Elaphe: driving the development of electric vehicles

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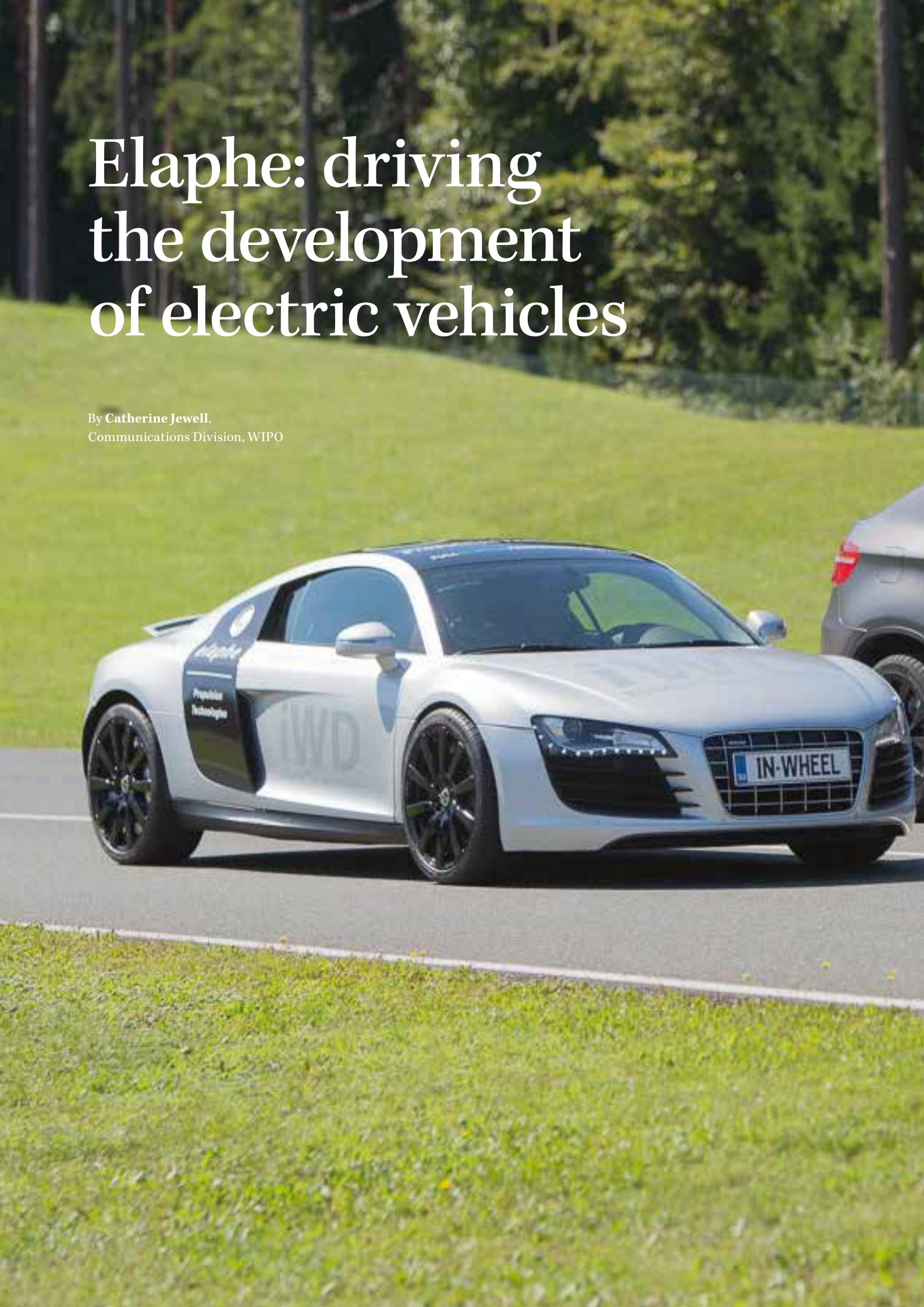


Photo: Courtesy of Elaphe Propulsion Technologies

Slovenian company Elaphe Propulsion Technologies is now working with leading brands in the automotive industry. The company wants to become a major global supplier of in-wheel motors for electric vehicles.

Photo: Courtesy of Elaphe Propulsion Technologies

In-wheel motors offer many advantages over traditional electric motors. They are light and powerful and small enough to allow for other components to be integrated into the wheel.

For over a century the internal combustion engine has dominated the auto industry. But concerns about the environmental impact of motoring and road safety are fueling interest in electric vehicles and the market for in-wheel motors. Business analysts Fact.MR predict that, for the period 2018 to 2027, the in-wheel motor market will achieve compound annual growth rates (GAGR) of 30.4 percent.

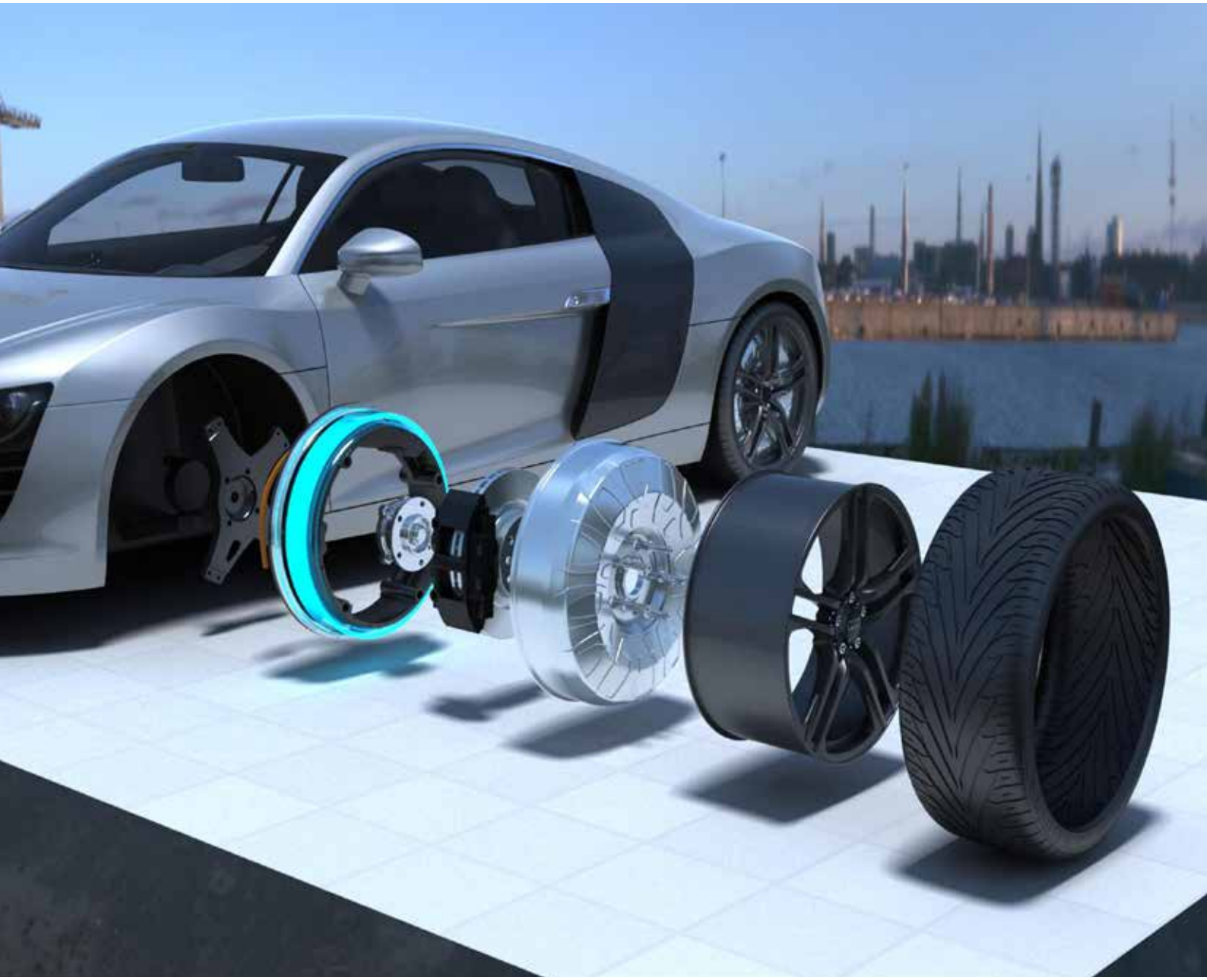
For the last 15 years, Elaphe Propulsion Technologies, a Slovenian company based in Ljubljana, has been at the forefront of in-wheel motor design, manufacturing electric in-wheel motor propulsion systems since 2003. The company's Chief Technology Officer, **Gorazd Gotovac** talks to *WIPO Magazine* about the role that innovation and intellectual property (IP) play in Elaphe's business strategy and its ambitions for the future.

Tell us about Elaphe and what it does.

Elaphe develops and manufactures powertrain systems for electric vehicles. We focus on a specific innovative architecture – our high-performance electric motors are placed in, and directly power, the wheels of a vehicle. This type of vehicle propulsion is simple and energy efficient. It also saves space, since in-wheel motors eliminate the need for the complex powertrain systems found in traditional internal combustion engines or electric motors. This makes it possible to completely reconfigure the interior layout of a vehicle and to introduce more user-centric design solutions. The company's R&D center and European manufacturing operations are based in Ljubljana, and we also have a production site in Hangzhou, People's Republic of China. We target global automotive markets and have a range of projects in a number of transportation sectors.

Ferdinand Porsche is said to be the first person to invent an in-wheel motor back in 1900. What sparked Elaphe's interest in this field and how do you explain the growing interest in in-wheel motors today?

Ferdinand Porsche's work has been a great inspiration, but we can safely claim that Elaphe is one of the pioneers of passenger car in-wheel motors. It all started in the late 1980s. Our mentor and co-founder Andrej Detela drew his inspiration from nature, in particular the anatomy of animals, and also had good technical reasons to believe his research could be applied to cars and other vehicles in the future. The availability of more robust, new materials (e.g. composites and high-energy density permanent magnets), combined with the belief that it was possible to produce a simple, clean and highly efficient powertrain architecture with very few moving parts, and most importantly, the vision about the potential to change how a car looks, how it is used and how to lower its environmental impact, spurred our commitment to



Photos: Courtesy of Elaphe Propulsion Technologies

Elaphe's unique in-wheel architecture and control algorithms offer interesting advantages over traditional electric motors. Independent four-wheel drive minus mechanical transmission provides greater stability and responsiveness to road conditions.

IP is central to Elaphe's business strategy and is increasingly important in attracting investors and raising the funds required for the company's expansion.

technological innovation. The initial designs proved the technological concept, so the obvious next step was to set up a company to support the development of this great new technology.

How do in-wheel motors work?

As a concept, it is very simple: two or four electric motors (depending on whether the vehicle is two-wheel or four-wheel drive) are integrated within the rim of a wheel. Each in-wheel motor is controlled by an on-board powertrain control unit developed by us. That unit controls how the motors behave together. There are no mechanical parts such as gears, differentials or drive shafts; therefore, the vehicle's architecture is much simpler and lighter. There is a great deal of engineering behind the technology. For example, the motor needs to be small, powerful and light, the brake needs to be integrated within the same space as the motor, the motor needs to be able to withstand road and environmental loads, and the control system needs to be able to control each motor for dynamic stability, etc. We have solved these challenges and the system looks really clean and simple.

How is your technology being used?

Our technology is being used in both automotive and non-automotive applications. It is integrated in a variety of vehicles and a growing number of automakers are either developing vehicles around our technology or evaluating it for the purposes of mass production of new vehicles based on in-wheel powertrain architecture.

What advantages do in-wheel motors have over traditional electric motors?

In-wheel motors offer many advantages over traditional electric motors. They are light, they save space, they improve vehicle dynamic performance, they allow simpler manufacturing lines and thereby reduce vehicle development and manufacturing costs. They also offer additional environmental benefits. Using fewer mechanical parts makes the vehicles lighter and enables the whole propulsion system to reach high driving efficiency values using a smaller battery to reach similar range.

What specific challenges did you have to overcome to put an engine into a wheel?

We started off by designing a motor which has the highest torque to weight ratio in the world (i.e. 45 Nm/kg in the L1500 motor). The motor is also really tiny, its active part measuring only 2 x 6 centimeters in cross-section. This design leaves enough space to integrate other components, such as steering, brake discs and calipers, in the wheel. This was a pretty revolutionary development given the power these motors have. When we demonstrated their impressive performance, we focused on making them cost effective, reliable and durable. Then we started developing the control software and electronics to provide functions that go well beyond what people expect from their cars today. Although our in-wheel motor is already a highly sophisticated product and we continue to invest in the electromagnetic design of our electric motor, the company is now focusing more on developing innovative mechanical design, production technologies and control concepts.

There is a lot of talk about self-driving cars. When do you think they will go mainstream?

We already see several levels of autonomy in cars, so I would argue that, to some extent, self-driving cars are already here. Full autonomy, however, is more elusive and I don't think anyone can give a definitive answer as to when that will become a reality. But I certainly hope that it is sooner rather than later, because, generally speaking, humans are terrible drivers.

Would it be fair to say that Elaphe's technologies are preparing the ground for driverless vehicles?

We are strongly committed to providing technology for self-driving cars and to support their development through our unique in-wheel architecture and the control algorithms they use. This technology offers interesting advantages. For example, independent four-wheel drive minus mechanical transmission provides greater stability and means a vehicle is more responsive and can react faster to road conditions. The integration of our in-wheel architecture in vehicles offers far greater stability than

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can be achieved by a human driver in harsh weather conditions, as demonstrated in our winter testing trials in 2017, 2018 and 2019 in Heihe, Northern China. Our in-wheel motors sense the state of roads and generate other cool data that make self-driving cars a safer travel option.

What has been the response to Elaphe's technology?

There has been a lot of interest in our technology since the company began operating, but there is still skepticism, in some quarters, surrounding the technical performance of in-wheel electric motors. We have made it our goal to overcome these concerns. Elaphe's technology is now mature enough to enter the mainstream market. We are working with leading brands in the automotive industry and interest in our technology is ramping up significantly. This is a strong indication of our success. Some parts of the automotive industry are ready to make the leap and reap the advantages of our technology. But our work is not yet done. We want all types of vehicles to use our products!

What role does innovation play in your company?

As a technology company, we rely on innovation to secure our competitive advantage. Innovation is at the heart of our business. The concept of our in-wheel architecture is innovative in itself and a significant advance on the work of Ferdinand Porsche in the 1900s. Achieving the same level of performance and reliability as a traditional 1900s combustion engine has proven a challenge and that is where our innovation has played a major role. But our achievements in overcoming these challenges have opened up new opportunities to produce innovative components and algorithms that allow our system to realize its full potential.

What role does intellectual property (IP) play in the company?

IP has always been an integral part of our business strategy. Typically, we use it as a defensive mechanism to secure the freedom to operate in this market. More recently, IP has also become central to our funding strategy. As the company has expanded, our ability to attract investors and raise funds has hinged on protecting the vast amount of IP we have developed around our innovations, which in the past, we treated as trade secrets.

"We are strongly committed to providing technology for self-driving cars and to support their development through our unique in-wheel architecture and the control algorithms they use."

Gorazd Gotovac, Chief Technology Officer, Elaphe Propulsion Technologies

What is your experience of using WIPO's Patent Cooperation Treaty (PCT) and how would you like to see the patent system evolve?

Elaphe has used the PCT extensively and for several reasons. The process is simple and provides a search report, which can supplement our own research on the state of the art. In a dynamic environment where new innovation is born every day, the timeframe of the PCT process gives us a certain freedom to delay strategic decisions until such time as the market and product information is clearer and the economic benefit of pursuing a patent is easier to evaluate. We are quite happy with the PCT, but in Europe, we would like to see the unitary patent system up and running. That would generate significant cost-savings and make the innovation process more affordable.

Are partnerships important to the company?

The automotive supply chain has a huge amount of knowledge on developing and manufacturing parts, so our partnerships are very important. They mean we avoid re-inventing components and technologies that can be produced much more efficiently by others. Our in-wheel motor has around 80 different parts of which around 50 are standard off-the-shelf components. Many of the remaining parts are developed in partnership with the supplier. This often involves making small modifications to their existing products. So partnerships offer many advantages both to Elaphe and our partners. It gives them a foot in the door and an established revenue stream, both of which will be useful when our technology starts pushing older automotive technologies out the door. Partnering with component suppliers is also very important when it comes to influencing the design of our systems. For example, manufacturers of braking systems, suspensions, wheel rims and so forth all bring invaluable insights to the table. And of course, putting appropriate IP arrangements in place is important in ensuring that these partnerships continue to work smoothly.

What are Elaphe's plans for the future?

We want to become the "go-to" company for in-wheel motors. The technology's potential has now been confirmed by the market so we are very optimistic that we will become a major global supplier for electric vehicles.

What do you think cars will look like 10 years from now?

Good question. I think that the form of the car will change to accommodate the new uses that connectivity brings to the industry. That means lots of space for passengers and screens, personalized interiors, software-defined functions, and advanced automated safety functions, at least for partially-automated driving. We will certainly see a high-performance electric powertrain with functionality that meets user requirements.

What message do you have for aspiring young inventors?

Many will tell you "it can't be done" because they heard someone tried and failed. Don't let that stop you. Keep thinking out of the box and test your ideas as quickly as possible. Look at the available proof, examine why a technology failed and use that information to test your approach. After all, the technology we take for granted today "couldn't be done" at some point in the past.