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Experience and Practice of Management Problem Solution at CDIO Implementation in University Education

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There have appeared a great number of management problems at universities first introduced CDIO ideology. Taking into account the fact that the ideology itself leads to critical technologies development in the current education system, solution of management problems is to result in significant changes in a university. The article lists and describes the problems solved in a definite university and the results.

Key words: managerial tasks, critical technologies, public-private partnership, project approach.

At present both in the world and in the country there is a situation of crisis in education both in general and in engineering education in particular. These conditions are observed at different levels of society and different institutions [1, p. 6-11]. Transition to competence approach and failure of education to measure new developed learning outcomes and the impossibility of manufacturers to develop professional standards have contributed to crisis, which, in its turn, has resulted in their recognition of the problem at the governmental level. For instance, during the summer of 2014, despite major efforts performed within 2 recent years, the top public officials arranged the meetings on problems of crisis in the engineering education and were charged with the task of solving them.

As a result, over the last years every university providing engineering training arrived at the decision of searching for ways to bailout. In this case the solution could be negative as well, i.e. the absence of crisis recognition. The key question to which the answer is sought for by the Ministry of Education and Science of the Russian Federation, Agency of Strategic Initiatives, Skoltech, leading universities and others: How to reform engineering education for

real production? To answer the question, it is necessary to solve a number of management problems in the university in case of a positive decision in management and the crisis response measure committee: to determine definite outcomes of this job and ways of its measurement, define the requirements for entrants and ways of finding and attracting youth to university, determine and provide a new academic process technology for the results revealed, perform personnel selection and development for this technology. In fact, engineering universities received a well-based project management task. Its specificity consists in the approach that has been chosen in the university as anti-crisis. One of them, but not the only one, is the CDIO international ideology [2, p. 6-8]. The characteristics of such an approach are, on the one hand, its sufficient development and testing in the world allowing it to be technologically realized in separate parts of academic process, on the other hand, range and flexibility of ideology itself permitting it to be adjusted and used in different real-life environment of academic process in engineering training [4, p. 1418-1420].

At Siberian Federal University the crisis of engineering education was recognized

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at the management level several years ago. Hence, there started the search for a tool of engineering education development and foundations for its choice. CDIO ideology was accepted as one of the approaches involved in performance by the university authorities. Therefore, more than a year ago the university started four engineering major developments: Heat technology and heat engineering, Metallurgy, Software engineering, Informatics and computer engineering. In such a case a number of management problems mentioned above were solved at the university, management approaches found in our project can be applicable for their scaling in other majors and allow development of engineering education. Let us consider the solution of management problems mentioned above at the stage of international CDIO ideology introduction into the university. Such management problems and approaches to their solution are models for the system of engineering education of the country and can be performed at different universities.

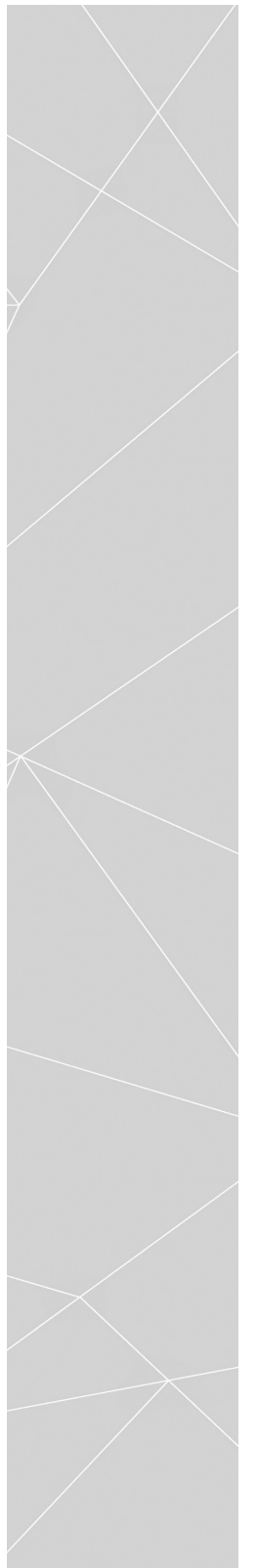
Solving the first problem in defining educational directions for CDIO ideology implementation, we determined the criteria of their selection: it is necessary for management personnel of the major to have internal professional motivation and capacity to critically develop their activity; demand for graduates' labour at the market; presence of a definite employer. As a result, apart from direct choice of four majors, we got potential employer – participator of approach implementation and definite people capable of being "drivers" in the process. Hereafter, consistency of the chosen majors depends significantly on the employer's activity. The key point in the considered approach is not a unit management decision taking, but development of critical views with which one can perform the management of different syllabuses. Hence, the solution of the first problem on the choice criteria of an academic major can be used many times.

The next (second) problem was

development of culture in CDIO ideology introduction activity in academic process of the selected majors. Obviously, this introduction approach as a project was chosen again. Perception of necessity and the possibility of the project approach itself for CDIO introduction management was spiral. On the one hand, this was required by the approach, on the other hand, due to its criticality the public cultural design of some experiments in educational practice conversion into the project was stimulated at the university. In this case the internal local acts were performed, project participators and their functions were clearly defined, resources and separate budgets were established etc. The crucial point here is awareness and registration of project priority developing education through their gaining the university status "Strategic project". Performing the development of activity into project we, taking into account great content-engineering differences of the chosen majors and employers' spectra, created the separate project in each major in addition to The Concentration Programs (CP) based on CDIO ideology [3, p. 6-8]. The four projects were common, united in the university; there were performance plans specified in each project in terms of their features, an information field devoted to CDIO, and expert-management activity.

The principle management issue at the university was resource allocation (staff, time, facilities and other) for CDIO implementation preparation. Therefore, projects themselves covered just that activity (preparation), control and expertise of which were performed during the whole academic year. Decisions of university administration were taken at the end of the year to admit CDIO to be introduced in definite syllabuses with new enrollment.

Thus, solving the second problem of management approach to CDIO introduction we chose the design of existing different approaches in science and education, developed four different projects united by common management, and performed the initial recruitment for



this job. Then it was necessary to select the personnel and assess their work.

Solving the problem in personnel preparation for the project we defined the content, time, and principles of the process. The experience has shown the inconsistency of initially low level of teachers with the necessary content, absence of staff for working with teachers and the high intensity of such a job. As a result, for this task we had about 70 teachers involved in different forms of qualification upgrade. Among them – about 30 teachers took a year-upgrading course. The key task for the next stage is search for the personnel responsible for such upgrading courses and their assessment.

In the course of the problem solutions in development and the agreement of new results in the project team and the existing university system we came across emotional professional rejection of the approach by the essential part of university workers. We spent a lot of time solving this problem, involved the employers capable of reaching common grounds and engagement in the development of the new academic process, revealed the agreement of Federal State Educational Standards (FSES) and CDIO, and developed the management concept of self-refuse to accept a position and teachers' motivation to participate in the project. In solving the problem we failed to achieve the acceptance of content and new results by all the project participators. It was impossible within such a period taking into account the level of personnel preparation for such an activity. The work was prolonged for the next stage.

The next management problem was to design syllabus and Concentration Program based on CDIO ideology in the arranged major project teams and new obtained educational outcomes. The syllabuses underwent changes due to new disciplines, changes in existing disciplines, the arrangement of continuous project activity focused on a student's professional growth [5, p. 1]. The main result of the process became an assigned

view of project participators on principles of syllabus design, its integrity and focus on the outcomes of every part, internal agreement of every discipline part [7, p. 46-48] etc., which is suggested by CDIO ideology itself:

- defining a real employer for the syllabus;
- establishing goals and requirements for a graduate together with the employer;
- division of those requirements into credits in terms of each requirement's significance;
- design of a competence matrix in years and modules with credits;
- development of a module syllabus.

Such an approach allows for public-private partnership. The results of public-private partnership are advantageous for all participators in a definite syllabus:

Company: training of students possessing professional skills and competence according to a company's requirements;

Development of personnel corresponding to the quality and structure of production demands; development of skills of future specialists' corporate professional culture; possibility to influence the content of the Concentration Program; shortening the adaptation period for conditions and the content of professional activity; upgrading courses for company employees in the educational-academic environment with the involvement of university teaching and research personnel; an increase in a company's competitiveness;

University: extension of possibilities in joint publications; involvement of highly-qualified manufacturers in the academic process; efforts of the participators in research, engineering, and project-design developments; investments of companies in the development of the university's material and technological resources; upgrading the courses of university workers in research and production spheres; support of university workers participating in the program; an increase in university graduates' competitiveness;

Student: job placement after graduation; learning specialist disciplines in demand at production; development of corporate professional culture skills; fostering advanced professional skills; possibility of participation in research, engineering, project-design developments; support of students by the company; shortening of adaptation time to the conditions of company production. Hence, public-private partnership became a base for syllabus development in the educational sphere.

In the course of planned syllabus implementation in terms of CDIO ideology management problem of methodical aid preparation was solved for the subjects of the first year on the basis of active training. The main technique was project-based learning, but it was not the only one. To the best of his/her professional preparation for the performance, every teacher made an attempt to plan such classes. Some elements of the new methodical aid were tested in the real academic process [7, p. 155-156]. The question of project activity monitoring and project learning outcome measurement in terms of the outcomes specified in the Concentration Program remained undetermined. These are the issues of the next stage.

At the end of the year while implementing CDIO ideology in the academic process we solved a number of university management problems pertaining to positioning the approach itself as a priority at the university, choice of majors for ideology implementation, selection and preparation of managers, teaching staff, development of employer's active attitude to the academic process from the time of its design, preparation of methodical aids based on active training techniques, material and technical support, improvement in students' enrollment. The criteria of syllabuses availability are as follows:

- The Syllabus is: to be clearly focused on practice through the outcomes

of CDIO 2, 4 performance; contain project activities via multi-leveled integrated projects and projects within a discipline or definite activity. The outcomes are expressed through: a list of competences agreed upon with the employer; determination of significant competence indicators with employer; determination of hierarchy and place of competences over four years of study; determination of modules (disciplines) forming competences (competence matrix); coordination of modules (disciplines) in the syllabus through program annotation (didactic units) and place in the syllabus with CDIO standards; development of module integrated syllabus; development of academic schedule with reference to project activity; development and approval of Concentration Program; mutual approval of concentration program with employer; signing of an agreement with employer on his participation in academic process; and the presence of the discipline "Introduction to engineering".

- Personnel are: to be enough in quantity to deliver learning within the syllabus with required professional upgrading in CDIO, take an active part in CDIO seminars, with definite roles and responsibilities in students' project supervision, involve auxiliary educational staff for arrangement of laboratory facilities in project activity.
- Methodical support. The outcomes are expressed through: selection of project themes, performance requirements (project passport), role in the academic process; development of curricula for the first academic year with the learning outcomes according to CDIO standards; preparation of teaching materials for modules (disciplines) of the first academic year using active teaching techniques (%); methodical aids for the discipline "Introduction to Engineering";

availability of textbooks for the first academic year.

- Enrollment of school-leavers should be arranged with definite students and planned outcomes. The outcomes are expressed through: plan of CDIO enrollment; preparation of advertising material; carrying out activities with entrants possessing the experience of project, research and other extracurricular work; availability of entrants' database with their achievements valuable for CDIO.
- Working place should meet the requirements for planned first year projects. The outcomes are expressed through: necessary working space for the whole syllabus; working space for the first year; preparation of class rooms for the first year of project work; preparation of facilities for project work; preparation of consumables; access to electronic resources for the first study year.
- Project monitoring. The outcomes are expressed through: regularity of working sessions on project (yes/no); the number of involved teaching staff into project meetings who can implement CDIO.

In fact, the work performed in university with CDIO was traditional for the project approach:

Initiation: initiation of the request for project as a critical technique of engineering education transformation on the part of university authorities with the support of Skoltekh; appointment of project managers and selection of the project management team in Concentration Program 4.

Planning: development of project management plan for a year; development of the project content; selection and preparation of executives; taking a decision about further project realization.

Hence the planned work should be as follows:

Performance: performance of the fourth-year project; monitoring the fourth-year project; correction of the project due

to the monitoring results.

Project completion: introduction of the project into continuously realized approach.

Therefore, based on the preceding year's results the university authorities are to take decisions on the following issues: models of the strategic project (admission of all four syllabuses to realization or admission of some syllabuses based on all CDIO ideology requirements with the result presentation to the Ministry of Education and Science, CDIO Initiative etc., development of the definite CDIO principles in some syllabuses), on the bases of syllabus preparation analysis for CDIO performance the management models of CDIO university project performance were revealed.

As options for project implementation management the experience of other Russian universities were considered, such as a selected management in a separate department, setup of a separate new structure within the existing university structure with CDIO functionality or realization of CDIO practice in the existing institution. When analyzing the experience – special attention was paid to the results of each approach and potential risks. From the point of view of risk minimization the decision to create special departments in the institutes was taken.

In future it is necessary to come to the following solutions: transformation of the management system through transition to syllabus management; shift away from the syllabus discipline approach to integrated modules with common outcomes; non-linear schedule of academic process using labour coefficient, but not hours in the form of quality assessment of students' syllabus proficiency; development of an engineer's motivation and intercultural competences in the course of the new subject "Introduction to engineering" including humanity subjects; teachers – "agents" of engineering education innovation, creators of new teaching teams.

Hence, choosing the tools for solution of

the management problems we have tested the approach to preparation of academic process using innovation teaching experience and found solutions valuable for the theory and practice. Due to their

universal character those solutions can be used in other syllabuses and engineering universities after adapting to the conditions. The results obtained set new tasks for us.

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