Self-driving vehicle technology has made significant advancements; now there needs to be an industry standard for self-driving safely.

Autonomous driving: Safety first
Safety is of paramount importance for operating autonomous vehicles. That doesn’t mean the safety of just the riders and passengers, but also other vehicles on the road, pedestrians, and bicycle traffic. To gain widespread acceptance, safety issues must be resolved to the full satisfaction of the public. Getting a handle on safety means also taking on a thicket of technological, legal, and philosophical challenges.

Autonomous vehicles are going to be part of our transportation network. Most industry experts believe it is only a matter of time before they’re plying the roads in increasing numbers. “[Autonomous driving] will come, but it’s not going to be instantaneous,” says Judith Hurwitz, president and CEO of consultancy Hurwitz & Associates. “There’s not enough data yet to test everything and train on everything.”

Just look at what the major automotive manufacturers are doing. General Motors recently invested $100 million in two manufacturing sites in Michigan to focus on rolling autonomous Cruise AVs off the line. Other major manufacturers, such as Ford, BMW, and Volvo, are similarly interested and invested in autonomous-vehicle programs.

Making good sense
Full visibility into how autonomous vehicles operate and how they decide to drive is necessary to assuage public concerns and enable government organizations to help ensure safe practices and accepted licensure for their operations. “This lack of transparency, and a lack of engagement with consumers to help them understand how this technology works, is a big part of the public perception problem,” says Jack Weast, senior principal engineer for Intel and vice president of automated-vehicle standards for Mobileye, a subsidiary of Intel that produces advanced driver-assistance systems.

Key takeaways

1. Full transparency into safety regulations for autonomous vehicles is needed to assuage public concerns and help governments encourage safe practices.

2. A regulatory framework would set standards for safe autonomous-vehicle operation.

3. Automakers are working to overcome technological, legal, and ethical issues, but regulatory agencies and others must weigh in before autonomous driving gains widespread acceptance.
At the Consumer Electronics Show in Las Vegas in January, a coalition of auto and tech companies, including Intel, launched Partners for Automated Vehicle Education, or PAVE, a consumer advocacy organization that will work with the National Safety Council to educate the public and policymakers about autonomous-vehicle technology.

Autonomous vehicles are programmed, responsive robotic systems, and as such they operate on three primary stages of functionality:

**SENSING:** accurately perceiving the surrounding environment.

**PLANNING:** involving the decision-making process, when the artificial intelligence (AI) embedded within the vehicle recommends taking actions such as changing lanes, braking, or accelerating.

**ACTING:** putting the recommendations to work to move and operate.

The sensing system comprises onboard cameras, radar, and lidar, a radar-like laser imaging system. Long-range, 360-degree cameras, which can detect shapes and “texture”—for example, words on a sign—provide a high-resolution view of the autonomous vehicle’s surroundings. That level of definition helps the vehicle understand the semantics of the road, including lane markings, intersections, traffic lights, and where pedestrians are and what their likely next moves will be. Cameras then create a 3D image of the surrounding terrain, other traffic, obstacles, and speed and distance measurements.

The radar and lidar work together to provide backup for the camera’s sensing picture, helping provide safety and protection against mistakes. “Maybe for some reason the radar was confused by a metal plate in the road. No problem—the camera is not bothered by that,” says Weast. “Maybe the windshield has mud on it or something, and the camera can’t see for a moment. We still have the radar and lidar that can provide information so we can help keep the passengers safe.”

These combined sensor technologies don’t become fatigued or distracted the way humans do and can accurately perceive objects over great distances, even in low light or inclement weather. They provide “a 360-degree view of the landscape that exceeds the capabilities of a human,” says Sumit Sadana, chief business officer for semiconductor producer Micron Technology.

There could be possibilities for occasional misinterpretation. A recent study describes “adversarial patches,” or images that can be used to fool the AI in autonomous vehicles into thinking it sees a stop sign, for example. But, Weast says, “these kinds of academic visual tricks are fun in academic circles but rarely affect a real system designed by companies that know better.”

**The thinking vehicle**

“Planning,” in the sensing-planning-acting triad, is where safety truly comes into play—it’s where decisions are made in response to what’s happening...
on the road. It’s also where the programming in autonomous vehicles manifests itself. But there are deeper philosophical and responsibility questions here: who decides how these vehicles make their own decisions? Who sets the safety standards?

Intel’s Responsibility-Sensitive Safety (RSS) framework is one example of the industry working to determine what it means for an autonomous vehicle to drive safely. As a proposed industry standard, it is technology-neutral—so it works with technologies from any manufacturer—and it is intended to foster trust between people and autonomous vehicles. RSS is designed to help people understand what autonomous vehicles do when presented with an unsafe situation. With the RSS framework, Intel intends to ultimately “democratize safety,” or help ensure that safety is the responsibility of all industry participants.

“Today there is no regulatory framework that would allow anyone to commercially deploy an automated vehicle. The vehicles on the road today are there for development and test purposes only,” says Weast. “The challenge that we as an industry face is, ‘How can we prove that these vehicles are ready for the road?’”

The RSS framework models what most humans do when they are driving, riding a bicycle, or walking. Once an autonomous vehicle has determined its location and the relative whereabouts of nearby pedestrian and vehicular traffic, the “acting” component is driven primarily by existing automotive technology like the power and braking systems, albeit controlled by the vehicle’s onboard processing.

The vehicle’s goal, Weast says, is to drive carefully enough to make its own safe decisions. “It should never do anything that could initiate an accident or introduce risk to others. And it should be cautious while being able to make reasonable assumptions about the behavior of others.”

The potential remains, however, for certain combinations of factors to cause confusion. “Think of what foggy conditions do to a human driver. [That would require] an autonomous software system to selectively filter out that input,” says Fred Bower, distinguished engineer at the Lenovo Data Center Group. Those conditions could be exacerbated by situations that human drivers encounter and deal with on a daily basis. “Accident scenes, construction zones, malfunctioning signals, and a myriad of other situations that are routine to an experienced human driver are a real challenge for the current autonomous fleet,” says Bower.

Industry alignment

Industry participants are joining forces to resolve lingering technological, legal, and ethical issues related to autonomous-vehicle operations, but it’s a work in progress. Gill Pratt, CEO of the recently formed Toyota Research Institute, believes autonomous-vehicle operations will expand in the near future but realizes the industry has a ways to go. “None of us in the automobile or IT industries are
close to achieving true level 5 autonomy—not even close,” he says, referring to the highest of driving automation levels, which requires no human intervention. Lower levels, such as 1 and 2, require human control. Pratt believes that within a decade auto manufacturers will have level 4 vehicles—which run without the need for human input—operating in specific situations.

But progress can’t take place in the automotive industry alone. To make autonomous driving a reality and ensure continued and consistent safe operational oversight, the auto industry, government regulatory agencies, and others must all weigh in and participate to help ensure the safety of autonomous-vehicle riders, other vehicles, and pedestrians. Only then will the technology gain widespread public and commercial acceptance.

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Jack Weast, Senior Principal Engineer, Intel

“Let’s have a common understanding and hear from consumers,” says Weast. “Let’s hear from governments and let’s understand what do they need to be convinced of the safety of these vehicles.” Genevieve Bell, distinguished professor of engineering and computer science at the Australian National University and a senior fellow at Intel, framed the challenge of incorporating autonomous systems into society as a series of unanswered questions.

“Who gets to decide what’s autonomous and what isn’t? Who gets to decide how that’s regulated? How it’s secured? What its network implications are?” Bell probed during a presentation in San Francisco in October 2018. “Those are not just questions for computer scientists and engineers. Those are questions for philosophers and people in the humanities and people who make laws.”
An autonomous vehicle employs a collection of technology components to perceive its surroundings and operate safely.

**Lidar**
Emits laser-light pulses that hit nearby objects, determining their shape and how close they are to the vehicle.

**Cameras**
Detect shapes and texture, providing a high-resolution view of the vehicle’s surroundings.

**Radar and lidar:**
Work together to back up the cameras’ vision, helping ensure protection against mistakes.

**Radar**
Uses radio waves to identify objects and determine their velocity.

**Artificial intelligence**
Supports functions such as image recognition and processing, motion detection, and data analysis to recognize pedestrians and traffic signals, and stick to mapped-out routes.

**Connectivity**
Supports communication with other vehicles and surrounding infrastructure to operate in accordance with speed limits, traffic lights, and signage.
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