PROTEAN

TaaS and the 360-degree view of enabling technology

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The automotive industry is being subjected to unprecedented legislative, technological and societal change. Rising levels of road congestion and transport-related air pollution have led numerous local and national legislators to introduce regulations to restrict the use and ban sales of cars with internal combustion engines within the next 15 to 20 years. Disruptive technology is already breaking down barriers to the roll-out of electrified vehicles, while connectivity and the development of autonomous technologies promises to bring new ways to move people and goods.

Meanwhile, the shared mobility movement is changing how consumers, businesses and the public sector think about transport. Transport-as-a-Service (TaaS) models can enhance mobility, productivity and quality of life for everyone, including and perhaps especially, for the mobility impaired. Such advances could render traditional car ownership / leasing models redundant.

Shared mobility

The movement towards car-sharing is gathering pace, albeit at different rates not just between countries, but even from one city to the next. While Zipcar was a first-mover several years ago and is well-established, new start-ups are popping up regularly. GreenMobility, for example, has operated in Copenhagen for a few years and has announced it will launch in England in 2020. And it's not only Western Europe, Moscow is one of the world's best-served car-sharing cities with a fleet of over 16,500 shared cars.

A step-change has occurred in the past few years, as major household automotive brands are jumping into the shared mobility market. BMW and Mercedes joined forces earlier this year under the Share Now banner. Volkswagen recently announced its entry into car-sharing with the world's largest single operation in Berlin: 1,500 electric Golf and Up! models are now on the city's streets, with more to join next year, and a roll-out to other cities in Germany and across Europe to follow. Kia has a large car-sharing operation in Madrid, operating alongside PSA's FreetoMove scheme which also operates in the US.

Beyond cars, shared mobility operations are now branching out to provide a more diverse offering, with electric mopeds and scooters from Bird, Lime and others flooding the streets and pavements in cities across the US and across Europe in the past few years.

It's impossible, too, to talk about shared mobility without considering the impact of Uber and Lyft on the attitudes of the smartphone-enabled mobility system. They are to minicabs what car-sharing is to car rentals. From a consumer perspective, both car-sharing and ride-hailing represent a remodelling of an existing solution. For businesses, they are a fundamentally new business model.

Autonomous mobility

As shared mobility evolves fast on our streets, vast resources are being spent on autonomous vehicle technologies and these are not quite ready to be unleashed to the public en masse. Some estimates say the investments have already exceeded $100bn, with the likes of Google's Waymo, GM's Cruze and Uber being among the most well-known proponents. The developers, experts and analysts seem to disagree on quite how quickly autonomous vehicles can become a regular feature on our roads: Tesla contends it's imminent (and its Autopilot feature is already deployed, although not without controversy). In any case, the momentum behind this self-driving juggernaut seems unstoppable.

When the shared mobility and autonomous technology movements combine, we will see streets occupied by cars with no driver and that are not owned by their occupants, and where transport and mobility may for most just be a commodity services paid for per mile or per minute.

This new era of mobility offers opportunities for brands able to embrace the changes and answer the demand for new solutions, services and revenue streams. Forecasts suggest the global intelligent mobility market will be worth over $1tn per annum by 2025 (source: Transport System Catapult Study).

Electrified mobility – but not as you may think

As the mobility paradigm shift spawns new technologies, it's apparent that the internal combustion engine will no longer be the primary source of power for the driven wheel.

Electric cars are claiming an increasing proportion of vehicle sales. In the context of a predicted 4% fall in worlwide car sales for 2019 (source: Forbes / CAR), during the first six months of this year, global sales of pure electric vehicles increased by 92% to 765,000 units, and they now account for 1.8% of all global passenger car sales (source: Jato Dynamics). The hugely important environmental benefits have been presented (and debated) over and over, but the opportunities for new electric technologies go beyond the greater sustainability issue.

For a wide range of applications, familiar electrified powertrain layouts (for hybrid, plug-in hybrid and pure battery electric vehicles) result in 'conventional'-looking cars, which may ease their uptake by car buyers. But such configurations also result in many of the same compromises as fossil-fuelled cars when it comes to design and packaging. There is a good reason today's electrified vehicles – from the Nissan Leaf and the Jaguar iPace to the Mercedes EQC and Tesla range – look relatively conventional: in place of a combustion-engine, they have a motor between the wheels, and they have an axle with a gearbox, shafts and joints employed to transmit the torque to the wheels. There is still a fixed driving position, dash, pedals, traditional doors, and the seats are all forward facing.

In a truly next-generation autonomous vehicle, there will be no need for a driver. Eliminating their fixed position in the vehicle's interior footprint enables the removal of much of the resulting associated hardware – steering wheel, dashboard etc – and the limitations on design and layout configuration that are imposed by this equipment.

Even removing this hardware still leaves electric motors mounted between the wheels, with driveshafts transmitting power to the wheels. This all takes up valuable underfloor space, constraining the newly available design options.

In-wheel motors (IWMs) eliminate these compromises. The compact and highly efficient motors are mounted within the wheel hub, and are simpler, lighter, and more energy efficient than eAxles. IWMs offer an "electric drivetrain 2.0" moment. Not far ahead in the future, but today. Production-spec prototypes of Protean's IWMs are already being tested in light commercial vehicles, passenger vehicles and autonomous mobility pods. One example is the Local Motors Olli, the world's first co-created, self-driving electric vehicle. Olli vehicles are currently being trialled by organisations across the US, including city administrations, college campuses, start-up mobility providers and public transit systems operators.

Returning briefly to the green credentials of electric power, direct drive in-wheel motor systems eliminate the losses that occur in the gearboxes and driveshafts of conventional electric vehicles, so offering the opportunity to downsize the battery for equivalent range with consequential reduction in vehicle mass, or to increase the vehicle range.

Not only does the technology bring cost efficiencies for operators, it also offers greater flexibility in vehicle design that can't be achieved with conventional powertrain configurations.

Unlike other IWMs, our ProteanDrive configuration – protected by over 160 patents, with another 150 patents pending – integrates the inverter with the motor assembly to provide a super-compact electric drive system. As a result, the technology exhibits a simple, highly integrated yet flexible design that delivers power with maximum efficiency.

As well as facilitating efficient use of interior space, the application of IWMs aids dynamics, handling and safety thanks to inherent torque vectoring capabilities. Weight distribution can be optimised thanks to the increased flexibility for positioning key components such as the battery. And in addition, the absence of an internal combustion engine or electric motor on the vehicle body helps to lower the overall centre of gravity.

Alongside our own robust development and testing procedures, ProteanDrive has been subjected to gruelling real-world trials by leading vehicle manufacturers and technology partners, who have proven how well suited our IWMs are for a broad range of applications. ProteanDrive operates in the most severe climatic conditions and resists the ingress of dirt and moisture in all environmental situations.

Protean's technology has reached production-readiness just as new players in the electrified shared mobility, last-mile transportation and autonomous vehicle sectors are emerging, and we are currently working with National Electric Vehicles Sweden (NEVS) amongst others, looking at how best our ProteanDrive IWMs could fit into their future products.

Maximising the potential of autonomous urban pods

The Local Motors Olli is the epitome of many people's views on what autonomous urban mobility solutions – in cities in particular – will look like within the next decade.

This medium-term future of urban mobility opens up the opportunity for this new class of urban transport vehicles. To develop such vehicles, new technological approaches are required in every aspect of the vehicle (as well as the infrastructure it operates in), and therefore design, packaging, and powertrain configuration. IWMs are perfectly suited to these pods.

But the opportunities for innovation don't stop there.

A few months ago, we announced the development of a completely new technological approach that goes even further in helping vehicle developers and mobility service operators to realise this future vision of urban mobility. If we accept that autonomous urban pods will move people and goods around our cities, it is clearly essential that they do so efficiently, quietly, comfortably and profitably.

Integrating advanced ProteanDrive in-wheel motor, steering and suspension technologies within a single package, the Protean360+ corner module gives vehicle developers what they need to package the mechanical components of a vehicle neatly in the corner of the pod.

The module's compact packaging allows for an entirely flat floor inside the vehicle and sufficient lateral access to offer wheelchair ingress and egress via front, rear and side doors, This also means the vehicle can park front-, rear-, or side-on to the kerb, and occupants can disembark straight onto the pavement without having to step into the road – a better mobility solution for all.

The exceptional manoeuvrability enabled by the unlimited 360-degree steering system allows for high versatility on busy urban streets, and parking in tight spaces with kerb-side precision. Once stationary, the pneumatic ride-height control of Protean360+ enables the vehicle to 'kneel', dropping its floor to kerb level. This will afford stepless and virtually gapless ingress and egress for heavy or cumbersome loads or passengers with impaired mobility.

The Protean360+ corner module was borne from our team's innovative thinking about how to meet the requirements of these next-generation urban vehicles. Its unrivalled capabilities significantly advance the effectiveness of the urban transport vehicle concept, and we are already in discussion with prospective customers to apply the technology into their future vehicles.

Profitability

Beyond greater power and packaging efficiency, IWMs also open up new sources of revenue from within the wheel arch.

Sensors integrated within the electronics of the IWMs have the potential to capture diagnostic data associated with the condition of wheel-end components including the motor, bearings, suspension, wheel, tyre and brake. This data can be communicated to the vehicle via the existing communications bus and then forwarded to designated recipients through a V2X gateway.

Using this system any excessive wear or minor damage can be identified and resolved before it becomes a more substantial issue or adversely impacting on other components. For drivers, such preventative maintenance can save cash and inconvenience. For operators of fleets and mobility services, it can help minimise downtime by scheduling maintenance for quieter periods, avoiding risking potentially reputation-damaging breakdowns and reducing risks to passenger safety.

Wheel-end data could also have value to third-party stakeholders, too. Road surface condition data, for example, could potentially be used by providers of traffic information to warn subscribing motorists of icy roads, road surface damage or where oil spills have occurred that have resulted in low grip conditions. The data can also be used by the relevant authority to arrange to address the issue before minor damage becomes more severe (and more dangerous), which in turn would require a costlier, more time-consuming repair. Fixing damage sooner will also help roads authorities avoid compensation claims from drivers whose cars have suffered damage.

Ultimately, this data may have a value to all road users, operators, service providers and wider society. As such, the value can be monetised to help ensure future mobility solutions are sustainable in the long term.

Conclusion

There is no doubt that the roads in the 2030s will be occupied by very different vehicles than the roads of 2019. Most major manufacturers have committed to fully electrify their model line-ups in the coming decade. The majority of cars on the roads of western Europe and the US will be internet-connected by 2023. Shared mobility is on the rise. Autonomous vehicles are a 'when' and not an 'if'.

In this perfect storm of seismic shifts in mobility, every aspect of how we are moved around our towns and cities is being rethought and redesigned. Within the coming decade, this will spawn new vehicle designs and new business models, and entirely new expectations from drivers, riders and mobility users.

We see compact, powerful, efficient in-wheel motor technology playing a key role in enabling the transformation of mobility.

From conventional passenger cars to autonomous mobility pods, IWMs are the future of the driven wheel, and a vital enabling solution as we all undertake a 360-degree rethink of how we transport ourselves in the future.

About the author

Dr. Chris Hilton has been Chief Technology Officer at Protean Electric for over a decade.

These "TaaS and the 360-degree view of enabling technology" provide an insight into the themes, thoughts and industry observations from an automotive technology CTO.