NEW ROLE OF EMPLOYER IN THE EDUCATIONAL PROCESS OF METALLURGY PROGRAMME

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ABSTRACT

This paper describes new ways in cooperation between higher education and an employer in terms of CDIO-based Metallurgy programme. A new role of industrial enterprises in higher education is substantiated, including the expansion of cooperation under key positions within the confines of Industry Training module of the SibFU's Metallurgy programme. In terms of collaboration between SibFU and UC RUSAL and JSC "Krasnoyarsk Plant of Non-Ferrous Metals" recent successful employer-university cooperation practice is exemplified. The paper discusses the content of Industry Training module and the changes it made to the role of the employer. The supplementary agreement between educational stakeholders for target training programs is discussed. Proposed collaboration model between stakeholders of higher education gives a broad range of possibilities for universities to enrich engineering education, and for industries to educate anticipated highly specialized engineers with deeper understanding of professional issues and actual working experience.

KEYWORDS

Metallurgy, Employer, Students Internship, Curriculum Design, Standards: 3, 6, 12

INTRODUCTION

Siberian Federal University (SibFU) has been implementing worldwide CDIO Initiative since 2014 in the framework of two undergraduate programs: Metallurgy and Heat Engineering, both are highly demanded by the industries of Siberian Region of Russia. The industrial enterprises interested in training of future engineers should take an active and key role in the practical side of the educational process. However, there is a trending passiveness among the industries of Russia resulting in the estrangement from the learning process. Commonly, the industries declare the list of demanded engineering skills leaving universities on their own in the educational process and skills formation.

The quality of engineering education is a keystone of CDIO Initiative with a multitude of ways to approach to the problem. In order to improve the quality of education, the system tends to address its inner capabilities rather than search for external ones. Thus, the CDIO Initiative is a framework for modernization of engineering education, which allows to develop a full-cycle programme for engineers training: from prognosis of specific industry branch up to the learning process implementation. This basis is successfully exemplified across numerous papers of CDIO Community.

However, since the problem is defined as a systemic gap between labor market requirements and learning outcomes, the solution is to be found outside the learning process, namely in the collaboration between educational institution and employer.

The transition to competence-based learning, which targets specific skills of graduates for professional activity, emphasizes the significance of dual education. It allows to integrate the efforts of social partners (university and employer) in the educational process by means of providing profession trials for students, thus introducing them to the range of professional problems. The depth of such collaboration of stakeholders defines the efficiency of dual education (Gafurova et al., 2013).

The dual education assumes that companies overcome their historical estrangement from engineers training in higher education. The establishment of public-private partnership between university and companies defines their broad involvement in all stages of higher education.

UNIVERSITIES AND INDUSTRY COOPERATION

The involvement of industrial companies in higher education in Russia is mostly limited to the roles of customer, evaluator and consumer, in fact being estranged from the learning process up to graduates' certification stage. However, there is a certain expediency of collaboration between industry and university (Table 1).

Table 1. The results of industry and university collaboration

	Company	University	Student
1	Training of engineers able to meet requirements	Company's funds attraction for university development	Employment after graduation
2	Staff development	Joint educational and scientific publications	Learning special disciplines for industry
3	Corporate culture development starting from undergraduate period	Involvement of industry experts in learning process	Corporate culture skills acquirement
4	Impact to the content of education	Joint efforts in science and engineering	In-depth professional skills acquirement
5	Reduce newbie employees' adaptation time	Teachers' professional skills development	Participation in scientific and engineering projects
6	Employees' academic skills development	Additional financial support for participating staff	Additional financial support from company
7	Company's competitiveness	Graduates competitiveness	Reduce adaptation time at new work

The shown practice of collaboration is yet to be established, however the idea of cooperation is in the very concept of CDIO Initiative (Crawley et al., 2007). Moreover, the concept of complete production cycle could be extrapolated to the concept of educational cycle, which can be described as follows:

1. Targeting (Conceive) the specific competencies of graduates which include employer's needs and worldwide professional challenges could be achieved as shown in Table 2.

Table 2. Partners' cooperation at Targeting stage

	Company	University
1	Expertise of the current state of sustainable staff development program	
2	Determine the demand for new specialists, developing their cluster of competencies for the nearest and further perspectives	Counsel and coordination
3	Particularization of graduates' cluster of competencies for each educational programme	
4	Counsel and coordination	Determine the changes in the content and technology of education aimed for education quality improvement
5	Counsel and coordination	Determine the programme requirements in the means of learning process organization and technology

2. During the stage of targeted development (Design) of educational programme, the involvement of employer is continued in terms of determining the workload of curriculum courses, and their integrative linking (Standard 3). At this stage the employer also provides the content and themes for Intro to Engineering course projects, including ones under joint supervision of university teachers and companies' representatives.

3. At the stage of programme implementation students are learning new content from employer in order to develop professional and interdisciplinary skills and abilities such as problems solving, solution finding and decision making in the situations of uncertainty and ambiguity in the rapidly changing world and technology (Jeschke, Hamers, 2016). A part of the learning process takes place in the real industrial environment. The important feature of CDIO-based curriculum in Metallurgy at SibFU is an Industry Training module, which extends learning environment (Standard 6) and which is described further in this paper.

4. The operate stage of joint collaboration between academic community and companies allows partners to foster the educational innovations, to share and distribute productive educational experience.

All in all, only full-scaled integration of efforts of both universities and industrial companies could produce next generation of engineers demanded by the world of work and able to answer current and future challenges (Kamp, 2014).

INDUSTRY TRAINING MODULE DESIGN

SibFU is implementing CDIO principles in the framework of Metallurgy and Heat Engineering undergraduate programs. Based on the backwards design concept, which allows planning of the education starting from learning outcomes through learning techniques to the content of education, particular curriculum modules were defined. The modules are unbounded from specific disciplines. Each module covers a broad educational field in order to achieve integrated learning outcomes (Standard 3). This paper shares the Industry Training module design, including the experience of university-industry collaboration and perspectives for future development.

In the scope of Industry Training module (ITM) SibFU and industrial companies completed an agreement defining key positions for employer's integration in the learning process. Despite the traditional practice of university-employer relationship in Russia, the proposed approach defines companies' full-scaled involvement into the development and facilitation of the educational process starting from the first year.

ITM includes continuous students' internship at metallurgical facility and a modular course for "Metals Production and Treatment" as shown in Figure 1.

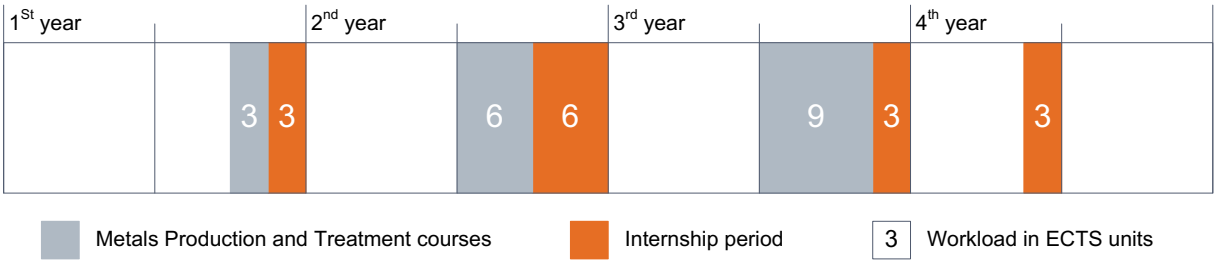

Figure 1. The structure of Industry Training module of undergraduate Metallurgy programme

After each year of studies, students undertake the internship at industrial company, each time deepening their knowledge and experience in future profession. Before the internship period there is a module of "Metals Production and Treatment" course, which is held by both university teachers and company experts. Thus, the theoretical knowledge is reinforced with an actual working experience within a real working environment, which facilitates interdisciplinary skills providing practice-oriented learning context.

The overall aims of ITM within undergraduate programme in Metallurgy are as follows:
- To introduce students to metallurgical enterprise;
- To acquire working experience;
- For students to learn their future professions;
- To make students aware of corporate culture and engineering ethics;
- To develop students' ability to integrate previous knowledge into learning ITM content;
- To develop students' ability to apply knowledge according to their professional and career interests.

The proposed aims of ITM could be achieved by specifying CDIO-based goals:
- Teach students to control variety of production processes at metallurgical facilities;
- Build the system of knowledge and understanding of metallurgical production cycle, specialized high-profile technologies, which allows to analyze and improve these processes;
- Facilitate students' intrinsic motivation for continuous expanding of professional skills, self-development and sustaining company's competitiveness along with career building;
- Develop individual and team skills;
- Develop environment-saving, health-care and resources-thrift thinking;
- Teach students to produce and present their results using various communication techniques and professional technical vocabulary.

ITM IMPLEMENTATION PRACTICE

Since the launch of CDIO-based Metallurgy programme in 2014, two metallurgical companies of Siberian region have become SibFU collaborators in the development and implementation of the programme: Krasnoyarsk Division of UC RUSAL and JSC "Krasnoyarsk Plant of Non-Ferrous Metals". According to the agreement between institutions, the involvement of the companies in the learning process is planned within the scope of the following activities:
- joint teaching of special metallurgy courses based at university;
- students' internship programme development;
- students' project themes proposal;
- Target Training Programs development;
- organization and participation in various public events.

Joint Teaching

SubFU invites companies' engineers for joint development and teaching courses within the framework of ITM and other modules of the curriculum. The invited professionals provide expertise in different areas of metallurgy and share unique practical knowledge with students, enriching their vision of future profession. SibFU teachers and UC RUSAL engineers are developing such courses as "Ecology and Industrial Safety", "Metals Production and Treatment", "Enterprise economy" etc.

Collaboration with industrial engineers is an important source of new practical knowledge for university teachers. To improve teachers' expertise even further, companies organize short training courses at industrial facilities, introducing current production process, management policy and staff development.

Students Internship

After each academic year students undertake internship period at partner companies' facilities. The programs of internship are developed by partners according to the required skills and competencies of engineering graduates.

The internship at UC RUSAL includes short teaching sessions and lectures on the history of aluminum industry, history of Russian metallurgy, company's production system and many others. Additionally, students attend various soft-skills trainings which are included into company's staff development programme. During these courses students are introduced to company's culture and they also improve their personal and interpersonal skills, such as communication, teamwork, leadership and time management (Standard 3).

JSC "Krasnoyarsk Plant of Non-Ferrous Metals" provides courses on advanced inorganic chemistry, pyro- and hydrometallurgy (company's basic production types) and about company structure. On site students get to know main and auxiliary chemistry laboratory equipment and participate in practical courses for chemical analysis methods.

Students Projects

Partner enterprises become the customers of students projects, that is relatively new practice for Russian higher education institutions. Instead of concluding long-term research contract, which is a common practice for university staff involvement into research projects where students are often left with minor utility functions; companies provide students with short-term

project themes based on current and future metallurgy problems. Starting from the second year, students are involved into research of scientific and technical problems supervised by company specialists. Most projects require students to visit company during the studies and to work in a lab.

UC RUSAL provides students with project themes mainly concerned with aluminum production, electrolysis technology improvement and process control. JSC “Krasnoyarsk Plant of Non-Ferrous Metals” offers projects on technology of rare and precious metals production. Making projects under professionals’ supervision allows partners to evaluate learning outcomes and teaching methods, providing feedback on the educational process (Standard 12).

Target Training Programs

In addition to Metallurgy undergraduate programme, partner companies provide Targeted Training Programme for students willing to qualify for working profession and being employed by the company after graduation. The Programme participants undertake additional courses held by the company. The courses include Corporate Ethics, Labor Safety and special training for chosen profession. During the internship period students attend staff training courses as a part of regular personnel training policy, and after that they can practice their profession with instructor in order to pass the qualification exam.

UC RUSAL offers the Target Training Programs for specialist of electrolysis, or calcination, or metal forming. Each year of internship students are able to improve their knowledge, master their working skills and have the opportunity to pass next qualification exam for a higher grade. Students’ highest advances are rewarded with personal scholarships sponsored by partner companies. In fact, students of Target Training Programs along with undergraduate diploma could get working qualification for which several years of continuous practice are required. The Programme provides a head start for career of young engineer and helps to find the right place in the world of work.

Public Events Participation

University-industry partnership is also aimed at increasing the prestige of engineering professions, attracting potential students to technical specialties, and for other companies to collaborate with.

Each year SibFU organizes a public meeting of students, teachers, senior management and companies’ representatives. This meeting is created for open-minded people to share their ideas, discuss the matters of cooperation and communicate freely with each other. Students projects presentations are also organized as a public conference. In this way, there is continuous feedback from all the stakeholders of the learning process.

KNOWN ISSUES AND CURRENT PROBLEMS

The diversity of collaboration forms between university and employer meets certain requirements for organization and legal support of both institutions’ activities. Networking agreement offers flexible connection between large companies with heavily branched administrative structure. Despite that, we’ve encountered some specific difficulties while we were trying to implement the partnership and organize the process of searching new partners.

Firstly, many companies were not ready to deploy significant time, finance and human resources for full-scaled participation in the educational process. This problem roots to historical model of industry behavior, as it has been discussed before. Another side of this problem is that company has been busy with its main production process and has its own staff training system, which often cannot be successfully adopted for students' internship.

Secondly, there is a pedagogical problem. Developing companies are ready to invest resources and personnel in the collaborative projects of universities, however they can hardly achieve significant teaching effectiveness due to the lack of pedagogical skills of even most qualified engineers. SibFU organize continuous staff training for their pedagogical qualification, which is obligatory for CDIO programs teachers, and is ready to involve companies' engineers for training.

Thus, in the nearest future SibFU is planning to make collaboration forms more flexible and efficient, to invite not only local industries to contribute to education, but cooperate with a colleagues and companies from abroad.

CONCLUSION

This paper shares the vision of SibFU of cooperation between higher education and employer in terms of CDIO-based Metallurgy programme. The proposed model of partnership includes broad range of joint activities starting from programme and learning outcomes planned through internship programs and special courses development up to evaluation of education results and continuous feedback. The industries provide project themes and expert engineers to work with students, introducing them to the company's activity. Students are able to undertake Targeted Training Program in order to qualify for working profession and being employed after the graduation at university.

The paper presents the actual experience of SibFU for collaboration with local industry companies: Krasnoyarsk Division of UC RUSAL and JSC "Krasnoyarsk Plant of Non-Ferrous Metals" in the framework of Industry Training module of Metallurgy programme. Since SibFU has become CDIO collaborator in 2013, we currently have the first and second year undergraduate programs running. Thus, this paper shares the most recent partnership practice and its perspective vision.

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