Developing the Next Generation of Automotive Engineers

Rob Harwood, ANSYS global industry director, met with professor Stefan-Alexander Schneider from the University of Applied Sciences at Kempten in Bavaria, Germany. Professor Schneider runs one of the world's only master's courses on advanced driver assistance systems and autonomous vehicles. Their conversation revealed how the University of Applied Sciences is helping to develop the disruptive technologies of tomorrow and the engineers who will deliver them. They also discussed why simulation is critical for autonomous vehicles.

A COURSE IS BORN

Rob Harwood: Professor Schneider, you run a unique master's class on autonomous driving at the university. Can you tell us more about how the course started and what it includes?

Stefan-Alexander Schneider: The idea started back in 2012 after the prime minister of Bavaria, Mr. Seehofer, visited Continental Automotive Distance Control Systems GmbH Industrial Sensors (A.D.C.) in Lindau and was told that engineers with specific engineering skills — such as systems engineering and those related to the development of driver assistance systems and autonomous vehicles — were needed. So we established the master's course for advanced driver assistance systems in 2014. It was driven by the industry — companies like AVL, Bosch, BMW, Continental and AGCO. The goal is to educate more engineers in systems engineering related to driver assistance systems,

Stefan-Alexander Schneider

rather than just turning out more specialists in mechanical, electrical or computer engineering. All of these companies provided their requirements, and that information helped us to develop the curriculum, which balances mechanical engineering with vehicle dynamics, and includes test and development methods, like the famous V-model in the automotive industry. It also includes sensor technology, like cameras and radars, microcontrollers, network protocols, and so on, as well as computer science for the algorithms needed, for example, to recognize patterns important for autonomous driving. We are really making great progress. We have projects that involve a number of companies. Using our knowledge, experience and material, we recently supported a master's course in connected automated vehicles in Sligo, Ireland, and we are also working closely with some universities in Japan. Our workshops like ROAD [roundtable on the purpose of autonomous driving] are very popular, and I'm really happy to be heading this master's course.

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RH: How many students are taking the course and how long does it take to graduate?

SAS: The course is three semesters: two for studies of six modules each and one for the master's thesis. We now have nine waves of students because you can start in the winter term or the summer term. Altogether that's around 120 students, which means about 12 or 13 students at each starting point.

RH: In addition to academic studies, you have also established some test facilities. Can you talk about how these facilities complement the academic work?

SAS: In Germany we have a two-layer educational system: universities and universities of applied science. The universities focus on longer-term developments, and we at the University of Applied Science focus on technology that has to be on the road in a couple of years. Therefore, we work closely with companies all over the world. The students have already been to Japan, the U.S.A., Italy and France. This is important to show the strength of our collaboration with the industry. We have established a "Drive Living Lab" to understand the development tools, and the development and test methods, that are necessary in the automotive industry. We have a facility of 500 square meters where we have now started to perform research with companies and educate the students. In addition, the Bavarian state funded a research institute for advanced driver assistance systems and connected cars close to Kempten so that our research can be done adjacent to real cars.

RH: How does your location, relatively close to Munich, help?

SAS: All of the important German OEMs like Audi and BMW are close by and Continental A.D.C. is in nearby Lindau and Ulm. They also have a test facility in Memmingen. Both small and large companies are nearby. Radar research and development for aircraft and cars has been centered in Ulm for a while. A number of established companies were already developing sensors that are now an important component of autonomous driving systems. In Germany, we would say we are like the middle of the spider's web.

RH: How did your passion for the automotive industry and for autonomous vehicles start?

SAS: I was always interested in cars. Recently I had a look at my old picture collection and I found a photo of myself driving an Opel when I was a small boy. I joined BMW in 2003 in a group focused on the development of embedded software and then changed my focus to the simulation of the full vehicle. I learned that system development needs simulation because it's not just a car, it's the interaction of the human and the machine. This brings all my passions together.

AUTONOMOUS VEHICLES: REAL OR HYPE?

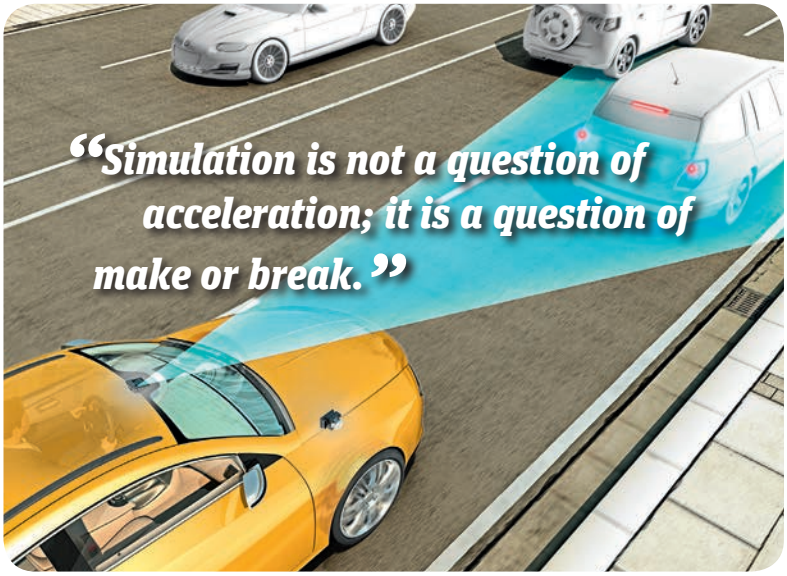
RH: Autonomous vehicles — are they real or is it hype?

SAS: It is not hype although you might think that because there's so much interest from all levels of

society. Transportation is a basic need of humanity, and everywhere that transportation is involved, people are thinking about autonomy.

RH: The human benefits of autonomous vehicles are reducing accidents and congestion, and increasing mobility. What do you see as some of the business aspects for people who are creating autonomous vehicles?

SAS: Typically, there's a triangle of factors. Safety is imperative and is a prerequisite. The second part of the triangle is that transportation is what people pay for. Finally, you must also pay for comfort.



RH: Do you see any downside, any negatives, in the rise of the autonomous vehicle?

SAS: One major issue that must be resolved is security. Another is social acceptance. When looking at other transport systems, like an elevator or lift, years ago someone helped you to press the button to ensure correct operation. Today everyone is used to selecting the floor and doesn't give it a second thought. I think eventually this will occur with autonomous cars, even though we don't know how and when, but there's a strong political, social and economic push for it to happen.

RH: We see a lot of pressure to bring the technology to market. What do you see as the biggest barrier to overcome?

SAS: The safety aspect and the security aspect are two pictures of the same social acceptance challenge. You have to show that this new technology is at least as good as the old and has more upside than downside. Then, the hurdle will be to show confidence in these functionalities. We expect that this new technology will be safer, so there must not be any accidents in 12 million km (the average distance between fatalities on German motorways).

RH: That's a vast number. Are the automotive design processes as they stand today able to get us to the point of proving safety within a practical time frame?

SAS: If you look at the homologation process (proving the ability to satisfy regulatory standards and specifications), it is not possible to drive 12 million kilometers and demonstrate statistical significance. Even if you have one thousand prototypes, this is not very likely. There's no way to do it through normal test activities, so test campaigns can be conducted using simulation methods. And this is one of the big benefits of simulation.

SIMULATION IS CRITICAL

RH: Simulation is the key to the practical delivery of safe autonomous vehicles. Can you explain a little bit more about the role of simulation?

SAS: Simulation is necessary to introduce short feedback loops in development, especially in the very beginning when you make basic decisions about design. It is important to get user experience or human–machine interaction feedback to understand the winning point of this function. Simulation no longer represents just the interaction between the vehicle and its environment, but all the important aspects (in abstract) of interaction between the vehicle, the environment and the driver. And the driver is not easy to understand. In a physical test of an autonomous vehicle on the motorway, full braking occurred and we did not understand why. When reviewing the camera videos, we saw that a caravan in the right lane had a bicycle mounted on the back and the algorithm detected this bicycle as though it was headed toward the car. The autonomous system said "stop" and braking occurred. This shows how humans when driving understand the context, and we must teach machines this contextual understanding. This is really challenging. At the moment, nobody knows which aspects of the environment are important and which can be neglected. Therefore, there's a strong need to understand this magic triangle of driver, vehicle and environment. Methods and simulation tools have to be able to support this.

RH: Simulation seems to span many aspects and include an ecosystem of tools. Is there a need for these tools to be open to interact with each other?

SAS: There is a strong need to have well-balanced modeling of all the different aspects. If you look at the landscape of tools, you will see that these tools are developed for specific use cases. For example, one tool is useful for the control code, and one tool is useful for special aspects of the vehicle models. If you want to benefit from these highly adaptive simulation tools, there needs to be a standardized interface to couple them. I think this will play an important role in the simulation of the driver, vehicle and environment.

RH: So how is the industry balancing functional safety and traceability with technologies like artificial intelligence and machine learning?

SAS: At the moment, this is really challenging because the homologation aspect is so important. Regulators will ask companies to explain how the algorithm works or what it will do, and this is very hard to determine. How to get out of this trap is a really interesting point of discussion. One idea is degradation and a regular understandable implementation of a code as a kind of watchdog, and you run an artificial intelligence code in parallel.

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RH: Is this the Control-Monitor or Con-Mon approach?

SAS: Yes, a watchdog algorithm or something like that.

RH: It is clear that simulation is critical to the development of these vehicles in a practical time frame. Do you have a feel for the potential time savings provided by simulation?

SAS: Simulation is not a question of acceleration; it is a question of make or break. This is perhaps the first time in development that you cannot do without some aspects of simulation or simulation support.

TRADITIONAL OR HIGH-TECH?

RH: Many players are now trying to enter the autonomous vehicle market, including traditional OEMs and their suppliers, but we also see other companies from the high-tech and semiconductor industries. When the market settles down, who do you think will be the key players?

SAS: This is difficult to answer. If you look at the traditional OEMs, they have a lot of experience, in some cases more than 100 years, in developing, manufacturing and distributing cars, and they have a development network all over the world. But these companies can lose agility. And in autonomous driving we see strong companies — new kids on the block — come into the market, especially from information technology. IT is a basic ingredient for understanding the value chain and therefore the interplay of the driver and the environment. And they are making great progress, but what they are missing is this network, the scalability, the industrialization. They make good prototypes, but they need to show that they can copy them in a way that a lot of people can benefit from. At the moment, we see a really interesting situation: All these companies are showing prototypes, both the old OEMs as well as the new companies. But they cannot make money with one prototype — they must copy this prototype a million times, so maybe joint ventures will be the path to success. Right now no one can say; you would need a crystal ball.

RH: As someone who is passionate about the automotive industry and automobiles, do you think you will ever be driven by an autonomous vehicle?

SAS: I will be the first! Yes, I like that, and it's amazing and overwhelming.

RH: And do you think one of your students will be the producer of the car that drives you around?

SAS: We have already had a running autonomous car on our facility, so yes, I think they are also passionate to drive and to be driven. Fueled to be driven!

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