

# **THE INITIAL EXPERIENCE OF EDUCATIONAL PROGRAMS' MODERNIZATION WITHIN THE CDIO CONCEPT IN SURGUT STATE UNIVERSITY**

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## **ABSTRACT**

Surgut State University became a member of the CDIO initiative in 2017. The Department of Automation and Computer Systems is the first in the University who began to implement educational programs in according to the CDIO standards. The Department provide two education programs: "Control in technical systems" and "Software engineering". Research and analysis of the CDIO initiative's organizational principles caused changes in the implementation strategy of educational programs. Evaluation of existing educational programs before beginning work on joining the CDIO was held on the 1<sup>st</sup> of February, 2017. The initial period of educational programs' modernization has been completed on the 1<sup>st</sup> of September, 2017. During this period there have been qualitative changes in educational programs. This has led to an increase in rating scores on the 1 - 6 standards of the CDIO. Thus, there has been progress in adapting educational programs and the system of training in accordance with them to the requirements of the CDIO standards. The more efficient correction of educational programs' will be possible after the first students' graduation and the survey of the stakeholders about the learning outcomes of the graduates.

## **KEYWORDS**

Modernization, Educational programs, Project activities, Standards 1, 2, 3, 4, 5, 6.

## **THE INITIAL EXPERIENCE OF EDUCATIONAL PROGRAMS' MODERNIZATION WITHIN THE CDIO CONCEPT IN SURGUT STATE UNIVERSITY**

Surgut State University became a member of the CDIO initiative in 2017. The Department of Automation and Computer Systems (ACS) is one of the first in Surgut State University who began to implement educational programs in according to the CDIO standards. The Department ACS has considerable experience in implementation of engineering educational programs.

The Department provide two education programs: "Control in technical systems" (CTS) and "Software engineering" (SE). The first specialists graduated in 1998. There will be 20th graduation of engineers in June, 2018. The total number of graduates on both education programs is more than 600 people.

**EVALUATION OF INITIAL STATE OF CTS AND SE EDUCATIONAL PROGRAMS**

In the traditional engineering education, the main emphasis is placed on the engineering and technical skills. The framework of CDIO Initiative is considerably wider than that. Research and analysis of the CDIO initiative’s organizational principles caused a change in the implementation strategy of educational programs "Control in technical systems" and "Software engineering".

Self-assessment of the existing educational programs before beginning work on joining the CDIO was held according to the following criteria, presented in Table 1.

Table 1. Assessment model of the compliance with the CDIO standards

Score	Criterion
5	Evidence related to the standard is regularly reviewed and used to make improvements
4	There is documented evidence of the full implementation and impact of the standard across program components and constituents
3	3 Implementation of the plan to address the standard is underway across the program components and constituent
2	There is a plan in place to address the standard
1	There is an awareness of need to adopt the standard and a process is in place to address it
0	There is no documented plan or activity related to the standard

Assessment results as of 01.02.2017. are presented in Figure 1.

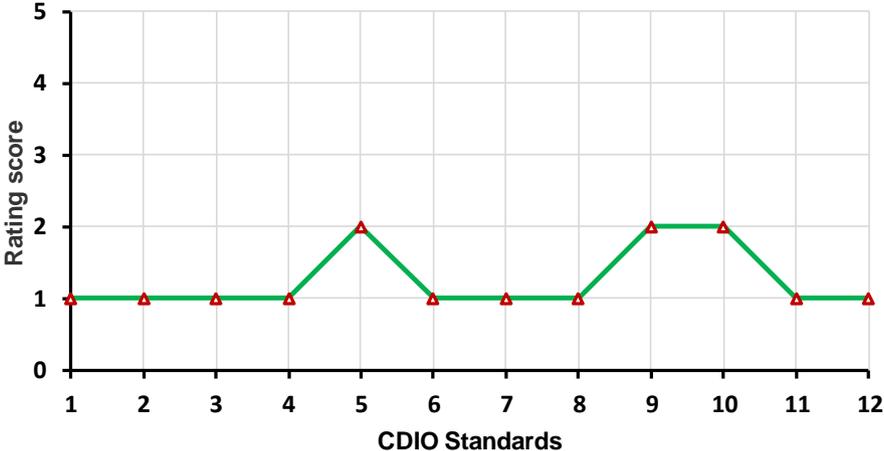


Figure 1. The initial result of self-assessment of the CTS and SE educational program's compliance with the CDIO Standards' requirements

**THE INDICATORS OF DYNAMICS IN RATING SCORES CHANGES IN THE PROCESS OF "CONTROL IN TECHNICAL SYSTEMS" AND "SOFTWARE ENGINEERING" EDUCATIONAL PROGRAMS' ADAPTATION TO THE CDIO STANDARDS**

The first stage in CTS and ES educational programs' modernization has been completed. As a result of the implemented actions progressive changes in programs were reached. Specification of the changes is given below.

**Standard 1. The CDIO as a context of engineering education**

As it was noted above, traditional educational programs of The Department of Automation and Computer Systems are based on the knowledge of engineering creativity processes and essence of technical systems. The initial level has been rated with score 1, as it has not yet been adapted according to the CDIO Standards.

During the implementation process, the CDIO principles were adopted most professors, involved in the implementation of the educational programs. We find especially important, that the University administration is providing effective and stable support for the implementation of the CDIO and ensuring progressive dynamics in the growth of rating scores on CDIO Standards. Thus, as result of the first stage of modernization, which we consider to be the beginning of the educational process based on the CDIO Standards, the level of the rating score rose to 2.

**Standard 2. Learning Outcomes: knowledge and skills**

At the beginning of the work on implementing the CDIO concept it became apparent, that revision of the purposes and results of the educational programs is necessary. To get detailed information about the results of the educational programs, a range of respondents-stakeholders was determined, and questionnaires were formed to record their opinion about the competence of the graduates. The questionnaire sample is presented in Table 2.

Table 2. The questionnaire for determination of the education results' formation level

№	Education results	Formation level 0-5	
		Real	Desirable
1	Professional tasks' implementation in accordance with the requirements of the working position		
2	The use of normative legal documents in professional activities		
3	Documentation and business correspondence maintenance within the working position		
4	Communicative competence: standard of speech, negotiating, meetings		
5	Competent registration and representation of the performed work results in an oral and written form		
6	Initiativetes, contributing to improvement of indexes of the organization activities		

7	The correct arrangement of priorities while solving arising problems		
8	The creative teamwork ability		
9	Basic knowledge in the field of professional activity		
10	Ability to generalize, analyze and perceive information		
11	Use of modern technologies in professional activities		
12	Adequate self-assessment of professional activities' results		
13	Ability of self-training, self-education		
14	Implementation of complex engineering projects		
15	Theoretical and experimental studies, including searching for and studying necessary information		
16	Compliance with professional ethics and social responsibility		
17	Foreign language skills (English) at the sufficient professional level		

The group of stakeholders included:

- Representatives of the employers;
- Graduates, who came to the industry;
- Surgut State University professors;
- Senior students.

Results of the questionnaire are presented in Figure 2. It should be noted, that in every group of stakeholders the deviation of the real education results' formation level from the desirable formation level is observed. Amplitude of mismatch is various. Figures show a comparative picture of the employers' (as main consumers of engineers) estimates mismatch, in relation to other categories of stakeholders.

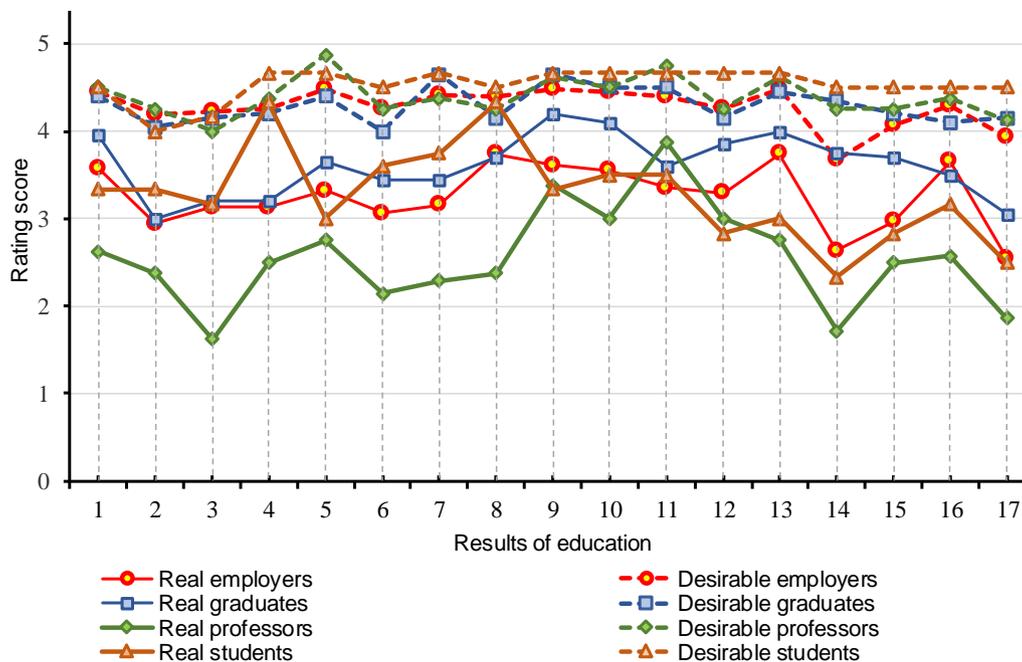


Figure 2. Comparative results of evaluation of education results' formation levels for employers and graduates

Primarily the mismatch is observed in the assessments of the real levels of the results formation. Moreover, in the pair employers – graduates opinions conform to the greatest extent. Whereas the lowest level of conformity is observed in the pair employers – professors. We explain this with the fact that professors seek to set higher requirements to enhance the quality of education.

Analysis of the Syllabus contents and the survey results has shown the urgent need to strengthen attention on development of the following results:

- interpersonal competences;
- enterprise and business context;
- system engineering and management.

The current evaluation score of the educational programs for this standard is 2.

### **Standard 3. Integrated curriculum**

In the course of adaptation of the curriculum to the CDIO requirements, the fully modular plans' structure was adopted. The sequences of disciplines are built within each module. The cross-program integration has been changed.

Curriculums are composed, approved and accepted for realization. Each plan contains interdependent disciplines, which are forming professional, personal and interpersonal skills. The following modules are integrated into the curriculum:

- Humanitarian;
- Mathematical and naturally scientific;
- Ensuring physical development of the person;
- Engineering and computer graphics;
- Theories of control systems;
- General technical;
- Mechatronics and robotics;
- Engineering;
- Software and informational technologies.

While developing curriculums the complex of actions was executed:

- The analysis of disciplines' content was carried out; the need to revise a part of them according to the CDIO concept was revealed.
- It was revealed, that poor attention was paid to development of personal qualities and interpersonal abilities.
- Increase in volume of disciplines' sections for development of Syllabus points 2 and 3 was provided.

Distinctive features of modernized educational programs:

- The multi-module concept of curriculums structuring for training engineers was adopted.
- A unification system was applied for the modules included in various educational programs.
- Mutually supported sequentially executed projects is being implemented in the disciplines' modules.
- As a result of the stakeholders' survey, a pool of disciplines that should be included in the curriculum was determined.
- Representatives of the employers were involved in teaching of several disciplines.

- Internship places for students are designated in consultation with the employers.

The current evaluation score of the educational programs for this standard is 2.

#### Standard 4. Introduction to engineering

Disciplines, devoted to introduction to the engineering activities have been traditionally present in curriculums of the engineering educational programs. This has laid the foundation for transformation. During modernization process the discipline "Introduction to Engineering" was adapted to the CDIO ideology. The connection between the "Introduction to engineering" discipline and all the subsequent project activities that are included in the curriculums was established. The rating score on this Standard was raised to 2.

#### Standard 5. Design-implement experience

Courses project activities are integral part of engineering educational programs. Traditionally - these are projects in separate disciplines. The structure of courses project activities is shown in Figure 3.

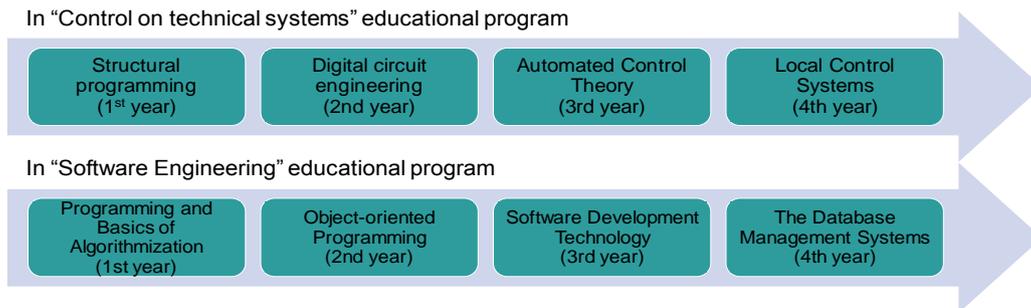


Figure 3. Courses project activities in the educational programs before modification

Modifying the curriculum a decision was taken to keep disciplines projects. But two new courses have been included to the curriculum:

- Project Activity Basics.
- Engineering Research.

The new structure of the courses project activities is shown in Figure 4.

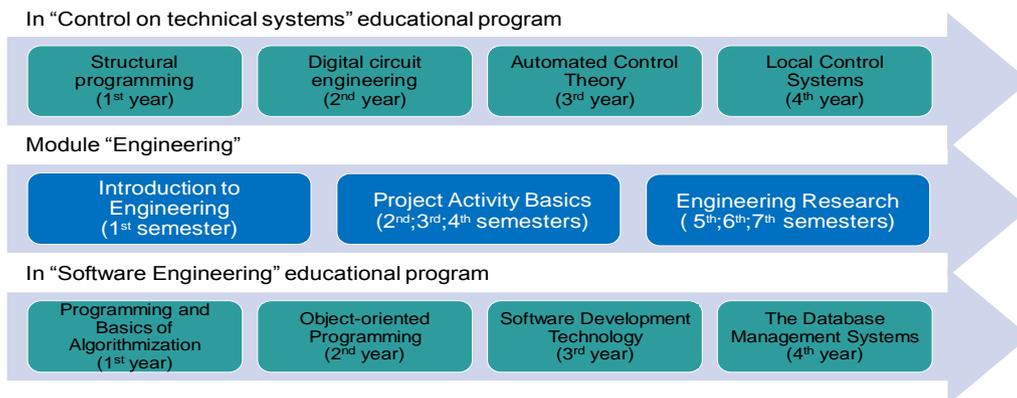


Figure 4. Project activities' structure in the modernized educational programs

These disciplines provide comprehensive project activities for 3 semesters each. In conjunction with the "Introduction to Engineering" discipline they form the "Engineering" module.

The Department of Automation and Computer Systems has significant experience in organizing scientific research work for students. A number of works was completed by producing the laboratory stands. The stands are used in the educational process. Using them, students research principles of automated control systems' organization. Examples of successful project implementation are shown in Figure 5 and Figure 6.



Figure 5. Laboratory stand "Automated traffic control system"



Figure 6. Laboratory stand "Automated system for sorting of objects"

Introduction of the "Engineering" module to the curriculum structure allows to assess the implementation of Standard 5 by the rating score 3.

### **Standard 6. Engineering workspaces**

Usually, project activities are decentralized and organized in educational laboratories. Currently, a dedicated space, adapted for the team project activities is provided. Assessment of the educational program on Standard 6 is increased to rating score 2.

### **Standard 7. Integrated learning experiences**

The Department of Automation and Computer Systems has the experience in creation and operation of students' design teams, the results of which are educational technical systems. The department is also engaging its' students as the leaders of extracurricular education students' teams in the robotics field.

Currently there are approved courses' content where personal and interpersonal skills integrated with disciplinary knowledge. But since at the time of writing of this article, students has completed only one semester, so the assessment of effectiveness cannot yet be adjusted.

### **Standard 8. Active learning**

Among the academic staff there is an understanding of the benefits of active learning methods. In the teaching of a variety of disciplines discussion and analytical case studies of engineering problems are applied.

### **Standard 9. Enhancement of faculty competence**

### **Standard 10. Enhancement of faculty teaching competence**

Plan for professional trainings of academic staff exists. The trainings are provided in the fields of personal and interpersonal skills, skills of creating new products, processes and systems, as well as implementation of teaching, learning and evaluating methods.

### **The standard 11. Learning assessment**

The need for improved methods to assess learning was identified and the analysis of current use of the methods was done.

### **Standard 12. Program Evaluation**

The need for assessment of the program was identified and a comparative analysis of assessment methods was initiated.

### **The final assessment of the educational programs' development**

After 11 months since the beginning of modernization of educational programs "Control in technical systems" and "Software engineering" in according to the CDIO standards there can be seen improvement in the performance indicators for Standards 1, 2, 3, 4, 5, 6. The progress in adapting educational programs and the system of educating by them to the requirements of the CDIO Standards is obvious. Dynamics of development of educational programs in accordance with CDIO standards are presented in Figure 7.

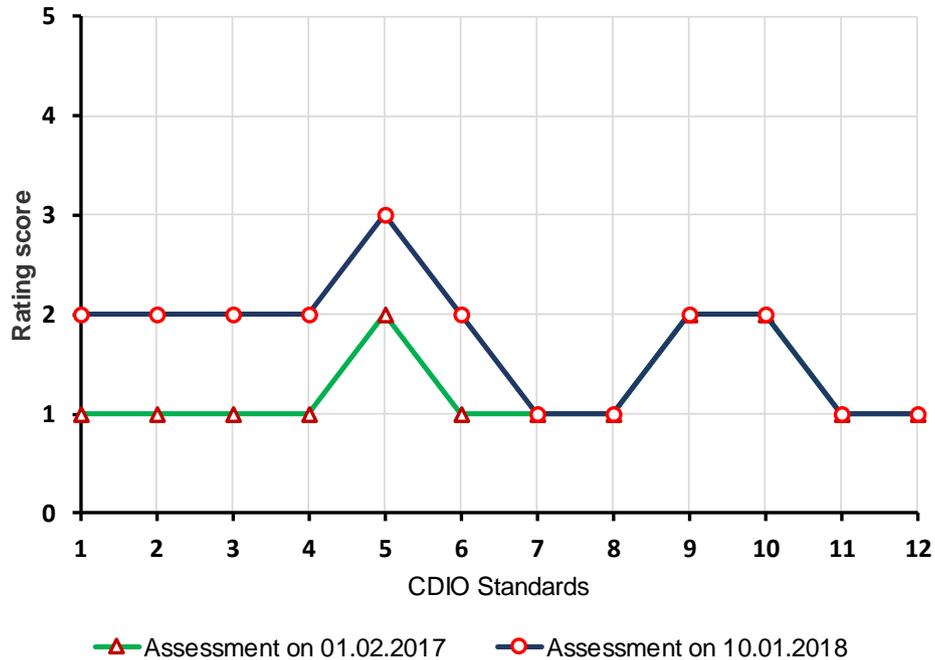


Figure 7. Diagram of dynamics of educational programs' development in accordance with CDIO standards

Because the nature of Standards is diverse, improvement dynamics on them are uneven. The more efficient correction of educational programs' control vectors will be possible after the first students' graduation and the survey of the stakeholders about the learning outcomes of the graduates.

## CONCLUSION

During one year after the beginning of work on Surgut State University joining the CDIO initiative members certain results were attained. Success in the implementation process of the initiative has allowed the increase in the criteria scores on six standards by one point. Currently the process of educational programs' adaptation is continuing successfully.

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