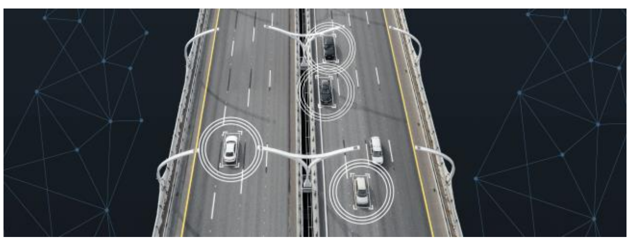
PREPARING SOCIETIES FOR AUTONOMOUS VEHICLES

A View From Asia: Embracing challenges from concept to reality

Technology continues to drive the development of autonomous vehicles while calling attention to requirements for real-life use. In the following Q&A, Joseph Wong, Director of Transport & Infrastructure, WSP in Asia, discusses the journey to achieve full-fledged autonomy, key considerations as societies plan for autonomous vehicles (AVs), and the benefits AVs can bring to communities around the world.



How do AVs work?

Joseph Wong: Every AV has an intelligent mapping computer with sensors that detect objects and continuously talk back to the computer about the surroundings of the vehicle to propel or halt the AV. Of course, intelligence must be built in, to imitate human driving behaviour and adapt to real-time external conditions, provide for safe operation and enable acceptable ride comfort.

Rapidly developing autonomous-driving technologies can enhance car navigation, route planning and optimization, environment perception and car control. Features of automation exist in today's vehicles, such as adaptive speed control, lane-keeping assist, and automatic emergency braking. Mass production of full-fledged AVs requires further progress in artificial intelligence [AI] capability and data availability; until that time, people will experience fully evolved autonomous vehicles in limited situations. For self-driving cars to operate safely in the broadest set of scenarios, they must be able to navigate in all types of weather and road conditions without human intervention. Globally, over the past several years, there have been incremental yet significant steps in the development of AVs—including cars, buses, trucks and shuttles, such as minibuses and pods—with variations in the levels of development, testing and scope of deployment.

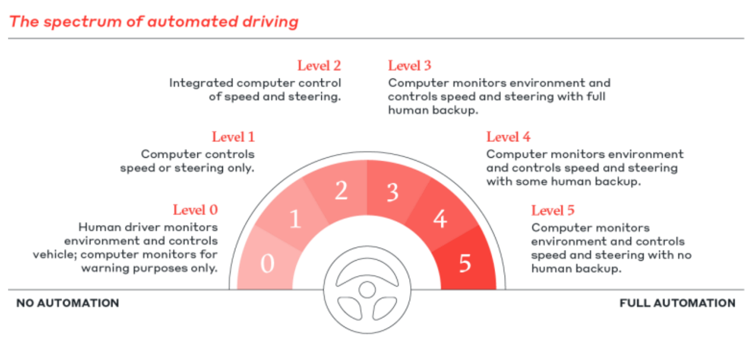


Figure 1 – Adapted from the Society of Automotive Engineers (SAE) standard J3016 levels of driving automation. SAE defines 6 levels of autonomous driving from 0 to 5 based on the human intervention required for the ride. The higher the level of automation, the more information the vehicle uses about the driving environment to automate driving tasks. For SAE levels 1-3, the human driver is required to perform some or all of the driving task(s).[1]

What are the potential end-user benefits of AVs, and how can they be realized?

[1] SAE full description of automated levels

Joseph Wong: With the combination of intelligent hardware and software—utilized by autonomous vehicles and on surrounding infrastructure—autonomous vehicles can facilitate the creation of a hassle-free driving environment and minimize the safety risk for all road users. These technologies can also bring about more accessible mobility for road users and support the development of environmentally friendly transportation solutions. Convenience, another potential benefit, may entail simple voice command to tell the vehicle computer the destination, specifying stops along the way, and directing navigation with toll or no toll; before the actual ride, people could use their smart phone to find the nearest public AV for travel.

As auto-navigation and autonomous driving technology evolve, the effectiveness of energy and fuel usage could be improved. Vehicle-to-everything connectivity will enable the fuel usage per trip to be minimized due to steady speeds, reduced idling time on roads, correct navigation and efficient routes. A further step forward would be a centralized intelligent computer that tracks real-time location, speed and destination information with control of any vehicle in its radar; the tracking can be fed back into the algorithm to predict and respond to traffic density and flow. In future development, the application of autonomous technology to electric vehicles with zero direct emissions could accelerate greenhouse gas emissions reduction in the transport sector.

With continuing progress, especially when levels 4 and 5 are reached, AVs will be able to provide an important mobility option for people with disabilities, the elderly, and people who have not reached the driving age. There will also be opportunity for autonomous taxis and minibuses to bridge transport gaps within certain regions—for example, between public transit and homes and in delivery services. Whether through ride-share companies or incorporated into public transport, AVs could thereby facilitate enhanced connectivity and thus inclusivity within and between communities—urban or rural.

What are a few considerations relating to safety?

Joseph Wong: AV safety should be viewed within the wider context of safe road traffic systems; around the world today, deaths and serious injuries remain at alarming levels.[2] Many factors contribute to road systems where all people can safely travel using multiple modes of transport. In terms of AVs, consideration of all road users is necessary from both hardware and software perspectives. For example, it is important to identify and implement the way to distinguish between living and non-living objects accurately under extreme lighting conditions, supported by a perfected algorithm to ensure the most appropriate decisions are executed under different scenarios. Decisions with ethical concerns, where nuanced judgment is needed, can be difficult to encode in the AI. Another scenario may be an underwhelming infrastructure, one with lack of adequate connectivity and system redundancy, making the autonomous ecosystem less reliable; reliability—necessary performance under varied circumstances—is essential to support a safe road system. As technologies mature and become more cost effective, they will ultimately resolve technical issues related to reliability and safety, thereby offering the possibility to avoid road bottlenecks and collisions. Of course, during the course of this development, education is necessary to help drivers understand how to properly engage with the autonomous driving process.

[2] World Health Organization, Road traffic injuries: Approximately 1.3 million people die each year as a result of road traffic crashes. Between 20 and 50 million more people suffer non-fatal injuries, with many incurring a disability as a result of their injury.

Safety must be prioritized as development continues, and with this prioritization comes opportunity for technology to help achieve a higher level of road safety. Reducing road-traffic fatalities and serious injuries depends on a highly collaborative approach to shaping supportive policy and built environments for safe mobility—that is, safe mobility for all people travelling the world's roads using diverse modes of transport. Multidisciplinary collaboration is fundamental to the Vision Zero approach to road safety; a similar type of collaborative effort among multiple stakeholders can guide creation of a framework for AV development.

How can AVs shape urban and non-urban environments of the future?

Joseph Wong: Future urban development that embraces the implementation of AVs could be described as actual and virtual—where cities gradually transform into environments akin to what we have seen in futuristic movies. More intelligent infrastructure will be built or modified from existing infrastructure. Some infrastructure, such as road signage, street nameplates and traffic lights, will not be necessary at the same levels and will be phased out in certain situations. However, the upkeep of the electronic, electrical and mechanical parts, as well as the steel in vehicles and concrete in infrastructure, will be necessary. The availability of computers and their software and the connectivity they bring will likely shape what is considered critical infrastructure and further define what is considered urban and non-urban.

Features not apparent to the naked eye, such as intelligent road-zone planning, will also aid in shaping our future landscapes digitally. Imagine that roads could be divided into zones for various purposes with high flexibility; for example, zones for parking, passenger pick-up and drop-off, and lanes for public transport or even shared mobility could be altered in accordance with the time of day, traffic condition and road usage pattern. By integrating roads with AVs and intelligent infrastructure, it is foreseeable that road utilization will be improved, traffic violations will decrease, and more convenience will be brought to the road users.

As countries take steps to become AV-ready, how does road-traffic culture factor into the process?

Joseph Wong: From the AV manufacturer perspective, their system may require adjustment in response to the road-traffic culture of different countries, such as road-user behavior and the mode of transportation most utilized. In some countries, the road traffic laws may not be developed or enforced comprehensively, allowing potentially unsafe practices to be accepted as the norm in the society. These practices may include permitting pedestrians to cross the road outside of crosswalks or drivers to double park, creating blind spots. In some Asian countries, motorcycles overwhelmingly occupy the local transportation, due to much lower cost relative to cars; car spacing may need to be tighter in those countries. Therefore, it may be necessary to fine-tune the auto-driving protocol to protect the safety of all road users and enhance traffic smoothness; elements of this protocol may include speed profile, driving logic, allowable distance between cars, and priority of road users to suit the given country.

You have already discussed the importance of providing proper digital and physical infrastructure. What are some other implementation-related factors and possible end-user concerns?

Joseph Wong All end-user concerns should be taken into account and dealt with in a well-considered way. Concerns about potential data breaches and safety issues may discourage people from accepting AVs. The impact of a data breach could be small such as a personal data leakage to other third parties for marketing purposes; however, user personal preferences could be acquired and even utilized in a detrimental manner, such as a hacker causing traffic paralyzation. One solution could be a fully independent central computer, or a few for redundancy, that can take over and even isolate problematic AV computers in the system once a breach is detected.

Implementation-related factors include land planning for new infrastructure or modifying existing infrastructure; standardization of technologies between car manufacturers and roadside infrastructure designers—in other words, a shared protocol; cybersecurity; reliability and safety; and defining the responsibilities of relevant parties. It is essential to establish legal and regulatory frameworks to govern the development and implementation of different types of AVs in a proper and controllable manner, and to address the liability issue; who should bear the responsibility in the case of an accident?

It is also worth noting two challenges related to maintenance that can be anticipated during AV development. The first challenge is insufficient maintenance facilities; the popularity of AVs will rise with respect to the maturity of AVs, and there will be a parallel rise in the demand for maintenance. One solution is to upgrade and increase the number of existing maintenance facilities to serve as smart checkpoints integrated with fuel-charging stations, which would be used for conducting basic checks and rectification during refuelling or battery charging. The second challenge is the coordination between maintainer and robotics. As AVs and infrastructure maintenance still require human intervention, and will continue to do so into the foreseeable future, responsibilities and processes should be defined clearly. For instance, concerning the interface coordination between robotics and the maintainer, how should an issue be resolved if there are discrepancies between the judgment of the maintainer and robotics? How is it best to evaluate the robotics performance and conduct rectification? Stipulation of dedicated training courses concerning standards for AVs with international recognition could be a proper direction to tackle such uncertainties.

What guidance can you provide regarding these issues?

Joseph Wong: The complexity across the different types of vehicles under development is substantial, and the economic impacts, legal implications and social acceptance have yet to be fully considered. The importance of public acceptance should not be underestimated.

Prior to launching, at every level of automation, several actions should be planned and implemented. One strategy is the formation of a task force. To be most effective, such a dedicated group should comprise experts across diverse disciplines responsible for all AV-related matters from the feasibility study to planning, with follow up on all issues after launch. Member stakeholders would make sure that proper attention is paid to the many quickly evolving issues and encourage governments to promote a safety culture, including guidelines, to support progress and safety throughout the lifecycle of AV development.

It is also essential to reserve sufficient time for public consultation, which creates a communication channel between end users and relevant stakeholders to discuss concerns and queries with open-mindedness. Public forums, trial demonstrations and early deployments all provide the public with an opportunity to see, touch and experience AVs in a non-threatening environment; they also give the infrastructure owner-operator the chance to learn important lessons to maximize safety benefits and minimize problems.

Trial tests within ordinary road environments is a long-term process requiring comprehensive planning, starting from the designated route to locations throughout regions and the entire country, and eventually cross-border. A multidisciplinary task force can facilitate the needed conversations early in the process and ensure these tests consider various operating environments and vehicles with different levels of automation.

In order to minimize the disruption to the public, governments could facilitate collaboration between hardware and software vendors, car manufacturers and map development companies, to develop a digital twin model with high fidelity for trial tests simulation. The collaborative modelling will help to fine-tune the technology from an asset management perspective, provide all parties with significant data to archive and study as well as important research outcomes to build upon. Progress to make AVs a reality requires close and continued collaboration between authorities, research organizations, technology companies, end-users, and automobile manufacturers.

To build trust and acceptance, it is important to maintain high transparency of analytic data with the public. Authorities should release relevant information such as the results of trial tests on reliability and safety, which should include a touch of controlled stress on the infrastructure. Keeping the public informed regarding newly discovered issues, updates on known issues, and anticipated benefits—while respecting the privacy of individuals and intellectual property of companies—can set the stage for further development.

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