# The future of driving is autonomous

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# Driverless vehicles are already on our roads, but how close are we to using them for our daily commute?

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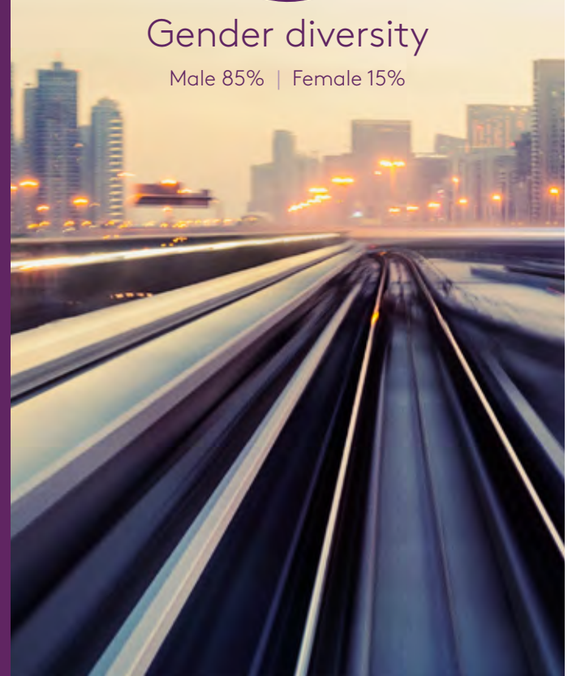

Welcome to this automotive industry trend from Proco Global. Over the following pages, we explore elements crucial to the future of driving (autonomy, electricity and connectivity), speak to Dr. Teresa Escrig, an AI expert, and consider the ramifications of the movement towards driverless technology on recruitment.

There are still many unanswered questions surrounding the level of autonomy that vehicles will have in the future—there's the question of whether passengers need to occasionally take control, for instance—and then there's the issue of what these cars will run on, whether it's a combustion engine, electricity or hydrogen. It's also hard to say whether individuals will need personal cars when it's easy to call or jump into a robotaxi.

Despite these lingering uncertainties, driverless cars are set to become just another modern convenience over the next few decades. From a recruitment perspective, this means that it's all change in the automotive industry and an incredibly exciting time to get involved.

I hope that you find the insights offered in this report useful. Please don't hesitate to get in touch if you would like to discuss any of these topics further—or to discuss your future career in this fast-paced industry.

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# What autonomous driving looks like and the driverless vehicles of the future

**Alex Smoker**
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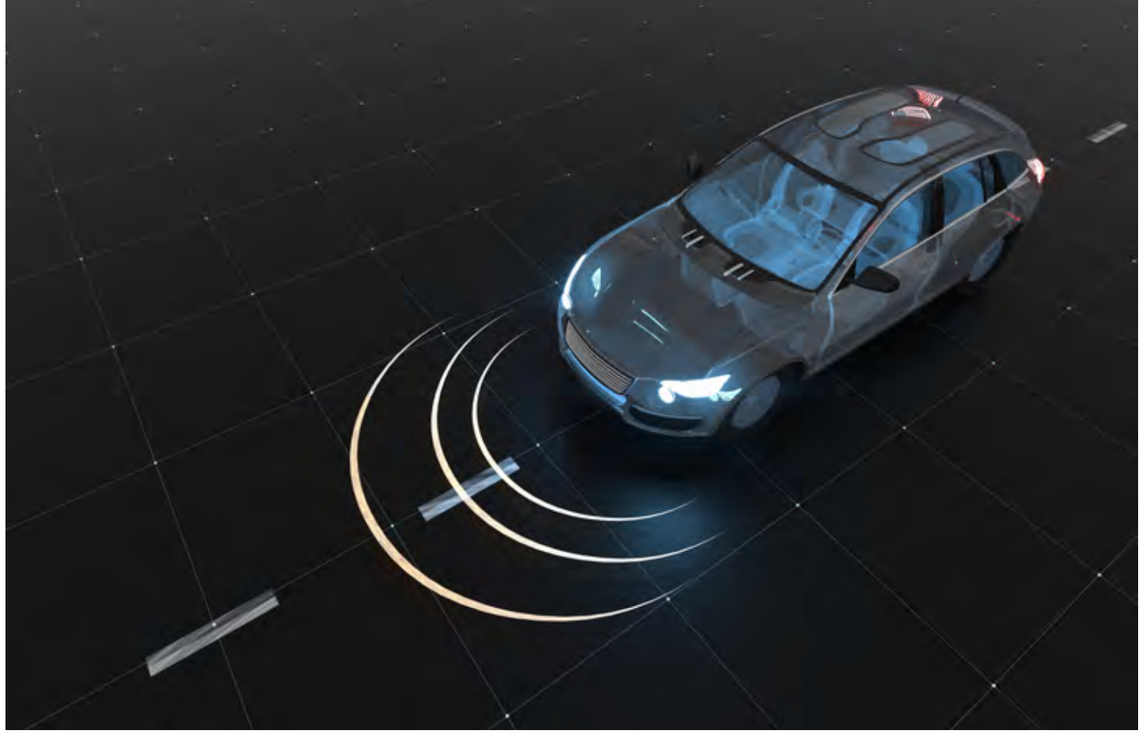

Automation is perhaps the most talked about aspect relating to the future of the automotive and technology industries. Self-driving cars seem like a space-age concept, but they will eventually remove human beings from the act of driving, consequently reducing emissions and increasing safety on the roads.

It will be a gradual movement towards completely driverless vehicles, but we've already made the first transition with the advent of features such as adaptive cruise control (ACC) and automated parking systems (APS). Companies have long been investing into research and development that will allow cars to operate via a series of cameras, lasers and sensors, meaning that commuters can sit back and relax during their journey. Current Tesla vehicles (and others, including Volvo and Mercedes models) drive at almost level 3 autonomy, meaning that the car can drive itself, but a passenger may need to take control at any time.

There are questions about how much human intervention will be required in autonomous vehicles. Drivers might have to alternate between modes, allowing them to take control of the car, if they are navigating city streets or open highways, for instance. There might be a steering wheel, or even a joystick in the car for this purpose—but joystick models were very early concepts and unlikely to become a reality (think back to the Saab 9000!). The Peugeot e-LEGEND is a good example of what an autonomous/semi-autonomous vehicle might look like in the near future.

There's currently a debate about whether both fully automated vehicles and driven vehicles can co- exist on the same roads – the potential for accidents will always exist and is very difficult to predict, even with the most advanced technologies. As technology improves, however, driving will become safer as sensors and cameras allow the autonomous vehicle to react with lightning speed precision. This will also remove the chance of human error behind the wheel. A commute will be smoother and congestion a thing of the past as traffic flow becomes centralised. Autonomous vehicles will also be able to communicate with other cars and the world around them thanks to increased connectivity.

In PwC's "Five Trends Transforming the Automotive Industry" report, it's suggested that user behaviour will play a key role in how cars are used in the future. Passengers will travel more frequently, vehicles will be used more intensively and autonomous cars will be more accessible as drivers won't need a driving licence. Many experts are still questioning whether full autonomy will ever become a reality, however.

As our mobility habits change, there will be a greater emphasis on using (rather than owning) vehicles as driverless options will eliminate the need for many to purchase a private mode of transport. Autonomous shared vehicles will be either station-based or free-flowing, which describes how and where the vehicle is available to use—either from a designated pick-up area or it will pick up riders en route from point A to point B.

While the future of fully automated vehicles is unfolding around us, some versions of driverless transport will likely become a reality over the next decade or so. Amazon is trialling delivery droids, which are compact autonomous vehicles that can transport parcels and groceries straight to your door. It's likely that we'll see more ecommerce businesses rolling out similar delivery methods in the coming years.

And then there's the robotaxis, automated taxi systems, which will ferry passengers around. These will be a safe and accessible way for people to travel. In the US, Alphabet—Google's parent company—launched self-driving car company, Waymo, and have been trialling robotaxis since December 2018.

Once the technology and infrastructure is in place, experts believe that level 4 autonomy can become a reality, where automated vehicles work within set perimeters, removing the potential for human error.

A segregated lane scenario has been mentioned. This is set to be a popular mode of transport in urban environments and, without the need to pay human drivers, should be cheap. Long-haul transport will also benefit from automated trucks that can travel across uniform stretches of highway with ease.

Many companies are struggling to develop a vehicle that can drive autonomously at all speeds; low speed (parking) and high speed (motorway) manoeuvres are relatively easy, but middle speeds (town driving) are more difficult as there are more variables and obstacles to navigate.

Another consequence of the rise of autonomous vehicles will be in urban planning, allowing for city centres to be designed in favour of pedestrians without the need for traffic lights and parking spaces. It could also encourage people to relocate to rural areas as commuting becomes less stressful, especially if congestion and traffic are irritations of the past.

It's not surprising that the concept of autonomous vehicles has captured our imagination— driverless cars have become the symbol of a futuristic, utopian society. In addition to this, they offer a greener, safer solution that will transform the way we travel.

With the excitement surrounding this industry, car manufacturers are looking for talent with experience in the autonomous technology and automotive space—especially senior leaders and technical experts in the field of advanced driver-assistance systems (ADAS) and autonomous driving.

# Electrified cars will change the way we drive and benefit the planet

**Tom Henderson**
Associate Director

It is a question of when, not if, we move away from using petrol and diesel. These fossil fuels produce carbon dioxide, the most abundant greenhouse gas in the planet's atmosphere, and almost all climate change scientists agree that these energy sources have accelerated the rate of rising temperatures globally.

Given the growing concerns about environmental issues and the consequential governmental regulations imposed upon manufacturers, the automotive industry has been forced to respond quickly. The future of driving is beginning to take shape as the sector acts to reduce emissions.

People aren't prepared to abandon cars because of the independence and ease of movement that automobiles offer—but the popularity of car subscription services, such as Zipcar, demonstrates that vehicle ownership isn't as important as the option of having quick and convenient access to a car.

In the future, automotive technology will have to adapt to address the environmental impact of driving and become increasingly sustainable. At the heart of this issue is the question of what the cars of the future will drive on—will internal combustion engines be a thing of the past? More cars are running on electricity these days, but what about hydrogen?

It is likely that for shorter day-to-day journeys, cars will drive on electricity, which will be more readily available through renewable sources and is therefore a cleaner option. However, when it comes to long distance trips, the combustion engine might still be necessary; this is because of the distance range of electric cars. While some electric vehicles (e.g. Tesla) have a range of over 300 miles and can be recharged to 80% in 15 minutes with superchargers, these cars still uncommon, particularly in the UK and EU.

Many of the past issues with electric vehicles, such as concerns about their road performance, will continue to be improved. In a PwC report, "Five Trends Transforming the Automotive Industry", it's predicted that over 55% of all new car sales could be fully electrified by 2030. In fact, the new Tesla Model 3 has outsold all car models within the same class in the US this year.

There is also a lot of discussion around the hydrogen-powered automobile, where hydrogen is converted into electricity to drive the car. The issue of where hydrogen can be sourced from is still a challenge to overcome before this option is viable.

Car manufacturers are already investing in electric vehicles: this month, it was announced that Jaguar Land Rover has teamed up with BMW to develop electric drive units (EDUs) and advance the technology that will push the industry forward for the next generation while sharing the costs. In January of this year, Ford and Volkswagen announced a similar agreement to pool their resources and mitigate research and development costs. Large original equipment manufacturers (OEMs) are also investing in smaller electric vehicle manufacturers, such as Ford, which has invested $500m in Rivian.

Accelerating the developments necessary to make the transition to electrified cars will see further collaborative efforts between car makers down the line.

In the meanwhile, there needs to be further consumer education about what they should expect from these vehicles. Mini USA recently conducted a survey to identify what drivers wanted in an electric car and they discovered that many customers were confused about the basic facts of electric vehicles, especially when it comes to the distance between battery charges. According to the findings, customers viewed electric vehicles as solutions for short, quick journeys in a city.

Driving range is often stated as the most prohibitive factor for individuals considering purchasing an electric vehicle, yet over 73% of the people surveyed by Mini USA (out of 1,004 adults) confirmed that 75 miles (121 km) on a single charge would be adequate for their daily needs. Ironically, this driving range is low compared with many of today's driving options, including the Tesla Model 3 (220 miles/354 km per charge).

Other concerns raised in the survey included respondents being unable to identify locations of charging stations and how long it took to charge a vehicle.

So while the next generation of electric cars are developed and investment into renewable energy is increased, it's the ideal time to educate the customer about electrified cars and what the future of driving will look like—and how these advancements in technology will mitigate the impact of fossil fuels and emissions on the planet.

All of this progress is currently having a significant impact on recruitment in the automotive industry. The demand for system and software engineers—not only in electrification, but also advanced driver-assistance systems (ADAS) and automated driving systems (AD)—is booming. Companies are also building large teams quickly, beginning with leadership roles.

# How it's all connected: the role of connectivity in autonomous vehicles

**Alex Smoker**
New Technologies

Connectivity is at the heart of modern life and, as technology has advanced, it's also transformed our driving experience. Today, we can control our car via our mobile phone and trust our vehicle to park itself.

But how will we interact with autonomous cars over the next few decades? And, more crucially, how will driverless vehicles connect to the world around them to guarantee comfort and safety of passengers?

Within the next 30 years, it's likely that people will view a car as an extension of their personal technology portfolio alongside a smartphone, tablet or computer. Now that we're always connected to these devices, we're accustomed to instant outcomes—and driverless cars offer quick and affordable transport solutions. The runaway popularity of app-based taxi services like Uber are a testament to the market demand for this type of convenience.

If passengers are not behind the wheel of a car, then a journey from point A to point B becomes an experience based activity. People will liken their interaction with a driverless vehicle to their relationship with their personal devices; just as we expect to catch up on an episode of our favourite television show while we ride the bus, in the future, passengers will want to be entertained—or at least productive—while in transit. This means that autonomous driving will offer another way that individuals can engage with technology.

In place of a driver, vehicles will rely upon virtual assistants, such as Siri, to route and navigate the car. Both Google and Apple have invested heavily in the development of driverless technology, so the cars are likely to have a fully integrated functionality with their products and services. Passengers will be able to access the internet, media or entertainment during their journey. Alternatively, they can be productive and work as they travel between meetings.

Wearable devices will also be connected to our vehicles, so an autonomous car will have access to your vital signs and might, for instance, adjust its speed based on your heart rate.

With insight into the mental and physical state of its passengers, this will make the experience of riders more personalised and comfortable.

The driverless car will be connected to the world around it as part of a larger transport network. Cars will communicate with each other and with external infrastructure, including traffic lights and crosswalks. Sophisticated sensors and data connectivity systems will have to work together to assess factors that link the environment inside the car to the outside world. This will require vast amounts of data being received and processed at high speed. This information that's collected has value too; it can be monetised directly (selling data) and indirectly (improvement of processes and predictive maintenance).

When we look at how an autonomous vehicle will communicate with external infrastructure in particular, this will be vital when it comes to safety; driverless cars will have to react instantly to any obstruction, from a toll booth to a cyclist. It's imperative that this data is accurate and highly sensitive to environmental factors, such as the weather or change of terrain.

While all of these in-vehicle systems and external sensors are communicating with each other, manufacturers must ensure that vehicles are not prone to any electromagnetic interference (EMI) to guarantee that human lives aren't put at risk. All of these crucial functions to autonomous driving demand reliable high-speed connectivity beyond what's available today, however.

In the future, passengers will communicate with their driverless vehicle and autonomous cars will communicate with external infrastructure. Because of the advancements that manufacturers are making in this industry, these conversations between human and machine and machine and environment are not far off—and we're listening with interest.

To keep up with these changes, car manufacturers are looking for talent with experience in the autonomous technology and automotive space, especially senior leaders and technical experts in the field of advanced driver-assistance systems (ADAS) and autonomous driving.

Artificial intelligence
Global Talent Pool

596,559
Professionals

+55%
1y growth

Gender diversity
Male 79% | Female 21%

7,881
Professionals
(Within the Automotive Industry)

# Artificial intelligence and the automotive industry: an interview with an AI expert

Dr. Teresa Escrig is an artificial intelligence (AI) expert based in Seattle, US, with distinguished accomplishments in research and development of innovative AI products.

Her impressive career includes publishing more than one hundred peer-review research articles, four books, four patents and receiving several awards, including the best PhD award and the National Prize on Science and Technology.

Dr Escrig is the founder and CEO of two startups in AI. She currently works as an independent consultant, supporting businesses to develop and implement safe AI roadmaps. Following Proco Global's recent blog series on the evolution and impact of autonomous vehicles on our Proco Thinking blog, we approached her to provide expert insight into AI generally and also the role that it plays in the automotive industry.

We're extremely grateful to Dr Escrig for taking the time to answer these questions. This is a rare opportunity to discuss the AI space with an expert with such vast experience and understanding of this field.

## WHAT IS AI?

The term 'artificial intelligence' was coined by John McCarthy the year before the famous Artificial Intelligence Conference at Dartmouth College in the summer of 1956. The purpose of the conference was to create a research field focused on the development of computer programs that emulate people's behavior or intelligence. Just as there's no agreement of the definition of human intelligence, there's no agreement in the definition of AI either.

In general terms, we can describe human intelligence as the ability to communicate, to perceive and understand our environment through vision, smell and touch, to identify and classify things, to make inferences from perceived information and find shortcuts, to find patterns in data to get insights and predict what might happen next, to learn how to do things we didn't know before, to remember how to do things we've previously learned, to glean abstract knowledge from the information perceived, to make decisions based on data or knowledge, to gain wisdom over time, to create art or music, to write a book or a poem, to take enjoyment from a painting or listening to a song, to organize things to create beauty and enjoy that beauty.

Every computer program that emulates one or more aspects of what we consider human intelligence can be called artificial intelligence.

## WHAT ARE THE BENEFITS OF AI?

According to McKinsey [1], AI has the potential to deliver additional global economic activity of around $13 trillion USD by 2030. The impact of AI might not be linear, but could build at an accelerating pace over time: an S-curve pattern of adoption and absorption.

Potentially, AI might widen gaps between countries. Leading AI countries could capture an additional 20 to 25% in net economic benefits, compared with today, while developing countries might capture only about 5 to 15%. According to Visual Capitalist [2], China might have almost double benefits from AI than the US.

It's possible that AI technologies could lead to a performance gap between companies that fully absorb AI tools across their enterprises over the next five to seven years—that might see a potential cash-flow growth of about 6% for longer than the next decade—and companies that don't adopt AI technologies at all, or haven't fully absorbed them in their enterprises by 2030, might experience around a 20% decline in their cash flow from today's levels.

## WHAT IS THE MAIN CHALLENGES FACING MID-MARKET CEOS IN THE ADOPTION OF AI?

Although most organizations have already begun to adopt AI in their business, only 17% of companies have an AI strategy and know how to source the data that will allow AI to work [3]. Many organizations still lack the foundational practices to create value from AI at scale.

> 67% of CEOs think that AI and automation will have a negative impact on stakeholders' trust.

The AI control resides in data scientists with low or no business knowledge. However, 75% of AI decisions impact business processes, talent development, the customer experience, corporate governance and ultimately lead to new business opportunities—all CEO concerns.

The fear surrounding the unintended consequences of a largely unproven technology is another main concern. 67% of CEOs think that AI and automation will have a negative impact on stakeholders' trust. Another main challenge is the lack of access to the appropriate talent.

## WHAT ARE THE MAIN BLOCKERS TO THE UPTAKE AND IMPLEMENTATION OF AI?

One of the main blockers is the lack of transparency, and therefore trust, in machine learning (ML) / black box type of AI. They have been a number of examples of AI going 'wrong', including Tay, the Twitter chatbot by Microsoft, using racist language and promoting neo-Nazi views [4] and the bots created by Facebook that were shut down when they were communicating in a language they invented [5].

The industry with the most advanced AI adoption has been autonomous vehicles. The main challenges in this industry include:

- Obscurity of the ML algorithms, even for engineers
- Difficulty of pinpointing errors
- Inability to apply Agile methodologies for algorithm development
- Long periods of testing on the roads with an unproven technology
- Unpredictable time and cost to market

For instance, Uber's self-driving car struck and killed a woman crossing a roadway in March 2018 because she was apparently considered a false positive [6]. As a result of these challenges, all the players in the industry are scaling back on ambitions, with a tremendous economic impact to these companies.

## HOW DOES AI BENEFIT THE AUTOMOTIVE INDUSTRY SPECIFICALLY?

The most significant use of AI in the automotive industry has been the implementation of self-driving cars. In order to overcome the challenges mentioned in the previous question, it's necessary to integrate other AI methodologies besides ML, which will bring transparency and repeatability to the algorithm development, as I explained in a previous LinkedIn post [7]

Other applications of AI in the automotive industry include the different advanced driver-assistance systems (ADAS); edge computing, which brings intelligence to the Internet of things (IoT) devices included in the cars; and voice communication to deliver commands to the car, including entertainment.

## DO YOU THINK THE FEARS AROUND GDPR AND NEGATIVE CONSEQUENCES OF AI ARE JUSTIFIED?

The fear around potential negative consequences of AI are completely justified. That's why I wrote the book Safe AI. The greatest danger from AI comes from the technology per se and it has the potential to end humanity. The combination of ML, where the hyperparameters are automatically selected by genetic algorithms (another black box type of AI) and run in a quantum computing with 200k times the computational power of current computers, a narrow goal and no ethics, is something we don't want to develop. I also discourage the development of general AI.

My proposal is to use holistic AI (integration of non-ML and ML technologies) to enhance humanity's potential in a way that allows us to increase our intelligence in a slightly exponential way (not only linearly, as it has happened to date) that we access in a device, like our phones, never a chip installed in our bodies because cyber security is a severe, unsolved problem and a chip only facilitates the already extended control over people. If we don't develop general AI, super-intelligence will never happen. The AI curve will always remain under the human intelligence curve.

The GDPR (European Union General Data Protection Regulation) and the California Data Privacy law were absolutely necessary and force corporations to develop technology that explains the logic of decisions made by AI engines, which will ensure fairness when the decisions affect people or have business implications.

## WHAT SKILLS WILL BECOME INCREASINGLY VALUED WITH THE DEVELOPMENT AND ADVANCEMENT OF AI ?

Real AI experts trained in a broader spectrum of AI methodologies with years of research and development. It will be critical for the automotive industries that want to be at the head of the autonomous vehicle development to work in the integration of non-ML AI and ML methodologies and overcome the challenges currently delaying the success of the self-driving car. Experts with the skills that can bring transparency to AI systems will be critical.

For example, I'm currently incubating a startup, Trace Eye, which provides traceability/transparency to self-driving cars by showing the relationship between the objects perceived by their cameras and the decisions made by the car (to comply with the mandatory safety regulation ISO 26262).

# How development of autonomous technology will change hiring in the automotive industry

**Alex Smoker**
New Technologies

## The automotive industry is rapidly changing as we shift towards autonomous transport.

While automotive companies invest resources into research and development in this area, there will inevitably be a knock-on effect on recruitment and hiring; the sector now needs people with a specialist technical skill set, especially when it comes to working with the vast amount of data involved and the movement toward Machine Learning (ML) and artificial intelligence (AI).

What skills are automotive companies looking for in prospective employees today and in the future? Firstly, many are turning towards what talent is available internally—while current employees might have a wealth of experience in certain technology relating to active safety, autonomous driving and related systems, they might not possess all of the necessary skills to allow them to develop the complete product from a full system perspective.

Companies therefore need to consider what gaps they have in their business and whether they must look externally to fill these roles. In some cases, they might acquire another business or a specific business unit or team with a relevant specialism in the market. Alternatively, they could retrain current employees, but the time needed to train them up might keep them behind the curve of the market.

A third option is to work with a specialist recruiter and identify individuals with the right skill sets outside of the organisation who can step in and fulfil a business need.

As a consultant, the conversations that I'm having with these companies often reflect a combination of these options—I'm either asked to source someone externally, or to replace someone inside the company who is moved into another position.

If a business opts to bring in external talent, the issue of attracting individuals becomes key. Working closely with a specialist recruiter means that the business is able to carefully control the message that goes out to market along with the image of the business and clarify the benefits that professionals can expect. In this candidate-led market, it can also be difficult to pinpoint the right person. There are only a small pool of companies in this field and they're spread across the globe.

For instance, a well-known tier 1 company is currently looking to expand their autonomous driving technology and hire engineers to work out of a location in Germany. The location isn't known for being a hub of advanced driver-assistance systems (ADAS) technology; this can have a massive impact on recruiting for jobs in these areas, leaving it to recruiters to make these locations attractive for candidates.

Thankfully, at Proco, our global network allows us to tap into talent from across the globe and we also have a deep knowledge of the client, so we're in the best possible position to convince people that the move to this particular area of Germany, for instance, is worthwhile. This gives us an upper hand over other search firms.

Much of these developments are driven by data, so skills in this area are highly sought after—driverless cars rely on the communication of vast amounts of information, from sensors, braking mechanisms, a computer built into the vehicle, data bouncing between cars on the road and then a centralised traffic monitoring system. All of this data needs to be managed, used and stored somewhere.

To understand this information, professionals with a deep understanding of data manipulation and the related software are needed; software, as always, is playing an increasingly vital role in autonomous driving. As more vehicles are becoming driverless, they must react to the world around them and adhere to certain safety standards and regulations.

The ideal candidate in this space typically comes from an engineering background with a strong technical degree from a specific set of universities that are reputed for developing talent in these areas. The specialisms would include electrical, mechanical and software engineering. In addition to this, an individual would ideally have experience in a role where they had a full system view.

Finally, being flexible is also a key factor. Candidates must be realistic about where they will potentially settle down with a family and where career prospects are—so they should look at where industry hotspots are, such as Berlin, Paris and Detroit.

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**What autonomous driving looks like and the driverless vehicles of the future**

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