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Mladenović, Miloš

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# Program-level Assessment in Transportation Engineering Education: Strategic Curriculum Plan for the Department of Urban and Road Transportation Engineering

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Miloš N. Mladenović

## **PURPOSE AND SCOPE**

The purpose of this brief report is the program level assessment of the Faculty of Traffic and Transportation Engineering. This assessment is taking into account the outcomes-based model of ABET accreditation. The report includes the overview of analysis of international and national context, institutional context, program-level analysis and recommendations for improvement. Recommendations are presented as high-level descriptions of possible curricular and assessment interventions.

## **INTERNATIONAL AND NATIONAL CONTEXT**

As of 2011, European Commission decided that Serbia is a candidate country for European Union (EU) accession ("Serbia - EU-Serbia relations,"). For Serbia, that is currently a country in a transition, the next step of the actual reception into European Union would present a significant, society-scale, change. However, Serbia still has a long stretch of road towards the reception in EU.

Country having wars and enormous economic crisis in the recent past, with \$ 10,700, Serbia is currently ranked as 106<sup>th</sup> state based on the GDP per capita ("Country Comparison: GDP - per capita,"). The annual change of real GDP percentage in recent years was negative or extremely small (2010 -3.1%, 2011 1.8%) with projected growth of 3.0% for 2012. The global and European economic situation is not in support of the Serbian economy either. Fiscal austerity programs applied across Europe and the debt crisis that erupted in Greece have disturbed complete European economy. This is increasing the chances of another recession, with labor markets showing little change since 2009. Current estimated unemployment rate in Serbia is 17.2% ("World Economic Situation and Prospects 2012 - Europe," 2012).

The country's educational system has a crucial role towards emerging from the crisis along with the successful integration in EU. The political abolishment of national borders between EU members will present a significant change in the Serbian labor market. Previously, just as most of the European countries (Patil & Codner, 2007), Serbian education was focused on domestic needs. However, EU integration will significantly increase personal and professional mobility.

There is already a process under way to integrate European countries in the sphere of education. This is the Bologna Process (Lucena, Downey, Jesiek, & Elber, 2008), whose aim is “to create a European Higher Education Area (EHEA) based on international cooperation and academic exchange that is attractive to European students and staff as well as to students and staff from other parts of the world” (“About the Bologna Process - The official Bologna Process website,”). The EHEA is intended to:

- facilitate mobility of students, graduates and academics
- prepare students for their future careers and for life as active citizens in democratic societies while supporting their personal development
- provide broad access to high-quality higher education, based on democratic principles and academic freedom

## **Vision 2015**

Considering these international tendencies, the Serbian education system will need to:

- Increase employability in the consulting and government sector
- Increase the economic potential of Serbia through high-tech development in the area of entrepreneurship or research institutes
- Increase academic reputation and competitiveness

The engineering education is recognized as one of the most important sectors of Serbian educational system, considering that the prime function of engineering is to create products or product-related techniques (Donald, 2002). This requires a broader set of skills, mainly related to reasoning and learned through practice. Due to the distinction between engineering and other subjects in content, purpose, and process, a successful engineer in a modern world with rapidly changing technology, globalization, outsourcing, and corporate downsizing, faces significant requirements. Topics such as communication, teamwork, lifelong learning, understanding ethics and professionalism, work in the global and societal context, knowledge of contemporary issues, higher-order thinking, design process, adaptive expertise, structural organization, synthesis and analysis skills, approximated modeling, etc. are all different aspects of the “required knowledge” for a new generation of engineers (John et al., 2010; Johri, 2011). This pressure for constant expansion of engineering skills and technological expertise is the high-level goal for the need for program level assessment and

development of the strategic plan for the Faculty of Traffic and Transportation Engineering (FTTE).

The current vision, due to the urgency of current economic situation and future political development in the region, will need to aim for preliminary results in the year 2015. The criteria used for are mainly based on criteria established from the Accreditation Board for Engineering and Technology ("Criteria for Accrediting Engineering Programs, 2012 - 2013,"). The special emphasis is on the General Criteria 3: Student outcomes, listed as following:

- a) an ability to apply knowledge of mathematics, science, and engineering
- b) an ability to design and conduct experiments, as well as to analyze and interpret data
- c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) an ability to function on multidisciplinary teams
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

## **INSTITUTIONAL CONTEXT**

In order to completely understand the current situation in the educational system of FTTE, we need to consider the institutional context that has a significant influence on structuring some of the important improvement constraints. Currently, the University of Belgrade has around 80,000 students, with the number of professors around 2,500 and associate assistants around 2,100. The annual budget is \$33,000,000. In comparison with other

European and North American universities, University of Belgrade is having higher number of students, with lower staff number and budget. Each Faculty as an institution is independent from the University of Belgrade. In addition, each Faculty has several Departments, which are also mutually independent. Professors of each Faculty are usually educated at the same institution, obtaining their undergraduate, master and doctorate degree.

The higher education system is envisioned after the WWII as a filter system and basis for creating scientific, economic, and most important, political elite. This system is highly dependent on the government funding, with very small percentage of self-financed students. The result is a system in a constant state of funding deprivation. Furthermore, this system bases on the “Gymnasium” high-school education that provides very broad educational base before specialization on the college level. This way, students are focused on specialization in a certain area, gaining their depth before the breadth. However, this system has little potential for research and development, and there is almost no program-level assessment. In this system, students do not have any significant influence – they are just their identification number. As a result, although there is solid potential in the undergraduate education, there is no research and development, the average studies lasted over 8 years, and there is constant immigration of the best students with little support for their comeback.

The recent, but still incomplete, changes based on Bologna Process resulted in the increase of passing rates and shorter time in college. However, the quality of education is decreasing. Each Faculty is forced to accept as many students as possible because the funding is directly related to the number of students. Since Faculties generally do not have other sources of funding from, e.g., research and development, they are trapped in the loop of accepting more students although the labor market does not necessarily require more incoming graduates.

## PROGRAM-LEVEL ANALYSIS

### The course relation to ABET criteria

In the Faculty of Traffic and Transportation Engineering ("Faculty of Traffic and Transportation Engineering,"), as among the majority of European universities, the emphasis placed on theoretical knowledge (Patil & Codner, 2007). As observed on the Figure 1, majority of the courses is directly related to identifying, formulating, and solving engineering problems, along with courses that emphasize on engineering skills, design, and application of science. On the opposite, classes that directly emphasize on skillset required for modern engineers (communication, knowledge of contemporary issues, work in multidisciplinary teams, knowledge of ethics) are in significantly smaller number.

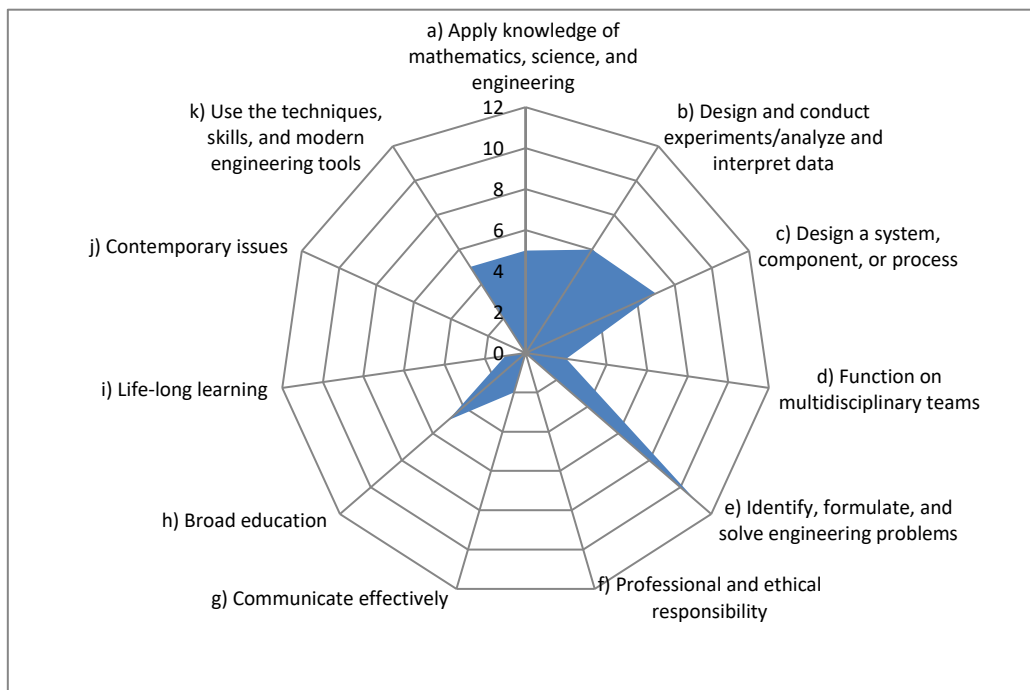


Figure 1: The number of courses directly related to ABET sub-criteria

However, all of the classes are indirectly addressing at least one of the ABET sub-criteria. The number of secondary courses per area are listed on the following Figure 2. However, the observed tendency is similar with the courses directly addressing ABET sub-criteria. Most of the courses are focused on applying scientifically knowledge or problem-solving. The positive fact is the number of courses indirectly addressing the knowledge of effective communication and ethical responsibility.

In comparison to the program area requirements for Civil Engineering programs in United States, this program is similarly preparing graduates to apply knowledge of mathematics, physics, and electrical engineering, conduct experiments, and analyze data, and design system components. However, there is a significant lack of directed focus on concepts in management, business, and leadership. In addition, there is no significant number of classes that are directly emphasizing on the topics of life-long learning, working in multidisciplinary teams, covering the contemporary issues.

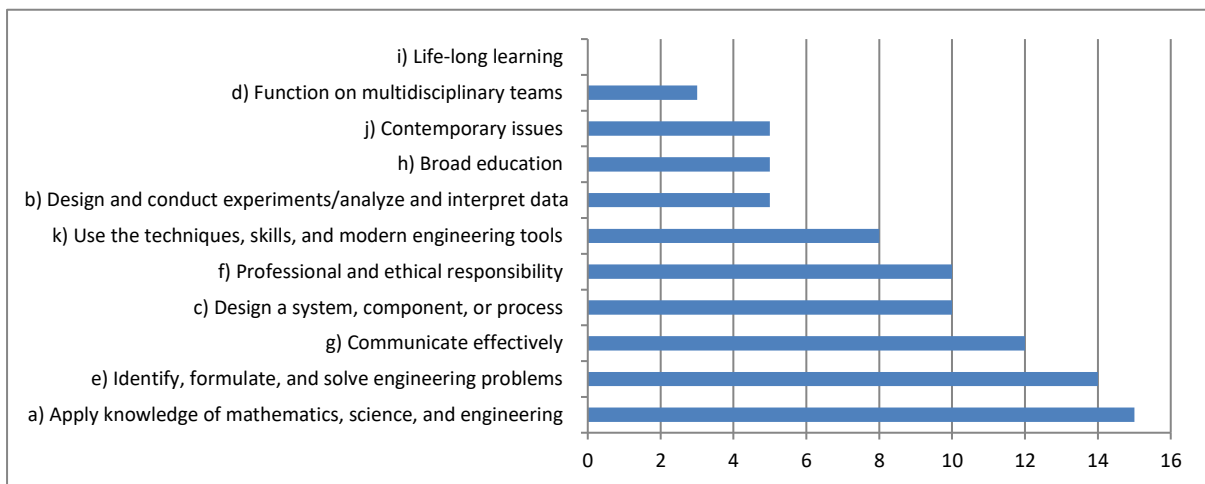


Figure 2: The number of courses indirectly addressing ABET sub-criteria

## Teaching and learning styles

The main teaching style in the Faculty is *ex cathedra* lecture. Professors and assistants are always the experts in their respective area. The information is highly structured and is a result of a continuum of years of consequent teaching the same or similar subject. However, the problem of expert blind spot can sometimes occur, when expert instructors do not notice the actual learning needs of students as novices (Ambrose et al., 2010). The teaching is primarily focused on the theoretical knowledge, along with science-based problem solving. There is a significant lack of practical skill-set development using state-of-the-practice software. Teaching highly depends on the knowledge gained in previous courses, originating from the structure of the coursework that is primarily fixed. Lecturers are highly aware of the content in the other courses, and they rely on coordinated learning. This often can result in redundancy and repetition, that is generally useful since students repeat the same concepts in different contexts and situations which helps them in understanding and retention. Students are generally encouraged to seek extra-curricular experiences, since



internship is an obligatory part of curriculum. This generally enables students to learn some of the skills not necessarily thought in FTTE.

Due to the high competition on the labor market, the students' awareness of the importance of their knowledge is high. This is the reason students are primarily internally motivated for learning. However, there is a noticeable lack of support of students' questioning the established frameworks (Eccles & Wigfield, 2002; Svinicki, 2008), that does not directly support creating great thinkers in transportation engineering.

The assessment methods are mainly based on written test and course projects. However, almost every course has included part of oral exam, where student is able to gain the highest grades. However, there is no innovative assessment methods used, or any validation and reliability testing on the existing assessment methods.

### **The resulting “output”**

As a result of the current program, students are gaining primarily theoretical engineering knowledge with smaller emphasis on engineering skills needed for the modern working environment. The current system of education at FTTE often cannot fulfill modern labor market requirements, and could consequently limit students' competitiveness on the domestic or EU labor market.

## **POTENTIALS FOR IMPROVEMENT**

In order to achieve the progress, to change needs to be achieved on the individual, group, and institutional level, thus leading to intuiting, interpreting, integrating, and institutionalizing processes (Crossan, Lane, & White, 1999). Only the coordination of previous three levels can lead to the related four processes that enable change. This is why the staff of FTTE needs to lead the change and include all the interested parties – from students up to related companies and government institutions.

The FTTE needs to maintain its vision as a base for engineering design and development. The familiarity of staff with the details of the program needs to be used for coordinated improvement across curriculum. The focus of the improvement should be in the following three areas:

1. innovative learning and teaching methods
2. improved quality assessment
3. finding of reliable funding sources

Potential suggestions for wider discussion among students and staff are as following:

- Cooperatively defining or clarifying goals and standards of performance through encouraging the dialog among faculty and students
- Introducing formative assessment for immediate evidence on student learning at the end of 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> year. There is a potential for use of concept inventories or portfolios since there is already available material from the class projects (Olds & Miller, 2008).
- The power of small professional community can be used to conduct employer survey that would rate the performance of recent graduates. These surveys should indicate the more important skills or knowledge. In addition, the surveys of graduating seniors should provide information on rating the balance of skills and knowledge. Finally, faculty surveys should be deployed to establishing the complete, cross-level, picture of the situation (Spurlin, 2008).
- Identify strategies for interpreting, integrating and assessing measurable ABET outcomes that would be linked to student learning across individual courses and contribute to outcomes-based criteria.
- Using the labor situation to maintaining the competitiveness level and emphasis on students' internal motivation.
- Cooperation with companies and EU research institutes for obtaining the software and hardware, cooperation on projects, and
- Increase the number of obligatory non-engineering classes, especially second language (German, French, Italian, Russian) and management (Communication, Public speaking, Organization and Leadership, etc.) classes.
- Encourage greater engagement of student representatives and provide transparency in decision-making process.

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