DEVELOPMENT OF APPLIED HIGHER EDUCATION PROGRAM BIOSYSTEMS ENGINEERING IN ESTONIA

Sven Peets, Matis Luik, Arvo Leola
Estonian University of Life Sciences
sven.peets@emu.ee, matis.luik@emu.ee, arvo.leola@emu.ee

Abstract. The curricula of agricultural engineering and Profession Standards defining the skills and competencies have been evolving continuously to cope with the social and economical influencers. The objectives of the paper are to report on the development of the new biosystems engineering program at the Estonian University of Life Sciences. A series of 5 seminars were organised by the university where a total of 54 experts attended who were either agricultural manufactures, processors of agricultural produce, suppliers of agricultural machinery or others with strong connections to agriculture. The experts were given the task to amend the statements presented in the Profession Standard of Specialist of agricultural machinery. It can be concluded there is an obvious need for highly educated engineers, technologists and managers who have to be competent in biotechnical system human–biological object–machine, i.e., they must have skills and knowledge about the technologies, working principles, basic construction, legislation and communication. The new 4-year professional higher education applied curriculum Biosystems engineering addresses the need for technical specialists.

Keywords: agricultural engineering, biosystems engineering, education, curriculum, profession.

Introduction

Agricultural engineering has made a significant contribution to the world food production by providing the population with sufficient, safe and available food. Mechanisation of agriculture has been ranked as the 7th most important engineering achievement of the 20th century by the National Academy of Engineers of the USA [1]. However, agricultural engineering education has faced some serious problems during the last decade such as reduced number of students, image and funding [2]. Under the name of biosystems engineering, the spectrum of agricultural engineering has been broadened towards the biological sciences arena (USAEE & ERABEE thematic networks [3; 4]). Similarly, the curricula of agricultural engineering have been evolving continuously in Estonia to cope with the social and economical influencers. Though, the move has been towards the core mechanical and electrical engineering sciences in bachelor, master and doctoral studies.

The academic education and professional competency of an agricultural engineer – agroengineer – has been the subject for several researches, pedagogues and politicians in Estonia and other countries [5-10]. According to the philosophy of free movement of labour (specialists) measures have been applied for the academic education, qualification and mobility of agricultural engineers (EurAgEng; FEANI; [11]). In order to improve the quality of higher education, attempts have been made to create adequate models of specialists [12-14].

Education and work experience are tied together by the 8 level Estonian (conforms to European) Qualification Framework [15] which encompasses all qualifications in formal education (general, vocational, higher and adult education) as well as vocational and professional qualifications [16]. The state recognised qualifications have to (1) be defined in a learning outcomes based qualification standard (curriculum or professions standard [17]); (2) have state recognised awarding institution (educational institution, professional association etc.). The profession standard of agricultural engineer [17] defines the knowledge, skills and attitudes of the agricultural engineer and specifies three levels: agricultural engineer (Eng), diploma agricultural engineer (Dipl Eng) and chartered agricultural engineer (Chart Eng).

Recent development at the Estonian University of Life Sciences is the introduction of a new 4-year professional higher education program “Biosystems engineering” aimed to produce technologists and managers for agricultural enterprises. The objectives of the paper are to report on the development of the biosystems engineering program at the Estonian University of Life Sciences.

Methodology – seminars with the stakeholders

A strong impetus for the development of the biosystems engineering curriculum at the Estonian University of Life Sciences came from the agricultural enterprises. In order to meet their requirements

best four seminars were organised by the Estonian University of Life Sciences within the project "Integrating the curriculums of agriculture and technology – biosystem engineering and product and technology development" in November and December of 2009. A total of 54 experts attended who were either agricultural manufactures, processors of agricultural produce, suppliers of agricultural machinery or others with strong ties to agriculture. An additional seminar regarding practical training of students was conducted in April 2010 with 9 persons representing the stakeholders.

Most of the experts were graduates from the University of Life Science. In the selection of experts their social activity and how well they were known were important aspects, so the experts were also either heads of structural units or leading specialists.

All of the seminars began with a short introduction of the participants and an overview of the contents and aims of the project „Integrating the curriculums of agriculture and technology – biosystem engineering and product and technology development". The skills and knowledge required from a future employee were discussed from an entrepreneurs' point of view. The experts' role in prioritising the student's skills (subjects) and in offering other propositions and solutions for the betterment of the curriculum was explained to them.

At the seminars the participants were given the following materials, which were explained in further detail:

1. Extract from the Standard of Higher Education;
2. Study outputs of the professional higher education level;
3. Statements from the professional standard on which "Biosystem engineering" curriculum was based on.

The entrepreneurs were asked to amend the statements presented in the Professional Standard of Specialist of agricultural machinery [18], i.e., add to it, change the relative importance if needed, strike off from etc.

Results of the seminars

The results of the comments, observations and suggestions amending the professional standard are as follows:

- Professional area of the specialist – in addition to tuition about cars, tractors, agricultural machinery and other types of mobile machinery there have to be subjects about farm equipment, food and preservation technologies, and electrical equipment also.
- Main focus of work – in addition to planning, organising and instructing the use of machinery, and planning the needs of the work force it is also important to learn the basics of different technologies, processes and logistics.
- General skills and knowledge – labour legislation, occupational safety, working environment, leading work groups and motivating workers. In addition to English and German, Russian should certainly be taught as well.
- Main skills and knowledge – understanding and reading drawings and usage of appropriate software is important. The main focus of teaching agricultural machinery and equipment should be on their working principles and basic construction. Local fuels, heating installations and systems, electronics and automatics have an important role in electrical and thermal energy studies. In plant production, organic farming, manure management, production of feed stuff, livestock farming technologies and feeding. Concerning buildings, evaluation of condition, maintenance, reconstruction and demolition are relevant.
- Additional skills and knowledge – driving of cars, tractors and other mobile machinery were important. Under personal characteristics logical thinking, need for achievement, and conscientiousness were stressed.

The experts had different opinions about the relative importance of speciality subjects. It was suggested to apply specialisation, e.g., teach one year of plant production, and the other year of livestock related subjects. The experts selected in the range of 600 hours the weights of the speciality subjects. The results are demonstrated in Table 1, where the number of credit points (ECTS) is calculated based on the mean number of hours.

The seminars about practical training related issues had the following outcome:

- Health and safety – instructions and manuals have to be organised jointly between the university and enterprises. Each trainee should have two instructors. The company should do additional training according to its specifics. The student must have a valid permit from an occupational health doctor prior the training period. Permit for handling of plant protection products.
- Wages – it was agreed the student should get paid for the job. If the student has a strong will to work, the wage should be above the minimum. Depending on the student, national mean wage could be paid. Students who lack the will to work will not be accepted to field training. Pay on a piecework basis should be used. Implementing a unified system has to be considered.
- State aid – was generally considered advisable. It motivates the instructor and allows increasing the student's wage.
- Accommodation, catering and social issues – non-work conditions at work are determined by the regulation. Accommodation arrangements include furniture and kitchen. Good meals are provided at work. Plenty of leisure activities are available.
- Additional points – minimum time of work at one company is two months. The entire training period should be done at single company. Must have a tractor driver's licence (training is provided at the university). Russian language skills are important.

Table 1

Relative importance of subjects as selected by the stakeholders

Subject	Number of hours			ECTS
	Min	Max	Mean	
Plant production	**250**	**300**	**270**	**20.8**
Plant	30	200	102	7.8
Equipment	100	220	168	12.9
Technology	61	135	93.6	7.2
Selection	36	48	42.8	3.3
Calculation	7	45	34.8	2.7
Buildings	4	45	16	1.2
Device	39	100	74.4	5.7
Selection	13	30	19.8	1.5
Usage	13	45	28.8	2.2
Service	13	40	25.8	2.0
Livestock	**250**	**300**	**280**	**21.5**
Animal	30	240	116	8.9
Equipment	60	250	164	12.6
Technology	30	160	94	7.2
Selection	10	50	32.6	2.5
Calculation	10	60	32.2	2.5
Buildings	10	50	29.2	2.2
Device	30	100	70	5.4
Selection	10	35	23	1.8
Usage	10	35	25	1.9
Service	10	40	22	1.7

Structure and objectives of the resulting curriculum

The results of the seminars were taken into account in the completion of the Biosystems engineering curriculum at the university. The curriculum was finalised in the spring of 2010 and the first group of 20 students enrolled in September 2010. The modular structure of the 4-year professional higher education curriculum is presented in Figure 1. More detailed information about the content of the modules is given in [19].

The objectives of the curriculum are creating possibilities for students to get a technical base education and specific skills, and knowledge necessary for a technical specialist in the field of production and processing of agricultural products. Training technologists, technical and other specialists, maintenance service managers, sales managers, product managers, consultants, etc. for manufacturing or development of the enterprises whose area of responsibility is planning, organising and supervising the use of machinery for the production and primary processing of agricultural products, workforce requirement planning, work supervision, accounting, communication with customers and suppliers. The acquired professional higher education enables students to apply for a relevant professional qualification after two-year professional work experience. Students having fully completed the curriculum may proceed to Master's studies, having acquired abilities for personal development through lifelong education.

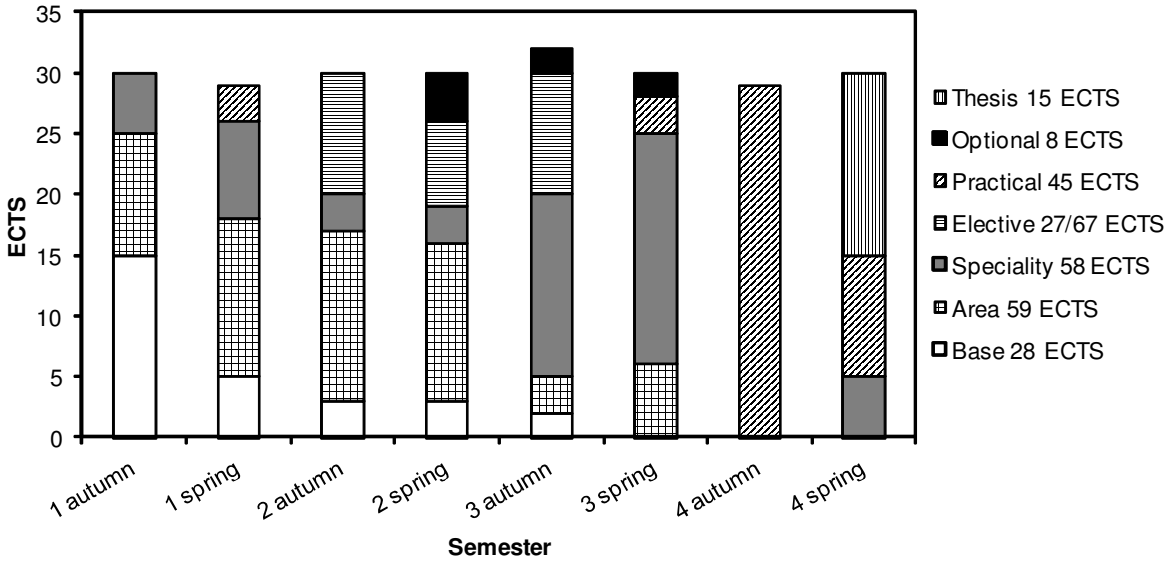

Fig. 1. **Structure of Biosystems engineering curriculum**

Results of the analysis of the curriculum following the FEANI requirements

The program of Biosystems Engineering taught by the Estonian University of Life Sciences was compared with the FEANI (European Federation of National Engineering Associations) requirements [20].

In general the program corresponds to the FEANI recommendations. However, there are some disagreements: the actual amount of mathematics is smaller than the requirement (15 versus 24 ECTS). This is the case in many programs throughout Europe as was found on the ERABEE workshop in Prague April 2010. The amount of engineering science subjects is near the upper limit (81 ECTS) or slightly above depending on the amount of electives. The number of credits for the agricultural/biosystems sciences is within the required range of 36–45 ECTS. The characteristic to this program is the large part of training in the value of 45 ECTS.

Conclusions

The following conclusion result from this work:

- There is an obvious need for highly educated engineers, technologists and managers for agricultural enterprises.
- These technical specialists have to be competent in biotechnical system human–biological object–machine, i.e., they must have skills and knowledge about the technologies, working principles, basic construction, legislation and communication.
- The new 4-year professional higher education applied curriculum Biosystems engineering addresses the need for technical specialists.

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