



## Volkswagen of America, Inc.'s Electronics Research Laboratory Focus: The Grand Challenge

Autonomous driving is an important topic for Volkswagen Research, in the context of advances in Driver Assistance Systems that Volkswagen – and its competitors – are providing to their customers. The last decade has seen the acceptance of numerous electronic systems improving the average driver's ability to handle dynamic driving situations (e.g. ESP – Electronic Stability Program), increasing comfort by decreasing the load a driver is subjected to during longer drives (ACC – Adaptive Cruise Control) or 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 idea of Driver Assistance to its limit as a car becomes fully autonomous, and the task of driving for the vehicle's passengers is reduced to zero, either temporarily or for the full extent of the drive. Although the philosophical discussion about whether or not this is a desirable outcome may be interesting, achieving this goal is certainly a formidable scientific and technical challenge. Along the way, many aspects of autonomous driving will be used for immediate application in more "conventional" driver assistance and safety systems.

### The Grand Challenge

The Electronics Research Laboratory (ERL) is contributing to this effort by supporting Stanford University's entry to the Grand Challenge competition. The Grand Challenge is an off-road race for autonomous vehicles organized by SCORE International, a premier off-road racing organizer (Baja 500, etc.). Last year, the selected contenders included vehicles ranging from nearly conventional stock vehicles to unconventional robots of varying size and shape, from six wheeled golf carts to full size trucks. To make things interesting, a \$2 million prize is offered by the Defense Advanced Research Projects Agency (DARPA) for the fastest vehicle completing an undisclosed course of about 175 miles. The keywords of the event are: "Ingenuity – Adventure – Fun."

In 2004, the first edition of the event drew unexpectedly high international Media attention and was followed closely by the tech-friendly American public. No vehicle finished the race. The furthest distance traveled by any team was slightly over 7 miles!

### ERL and Stanford Collaboration

The Stanford School of Engineering will enter the competition for its second edition in 2005, and together with the ERL, the team has built a highly competitive autonomous vehicle based on the off-road-proven Volkswagen Touareg. Stanford University has formed a very strong interdisciplinary team led by Artificial Intelligence expert Professor Sebastian Thrun, and can rely on the extensive knowledge in the field of autonomous vehicles that Volkswagen offers in addition to the ERL's automotive expertise. This will be the team to watch on October 8<sup>th</sup> 2005, when the race day is scheduled.



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Grand Challenge 2005



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### **The Electronics Research Laboratory**

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 to represent 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.

The ERL works across many technology fields and is equipped with facilities for electronic and mechanical prototyping. Its team of approximately 40 engineers and industrial designers is committed to bringing fresh ideas to the Volkswagen Group. Just about every traditional electronic component of a vehicle – for example: 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.

### **Facilities**

Producing "living and breathing" prototypes built into drivable vehicles is a hallmark of the ERL, and a key to its success. Several facilities and resources support these activities.

#### *Electronics Lab:*

Stocked with soldering irons, multimeters, oscilloscopes, and all types of electronic components, the E-Lab is at the heart of the ERL. It empowers engineers to design and build electronics from scratch, or to modify existing devices and controls.

#### *Machine Shop:*

The machine shop contains equipment that enables engineers to build parts rapidly for hardware prototyping in automotive-grade metals and plastics. These include a lathe, manual mill, Computer Numerically Controlled (CNC) mill, Fused Deposition Modeling (FDM) machine, and laser cutter. Computer Aided Design (CAD) workstations provide the backend for these prototyping efforts.





### *Vehicle Workshop:*

The ERL has a large garage with vehicle diagnostics hardware, fully equipped tool chests, service bays for four cars, and technicians skilled in vehicle integration. Prototypes are built into vehicles within days or even hours, so that they can be tested, improved, and tested again.

### **People**

The ERL employs approximately 40 people, roughly 75% of which are engineers and project managers. A range of culturally diverse mechanical engineers, electrical engineers, software engineers, social scientists, and product designers make up the core team dedicated to executing the ERL mission. This technical staff is made up entirely of Master's and PhD-level individuals who possess expertise in at least one of the ERL research fields. An extensive internship program in partnership with top Universities, such as nearby Stanford University, provides an excellent opportunity for learning by students while enabling real contribution to the ERL project portfolio.

### **History**

Founded in 1998, the ERL has grown from five employees working on one project to nearly 40 employees and dozens of projects. 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. Beginning in 2002, the ERL embarked on a personnel and facilities expansion phase to accommodate these new functions. The original staff of five was expanded to include electrical engineers, mechanical engineers, software programmers, materials scientists, social scientists, and automotive technicians. Around the same time, the ERL moved from its original Sunnyvale, California office to its current location in Palo Alto.

*For on-line information please see our website: [www.vwerl.com](http://www.vwerl.com)*



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### **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.



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