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ELECTIVE COURSES WITH SUPPORT FROM AUTOMOTIVE ELECTRONICS INDUSTRY

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Abstract: *The collaboration between industry and higher education was materialized in organizing a facultative course for introduction in automotive electronics for the students of the Faculty of Electrical Engineering and Computer Science of Brasov. The novelty of this specialized course was that it addressed all the students from all the programmes of study from the Faculty and from all years of study. This paper presents the didactic and organizational challenges raised by this course with large audience. The feedback from students has analysed and conclusions drawn in order to improve the curricula of Programmes of study.*

Key words: *automotive electronics, elective course, engineering education.*

1. Introduction

The Faculty of Electrical Engineering and Computer Science of Braşov has good collaboration with automotive companies interested in developing local production plants in the area. The collaboration between industry and Higher Education is in continuous development around the world and drives a rapid advance of technology.

Edoardo Merli, Director of the Automotive Product Group, states in [9] that India has a key role in automotive electronics, automotive industry having a very large growth of market and production. He considers that in this development the role of educational institutes is also rising.

The study presented in [10] describes the introduction of an Automotive Electronics course at a university from India. The study shows that such a course demands existing knowledge from many fields such as mechanical, electrical, electronic engineering and computer science. The biggest challenge of this course was teaching electronics to students at mechanics and mechanics to students at electronics. The course was focused on real-world case studies, which increased the attractively of the course. Also the courses included animations and video to clarify concepts and some of the courses was presented by experts from industry.

In the book edited by David Greenaway and Chris D. Rudd [6] an entire chapter is dedicated to the role of Higher Education in the increase of Chinese economy, underlining the complex economic relations between England and China. In the automotive field, Shanghai Automotive purchased the Longbridge Assembly fab,

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but kept the production in England. This was due to the fact that a large number of Chinese students are trained in universities in England.

A study based on the O*NET database of the US Department of Labor [1] analyses the green engineering jobs. Fist job analysed is the automotive engineer with job description and skill demands. They affirm that education must follow the dynamics of industry to be able to prepare students able to face today's challenges.

A set of original proposals to modify the teaching methods have the role of making the teaching process more attractive. The work in [12] proposes a method of study based on puzzles in the Indian universities.

A same initiative to create such an introductory course into engineering in the secondary education system is presented in [13].

2. Elective Course Content

A special relation exists between the Faculty and the company Continental Automotive Products from Sibiu, based on frame contract of collaboration regarding internship positions, diploma project opportunities, factory visits etc. In 2014 a new facultative course was conceived, with a duration of 1 semester which took place in the first semester of the 2014-2015 university year.

An important reason for organizing this course was to complement the knowledge of the students with state of the art informations coming from a well-known company and a big employer. A study is presented in [4], which predicts the students' performance based on educational data, including facultative courses they have chosen. It is underlined the difficulty of choosing such courses but also the importance of it. Also Rozanc and Slivnik [11] consider that one of the most important results of the Bologna reform is the possibility for students to take on elective courses. Their work presents the results of student choices for elective courses from a much broader spectrum than their own domain of study. Tracking the choices of good students, conclusions on compulsory courses can be drawn and their structure can be modified to obtain better educational results.

Our main goal was to organize a course addressed of the students with different levels of training. A similar course addressed of all the students in technology field is presented in [2]. This elective course in Electromagnetic Compatibility (EMC) will provide students the knowledge of dealing with electronic systems as a whole. Another elective course that addressing students from different backgrounds is presented in [8], this underlining the importance of “Hands on Sessions”. To this effect, the course "Introduction in Automotive Electronics" was designed as a series of laboratory sessions with a carefully selected accompanying course syllabus.

A novelty of this course was the fact that it was addressed of students from all programs of study and from all years of study from our Faculty. To prepare the syllabus for a such course for to be accessible of all students with different backgrounds, significant efforts were necessary. As a reference for the syllabus the book of Hollembeak [7] was used and also the experience presented in [3] was analysed.

The contents of the course is presented in the following paragraphs.

The first group of courses, presented at block level with explaining of the specific terminology, the most known automotive subsystems: passive safety (Airbags), active safety (ABS - Anti-lock Braking System, ESC - Electronic Stability Control, TCS - Traction Control System), assisted direction, Vehicle Dynamics

Management, assisted driving systems, connectivity, Human Machine Interface, Power Train (ECU - Engine Control Unit, TCU - Transmission Control Unit), fuel and exhaust systems.

Two courses presented the requirements of international standards and examples of client requirements. Also, were presented typical electronic modules including sensors, power supplies, protection circuits, actuator drivers, along with the specific requirements for these parts.

During courses there were discussions with students about interpreting the datasheets of passive and active components, the heat dissipation calculus, the simulation programs for electronics (e.g. PSPICE). Also Worst Case Scenario calculations were presented, a notion less known by students.

The attractivity of the course increased through offering diplomas and other rewards by Continental. Such rewards included support for diploma projects, possibility of internship, trips to some internal and international symposiums and scholarship funding.

When the course was announced, organizers did not known what interest this will have amongst the students. The very large number of applicants (144 students signed up) involved big organizational efforts. A sub-page on the Faculty website was created to manage the contact with students and to disseminate the course materials, assignment lists, laboratory programme etc.

3. The Analysis of the Survey

The analysis was carried out based on the questionnaire answers given by students.

The survey has aimed the next main objectives listed below:

1. To identify the best way to inform the students.
2. To determine the interest level of the students for this course.
3. To match the courses content and the didactic strategies to current requests in involved technological area and also to the students' motivational profile.
4. To test organizational capacity of the department/faculty, more precisely the reaction speed and quality organization.

After the courses session a selection of the students were performed based on the presence to the courses and passing of a test. A number of 70 of them passed this selection and were asked to complete an anonymous survey.

The research is of a quasi-experimental post-test type, conducted after finishing the course using a questionnaire with closed answers measured on a Likert scale with 3 or 4 steps and also some open questions. The students were also asked express their opinions, on the back of the questionnaire.

3.1. Informing the Students

From Figure 1 it follows that by far the most efficient way to inform the students is done through the department website. Of course other means of informing like posters or direct communication are not to neglected.

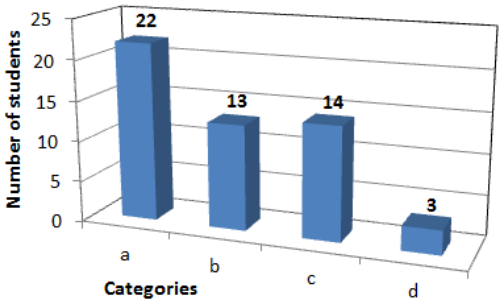

Fig. 1. *The source of information about this course; the categories meaning are: a) department site; b) poster; c) colleagues; d) other sources like teachers or information at the opening of the academic year*

3.2. The Interest for the Course

The number of students enrolled in this course and the evolution of their attendance to courses is presented on Figure 2.

As it can be seen, the initial interest was very large, a number of 144 students from all programmes were enrolled. During the courses, however, the interest was begun to decline and barely half of the initial number of students passed the threshold of at least 75% presence (threshold which had permitted the participation to the test of admission at lab) and only a number of 48, actually participated on test. Some of their motives for losing interest are identified in sections 3.3 and 3.4.

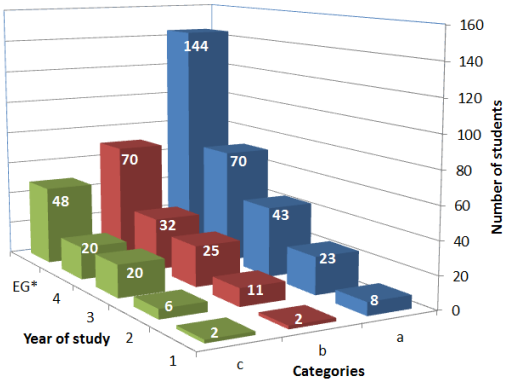

Fig. 2. *The presence of students from matriculation to testing; the categories meaning are: a) matriculation; b) 75% presence; c) presence at test; *) EG - Entire group*

The analysis of their attendance reveals the fact that first year students have been enrolled in lower numbers and they quit quickly after they realizing their lack of fundamental knowledge to finalizing successfully the course. The only 2 remain, they are having solid background knowledge of electronics from high-school.

The students in years 2nd and 4th present an evolution similar to the general tendency. The main difference is given by the students of the 3th year, who exhibit the lowest rate of decline in attendance (and their interest).

The interest for the course is also shown by the students perception regarding the course, resulted from the survey as presented on Figure 3. The resulted diagram reveals the fact that the perception of the importance of the course decreases from first to final year. The high interest for the course expressed by the students of 3rd year is also enforced by their perseverance in attending it. Moreover, these students had nuanced opinions about the utility of the course (one of the students claimed less useful).

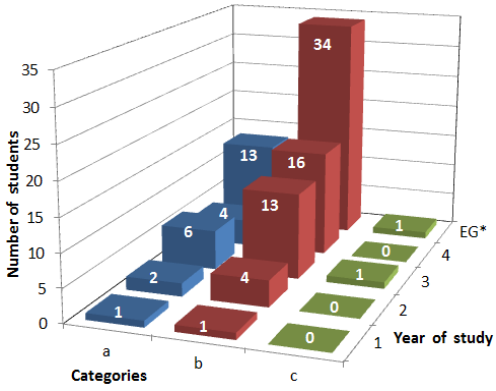

Fig. 3. *The students' perception of usefulness of the course; the categories meaning are: a) very useful; b) useful; c) a little useful; *) EG - Entire group*

The attending students of this course were classified in relation with their programme of study. The resulted chart is presented in Figure 4.

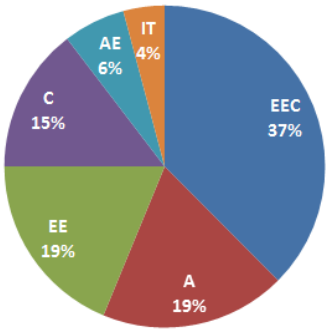

Fig. 4. *The structure of the students group*

The abbreviations refer to: EEC - Electrical Engineering and Computers (in English), A - Automations, EE - Electrical Engineering, C - Computers, AE - Applied Electronics, IT - Information Technologies.

3.3. Achievement of the Course Objectives

The achievement of objectives is measured firstly by considering of the students perception and secondly by testing the knowledge and abilities attained during the course. Figure 5 presents a chart of the level of understanding the concepts presented at the course as seen by the students resulting from their answers. The level of understanding is higher in the case of the students of 3rd year and especially of 4th year (thing expected given the existing background knowledge).

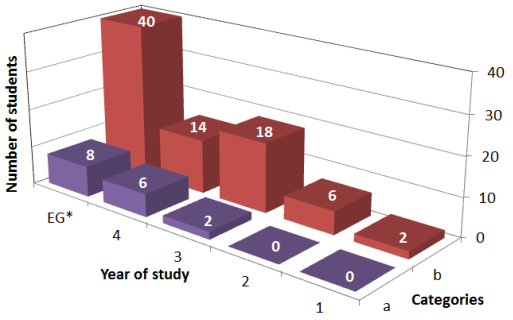

Fig. 5. *The understanding level of new knowledge; the categories meaning are: a) to a great extent; b) to some extent; *) EG - Entire group*

Also, the students were asked to identify the cause of difficulties in understanding the course. Their answers are classified on the chart presented in Figure 6 in the main causes of difficulties. As it can be seen, most of the students give the lack of previous knowledge as the main reason for the difficulty of completely understanding the notions from this course, and only to some extent the high level of the course. According to the teachers (who were present passively at the course and actively at the laboratory) the actual level of the course was not so high, but it was perceived as difficult due to lack of some basic knowledge.

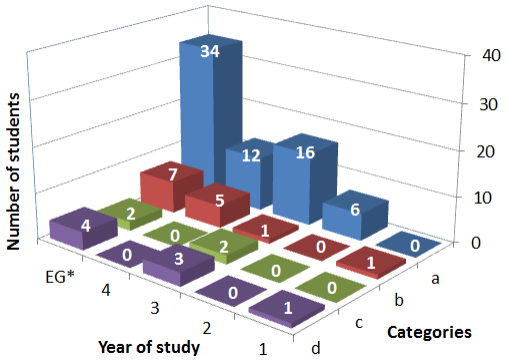

Fig. 6. *The main reasons invoked by the students relating to the difficulty in understanding; the categories meaning are: a) lack of knowledge; b) too high level of teaching; c) teacher unintelligible; d) other reasons like noise in the classroom and the schedule inappropriate; *) EG - Entire group*

The student scores after the tests (both the theoretical and the practical) are presented on Figure 7. This show an almost normal distribution with a mean around 6.12.

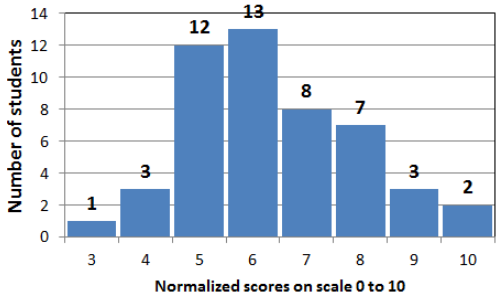

Fig. 7. *The distribution of test scores*

Comparing the grades of the programmes of study (Figure 8), a better preparedness of the AE, A, EE, and EEC students can be seen, while students of IT

and C obtained lower grades with the mean below 6.

The general opinion about the course organizing indicate a good or a very good satisfaction (more than 80%).

The major cause of dissatisfaction was related to the timetable and the length of the course session. But, taking into account the large number of constraints (having students from all programmes and also the classrooms having a high loading) the number of displeased with the organization is acceptable.

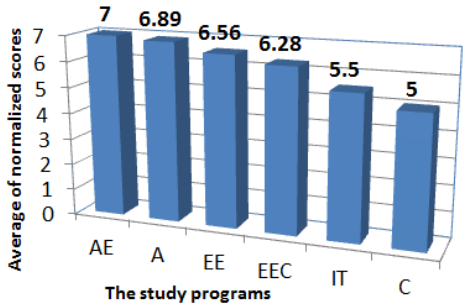

Fig. 8. *The average of normalized scores per study programme*

4. The Course Novelty, Discussions and Educational Implications

Introducing this course has shown at the didactic staff some of the directions of interests of the students manifested during this course. Identifying these directions had an immediate effect through the thinking of possible enhancements of our own curricula. For example, the elective course had mentioned without much details some notions of EMC (Electromagnetic Compatibility) and EMI (Electromagnetic Interference). The EMC course holder has introduced in the syllabus for next year a new chapter which referring to EMC in automotive domain, with some examples of interference, measurements and specific standards. The interest of students in debugging was a good opportunity to introduce some examples of out-of-the-box approach into the EMC course. For example, the possibility of diagnosis based on noise [5] was considered an original idea by the students.

The elective course had a big portion of presenting block diagrams for microcontroller based control for many subsystems in a vehicle. Because most of the students did not studied microcontrollers yet, these block diagrams were not treated in detail. The attention of the students was however attracted to a block unknown to them which appeared on all block diagrams, more precisely the CAN bus (Controller Area Network), specific network in automotive communications. The interest of students was manifested through both questions and discussions about it, so it was followed up by introducing this type of communication systems into the course about microcontrollers and interfaces. An immediate result of this course was also an intervention of a student who decided to use CAN communication in his diploma project targeting an automotive application.

Another discussion initiated by students passionate for PCB design, whom usually participate at international design contests. Many students had asked about the history of electronic components and assemblies in vehicles. In the ensuing discussions, students noted some key moments of this history, using internet search results on their smartphones. Due to the major interest in these aspects was took the decision to introduce a small chapter about the history to first course.

5. Conclusions

For the first time in our faculty was organized a technical course for all study programmes and for all study years. In this paper is highlighted the original contributions of the authors, the most important one being:

1. Fixing courses and laboratories topics so as to be accessible to all students;
2. Integrating this course between technical courses taken or to be taken;
3. Continuously, both the content and the teaching strategy were adapted considering students' feedback;
4. The conclusions drawn by this course were used to improve the curricula of study programmes.

Based on the statistical analysis of the survey results the following conclusions were drawn:

The most effective information source for students is the website of the department, but with significant share are also the classic methods to informing (posters, direct communication), so the best approach to maximize attendance is to use in parallel all these sources.

Interest for this course was very high in all years of study, but with a higher proportion among the students of 3rd and 4th year.

During the course, the interest remained at high level especially among the students of 4th year and higher for the 3rd year.

Irrespective to the year of study, all students understood the fact that they lack some key competences needed to fully understand the notions presented at this course. After course many students of the 3rd and 4th year have reaffirmed their personal goal to accord a higher attention to courses, but also the students of 1st and 2nd year found a new motivation in this course to give higher attention to the fundamental courses.

The level of teaching was adequate for the existing level of the students, this was reaffirmed by the normal distribution of the score and mean score of 6.12.

To be in line with the study programs of Computers and Information Technology, the course should be extended towards the computational component in automotive systems.

To increase the level of satisfaction of the students regarding the organization of the course, some enhancements must be implemented: using a sound system in the classroom, finding a more convenient time schedule and a flexibility of the duration of the course modules.

Following the discussions on the impact analysis a great effect was the awareness of the interdependency between electronic and mechanic systems, interfacing with sensors and actuator being the most significant aspect. Grouping the students from different programmes for this course led to professional discussions highly animated and highly useful. The teachers who organized this course proposed forming of multi-disciplinary groups of students for working together on some projects and also to their diploma project. The high attendance to the course and the professional interest of the students lead to the decision to repeat this course also in next year.

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