

Recent Challenges of Forest Engineering Academic Education

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Abstract – Nacrtak

This paper presents the history and tradition of forestry academic education in Europe. In the last few decades a lot of changes have occurred and forestry academic education has lost a high-level position in European society and economy.

In many European countries, higher education forestry programs are just a part of the educational system of universities of applied sciences, life sciences, agricultural or technical sciences.

Important changes of higher education systems have been made with the establishment of new educational programs according to the Bologna principles. Some problems and disadvantages will be discussed on the Croatian example, where the reform of teaching programs according to the Bologna process was made 7 years ago.

The most important problems are related to the employment of bachelors of forestry, decreasing number of students, and evaluation of forestry educational programs in forestry practice.

Also the field of forest engineering, which still has a quite strong position in forestry practice, is not adequately present in teaching programs in many countries.

In order to provide the place that belongs to higher forestry education in the Republic of Croatia and Europe, the existing study programs should be revised and updated with the development of new teaching methods, promotion of new and updated teaching materials and handbooks, encouragement of students for scientific and individual work.

With the aim to preserve and recognize the importance of education in the field of forest engineering, some existing principles of Bologna process could be accepted. First, the need should be stressed for the development of joint master studies in the framework of Erasmus Mundus program, which would strengthen the existing cooperation and serve as the basis for a more fruitful scientific-research and educational work.

It needs to be pointed out that the establishment of new graduate studies in the field of forest engineering would contribute to the development of higher education in the European environment, with an aim of providing student and academic staff mobility.

Keywords: educational programs, forestry, forest engineering, Bologna principles

1. Introduction – Uvod

Forestry is a profession, science and art of managing and preserving forest ecosystems, whose purpose is to secure permanent benefits to man, society and nature. According to Helms (1998) forestry is the science and profession of creating, managing, using, conserving, and repairing forests and associated resources in a sustainable manner to meet desired goals, needs, and values for human benefit.

The first signs of forestry can be found in the Roman province of Gaul, where Pliny mentioned beauti-

ful, managed forests called »sylvae caeduae« (Anon 1963). In the Middle Ages, the beginnings of forestry can be found in the statutes of cities, where certain provisions were mainly related to prevent excessive logging. With the time, they started giving instructions how to manage forests.

Forestry as a science appeared in the 18th century. It sprang from the need to provide a sustainable use of forest resources and preserve forests after deforestation (disappearance of water springs, onset of torrents, soil erosion, formation of bare rock, decrease in soil fertility, loss of forest resources) resulting from intensive cutting

operations in the 17th century and the first half of the 18th century. Forestry is based on the principle of sustainability, defined in 1712 by the German scientist H. C. W. Carlowitz, who published the famous paper »Sylvicultura oeconomica oder hauswirthliche Nachriht und naturmässige Anweisung zur wilden Baum-Zucht nebst gründlicher Darstellung wie zuförderst durch götliches Benedeyen den allenthalben und insgemein einreisenden grossen Holz-Mangel vermittels Säe-Pflanz- und Versetzung vielerhand Bäumen za rathen« (Anon 1998). It is still the only proper example of sustainable development and sustainable management.

Roots of forestry science can be found in the works of the French naturalists R. Reaumur (1721); G. Buffon (1739); G. Duhamel du Monceau (1764) and Varenne de Fenille (1791); they set some basic principles of forestry and defined the growing stock, increment, age classes in even-aged forest, absolute maturity of forest, etc. (Anić et al. 2012).

The Forest Order issued by the Austro-Hungarian Empress Maria Theresa in 1769 is an important document for forestry in Central and Eastern Europe as it provided felling maturity for the main tree species. In the Austro-Hungarian Empire professional forestry services, based on certain principles of forestry science, were legally prescribed and introduced in 1894 (Anić et al. 2012).

The development of forestry services and forestry science leads to the establishment of state institutions that systematically engaged in forest management and scientific research, as well as to the development of the first educational programs for forestry experts. The International Union of Forest Research Organizations, as the only international organization that coordinates forest science efforts world-wide, was founded in 1892 at Eberswalde University in Germany (www.iufro.com).

2. Forest Engineering in terms of academic education – *Šumarske tehnike i tehnologije u sveučilišnom obrazovanju*

The first forestry schools in Europe were established at the beginning of the 19th century and namely: 1807 in Würtemberg (Germany); 1813 in Mariabrunn (Austria); 1816 in Tharandt (Germany); 1824 in Nancy (France); 1828 in Stockholm (Sweden); 1846 in Bánska Štiavnica (Check); 1872 in Florence (Italy) and in Vienna (Austria); 1885 in Zurich (Switzerland), etc. (Anon. 1998). Very soon forestry schools became a part of universities and forestry education entered into the system of academic education.

The basic principles of forest sustainability, which were generally accepted, were introduced and evolved

through newly created courses of forestry academic curricula: forest management, forest silviculture, forest pedology, forest exploitation, etc.

The beginning of higher forestry education in Croatia dates back to 1860, when the High School of Agriculture and Forestry was established in Križevci and to 1898, when the Forestry Academy was founded in Zagreb. With this Academy, forestry education in Croatia gained university status and it was the fourth high school of the University of Zagreb.

A 4-year study was introduced at the beginning of the academic year 1907/08 and the study courses were divided into: common science courses, natural science courses, technical courses, legal and regulatory courses and forestry professional courses.

The above distribution of courses was in accordance with the notion that forestry, as a joint action of science and profession, should enable finding, adopting and implementing the most favorable solutions for the preservation and maintenance of forest ecosystem stability and realization of benefits that forests can offer. In order to do this in accordance with biological and ecological criteria (observing forest demands) and economic criteria (in accordance with economy laws), the solutions must be provided by the technical and technology component of forestry. Meanwhile, the term forest engineering has been introduced instead of technical and technology component of forestry.

In general, forest engineering could be defined as the application of engineering principles to the solution of forestry problems, such as those dealing with harvesting, forest transportation, materials handling, and mechanical silviculture, with regard to long-range environmental and economic effects.

The current development of study courses of forest engineering has enabled the introduction of mechanized labor, first replacing manual labor with manual-machine work, and later completely with machine work, all with the goal of increasing productivity and worker protection.

At the beginning of systematic forest management, timber harvesting was performed manually, using simple tools and animal power. In 1796, J. Watt invented the steam engine, and in 1878 the English engineer Ransome tried to use the steam engine for felling saws. The first chainsaw was designed by the Swedish engineer Westfält in 1916 and he perfected it in 1924. The saw was known as »Sector«. In 1954 the manufacturer »Stihl« produced a chainsaw that could be handled by one worker. In 1959 the production of petrol chainsaw »Stihl Contra« was started. The use of motor powered chainsaws raised the level of productivity in forestry and humanized tree felling and processing.

The mechanization of timber skidding, by using agricultural tractors (mostly crawler tractors), began in the period just before the World War II, and after the war it became quite intense.

As early as 1951, the first skidder was produced in USA and in 1954 the first skidder with articulated steering was produced. In the Scandinavian countries, skidders have been used in forestry since 1962, in Austria and Germany since 1964, and in Croatia since 1968.

Further development of special forest machines continued with the design, manufacturing and use of the first processors (1965, Canada), forwarders (1961, Sweden), feller-bunchers (1957, Canada), single-grip harvesters (1966) (Drushka and Konttinen 1997).

The period of intensive mechanization of forestry operations, particularly timber harvesting lasted until the '80s of the last century. Forestry academic education followed forestry practice and educational programs and courses formed the field of forest engineering. It developed quickly in order to cover the new areas: implementation of new technologies, research productivity and cost efficiency of mechanized work, organization of forestry works, optimization of harvesting systems, forest opening and construction of forest roads, ergonomics in forestry.

Soon, scientists and experts in the field of forest engineering faced a new task: assessing the impact of forest machines on forest environment. The International Society for Terrain-Vehicle Systems (ISTVS) was founded in 1962 at the request of the General Assembly of the First International Conference on the Mechanics of Soil Vehicle Systems held in Turin, Italy. The motivation behind this was to acquire and advance knowledge of the mechanics of terrain-vehicle systems and machinery interacting with soils in all environments (www.istvs.org).

The firsts Symposium »Forestry Mechanization« (today »FORMEC«) was held in 1966 at Zvolen in former Czechoslovakia, as a meeting of European professors from the field of forest harvesting. The original idea of the meeting was to give an opportunity to scientists from Eastern and Central European countries to gather and discuss about forest engineering matters, deepen the knowledge in that field of science and overcome gaps due to different technology levels (Šušnjar 1999). At that time, forestry academic education was provided by a number of universities across Europe.

Modern forestry generally embraces a broad range of concerns, including assisting forests to provide timber as raw material for wood products, wildlife habitat, natural water quality management, recreation, landscape and community protection, employment, aesthetically appealing landscapes, biodiversity man-

agement, watershed management, erosion control, and preserving forests as 'sinks' for atmospheric carbon dioxide.

Forest ecosystems have come to be seen as the most important component of the biosphere, and forestry has emerged as a vital field of science and technology.

Kennedy and Koch (2008) explained changes in forestry and forestry education caused by the rise in awareness of the importance of forests and forest ecosystems. They defined »human-ecosystem relationship« as the concept of managing natural resources for multiple and diverse social values, which were developed to make sense of all the different sociocultural, economic and political/legal systems and impacting traditional forest management. The new approach, the so called social value model of ecosystem management, increasingly required from forest professional educators and managers to include social considerations.

Today, the forestry profession includes a wide diversity of jobs, with different educational requirements ranging from bachelor's degrees to PhDs for highly specialized work.

Over the past centuries, forestry was regarded as a separate science. With the rise of ecology and environmental science, there has been a reordering in the applied sciences.

As the result of reorganization of universities across Europe (excluding faculties as organizational units) and the increasing awareness of the importance of forest social functions, forestry in the traditional sense disappears from the names of many former forestry faculties, particularly in Western Europe.

In many European countries the higher education forestry programs are just a part of educational systems of universities of applied sciences, life sciences, agricultural or technical sciences. Forestry faculties under the same name have remained only in the southeastern and eastern Europe.

3. Challenges of Bologna process – *Izazovi bolonjskoga sustava*

Important changes of high education systems have been made with the establishment of new educational programs according to the Bologna principles. The reform of the higher educational system was initiated at the Ministerial Conference in Bologna in 1999 with the issue of the famous Bologna Declaration and has been further developed at subsequent biannual conferences of the European Union Ministers. The Bologna Declaration is the core document for the reform of the higher educational system in the European Area of Higher Education (EHEA).

Guidelines for the development of higher educational and research processes in the European area are contained in a number of political and professional decisions and documents of the European Union. The European Council convened in Lisbon in March 2000, where the representatives of the governments of the European Union passed knowledge-based strategic goals intended to increase employment and strengthen economic reforms and social cohesion in the decade to come («to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion»).

The reform of the higher educational system was completed at the Berlin Ministerial Conference in 2003, where doctoral studies were put in a three-tier cycle of the higher education – undergraduate, graduate and doctoral.

The higher educational system has been reformed with the goal of providing more purposeful education and enabling competent and skilled young experts to join global economic trends and create their own careers. The criteria of excellence, competence and mobility rank high in this reform.

According to the agendas from SILVA Network annual conferences in the last few years, almost the same problems about the adoption of the Bologna process in forestry academic education have occurred in all European countries. The SILVA Network is an association of institutions that offers educational programs leading to Master's and Doctoral Degrees in forestry with the primary objective to stimulate and facilitate educational co-operation in the field of forestry in Europe.

Some problems and disadvantages will be discussed on the Croatian example, where the reform of teaching programs according to the Bologna process was made 7 years ago.

The most important problems are related to the employment of bachelors of forestry, decreasing number of students, and evaluation of forestry educational programs in forestry practice. The solution of these problems lies in the cooperation between forestry education-science and forestry practice.

In our opinion, the problem is also in the fact that the government has promised to secure employment of bachelor graduates. In case of forestry, it is important to take into account the professional needs for certain qualifications. With the development of qualification frameworks, it is necessary to align the learning outcomes of study programs in the field of forest engineering with working competencies and demands for performing forest operations.

Many employers in the field of forest engineering (private contractors, state enterprises and forestry institutions) often criticize the system of forestry education in accordance with the Bologna process, or the acquired competencies of bachelors and masters in forestry. On the other hand, they have mostly not adjusted the systemization of their jobs to the professional status of persons with the academic education. The problem occurs primarily with the employment of Bachelors in Forestry, whose education is considered incomplete for managing all forest operations, while Masters in Forestry are still compared with the previous Diploma Engineers. Therefore, most bachelor graduates pursue a master study. It is quite common for the bachelors to look for employment for some time and to continue the master studies after a year or two.

Due to this situation and poor relationship between forestry practice and higher forestry education, students have lost interest for forestry academic programs. Only in countries with a strong forestry tradition, the number of forestry students has not fallen. Strained relations between forestry practice and forestry higher education irreversibly leads to the decline of the role and importance of forestry profession. The increasing emphasis on social values of forests and the protection of natural areas and forest ecosystems also leads to a decreasing importance of higher education in the field of forest engineering. These problems are not expressed only in countries where forestry as an economic sector takes a considerable part in the economy of the country.

Therefore, steps should be taken promptly and without delay to stop this negative trend and to change its direction in near future. It is necessary to develop a new brand related to these undergraduate studies that will be recognizable among potential, future students. The following steps should be made in order to solve the said problem:

- ⇒ The existing programs of undergraduate studies should be revised and updated,
- ⇒ The revision of the curricula need to be done taking into account stakeholder interests,
- ⇒ Employment profiles of bachelor graduates need to be more defined,
- ⇒ Promotion of undergraduate studies should be continuous and intensive, and love towards forests and forestry should be encouraged with future students at an early age.

On the other hand, the improvement and recognition of bachelor graduates and better opportunities for their employment can result in a decreased number of master study students.

Another experience gained is the problem related to the regulation of admission to master studies and the flexibility within the master studies. This led to some problems in master courses as students' knowledge was inadequate, and also at the labor market as the graduates failed to meet the expectations of the employers.

It is necessary to further analyze the requirements for admission to graduate studies in forestry, especially in the narrow field of forest engineering. In recent years, at the Faculty of Forestry, University of Zagreb, bachelors of science in agronomy and even in technical fields (construction, transport) have shown interest for enrolling in master study »Techniques, Technologies and Management in Forestry«. Differences in their learning outcomes in relation to the undergraduate forestry students are enormous, and each student should prove that he/she meets the admission requirements for the master study.

Another important topic is the impact of the Bologna system on internationalization through mobility of students and teaching staff.

In general, the Bologna system has actually failed to further enhance the exchange of students between universities and countries. The recognition of foreign studies/courses is not easy, as the curricula are not harmonized.

When applying for one semester mobility within Erasmus or CEEPUS program, students require the Learning Agreement and want to choose courses equivalent in semester to courses of their home university. Due to the non-harmonized curricula, choosing equivalent courses in semester becomes impossible.

By choosing equivalent courses, undergraduate students in Erasmus exchange program often attend graduate study courses at the foreign higher education institution. By attending equivalent courses from different studies, students gain knowledge that is recognized as relevant, meaning that they do not have to prolong their studies by attending courses and taking exams for compensating differences between semester courses at the domestic and foreign higher education institution.

Student mobility imposes a need to conduct more courses in English or another foreign language, or to establish graduate studies in English.

It should be pointed out that the establishment of new graduate studies from the field of forest engineering would contribute to the development of higher education in the European environment, with the aim of providing student and academic staff mobility.

In order to preserve and recognize the importance of education from the field of forest engineering, some existing principles of Bologna process could be accept-

ed. First, the need should be stressed for the development of joint master studies, which would strengthen the existing cooperation and serve as the basis for a more fruitful scientific-research and educational work.

4. Conclusions – *Zaključci*

This paper deals with the problems and challenges faced by the higher education in the field of forest engineering in Europe, caused by the reform of higher education system in Europe and changes in forestry caused by an ever evolving society. In doing so, emphasis is given to only some of the problems and challenges that are currently most evident. To consider all advantages and disadvantages, and provide guidance for further development of higher education in the field of forest engineering is a very complex job that needs to be thoroughly implemented with the involvement of all relevant factors - universities, scientific-research, government and professional institutions, forestry employers. Currently, the most important task is to firmly connect the enumerated factors and to provide effective transfer of forestry engineering knowledge and technology from higher education and scientific institutions to forestry practice as well as to the industrial sector of forest machinery and equipment.

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Sažetak

IZAZOVI U SVEUČILIŠNOM OBRAZOVANJU IZ PODRUČJA ŠUMARSKIH TEHNIKA I TEHNOLOGIJA

Članak prikazuje povijest i tradiciju šumarskoga sveučilišnoga obrazovanja u Europi. Tijekom posljednjih nekoliko desetljeća dogodile su se mnoge promjene koje su donekle smanjile razinu nekadašnjega položaja šumarskoga sveučilišnoga obrazovanja u europskom društvu i gospodarstvu.

U mnogim su europskim zemljama visokoškolski šumarski programi samo dio obrazovnog sveučilišnoga sustava najčešće primijenjenih znanosti, prirodnih znanosti, poljoprivrednih ili tehničkih znanosti.

Važne promjene u visokim obrazovnim sustavima napravljene su s uspostavom novih obrazovnih programa u skladu s bolonjskim načelima. Na hrvatskom primjeru, gdje je bolonjski sustav uveden prije sedam godina, prikazani su neki od problema i nedostataka novoga sustava.

Najvažniji se problemi javljaju u zapošljavanju prvostupnika šumarstva, u smanjenju broja novih (upisanih) studenata te procjeni šumarskih obrazovnih programa koju daje šumarska praksa. Također, smjer šumarskih tehnika i tehnologija, koje same po sebi još uvijek imaju vrlo važan položaj u šumarskoj praksi, nisu u dovoljnoj mjeri zastupljene u nastavnim programima mnogih europskih zemalja.

Kako bi se u budućnosti osigurao dostojan položaj sveučilišnoga šumarskoga obrazovanja u Republici Hrvatskoj, ali i u cijeloj Europi, postojeći studijski programi trebaju se preraditi i ažurirati u skladu s razvojem novih nastavnih metoda, trebaju se promovirati novi nastavni materijali i priručnici te se trebaju poticati studenti na znanstveni i samostalni rad.

Radi očuvanja i prepoznavanja važnosti obrazovanja iz područja šumarskih tehnika i tehnologija neka se od postojećih načela bolonjskoga sustava mogu prihvatiti. Primarno valja istaknuti potrebu za uspostavom zajedničkih diplomskih studija u okviru programa Erasmus Mundus koji će ojačati postojeću suradnju i poslužiti kao osnova za kasnije uspješno zajedničko znanstvenoistraživačko djelovanje i obrazovanje.

Istaknuta je važnost osnivanja novih diplomskih studija iz područja šumarskih tehnika i tehnologija, što će pridonijeti razvoju visokoga obrazovanja u Europi radi povećanja pokretljivosti studenata i sveučilišnoga osoblja.

Ključne riječi: obrazovni programi, šumarstvo, šumarske tehnike i tehnologije, bolonjski sustav obrazovanja

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