On the road to automated driving:
A JAMA overview of the advances made so far and the further progress required to make automated driving a reality
The Japan Automobile Manufacturers Association (JAMA) is engaged in broad-ranging activities whose common aim is the achievement of motorization which, by means of advanced-technology vehicles, makes road transport safer, more efficient and more comfortable for all road users, including pedestrians.

To that end, advances are continuously being made not only in the manufacture of motor vehicles but also in the development of road infrastructure and of public awareness in regard to road safety and the efficient use of automobiles.

Japan’s automakers have been investing increasing effort and resources in recent years in addressing the major challenge of making automated driving a reality. Progress in this area requires that cooperative advances be made within both the domestic and global auto industry and across the spectrum of all the sectors concerned.

The scope of the challenge, involving, inter alia, technologies from various industries and the overarching need for public acceptance, prompted JAMA to establish, within its organizational framework, a dedicated Automated Driving Study Group of experts to formulate a “JAMA vision for automated driving.”
JAMA member companies share a common understanding of what that vision is: achieving, through the use of automated driving, safe, efficient and comfortable road transport enabling zero accidents, zero traffic congestion, unrestricted travel distances, and efficient transport for all road users, including drivers, passengers, motorcycle riders, bicyclists, and pedestrians.
As a first step, road mobility issues that can be addressed by automated driving technology have been broken down into three categories based on road type or, more specifically, the driving environment:

- First, the need to reduce road accidents and road congestion in urban agglomerations, with their high population densities and heavy road traffic;
- Second, the need to achieve smooth and steady traffic flow on highways in order to make such high-speed driving more comfortable and long-haul freight transport more efficient, by reducing driver workload; and
- Third, the need to make driving in Japan’s rapidly depopulating and therefore increasingly “aging” rural communities safer and more comfortable.
Those issues are underscored by basic realities related to road transport in Japan, namely:

- Road injury and fatality rates;
- The adverse economic and environmental impacts of road congestion;
- Depopulation in rural communities, which are furthermore less well-served by public transport, and dense population in large urban areas, where heavy traffic reduces the comfort and convenience of vehicle use; and
- The shrinking pool of drivers of commercial vehicles (including trucks, buses, and taxis) in the rapidly graying national population, and the trend of increasing demand for small-parcel freight transport.
Taking into account all of these issues, the Japanese automobile industry has identified two main sets of objectives, the first being the elimination of road accidents and congestion and the second being the realization of optimally independent mobility and efficient freight transport.

Automated driving will not, by itself, assure the achievement of these goals, but it will provide technology essential to resolving the challenges involved.

The viability of automated driving technology is predicated on its acceptance by society, which requires consensus among vehicle users, the automobile and other industries, government, and the public at large.

On the basis of such consensus, the development of the technologies required and their step-by-step commercialization can be undertaken by the automobile industry in collaboration with all other relevant stakeholders.

From the auto industry’s point of view, automated driving is also expected to enhance the value of its products by making motor vehicles more attractive to users.
Pathways to resolving the challenges with technology are shown here.

To address the challenge of eliminating road accidents and traffic congestion, the problems of driver inattention and inappropriate inter-vehicle distances and speed need to be solved.

And to achieve optimally independent mobility and efficient freight transport, automated steering and other automation technologies need to be developed, to reduce driver stress by making driving easier, hands-free and more comfortable, even when driving long distances.
To resolve the problems of driver inattention and inappropriate inter-vehicle distances, the possibility of human error has to be eliminated. To reduce road congestion, greater efficiency in road and vehicle use must be achieved.

To make vehicle operation itself easier, safer and more comfortable, even for commercial vehicle drivers coping with heavy traffic and tight schedules, the means for achieving optimally efficient vehicle use must be provided.

In terms of the technologies applied, *driver assistance systems*—many of which are already available in the market—supplementing driver input help reduce or eliminate human error. *Automated driving functions* take those “drive-assist” systems to higher levels of driver support through advanced automation technology.
Shown here are various driver assistance systems that are already in real-world use.

“Smarter,” more advanced driver-support technologies will be developed on the basis of these and other active safety systems in the pursuit of safe, efficient and more comfortable driving.
Advanced automated driving technologies will eventually enable totally automated lane changing, exiting from or merging into highway traffic, turning at intersections, driving on busy city roads without human operator input, and driverless parking.

The development of these technologies will, however, require very considerable time and effort.

All of JAMA’s member manufacturers and various Japanese parts makers are developing automated driving technologies.

The development of automated driving and peripheral technologies has also been undertaken by Japan’s information technology industry.

Meanwhile, public interest in automated driving is steadily growing.
Development of these technologies as well as their market introduction and expanded use will be incremental.

Those efforts will be predicated on public acceptance—in other words, on society’s common consent on the extent to which the real-world adoption of such technologies is desirable.
A scenario for the commercialization of automated driving must, furthermore, take into account a broad range of factors, which can be classified into three categories:

- First, the evolutionary framework for automated driving technology itself;
- Second, the basic, cross-sectoral integrated technologies required for the real-world use of automated driving; and
- Third, other factors, in all relevant infrastructures including the regulatory infrastructure, critical to the implementation of automated driving.

This scenario thus subsumes collaboration on a wide scale, integrating efforts on the part of industry, government, and academia.
First, the evolutionary framework for automated driving technologies is determined by the extent of automation or *automated driving level* involved, and the driving environment with which such automation interacts. Broadly speaking:

- In lower-level automation, or “autonomous driving,” sensors on board the vehicle work together in “sensor fusion” to detect and process data concerning the vehicle’s surroundings.

- Higher-level automation, or “adaptive driving,” refers to the automation of certain vehicle operations based on information obtained, via onboard sensors and roadside signals and communications equipment, through communication with other vehicles and with road infrastructure (“V2V” and “V2I” communication, respectively).

- Driving environments, as shown in this graph, range from the “simple” to the “complex.”

Here, the progression from “autonomous” to “adaptive” reflects the degree of technical difficulty for completion of the driving task. The driving functions shown in the upper right of the graph are the most difficult to automate and thus will require relatively longer development periods.
Next, represented here in the same graph format, are the basic technologies applied in real-world automated driving systems. They involve multiple, cross-sectoral industries and their application to automated driving should be advanced on a collaborative basis, through joint development initiatives.

Information and communication systems constitute a core infrastructure, whose further development should be undertaken on the basis of collective efforts aimed at building a secure framework for the protection of both vehicles and personal information from hacking and cyberattacks. With respect to vehicle safety and driver interaction technologies, standards will have to be established defining the conditions under which automated operation will shift to manual, i.e. human driver, operation and identifying all relevant operational requirements in the case of system breakdown. These criteria need to be common criteria and thus globally harmonized standards for automated vehicle safety and design will need to be established. Globally harmonized standards for the development and practical application of high-precision positioning technologies, high-precision mapping technologies, and dynamic mapping technologies—which continuously update real-time information on, for example, surrounding structures and road traffic and weather conditions—should also be established.
Finally, shown here is a summary of the areas in which further development is required to support the full-fledged implementation of automated driving, including not only communications and data supply infrastructures, but also a regulatory infrastructure.

First, an advanced communications infrastructure needs to be developed to enable the transmission of real-time dynamic mapping data and V2V and V2I data.

Second, regulations are necessary because the responsibilities of vehicle drivers and of the automated driving technology itself must be clearly defined, while user incentives such as tax breaks, for example, should be provided to encourage the wider use of such technology.

Third, further development of the data supply infrastructure will be necessary to ensure the continuous transmission of all the real-time data required in automated driving systems operation.

And fourth, upgrades in the road environment are needed to provide the various road-based elements that are required for automated driving, including advanced sensor-based recognition systems, appropriate lane markings, traffic signals and signboards, dedicated lanes for automated driving, and the more flexible application of speed limits.
JAMA has drawn up the timeline shown above for the introduction of automated driving.

This roadmap envisions: The wider introduction of automated driving functions in the lead-up to 2020; between 2020 and 2030, the expanded application of automated driving technologies in various driving environments; and a full deployment, based on public acceptance, of advanced levels of automated driving by 2050.

Meeting these milestones will require the development and implementation of the necessary technologies, communications and data supply infrastructures, advanced road environment and regulatory legislation, based on collaboration among industry, government, and academia, as stated earlier.

Meanwhile, the wider use of existing active safety and driver assistance systems should be proactively promoted as an incremental step on the road to achieving public consensus on the merits of automated driving itself.

The Japanese automobile industry’s ultimate goal is to eliminate social burdens associated with the use of motor vehicles through the evolution of existing vehicle technology into innovative automated driving technology.
A “Strategic Innovation Program” is in fact underway in Japan, aimed at introducing next-generation road traffic systems and automated driving systems by the target year of 2020, when Tokyo is scheduled to host the Olympic and Paralympic Games.
Japan’s automobile industry will be investing maximum resources to meet its 2020 goals for the development of automated driving.

The industry looks forward to addressing the challenges that lie ahead on the basis of a common understanding with the public at large of the optimal relationship between motor vehicle use and social needs.