Nissan’s Ambitious Safety Vision

“Safety should be the top priority for any automaker – because more than 1.3 million people die on the world’s roads each year,” says Tetsuya Iijima, head of safety strategy at Nissan Motor Company. “Safety is very much our top priority. But our ambition is to go way beyond simply meeting the standard. We want to set the standard – and earn our brands the reputation as the leaders in automotive safety worldwide. In fact, we are on track to achieve that goal.”

Twenty years ago, the focus was on “passive safety” – helping vehicle occupants to survive a crash. But the frontier in safety innovation has moved way beyond air bags and side-impact protection. Today, the frontier is “active safety:” preventing collisions before they occur.

The leading edge in active safety is overwhelmingly electronic, combining sensors (increasingly affordable) with sophisticated IT-driven judgment systems and electronic control of systems like brakes and steering. But the critical element is acute engineering insight into the complex matrix of factors involved in collisions – and this is where Nissan excels.

The umbrella for Nissan’s active safety vision is its “Safety Shield” concept, a comprehensive approach to 360° risk mitigation that focuses on evaluating risk and responding with a spectrum of safeguards that address all eventualities from before the first appearance of any threat, through the point when impact becomes inevitable, and after a collision.

The first line of defense is to help drivers operate safely under normal driving conditions; second, to provide aids that help identify early-stage risks and respond with non-emergency evasive measures; third, emergency intervention to avoid an imminent collision; fourth, to reduce damage on impact; fifth, crash safety; and, sixth, post-crash safety measures such as automatically alerting emergency services.

Over the past 12 years the Safety Shield has been progressively reinforced with technological innovations, including ‘world-firsts’ such as Distance Control Assist, Around View Monitor, Lane

“And we’re nowhere near done yet,” Iijima says. “We’re moving ahead rapidly on two tracks. One is ‘expansion,’ an effort to make our existing innovations affordable enough that they can be included in vehicles at any price point. The other track we call ‘advancement’ – pioneering new capabilities to radically reduce accident risks to the level of our ultimate goal… which is, admittedly, really, really ambitious.

“The ultimate goal is to reduce fatalities involving our brands to ‘substantially zero.’ Is that too ambitious? We don’t think so, because in our minds, there is no such thing as an acceptable fatality. So we’re not going to rest until we get to zero.”

There is a long road still to travel, but the team has already made huge strides, halving the number of fatalities and serious injuries involving Nissan vehicles in developed markets compared with those of 1995.

“That was our goal by 2015, and in key markets, including Japan and the UK, we achieved it six years ahead of schedule,” Iijima says. “Now we’re ready to show the world what we believe is a truly revolutionary advance.”
Forward Collision Avoidance Assist

“The first and preferred goal of active safety is to help the driver respond to avoid a collision safely,” Iijima says. “However, the more imminent a crash becomes, the more difficult it is for the driver to respond in time and successfully to an alert. You do not want to initiate decisive automatic intervention unless a collision is really imminent, but there are circumstances where technology can recognize a threat a crucial split-second earlier, alert the driver instantly, and then – if the driver fails to respond – execute the optimum response to avoid or mitigate the collision.

“The goal is to provide the driver with all possible assistance to independently execute a safe response – and provide supplementary assistance if absolutely necessary.

“A massive amount of work has gone into this, and the result is our Forward Collision Avoidance Assist System. It is highly effective and reliable – and it represents a major advance in safety.”

Detecting and identifying threats
The system’s core technology is an on-board computer (the Electronic Control Unit or ECU) that receives information on emerging threats from an array of electronic sensors, including video cameras, radar and laser scanners.

Not so long ago, such an arsenal of on-board computing and sensing power would have been prohibitively expensive. But as electronic gear has become commoditized the potential for widespread application has opened up – especially as Nissan engineers have figured out how to make each component serve multiple functions.

The ECU features sophisticated pattern-recognition software that can identify critical information from the video signal stream such as lane markings, the location and speed of surrounding vehicles and the presence of pedestrians.

But as video can only report what the camera can see, radar is needed to see around the car ahead and into adjacent lanes – for example to detect when the vehicle two cars ahead slams on its brakes, or to detect oncoming traffic obscured by the car ahead.
Informed by multiple real-time data feeds, the ECU has a 360-degree view around the vehicle and can even see beyond the car ahead, further than the driver. What’s more, the ECU doesn’t just guess the speed and proximity of surrounding objects. Armed with precise measures, it can rapidly calculate the implications.

Judging how to respond
Once the ECU has identified a threat, it must then judge how to manage the situation. The preferred response – while there is still enough time – is to help alert the driver with audio and visual cues (buzzers and lights). If the driver attempts to change lanes without noticing a car in his blind spot, this kind of warning is usually enough. But when the ECU detects a sudden and urgent threat, it alerts the driver and monitors whether the driver still has the opportunity to respond successfully. Once the system judges that avoiding a crash will soon become physically impossible, and that the driver’s response is insufficient, it then instantly executes the best possible assistance.

For example, in the event of an imminent frontal crash the system will execute a phased response. The ECU first warns the driver before initiating moderate deceleration and tensioning the seatbelts in preparation for a crash. When the driver’s window of opportunity is about to close – and this may be a split-second later – the system will immediately initiate emergency braking.

“So far, we’re talking about the relatively easy part,” Iijima says. “Because you don’t want to second-guess the driver unless absolutely necessary, the system of course needs to be very sophisticated – and our system is. But automatically braking in an emergency is fairly straightforward – and we’re ready to commercialize this functionality.

“What if braking isn’t enough, though? In some situations the driver’s best course of action is to swerve in order to avoid the obstacle. This was a much bigger challenge – but we’ve done it.”

Breakthrough: Autonomous Emergency Steering
When a sudden threat emerges ahead, within the car’s braking distance, drivers are forced to make split-second decisions. What’s the threat? And what are the alternatives to impact? To technologically replicate the sophistication of human judgment is a huge challenge.

Since swerving to avoid impact can create a worse disaster – for example veering into the path of oncoming traffic – the system must be able to rapidly judge the likely consequences of swerving right or left. This is where radar is invaluable, allowing the ECU to spot oncoming traffic in one adjacent lane or parked cars in the other. This radar eye, combined with video signal pattern-recognition, gives the ECU the ability to process a vast number of variables in a split-second – even the presence of pedestrians – to determine the best course of action.

The system first decides whether to respond with emergency braking or a steering solution. If the distance to impact is too short for effective braking, and steering is judged to be the best possible
remedy, the system will first alert the driver to steer in a specific direction. Almost instantly thereafter the system will automatically execute the required maneuver very accurately.

“This is definitely the frontier of safety research,” Iijima says. The system is still under development, but we’re testing it in every scenario we can think of — and it’s proving highly effective. And we are continuing to improve the eyes and brains — the sensors and judgment systems — behind all our Safety Shield technologies.

“So considering all the innovations we’ve brought to market over the past decade, and where we are on the frontier, I think it’s fair to say that Nissan is the global leader in automotive safety.”
Nissan’s ever-stronger Safety Shield

As Nissan pushes ahead on the frontiers of safety, a steady stream of world-first safety innovations is gradually being introduced to the global product line-up. The strategy is to reinforce the Safety Shield via two parallel tracks, expansion (proliferating innovations across the product line-up) and advancement (pushing ahead on the frontiers of safety research).

One of the first Safety Shield innovations to appear was Nissan’s award-winning Around View Monitor (AVM), which went light years beyond conventional backup cameras to give drivers a 360-degree view of their car’s position. First featured on the 2007 Elgrand (Nissan’s Japan-market full-size van), AVM is now available even in compact cars like the Nissan Note.

Since then, Nissan engineers have continued to find new applications for video-camera technology that help enhance safety in a variety of driving situations.

One camera, three huge strides in safety
Beyond simply using the backup camera’s video signal to display moving images on a monitor, Nissan engineers were intrigued by the potential for advanced signal-processing to interpret objects and patterns in the car’s vicinity.

From the video signal, they learned how to:
• reliably identify traffic lane parameters;
• identify other vehicles as they entered the driver’s blind spot; and
• detect the movement of objects in the car’s vicinity — for example a pedestrian entering the car’s path as it reverses.

“This was very, very exciting for us,” says Tetsuya Iijima, head of Nissan’s safety programs, “because we could see the path to solving several safety issues with a single rear-mounted camera. In this way we can compensate for humankind’s evolutionary failure to match the functionality of the horse.”

Nissan engineers used this equine analogy in framing the question: How can we give drivers eyes in the back of their heads?

1. Blind Spot Warning
As they change lanes, drivers sometimes fail to notice other vehicles in the notorious “blind spot,” the area adjacent to the rear side of the car that doesn’t show up in mirrors.

Nissan’s Blind Spot Warning (BSW) function helps reduce the risk of collision by displaying a warning light whenever the rear camera detects another vehicle in the blind spot zone.

2. Lane Departure Warning
Cars stray from the traffic lane for all sorts of reasons. Drivers often get distracted – perhaps reaching for coffee or tuning the radio. Usually, the driver realizes the error and corrects course in a split second with no consequences. But in far too many instances lane-departure errors have fatal
consequences. In fact, they are involved in more than half of all fatal crashes in North America and Europe.

Nissan’s Lane Departure Warning (LDW) function helps reduce the risk with visual and audible warnings whenever a driver begins to stray from the lane without signaling.

“We are talking about more than 20,000 deaths a year here,” Iijima says. “Obviously, if we can support the driver with functionality that addresses lane-departure errors we should be able to help save a great many lives.”

3. Moving Object Detection
Whenever a car reverses, unseen pedestrians and other moving objects entering its path pose a “back-over accident” risk.

A 2006 U.S. government study estimated that back-over accidents kill nearly 200 people and injure more than 7,000 people each year.

Nissan’s Moving Object Detection (MOD) function aims to help reduce the likelihood of such accidents. When the car goes into reverse, the MOD signal-processing unit scans the image stream from the rear camera in search of moving objects that match the patterns of identified risks, alerting the driver when a moving object is detected.
Preventing "pedal misapplication"

In Japan, about 7,000 accidents occur each year, typically in parking lots, when a driver hits the accelerator instead of the brake, or steps on the accelerator too hard, thus causing a collision.

Nissan engineers identified a way to help overcome this risk by using video signal data from the system's four cameras to make the car “context aware” – in other words, able to tell the difference between an expressway and a parking lot.

With this new function, the car will still accelerate smartly when you “floor it” on the freeway. But try the same thing in a parking lot and the car will refuse to comply – which is precisely what a horse would do if you tried to spur it into a brick wall. It’s a matter of simple “horse sense.”

This new feature will make its debut on the new Nissan Elgrand in early 2013.

Safety: the best value for customers

“Ultimately, it is up to the customer to practice safe driving at all times. While Nissan can only offer solutions that help to reduce risks, that help is increasingly significant. Surely, there is no greater value we could give to customers than that, and there is nothing that could bring more honor to our brand than delivering such value,” said Tetsuya Iijima, Nissan’s head of safety strategy.