects in their flight paths. In April, the Air Force Research Laboratory (AFRL) and Lockheed Martin demonstrated a successful manned/unmanned aircraft team in a strike package to improve combat efficiency and effectiveness.

Interestingly, one of Boeing's major competitors seems to be focused on a distinctly different approach: Airbus revealed a modular, self-piloting flying car concept back in March. Their Vahana flying autonomous vehicle project has debuted a concept design at the Geneva Motor Show after several months of discussion.

With an eye beyond the skies, NASA has also begun research on automated planes and spacecrafts. If the logical next steps of automation are moving from vehicles to aircraft, why shouldn't space exploration be next?

PAULA HOCK

Paula is one of PreScouter's Project Architects. She specializes in the transportation industry. She works with scholar teams to provide clients with cutting-edge, actionable information to improve their businesses. This can mean problem solving, process optimization, entering new markets, assessing intellectual property, and more. Paula earned her B.S. from DePaul University in Chemistry before continuing on to her Ph.D. in Physical Chemistry at the University of Pittsburgh. There, her research focused on characterization of organic semi-conducting thin films for use in electronic devices. That is also where she started with the PreScouter Global Scholars program in August of 2014. After working as a scholar for a few months, she became a Team Leader before eventually taking a full-time role with PreScouter.

AI'S FUTURE IMPACT ACROSS THE TRANSPORTATION INDUSTRY

Anu Antony

Research into artificial intelligence (AI) has experienced a surge in the last few decades. This was built largely on pioneering results from the 60's and 70's, including the utilization of advanced neural networks (NNs). It has even taken inspiration from biological behavior for methods like fuzzy logic or genetic algorithms (GAs).

A major area where AI has taken off is in transportation. Media hype has covered quite a bit of recent advances, like self-driving Ubers or Tesla's new semi-autonomous trucks, but what else lies ahead? How will AI impact this industry?

How AI Can Help Transportation

Transportation problems arise when system behavior is too difficult to model according to a predictable pattern, affected by things like traffic, human errors, or accidents. In such cases, the unpredictability can be aided by AI.

AI uses observed data to make or even predict decisions appropriately. NNs and GAs are perfect AI methods to deal with these types of unpredictability. AI has been in development and implemented in a variety of ways. Some examples are given below:

- **Improvement of Public Safety:** Safety of citizens when traveling by public transport in urban areas is improved by tracking crime data in real time. This will also enable the police to increase their efficiency by patrolling and keeping their citizens safe.
- **Corporate Decision Making:** The road freight transport system can utilize accurate prediction methods to forecast their volume using AI methods, which simplifies transportation company planning. Additionally, several decision-making tools for transport can be designed and run by AI. This will affect investments made by companies in the future in a productive way.

- **Autonomous Vehicles:** Self-driven cars and trucks have been of high interest in the last several years. In the commercial sector, Uber and Elon Musk have produced self-driving trucks to reduce the number of accidents on highways and increase productivity.
- **Traffic Patterns:** Transport is greatly affected by traffic flow. Traffic congestion in the US costs around $50 billion per year. If this data is adapted for traffic management via AI, it will allow streamlined traffic patterns and a significant reduction in congestion. Several similar systems are already in place. For example, smarter traffic light algorithms and real-time tracking can control higher and lower traffic patterns effectively. This can also be applied to public transport for optimal scheduling and routing.
- **Pedestrian Safety:** The use of AI to predict the paths of pedestrians and cyclists will decrease traffic accidents and injuries allowing for more diverse transportation usage and an overall reduction in emissions.

The Impact of AI in Transport

Benefits:

In October 2016, Uber announced a driverless truck made by Otto that successfully drove 120 miles at 55 mph without any issues. Additionally, Daimler trucks has produced an 18-wheeler semi-autonomous truck with an auto-pilot system.

Costs of labor in this sector will continually decrease with increased use of AI, providing

higher profits for industry players. The issue of long driving hours and stopping for a break will no longer be a concern with fully automated fleets.

Beyond straightforward labor costs, safety and traffic accidents will be majorly affected by AI. The number of accidents involving truck drivers at night is a large issue and can be significantly improved with the use of smart unmanned vehicles. The personnel and financial costs of these accidents are quite substantial. Auto-pilot or complete unmanned vehicles can allow the driver to have a snooze without causing severe accidents. Some AI trucks even have a special feature of predicting accidents as well as health issues of people around the truck like detecting a heart attack and alerting the emergency services automatically with the location and details of diagnosis.

Drawbacks:

Automated trucking has sparked a hot debate among 3.5 million truck drivers in the US alone. Developments would mean autonomous trucks, ships, aircraft or trains slated for the future, along with any future vehicles becoming completely unmanned. Job flow is thus a major concern for truck drivers, taxi drivers, and other members of the industry. Social experts have argued that job skills can be shifted or evolved to other sectors, but tensions remain high.

Implementation around the world presents another major issue. Undeveloped and third world countries face enormous challenges in utilizing these solutions, as their infrastructure is not as stable or capable of providing maintenance and repairs. It will be a long time before AI can become a reality there.

Increasing focus on AI also presents a dilemma for transport companies: transport costs contribute to the company turnover by 3-10%. This makes it a very important factor in corporate economies as a whole. All existing businesses will need to engage in, develop, and implement AI technologies to remain a competitor in the transportation industry. This affects transportation logistics as well, as it is used in the supply chain of operations and manufacturing and even predicting the time and total cost of the entire process.

The Future

By 2020, it is estimated that there will be 10 million self-driving vehicles and more than 250 million smart cars on the road. Tesla, BMW, and Mercedes have already launched their autonomous cars, and they have proven to be very successful.

Experts like Elon Musk and Stephen Hawking predict that AI can be a grey area when the root of AI decisions cannot be comprehended by humans. Stephen Hawking warned at the Web Summit tech conference in Lisbon that:

> *"Unless we learn how to prepare for, and avoid, the potential risks, AI could be the worst event in the history of our civilization. It brings dangers, like powerful autonomous weapons, or new ways for the few to oppress the many."*

Despite this, we can gain tremendous productivity improvements in several industrial areas. Interstate driving in the US and delivering products to customers will become an easy task for companies, thereby increasing their profits.

As the transport industry becomes more data driven, the talent profile will also shift as new skills will be needed in the workforce to keep up with ongoing changes. Companies will need new strategies to navigate this dynamic environment.

ANU ANTONY

Anu is currently pursuing her PhD research in renewable energy at Newcastle University. She has also completed her Masters in Renewable Energy. Anu is extremely passionate about sustainable energy. She has worked as an Intern/project coordinator at Pollinate Energy (Hyderabad) a social business in India (sponsored by UNSW,UTS insearch, AECOM, Australia) which provides easier renewable energy accessibility for the urban poor in India as well as being involved in Product Development, Business processes, Recruitment,Training and Market Research while successfully completing related projects. She has also volunteered as an auditor for the Green Impact program at Newcastle University.

A GLIMPSE AT THE FUTURE: TAXIBOTS

Francois Callewaert

It is 7:30 am. You just had your breakfast and are now leaving your building with your two kids. In front of the door, a driverless car is waiting, displaying your name on its doors. You enter the car which greets you and starts to drive towards your kids' school. After leaving your kids at school, the car resumes driving towards your working place while you enjoy reading the news and consulting your emails on the display provided. When you arrive, the car lets you out in front of the door, greets you goodbye and leaves to find another customer. Another car will automatically come at 5:00 pm to drive you back from work and look for your kids, unless you want to reschedule, which you can do very easily with your smartphone.

This is what commuting to work, school or grocery shopping will look like for most people in just a few years thanks to the very fast progress of self-riding cars and car sharing technologies, combined in what researchers call "taxibots".

The Predicted Benefits of Taxibots

According to a recent study, the average American spends 1 hour and 41 minutes driving every day, and spends on average $8,000 a year to own and use a vehicle. Although driving can be an enjoyable thing to do, most of the time is just lost commuting and the expenses can be a real burden for many people.

With the advent of self-driving cars, all this time lost driving can be used for more useful or enjoyable purposes like consulting emails, making phone calls, watching a movie or just relaxing. At the same time, self-driving cars are expected to improve driving safety and moving smarter across the city in order to avoid traffic jams.

Furthermore, combining self-driving with car sharing will allow us to significantly reduce our transportation expenses while enjoying the comfort of riding in high quality and newer cars only as the cost of these vehicles will be allocated

between multiple users. Simple calculations show that daily use of a taxibot service would reduce the transportation expenses of households from $9,000 down to less than $3,000, with all the advantages described above.

Additionally, studies show that replacing the personal car by taxibots could completely change the way our cities look. Taxibots can reduce the number of vehicles by as much as 90%, and thus the need for corresponding parking space. This will decrease the global infrastructure costs of cities while liberating space and making them more enjoyable and cheaper to live in.

Future Prospects

This future is what Google, Apple and Uber are preparing in collaboration with traditional car companies. Driverless cars may seem far, but the transition will come very fast as self-driving features get better and better. In fact, the transition has already started as some self-driving features have already been introduced in the market. Ten million cars with self-driving features are expected in 2020, and fully autonomous self-driving cars will be available as soon as 2019.

In conclusion, services of driverless car sharing will make personal transportation an easier, cheaper, safer and more enjoyable experience in the near future.

FRANCOIS CALLEWAERT

Francois Callewaert is a PhD candidate in the department of Electrical Engineering at Northwestern University. His research focuses on novel optoelectronic devices for advanced sensing capabilities.

His interests cover nanotechnology, optic/electronic devices and systems and renewable energy.

"I don't know enough about X, and I don't have the time to research and learn it. Quickly get me up-to-speed on what I (specifically for my role and context) need to know, so I can understand my options."

Spend less time on tedious, tactical activities	Spend more time on high-impact, strategic activities
Calling external innovators for information	Collaborating with external innovators
Searching databases	Analyzing landscapes that are state of the art
Studying research journals	Road-Mapping internal programs
Mining large amounts of data	Making decisions

Have top tier advanced researchers work on your project

Our clients value the unbiased insights and innovative thinking that our network of over 2,000 researchers provides.

We take care of everything

Our proven system removes the stress of interviewing, selecting and managing talent to produce high quality results.

"PreScouter made us aware of 23 emerging technologies that we probably would not have become aware of (otherwise)"

Dr Richard Demke

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PreScouter, Inc. 1 N. Franklin St, Suite 1850, Chicago, IL 60606 • info@prescouter.com • (872) 222-9225

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www.prescouter.com