Automotive Mechatronics

New specialization at Stuttgart University strengthens ties between technical college and industry

Located in one of the world’s preeminent vehicle producing countries, the German auto industry represents a pioneering force in the development of innovative components and systems. The training and education of automotive engineers has therefore been a main focus of the country’s technical colleges and universities for more than a century.

The University of Stuttgart is one of the leading institutes of higher learning in the fields of engineering sciences and automotive technology in Germany. To meet new challenges also in the field of automotive research, it has gradually phased in a new structure in the area of Automotive and Engineering Sciences.

To this end, the funding for the recently established Chair of Automotive Mechatronics was donated by five automotive companies – Befor GmbH & Co. KG, Robert Bosch GmbH, DaimlerChrysler AG, Dr.-Ing. h.c. F. Porsche AG, and ZF Friedrichshafen AG – in the “auto state” of Baden-Württemberg. The Chair’s professorship was assumed on April 1, 2004 by electrical engineer Prof. Dr.-Ing. Hans-Christian Reuss with tenure at the Department of Combustion Engines and Automotive Science (IVK) of the Faculty of Mechanical Engineering. At the same time, he was elected member of the Board of Management of the research institute for automotive engineering and vehicle engines of Stuttgart University (FKFS).

Automotive mechatronics in research

The declared objective of the new Chair of Automotive Mechatronics is the pursuit, in both research and teaching, of a harmonized approach to the development of mechatronic systems for the automobile. In research, this addresses, aside from the consistent development of new functions, also the formulation and improvement of new methods and tools for design, testing, and diagnostics.

A major challenge in this context consists of the need to master the attendant complexity Automotive electronics has seen a meteoric evolution. Where the respective functions were handled by stand-alone systems only a few years ago, today’s standard comprises an overall networked system of great intricacy and pronounced internal reciprocal effects – effectively a composite of contributions from many partners. As the sum of its parts, the resulting system must be optimized in accordance with criteria, such as costs, reliability, availability, safety, customer benefits, environmental compatibility, installed space, weight, as well as a development time and manpower.

Ongoing research covers the following subject areas:

- Electrical on-board network and energy management
- Networking and architecture
- Function and software development
- Modeling and simulation
- Powertrain optimization and hybrid drives
- Testing and diagnostics

For example, research efforts are aimed at optimizing the flows of energy and information in both powertrain and on-board electrical and information networks. The objective is to reduce fuel consumption and exhaust emissions and increase driving comfort. Essential activities also focus on analyzing the influence of driver and driving situation on fuel consumption, which is closely linked to the development of situation-adaptive gear selection strategies for automatic transmissions in passenger and commercial vehicles, plus the design, dimensioning, and control of hybrid drives (Figure 1). In the same context, researchers investigate the deployment of digital cards and GPS location tracking in forward-looking drive system control, and driver assistance systems aiding fuel-saving driving habits.

As a byproduct of the increased level of complexity of automotive electronics and software, the demands on testing methods during the development phase have become more stringent as well. Hardware-in-the-Loop simulators and laboratory vehicle setups have become permanent fixtures in the development departments of many automakers and system suppliers. Especially in the early phases of development, such installations serve to augment road testing, while taking care of important work segments in the development and integration of automotive electronics.

For those frequently repeated testing tasks that represent a sizeable contribution to the shaping of the development process, and that influence the safety of the production vehicle to a significant degree, the FKFS has developed the P.A.T.E. system (Personal Automatic Tester for Electronics). It comprises an easy-to-operate, open-loop testing environment equally suitable for deployment as a stand-alone tester at single workstations and larger testing installations in the development departments of OEMs and electronics suppliers. The P.A.T.E. system can also be deployed in test vehicles.

Teaching automotive mechatronics

Aside from the cited research activities, the new Chair is also charged with offering the appropriate courses of study, that is, to convey the secrets of the “art of mechatronics” to its students.

Beginning with the winter semester 2004/05, Automotive Mechatronics has been therefore offered as a new major and compulsory subject of the main course of studies of Automotive and Engine Technology.

The core subject lectures are concerned with electronic components and systems in the automobile (Automotive Mechatronics I), the design of functions for the automobile (Automotive Mechatronics II), as well as

Automotive Software Engineering

Since the early seventies, the development of the automobile has been characterized by a rapid rise in the deployment of electronic systems and software. This trend continues unabated and is driven by rising end user demands and increasingly stringent environmental requirements. Today almost every function onboard the modern vehicle is electronically controlled or monitored. The reference book “Automotive Software Engineering” published by ETAS provides up-to-date information about the use of electronic systems and software in current vehicles. It has become the textbook of choice for lectures at numerous universities and technical colleges. Many practical examples emphasize the significance of software in the vehicles of today and of the future.

Summary

The recently founded Chair of Automotive Mechatronics represents the implementation of a pioneering concept for lectures and research on automotive technology. Its location in the immediate proximity of renowned teaching and research facilities on the Vahingen Campus of Stuttgart University was funded in equal parts by the University Directorate and Office of the Dean, the Baden-Württemberg State Ministry of Science, Research and Art, and the state’s automobile industry.

Concurrent with the execution of industry-related research projects, the training of diploma engineers (M.Sc.) desperately needed by industry results in a unique strong suit which places the Stuttgart location on the high ground in the German knowledge landscape.