Volkswagen of America, Inc.'s
Electronics Research Laboratory

Research for Safer Vehicles

Autonomous driving research is an important step for Volkswagen Research towards the next generation of vehicle electronics The last decade has seen the acceptance of numerous electronic systems that improve the driver's ability to handle dynamic driving situations (e.g. ESP – Electronic Stability Program), increase comfort during longer drives (ACC – Adaptive Cruise Control) or assist parking maneuvers (Electronic Parking Assistance). All of these systems are designed primarily to make the task of driving safer, easier and more enjoyable. Pushing the concept of driver assistance to its limit, a car will someday be able to drive autonomously, either temporarily or for the full extent of the drive. Along the way, many aspects of autonomous driving technology will be used for immediate application in more "conventional" driver assistance and safety systems.

The Urban Challenge

Volkswagen of America's Electronics Research Laboratory (VW ERL) is contributing to this effort by supporting Stanford University's entry to the third edition of the DARPA Grand Challenge autonomous vehicles competition, called The Urban Challenge. The first event was held in March 2004 without Stanford or Volkswagen competing, and no vehicles successfully completed the course.

In the second Grand Challenge, which took place in 2005, four autonomous vehicles successfully completed a 132-mile desert route under the required 10-hour limit, and DARPA awarded a two million dollar prize to the VW Touareg "Stanley", a collaboration between Stanford University, the VW ERL, and other supporters. Stanley finished the course first in just under seven hours. "The 2005 Grand Challenge was the perfect platform for collaborating and developing real technology used in autonomous driving and future driver-assistance systems" says Dr. Burkhard Huhnke, Executive Director of the VW Electronics Research Lab.

The Urban Challenge of November 3rd 2007 will feature autonomous ground vehicles conducting simulated supply missions in a mock urban environment. DARPA has recently finalized cash prizes for the Urban Challenge and will give $2 million, $1 million and $500,000 awards to the top three finishers completing the course within the six hour time limit.

VW ERL and Stanford Collaboration

"After the successful participation in the 2005 Grand Challenge, Volkswagen is excited to be joining this 2007 Urban Challenge – we see an opportunity to further advance intelligent technologies used in passenger vehicles of the future" says Dr. Huhnke. He continues: "The challenge for the Stanford Racing Team as well as other teams will be much bigger this time. We

are facing dynamic traffic situations; that is orders of magnitude more complex."

Stanford University has formed a very strong interdisciplinary team led by Artificial Intelligence expert Professor Sebastian Thrun. The Stanford Racing Team's expertise in Artificial Intelligence is combined with VW ERL's extensive knowledge in the field of autonomous driving.

The Stanford team in collaboration with theVW ERL is building a highly competitive autonomous vehicle based on the Volkswagen Passat. This production vehicle is already a step closer to autonomous driving than the Touareg used to win the previous competition, because it incorporates some production drive-by-wire systems. "Modern cars require less and less additional hardware to convert them into computer controllable vehicles. For instance, Stanley required a lot of mechanics to shift gears, the new VW Passat "Junior" can do that with just a few lines of software code" says Ganymed Stanek, Project Manager for Autonomous Driving at the VW ERL.

The Electronics Research Laboratory

Founded in 1998, the Volkswagen of America Electronics Research Laboratory (ERL) focuses on providing customers with smarter cars, sooner. It aims to identify new technologies and accelerate their development into future production vehicles. Located in Palo Alto, California, the ERL is the only facility of its kind representing the Volkswagen Group in North America. Its presence in the heart of Silicon Valley allows the Volkswagen Group to work directly with the world's leading high-tech companies and start-ups. Working closely with these partners allows the ERL to design and develop innovative features and applications, which are then integrated with Group vehicles for evaluation and testing.

First established as a trend and technology scouting office, its functions now cover most of the product development process, from advanced research to highly focused predevelopment tasks. The ERL works across many technology fields and is equipped with facilities for electronic and mechanical prototyping. Its team of approximately 40 electrical and mechanical engineers, industrial designers, social scientists and automotive technicians is committed to bringing fresh ideas to the Volkswagen Group. Just about every traditional electronic component of a vehicle – displays, buttons, speech interfaces, communication channels, and even basic driving controls – is a candidate for further advancement with the goal of making customers safer, more comfortable, and more excited about the driving experience in the Volkswagen Group's cars.

Mission and Purpose

The ERL strives to be a strong source of innovation for the Volkswagen Group. Its

research will result in advancements that differentiate and bring value to the Volkswagen Group's consumer products, as well as strengthen the value of technical knowledge that is held by the Volkswagen Group. It will be the center of expertise for electronics associated with the North American Market, and this knowledge will be of benefit to all regions. The ERL fulfills its mission with a combination of internal technical expertise and external collaboration. Its staff of engineers and management brings novel ideas to the Volkswagen Group through various technology scouting, prototyping, use-case definition, and specific development activities. Once appropriate focus has been determined in a technical field, the ERL leverages relationships with industry and university research teams to bring technology concepts to the Volkswagen Group. Being located in Silicon Valley allows the ERL to work with the most innovative high-tech startups in North America along with prominent research teams from larger suppliers and local universities.

Affiliation to Volkswagen Group

The ERL maintains close ties with the Volkswagen Group in Europe. This direct relationship maintains focus at the ERL and maximizes relevance of the ERL's project portfolio. It also represents the top level of a structured relationship between the ERL and Volkswagen and Audi in Germany, whereby individual project leaders at the ERL interface closely with project customers representing the brands within the Volkswagen Group. Customers are specific group leaders or teams from Research and Development in Europe that bring ERL-developed applications to the attention of product strategists and business units within the company. The close relationship with headquarters in Germany gives ERL engineers a unique opportunity to work directly with Volkswagen Group counterparts and project their ideas onto fast-moving timelines within the company.

Besides regular communication with colleagues throughout the year, the ERL also presents its work at least semi-annually in Wolfsburg and Ingolstadt. It participates in company-wide internal research fairs and supplemental dates dedicated to the display of ERL work. Every event permits the ERL to show its latest prototypes and progress directly to executives, board members, project customers, engineers, and designers. The ERL's project showcases typically involve several vehicles with integrated applications accompanied by an array of interactive tabletop technology demonstrations.

Research Activities and Fields

One of the ERL's primary responsibilities is to evaluate the promising new technologies that are being developed by local companies and universities, and to accelerate their eventual incorporation into series production. However, as the Volkswagen Group's distinct technology research and development facility in the United States, the ERL is charged with additional responsibilities. It must also scout technologies throughout the

North American Region, spearhead definition of US-specific features, and contribute to critical-path product development in a number of Group research topics.

Engineers at the ERL take a project-oriented approach to meeting this variety of needs. Working in versatile cross-functional teams, they are able to conduct a number of projects simultaneously. These projects fall into the categories of Exploration, Research, and Predevelopment

For on-line information please see our website: **www.vwerl.com**

Volkswagen of America, Inc.
Founded in 1955, Volkswagen of America, Inc. is headquartered in Auburn Hills, Michigan. It is a subsidiary of Volkswagen AG, headquartered in Wolfsburg, Germany. Volkswagen is one of the world's largest producers of passenger cars and Europe's largest automaker. Volkswagen of America and its affiliates employ approximately 3,000 people in the United States and are responsible for the sale and service of Audi, Bentley, and Volkswagen products through retail networks comprising of more than 900 independent U.S. dealers.

In addition to its headquarters in Michigan, Volkswagen of America maintains major port operations in California, Delaware, Georgia, Rhode Island, and Texas. Volkswagen operates major parts distribution centers in California, Florida, New Jersey, Texas, and Wisconsin. Additionally, the Volkswagen Group's principal warm-weather test facility is located in Arizona and Design Studio in California. Volkswagen's financial arm, VW Credit, Inc., operates large customer service centers in Illinois, Michigan, and Oregon, and owns an FDIC-insured bank, Volkswagen Bank USA, in Utah. Volkswagen of America's International Purchasing Department is responsible for sourcing from U.S. suppliers approximately half a billion dollars worth of components annually for the Volkswagen Group's worldwide production.

For on-line information please see our website: **www.vw.com**

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