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The CEO of AutonomouStuff talks to **Nick Flaherty** about how the company is accelerating the adoption of driverless vehicles

The right stuff

When the US Department of Transport (DoT) announced its regulations for autonomous vehicles in September 2016, every car behind them was a customer of one particular company – AutonomouStuff (AS).

"Our technology was front and centre throughout the announcement, on the University of Michigan's Mcity car that was built by us and outfitted with our sensors," says Bobby Hambrick, CEO of AS. "The rest of the cars in the background [from Carnegie Mellon University, MIT, Stanford, University of California Berkeley, University of Michigan and Virginia Tech Transportation Institute] are also equipped with some type of technology from AS."

The Federal Automated Vehicles Policy is a key step forward for the roll-out of what the DoT calls highly automated vehicles, or those in which the vehicle can take full control of the driving task in at least some circumstances.

"I believe that autonomous vehicle technology is at a tipping point, and soon every vehicle on wheels will begin to adopt it. We are in the unique position by being in the middle of the transformation of transportation," Hambrick says.

He has taken a very different approach from other companies to the development of technology for autonomous vehicles. The company started when Hambrick noticed a large gap in the industry's supply chain. He realised that engineers developing systems in the robotics industry were having a hard time gaining access to the technology needed to solve their applications, so AS was born.

The different approach is highlighted by its involvement in the first track day for autonomous cars in June 2016, with hobbyists and enthusiasts coming together to put the technology through its paces (see sidebar: Track day).

"We partner with the world's best technology providers," Hambrick says. "We pull together the best technologies that enable self-driving, including perception with radar, Lidar and vision systems, GPS and IMU positioning, computing, actuation, software, engineering services and more. AS has supplied components to more than 1600 customers worldwide."

Its customers include those in the automotive, military, mining, maritime, and agriculture sectors, as well as academia and start-ups, which gives Hambrick a unique overview of the state of the technology. "Some of our customers

Autonomous vehicle technology is at a tipping point, according to technology supplier AutonomouStuff

Track day

A track day in California brought together technology enthusiasts and start-ups to test out autonomous driving systems for the first time

AutonomouStuff (AS) was at the heart of the first autonomous car track day at Thunder Hill Raceway Park in Willows, California, earlier this year. AS had one of two vehicles that drove autonomously around the track, and was the only team driving 100% autonomously.

Of the four teams with designated track time it was also the only team to complete a full-speed lap around the track, in its self-driving Lincoln MKZ.

Companies at the track day included comma.ai, a start-up using Nvidia technology to train its deep neural network and run the neural network that drives the car. The company drove its Acura ILX and also had a wheego Whip electric vehicle on hand, using an Nvidia Drive PX card in the trunk.

PolySync drove its Kia Soul, and is planning to run its advanced middleware platform on a Drive PX. Tier-one component supplier Denso drove its Tesla Model S, complete with Lidar sensors integrated into the side mirrors, while Audi drove its RS 7 'Audi piloted driving' concept car, and Renovo Motors demonstrated its electric coupe.

have a very high level of capability of integrating technology to enable their applications, while others need assistance based on our expertise," he says.

One of the leading projects is the nuTonomy autonomous taxi fleet in Singapore, the first in the world to start public trials (see page 26). "nuTonomy is very advanced and is capable of doing amazing things," Hambrick says. "We have provided only the sensor hardware. It's an example of AS meeting the customer where they are and where they need help, from supplying individual components to kitting out entire vehicle platforms and providing reference software.

"nuTonomy was specifically interested in radar from Delphi and Lidar from Velodyne and IBEO. These products are chosen because they best fit the application requirements of nuTonomy, as well as other customers."

This has led to Hambrick working with many of the leading autonomous car and truck developers, such as Otto, Cruise Automation and Ottomatika. Carnegie Mellon University spun out its autonomous systems expertise into Ottomatika, which last year was bought by car component supplier Delphi.

Truck system developer Otto was launched earlier this year by an engineer who had worked on Google's self-driving car, and it was acquired by ride-sharing company Uber in August 2016. And Cruise Automation was bought by General Motors this year for more than $1 billion to accelerate the mainstream development of autonomous systems.

"Otto was a customer of ours in the garage, and I was sitting down with Kyle Vogt [CEO] of Cruise Automation to work out what he needed. Those companies went as fast as they did because of their amazing technology and our ability to help them; nuTonomy is another of those companies."

Being independent is essential so that AS can work with the widest range of suppliers, says Hambrick. "We work with Nvidia, Qualcomm, Intel, NXP and Renesas, who are all aiming to provide great solutions for automated driving, but right now we maintain

our independence," he says. "We have our own hardware partners but the software is independent of hardware and middleware so that it can be interchangeable."

As a result, Hambrick became the co-founder of a key software technology developer. PolySync, (formerly Harbrick Technologies) was set up in 2013 to develop middleware software using a technology called Data Distribution Service (DDS). DDS uses a publish-subscribe model to act as the data backbone for all the different elements in an autonomous vehicle.

"PolySync abstracts the DDS with a standard API that extracts the sensor data," Hambrick says. It decouples code from hardware such as sensors, computers and actuators. To a PolySync application, Lidar points are just Lidar points, no matter which sensor they came from, and the control commands are the same for any vehicle.

The company is also working on another software technology. "The Robot Operating System [ROS] is an open source product based on Linux which is designed for general robotics applications and is a very useful tool for researchers' automation projects," says Hambrick. "In fact, I consider our team at AS to be experts when it comes to integrating and building applications on top of ROS.

"A lot of our automation applications are independent of middleware, allowing our customers to choose whichever middleware is familiar to them. Also, there are several commercial middleware companies who have built ROS compatibility layers to port ROS code over to a more robust and proven commercial product."

AS also developed its own computing platform, called Lumina, with a manufacturing partner, based on Intel's Core i7 processors that runs the Ubuntu Linux operating systems and ROS so that engineers can use the most suitable tools to build, test and simulate their systems.

"The reason we use Lumina is the flexible I/O with multiple CAN cards and Ethernet cards for research," says Hambrick. It is the I/O requirements that are challenging, he says – the embedded computer boards need to have as much high-speed I/O as possible to cope with optical cameras, radar and Lidar.

"It's really the I/O compatibility that is essential, so we are looking to re-purpose boards with a limited set of sensors," he says.

The remaining key element for AS is the actuator system that turns existing vehicles into a self-driving version. This includes a throttle and brake-by-wire controller module, a steering and gearshift-by-wire controller module as well as a power distribution panel and a centre console switch box.

This comes with a 600 W true sine wave inverter for ac power loads and the wiring harnesses for all hardware modules, linking to the I/O on the embedded PC.

"Our Ford Fusion is just launching, and we have a Lincoln MKZ, plus a smaller electric vehicle that includes components from us that we already had, and our autopilot runs on both ROS and PolySync," says Hambrick.

"What we are providing with these platforms is the ability to figure out what the customer wants to do with it," he says. "We provide all the interface information while we are building the system, and if they prepare their software correctly they can show up on our doorstep and have it running on an autonomous car on day one. That used to take a decade."

Looking forward, the challenge is in bringing all the elements together as the cost of the components falls. "In the future, all the sensors will be commoditised," says Hambrick. "There will be perhaps 100 Lidar manufacturers in five years' time, and every silicon manufacturer will be making Lidar chips.

"So what we are doing is connecting to these companies and building software to enable Lidar data processing and software that is independent of the sensor."

Bobby Hambrick

Bobby Hambrick set up AutonomouStuff in 2010 in Morton, Illinois, shortly after the DARPA Urban Challenge, to provide sensors, engineering services and automated driving software.

He was a co-founder of PolySync, formerly Harbrick Technologies, in 2013 with Josh Hartung. This start-up, in Portland, Oregon, was created to develop an entire software platform to help developers build, test and deploy automated vehicle applications quickly. PolySync applications are developed similarly to mobile applications on iOS or Android, by calling a set of well-defined and standardised APIs.

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