

Remarks on the Organization of Teaching Electronics in Serbia

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Abstract

This paper presents some consideration about the level and organization of teaching in electronics in Serbia, with a particular emphasis on teaching this subject at Departments of Computing¹.

Introduction and General Comments

The considerations in this paper are motivated by the fundamental questions about the necessity of reformation of the education system in Serbia. Thus, it is the best to first express our attitude towards this subject.

Political and economical changes in a society, usually strongly related, necessarily highly influence the education and scientific work. Unification of Europe caused such changes in the education systems in EU countries resulting in introduction of internationally agreed standards, emphasising strong cooperation, unification of criteria in teaching and evaluation of the work of students and teachers, mobility of both students and faculties, equalization of the level of knowledge provided, the way of teaching, supporting equipment and related facilities, etc.

Dramatic changes in Serbia in over than a decade have influenced the education system in our country strongly, sometimes even beyond description by imposing inadequate laws and rules, besides economical difficulties, and in other ways. These numerous internal and certain external influences, as for example, restricted communications, and others, culminating in a few months break in teaching and direct destruction of educational facilities in 1999, have imposed strong challenges to the education in our country. Another aspect is that we have to adapt our system to the changes in the education in the EU and other international standards.

There are at least three possible answers to this fundamental question about scheduling of the work towards the reformation and the way to implement it:

1. The reformation now, extensive and fast,
2. Now, but slowly, and restricted,
3. Minor adaptation as an answer to the changed circumstances in the international environment.

There are many pro and contra reasons for each of these answers. Main concerns regarding the first two answers are, that negative consequences of the reformation and all possible mistakes

¹ The name « Department of Computing » is used in this document as the closest to the Serbian name and to express the equal importance of software, hardware and applications.

will be visible only after several years, when first generations of students complete their education under the new system. Thus, fast but not properly founded changes can be dangerous. In spite of that, we want to explicitly state that we are personally strongly inclined to the first answer. The main reason that determines this attitude is not related to the level and contents of knowledge provided to the students, which have been already discussed quite much, but are rather economical and related to the psychological and other requirements, or more precisely, the overload for the students, which all together make the educational system inefficient and inadequate. The organization of teaching and regime of study combined with the rigid methods of evaluation of students, lack of efficient control of the work of teachers, and other reasons, make the average time of completing the study in the area of electrical engineering in Serbia much longer than estimated in officially accepted university programs. The results are very expensive studies when we take into account that students have to be supported by parents or in general, by the society, for a couple of years longer instead of starting to work and, in this way, returning back to the society. In this remark, we stress on inadequate facilities offered to students at the universities, which do not concern just the lack of modern equipment and elementary comfort in lecture rooms, but also a frigid ex cathedra teaching without much interaction with students and their involvement into the various aspects of the real university work. We hope that other aspects that reflect this problem, as for example, desire to keep the status of a student as long as possible for unemployment problems in the country or obligatory military service for male students, would be solved by the government and other relevant state and political institutions.

Inadequately estimated requirements often imposed to the students, lack of coordination in the time schedule of the requirements and task assigned to a student, a rigid purely administrative system of control of the work of students, in practice mainly reduced to the requests to pass a sufficient number of exams to be assigned to the next year, that proved quite inefficient in the past, lack of control of results of exams after the exam period as a measure of the quality of work of the teaching staff, and other reasons, result into difficult studies with rude psychological pressure to students. We can easily observe that after completing the study many students are feeling tired and exhausted, and without much willingness to continue professional learning at the working place.

We believe that a similar situation is present at other related faculties and universities in Serbia. These are the reasons sufficient to argue for an immediate start of the reformation however paying a strong attention to avoid as much as possible the eventual mistakes.

Some other reasons from the point of view of the concrete interest of Faculty of Electronics in Niš are discussed in [1].

Level of Teaching in Electronics

It is often heard and commonly accepted that electronics are everywhere around much present in everyday life, that necessarily has to be taught in each modern education system. This completely resolves the basic question, do we need electronics as a part in our education system in the country? However, another important question raises for small countries as Serbia, from the present situation at the electronics production and market World map and distribution of centres of power in this area. This is the question - teaching up to which level of expertise should be provided by our education system in the country. This is a legitimate question taking into account the small probability to take a considerable role in the production and marketing of electronics, and on the other side, the cost of a proper organization of teaching of electronics. The definitive answer should be absolutely the highest level, since restricting to the consumer of electronics level means exposing to uncritical buying of licences, impossibility for their adaptation to local circumstances and possibly improvement. In general, dependency on foreign consultants and experts.

However, taking into account expenses of organization of such studies and requests in ensuring the level of quality, we would suggest the reorganization of the present system. In that respect, we vote for a system of accreditation and licensing of institutions and individuals that may be allowed to organize postgraduate and doctoral studies as well as post-doctoral research. Further, we want to suggest to join and share resources between the universities and other relevant institutions in the country. We propose the organization of a National school for doctoral studies and postdoctoral research, whose main task will be organization of courses that will be offered for doctoral studies and related research activities. Although intended to prevent localization in a negative sense, this proposal does not implies centralization of study in Serbia neither a monopoly in organization of this highest level of study. The School will not assign students, neither recognize ranks nor issue diplomas. That will be done by the Faculties as it is now, and the Faculties will be allowed to organize and offer the courses to students at postgraduate studies. However, the School will be in charge to organize courses, besides those organized at the Faculties, by engaging the best experts in the area, including experts from abroad. The courses will be realized at different Faculties, or some other places, and will be attended by postgraduate students from all the Faculties. These courses will be recognized and accepted by the Faculties as a part of fulfilments of requirements for a Ph.D. diploma at every particular Faculty. In this way, the School will support the organization of high level courses at Faculties and does not represent a competing institution in organization of doctoral studies and post-doctoral research. These courses can be also offered to engineers in industry as a part of continuous learning. Activity of the School can be extended to the organization of various seminars, colloquia, summer schools for advanced students, etc.

The School should work under auspices of the Ministry of Education or Ministry of Science. It will consists of few employees, that will organize courses, engage highly recognized lecturers, and undertake the administrative work in communication with Faculties and registering attendees. Fig. 1 explains the role of the National School in doctoral studies and postdoctoral research. It shows that the role of he National School is to help Faculties to organize high level courses at doctoral studies and postdoctoral research, moreover courses organized by whatever the School or particular Faculties could be shared. The School should be also in charge for courses for continuous learning for engineers in industry to avoid possible problems that may appear if this job is left to the level of particular Faculties and companies without a supervision system that is always recommendable. The same model should be extended to other areas in education system in Serbia.

Teaching of Electronics at Undergraduate Studies

At undergraduate studies, teaching of electronics should be organized in a way to meet two goals

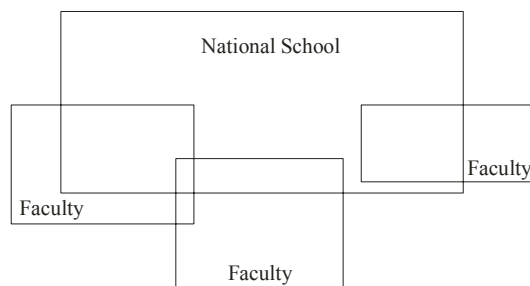


Fig. 1 National School and postgraduate studies.

1. Ensure a basis for development of electronics as a separate scientific discipline and offer courses with the required content to students in this subject that would specialize further in different branches of electronics.

2. Provide fundamentals of electronics required for a general knowledge of an electrical or computer engineer and notions necessary for understanding and study at other education profiles in these.

These goals can be achieved through organization of different programs whose contents and the way of realization (number of lectures, exercises, lab exercises) would be determined by the specific requirements of the education profiles to which particular programs are intended.

The programs should be defined in cooperation with experts in teaching in education profiles to which they are intended. Some concepts and required knowledge may be left to be introduced at the places where they will be used within lecturing in these different areas. This would make easier the courses in electronics themselves.

The programs in electronics should be realized through a series of specialized and properly sized courses, rather than an extensive general course. Efforts should be made to provide written materials for each course, prepared by following the recommendations in Fig. 2, and besides lecture notes, some appropriate carefully selected chapters from nationally or internationally recognized textbooks should be recommended. Whenever possible, teachers and tutors should be encouraged to use modern technical teaching facilities.

Faculty and Departments

Teaching is an educational process, and should be supported by the corresponding organization of the Faculty. The main background idea is that teaching

should be considerably based on the laboratory work and this would not be finished after just completing a required set of lab exercises. Instead, labs should be

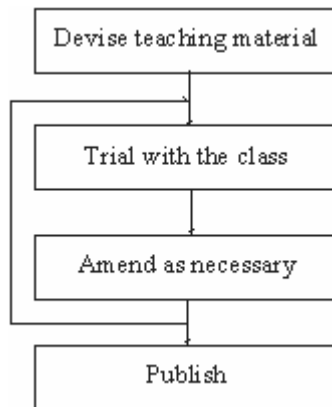


Fig. 2 Recommendations for preparing lecture notes.

open for students at any available time. In that respect, whenever possible, research and teaching labs should not be completely separated, which will permit to gradually involve advanced students into research work at the Faculty.

It follows that teaching and research Labs should be the basic organizational units of the Faculty, with Labs working in the same area united into Departments. The Departments in the

related areas can be united into higher organization units called, for example, Divisions. Fig. 3 shows this possible organization the Faculty. A reasonable union of departments could be between Departments of Computing and Telecommunications, or Electronics and Automation Control and Robotics, or Computing and Electronics, Computing and Mathematics, etc., which will depend on the concrete programmes of study offered by the departments and their research areas. Efforts should be made on the national level to provide a synchronization of the teaching programs at the doctoral studies and research areas to avoid unnecessary overlapping of programs at different Faculties and provide a complete coverage of the scientific areas at the national level in the country. That should ensure a complete and well established education system in Serbia.

With respect to teaching, Labs should be in charge for organization and offering courses in the area of their expertise. The Departments should determine education profiles by combining courses offered by the Labs into reasonable and complete Programs. To accomplish that, Departments may require Labs to provide some particular courses if there are available knowledge and human resources. If not, then required courses may be provided through the cooperation with other Faculties in the country or abroad. The Divisions can create new education profiles offered by the Faculty by combining courses offered by the constituting Departments and other Departments at the Faculty.

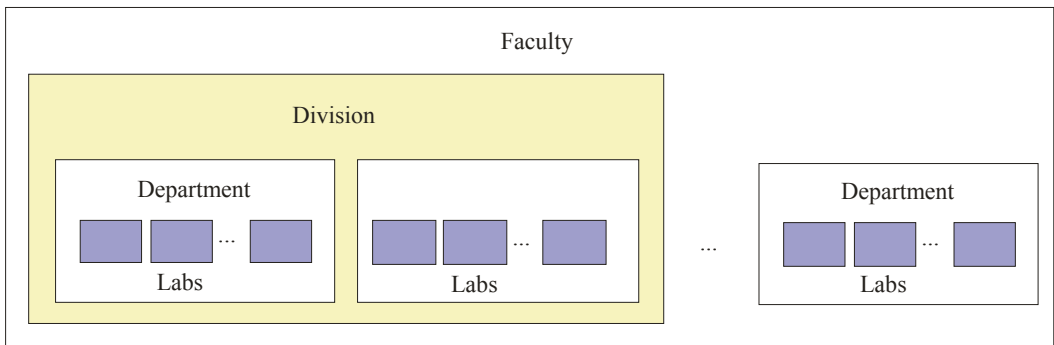


Fig. 3 Structure of the Faculty.

Programs in Mathematics, Electronics, and Computing

The interaction and links between these three areas will be briefly discussed based on the example of the problems of automation of the design of complex systems.

In practice, we are requested to design increasingly complex systems within shorter time spans. To achieve the necessary increase in productivity, the level of abstraction at which design entries are made must be raised. In this respect, we need strong links between mathematics, computer sciences and electronics. Mathematics should provide models that will permit to describe systems at varying levels of abstraction. Computer science provides for algorithms of synthesis at logical level, while electronic should provide methods for final physical realization.

The first embedded computer applications were simple enough so that their design principles were well understood. Recently, the increased integration level of VLSI circuits has brought very large and complex embedded systems into existence which is why the traditional ad hoc design methods fail more often than before. An increasing number of people in the embedded systems design community are looking for answers in formal methods, which are mathematically justified, rigorous approaches to specification and design. At this level, formal methods involve software-assisted proofs to allow mechanized reasoning about the behaviour of a system.

In that respect the programs in mathematics at the Department of Computing should be upgraded with some lectures on particular subjects, as for example, in mathematical logic, temporal logic, temporal logic of actions, Petri nets, etc.

At the Departments of Computing, a basic course in electronics should be provided as a course obligatory for all the students. Then, few different courses should be offered to students in software, hardware and information technologies including signal processing and similar areas. The contents and number of these courses should be adapted to serve the best study in the major topics for students in these particular subareas of computer engineering and computer science. The contents for each particular course should be determined by following the guidelines of IEEE/ACM [2] however by taking into account particular local circumstances and needs. In particular, coordination of the contents of courses in electronics is, with other courses at the Department of Computing, of a considerable importance. These courses in electronics should be offered as electives, however, as prerequisites for the corresponding and related courses at the Department of Computing for which this appropriately selected knowledge in electronics is required. Together with the obligatory basic course in electronics, these electives should provide a well organized sufficient knowledge in that subject for every student at Departments of Computing in their specialization in different subareas.

We give the following example to explain better what we expect as a possible contents of these electives in electronics.

Various methods of signal compression are a standard part of courses at Departments of Computing. Courses discussing concrete realizations of these methods in hardware from the point of view of electronics would provide a complementary knowledge in these topics.

References

- [1] Stanković, R.S., “An approach to the reorganization of teaching at Faculty of Electronic Engineering”, *Tempus Proceedings of Workshops on Computer Science Education*, Faculty of Electronics, Niš, 2004,
- [2] www.computer.org/education/cc2001