BLENDED LEARNING IN AUTOTRONIC SYSTEMS

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The expanded use of electronics, microcontrollers, sensors, actuators, high-speed data buses, and X-by-wire technologies in the automotive industry have a major impact on the education of automotive professionals. The paper describes the design and implementation of blended learning solution and laboratory for qualification and training in the field of autotronics. It considers techniques to incorporate skill-driven blended learning model, which links modern e-learning methods with practical sessions on hardware equipment. The developed software tools are also considered. All products have a modular architecture allowing easy integration into any training format.

Keywords: Blended learning, web based training, automotive electronics

1. INTRODUCTION

Today's vehicles are as much electronic as they are mechanical, thus creating a new AUTOTRONIC area (AUTOmobile + elecTRONIC). A modern car has several control modules, which monitor and manage every major system in the vehicle. The most common types are engine and drive line control, cruise control, suspension control, anti-lock braking and airbag control, climate control, GPS-based navigation system, stability management system, instrumentation, multimedia, etc. Systems such as 'by-wire' braking and steering systems, collision warning, voice recognition, Internet access, night vision enhancement and collision avoidance systems all start to be introduced.

New technologies in the area of motor management, communication technology, on-board digital systems, additional features and extras, the constantly rising safety and emissions requirements need fundamentally different learning approach and both a solid basic education and consistent further education of personnel to be successful and efficient in diagnosing errors, maintenance and repair. Troubleshooting of modern cars requires knowledge on microcontroller based control systems and also proofed skills in using sophisticated equipment for diagnosis.

The main goal is to enhance understanding of automotive control systems; to create ability to apply already learn topics and to create skills for fault diagnosis. To achieve these goals we apply skill-driven blended learning pedagogical model with extensive use of interactive simulators and practical training.

The paper describes the design and implementation of blended learning solution and laboratory for qualification and training in the field of automotive electronics. Skill-driven learning model is chosen to mix knowledge on digital technologies, electronic motor management, communications via bus technology, comfort and safety electronics, with service and maintenance skills obtained in practical sessions.

2. BLENDED LEARNING MODELS

The term blended learning is used to describe a solution that combines several different delivery methods, such as collaboration software, Web-based courses, and knowledge management practices. Blended learning also is used to describe learning that mixes various event-based activities, including face-to-face classrooms, live e-learning, and self-paced learning.

Blended learning is categorized into three models [1]:

- skill-driven learning, which combines self-paced learning with instructor or facilitator support to develop specific knowledge and skills
- attitude-driven learning, which mixes various events and delivery media to develop specific behaviors
- competency-driven learning, which blends performance support tools with knowledge management resources and mentoring to develop workplace competencies.

Blended learning that's skill-driven mixes interaction with a facilitator through email, discussion forums, and face-to-face meetings with self-paced learning, such as Web-based courses, simulations, and web-based tests. Learning specific knowledge and skills requires regular feedback and support from the trainer, facilitator, or peer. It's clear that combining self-paced learning with facilitator support keeps the learner from feeling isolated, which assists in the successful completion of the self-paced modules.

The behavior-driven approach blends traditional classroom-based learning with online collaborative learning events. At times, the nature of the content, as well as the desired outcome (developing attitudes and behavior) necessitates the inclusion of collaborative learning that's facilitated through face-to-face sessions or technology-enabled collaborative events. Activities that should be incorporated into the overall learning experience include discussion forums, Web seminars, group projects, and online debates that use chat modules.

The success of knowledge workers depends on how quickly employees make decisions in the work place. While part of the decision-making process is guided by common facts and working principles, people also need tacit knowledge that's often retained by experts. Learning that facilitates the transfer of tacit knowledge requires a competency-driven approach. Because people absorb tacit knowledge by observing and interacting with experts on the job, activities may include a blend of online performance support tools with live mentoring.

3. BLENDED LEARNING LABORATORY

Traditional teaching methods are beginning to merge with modern information technologies to prepare automotive professional to be successful and efficient in car maintenance, fault diagnosing, and repair.

Skill-driven blended learning approach is considered to be very appropriate for qualification and training in the field of automotive electronics. Indeed, this approach works best when people are learning content at the knowledge or application levels. Techniques to incorporate skill-driven blended learning include:

- creating a tightly scheduled group learning plan
- using instructor-led overview and closing sessions
- using synchronous learning labs
- providing practical session on hardware equipment
- providing support to learners through email.

The developed blended learning laboratory links modern e-learning methods with practical hardware sessions and trainings on a real car. It contains:

- E-learning content for theoretical and simulation based training
- AICC-compatible LMS to manage the learning process and store test results
- Authoring tools to generate tests and additional contents
- Cat-to-computer interface for training on system diagnosis
- Fault simulator interface to program fault simulation into the car

3.1 E-Learning Package

E-learning package contains a set of web-based learning products incorporated in a learning management system (LMS). The design philosophy of the e-learning courses is based on the latest state-of-the art software technology. All system software is designed based on an open architecture and an open system concept to enable future system expansions. All interactive final tests save results into the learner history file. Communications are enable with the LMS.

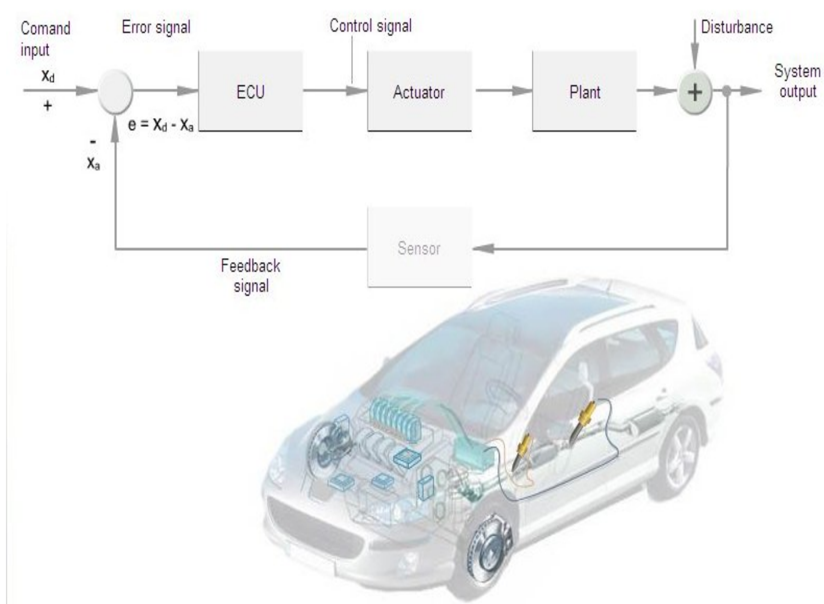

Fig. 1 Illustration of a closed-loop architecture in the engine management system

A learning unit are autonomous down to the level of the content of one screen to allow the teachers to change the configuration, add new content or even link knowledge unit to customize the courses.

Topics as car management system, control strategies, architecture of electronic control unit (ECU), microcontrollers, memory types, look-up table approach, CAN (control area network) bus, message strucure and bus arbitration, end of line (EoL) programming and re-programming are covered. Principle of operation of typical sensors and actuators are also considered. Special attention is given to on-board diagnostic.

All topics are considered through interactive multimedia components. Theoretical problems are illustrated with appropriate examples from specific systems in a car as shown in Fig. 1. Most of the objects in the diagrams or systems are implemented as active areas, which change their behavior when interacting with them.

3.2 Simulation-Based Training

Simulations, interactive multimedia components, cognitive knowledge and comprehension tests prepare the learners for the practical exercises. Complex theoretical problems are considered using "learning by doing" pedagogical model with extensive use of interactive simulators designed to cope with the increasing demand of e-learning for feed back and "virtual teachers" guidance.

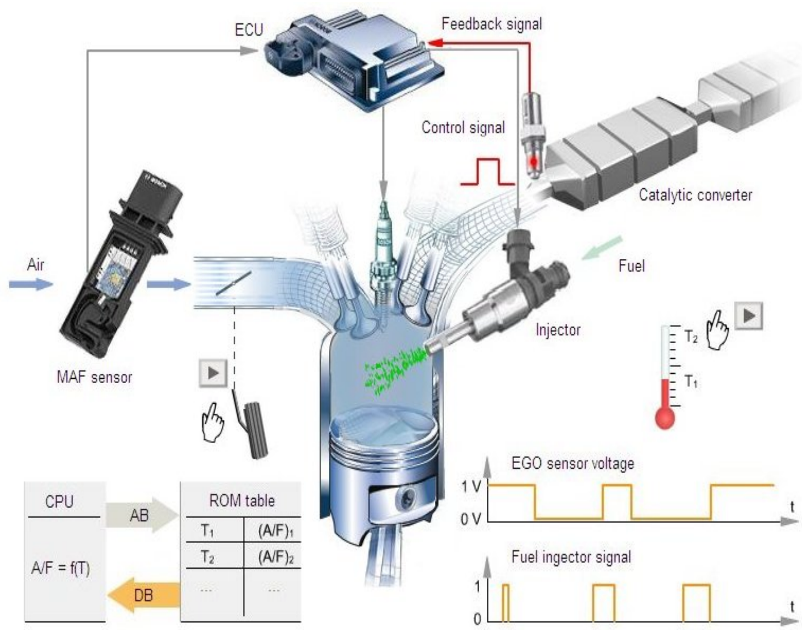

Fig. 2. Simulation of closed-loop mode of fuel injection system

It is the objectives of electronic control in modern cars to provide the torque demanded by the driver, while at the same time satisfy requirements regarding exhaust emissions, fuel consumption, power output, comfort and safety. Mode of operation of major car control systems [2,3,4] are given as examples and learners are guided to understand them by changing operational conditions, and observing system behavior. Simulation approach thus provides the learner with the background to see how electronic controls are applied.

Fig. 2 shows a simulation example of fuel control system in open loop mode of operation. By pressing the acceleration pedal the learner change the throttle valve position, thus changing the mass air flow entering the engine. All processes are visible – piston movement, quantity of injected fuel in relation to engine mode of operation (warming-up, acceleration, wide-open throttle), ECU pulse width of control signal, which manage the process, coolant temperature influence, look-up table operation, etc. The system is than upgraded to closed loop mode and the results are compared. Emphasis is given on ECU operation during calculation of appropriate pulse width.

Fig. 3 shows simulation example of an Antilock Braking System (ABS). ABS is safety-related feature that prevents wheel lockup by regulation of braking force, so that the vehicle remains steerable and the risk of skidding is considerably reduced in critical driving situations on wed or icy roads.

During automatic brake control the stability of wheel motion is kept by a sequence of pressure rise, pressure retention or pressure drop phases (as shown in figure). The cycle continues until the vehicle is stopped. After interactively pressing brake pedal learners observe system mode of operation. Wheel speed sensors signal, ECU control signal and corresponding brake pressure changes caused by hydraulic modulator are all visible for better understanding.

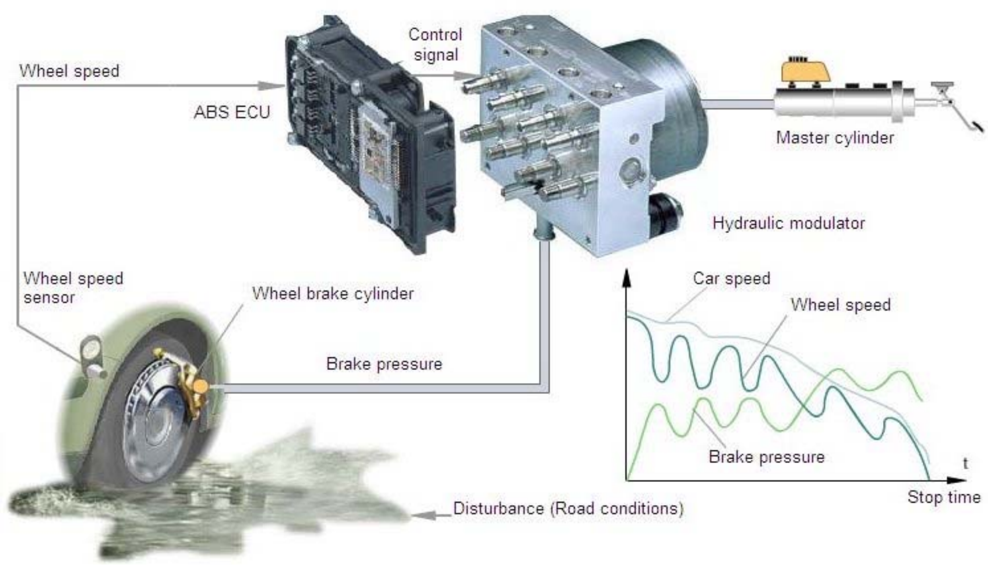

Fig. 3. Simulation of an Antilock Braking System mode of operation

3.3 Practice

The development of electronic engine control has increased the complexity of diagnosis and maintenance. On-board digital systems can also store diagnosis information whenever a failure occurs in a component or subsystem. Trouble-shooting of modern cars requires knowledge on microcontroller based control systems and also proofed skills in using state of the art tools and technology. In fact, the best diagnostic methods use special-purpose computers that are them selves microprocessor based.

The serial car (Opel Corca) modified for training and teaching process is used for practical exercises. Connected to the PC workstation it offers the possibility to measure and display the real behavior of the motor management system. Accomplished with fault insertion and trouble shooting infrastructure the learner can study, operate, insert faults and troubleshoot them. Students retrieve the diagnostic information electronically, measure relevant sensors and actuators and then are required to detect faults by analyzing the measured data.

Fig.4 Blended learning laboratory with educational car

4. CONCLUSIONS

The paper presents developed blended learning solution and laboratory for training in the field of autotronics management systems. The laboratory links modern e-learning methods with service and maintenance skills obtained in practical sessions. E-learning package contains a set of web-based learning products incorporated in a LMS. All products are AICC and SCORM compliant. Blended learning autotronic laboratory is designed and implemented with joint effort of proffesionals from Technical University of Sofia (e-learning materials, LMS, and interfaces), Ingenatic Gmbh (didactic concept) and Lucas Neule Company (education car and hardware equipment). The learning approah have been succesfully used in many contries for certified education in the field of autotronic management systems.

5. References

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