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TRENDS IN THE DEVELOPMENT OF CDIO AND INDUSTRY COLLABORATION BASED ON INTERNATIONAL EXPERIENCE

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Abstract: This article analyzes trends in the development of the international CDIO (Conceive - Design - Implement - Operate) educational framework and industry collaboration on the basis of international experience. Developed at the Massachusetts Institute of Technology, the CDIO framework currently encompasses more than 140 universities in over 30 countries. The article compares advanced practices in Finland, India, Australia, and the Netherlands through a series of tables. The findings indicate that aligning CDIO standards with industry needs can improve graduate employability, facilitate the creation of intellectual property, and contribute to the achievement of the Sustainable Development Goals. Emerging trends, including curriculum agility and the integration of artificial intelligence technologies into engineering education, are also discussed.

Keywords: CDIO, industry collaboration, engineering education, international experience, curriculum agility, project-based learning, sustainable development.

INTRODUCTION. In the twenty-first century, the global economy and industry are developing at an unprecedented pace. During this era, commonly referred to as the Fourth Industrial Revolution (Industry 4.0), innovative solutions such as digital technologies, artificial intelligence, big data, cloud computing, the Internet of Things, and additive manufacturing (3D printing) are fundamentally transforming production processes. Against the backdrop of such rapid change, engineering education faces a major challenge: bridging the gap between academic theory and industrial practice.

According to statistical data, more than 40% of the world's leading technical universities report that their graduates lack the practical skills required by industry. To address this problem, a number of international initiatives to reform engineering education emerged in the late twentieth and early twenty-first centuries. The most prominent and widely adopted of these is the CDIO (Conceive - Design - Implement - Operate) framework.

The CDIO Initiative was founded in 2000 by the Massachusetts Institute of Technology (MIT), Chalmers University of Technology, Linkoping University, and the KTH Royal Institute of Technology. Its central idea is to integrate the complete life cycle of engineering products - from design through production and operation - into the educational process. The CDIO framework is based on 12 standards and the CDIO Syllabus. Version 1.0 of the syllabus defined four core areas and 99 detailed competencies; subsequent versions (2.0 and 3.0) introduced new elements that respond to contemporary requirements, including sustainable development, social responsibility, and digital competencies.

Today, CDIO encompasses more than 140 universities in over 30 countries. Geographically, the network covers Europe (including the United Kingdom, Sweden, Finland, the Netherlands,

Denmark, Russia, and Ukraine), North America (the United States and Canada), Asia (China, India, Singapore, Kazakhstan, and Uzbekistan), Australia, and South America (Brazil and Chile). In recent years, CDIO centers have also been established in Africa.

The principal aim of this article is to identify global trends in the development of CDIO and industry collaboration by analyzing advanced international practices, and to formulate evidence-based recommendations for adapting these practices to Uzbekistan's national education system.

The main objectives of the article are to:

systematize the theoretical and methodological foundations of CDIO and industry collaboration;

conduct a comparative analysis of practices in Finland, India, Australia, the Netherlands, and Belgium;

identify trends in the development of CDIO-industry collaboration;

develop practical recommendations for technical higher education institutions in Uzbekistan.

Scientific significance of the study. The study systematically analyzes international experience in CDIO and industry collaboration, compares these practices across regional and sectoral contexts, and provides a scholarly rationale for emerging trends in engineering education, including curriculum agility and the integration of artificial intelligence.

Research methodology. The study employed comparative and analytical methods, systems analysis, the synthesis of statistical data, monographic review, and tabulation. Its empirical basis comprised official materials of the international CDIO organization, presentations delivered at CDIO conferences held between 2023 and 2025, and published scholarly articles.

MAIN PART. ***Theoretical Foundations of CDIO and Industry Collaboration***

The CDIO framework is based on 12 standards and the CDIO Syllabus. The following standards are particularly important for developing industry collaboration:

Standard 6 - Engineering Workspaces: students are provided with modern, well-equipped laboratories and workshops for project activities;

Standard 7 - Integrated Learning Experiences: real projects are implemented through interdisciplinary integration;

Standard 8 - Active Learning: methods are used to encourage students' independent and creative activity.

The central philosophy of CDIO is grounded in the principle of mutually beneficial partnership between universities and industry. Industry representatives participate in curriculum design, provide practice-based learning facilities, and supply authentic problems for student projects.

International Experience

The following section analyzes advanced practices in CDIO and industry collaboration in five countries: Finland, India, Australia, the Netherlands, and Belgium.

Finland: theFIRMA Project Office Model. The theFIRMA project office, established in 2015 at Turku University of Applied Sciences (Turku UAS), is one of the most successful models of CDIO-industry collaboration. The center enables students to carry out real client commissions involving websites, mobile applications, graphic design, and user training.

India: RIT Industry-Institute Collaboration Ecosystem. The Industry-Institute Collaboration Ecosystem (IICE) model implemented at the Ramco Institute of Technology (RIT) in India demonstrates the comprehensive integration of CDIO standards with industry. Under this model, a New Product Development Centre and modern laboratories for additive manufacturing technologies have been established.

Australia: Monash University and the CDIO 2025 Conference. In November 2025, Monash University in Melbourne hosted the 21st International CDIO Conference. Industry leaders, faculty members, and students discussed the future of engineering education. In particular, students' responses to the question, "If you had a magic wand, what would you change in education?" opened up new perspectives.

The Netherlands and Belgium: The Community Service Engineering Model

The Community Service Engineering (CSE) model developed by The Hague University of Applied Sciences in the Netherlands and Thomas More in Belgium demonstrates the application of CDIO to socially oriented innovation. The model focuses on developing engineering solutions that meet the needs of vulnerable social groups.

Table 1

Models of CDIO-Industry Collaboration in Different Countries

Country / University	Model	Key Features	CDIO Standards	Outcomes
Finland (Turku UAS)	theFIRMA project office	Students work on real client commissions; IT, design, and training projects	Standards 6, 7, 8	Students acquire professional skills; industry gains cost-effective solutions
India (Ramco IT)	IICE model	New Product Development Centre; additive manufacturing laboratories	Standards 3, 5, 7, 9, 10	Graduate employability increased; intellectual property was created
Australia (Monash)	Conference and network	International collaboration; student panel; CDIO Academy	Standards 1-12	Collaborative innovation; student projects
The Netherlands / Belgium (THUAS, Thomas More)	CSE model	Social-impact projects; transdisciplinary approach	Syllabus 2.0; design thinking	Engineering solutions for vulnerable groups; international collaboration

Table 2
The Role of CDIO Standards in Industry Collaboration

CDIO Standard	Content	Significance for Industry Collaboration	Countries of Implementation
Standard 3	Integration of interdisciplinary curricula	Designing curricula aligned with industry requirements	India, Finland
Standard 5	Project-based learning (PBL)	Gaining experience through real projects	Australia, Finland
Standard 6	Modern learning and engineering workspaces	Laboratories comparable to industrial facilities	India, Finland
Standard 7	Integrated learning experiences	Interdisciplinary and cross-sectoral collaboration	The Netherlands, Belgium
Standard 8	Active learning	Student autonomy and creativity	All countries

Table 3
Emerging Trends (2023-2025)

Trend	Description	Relationship to CDIO	Examples
Artificial intelligence and education	Integration of AI tools into the educational process	New competencies; transformation of teaching methods	Monash CDIO 2025
Curriculum agility	Rapid adaptation of curricula to industrial change	Proposed Standard 13	International CDIO Conference, 2024
University of the Future concept	A university model designed for 2050	Integration of research; digital teaching	Eindhoven TU, the Netherlands
Technician track	Strengthening the role of technical staff in CDIO programs	Preparation for CDIO 3.0 and 4.0	Conferences in Tunis and Singapore
Sustainable development (SDGs)	Integration of environmental, social, and economic factors	CDIO Syllabus 3.0	India's IICE model

Analysis and Synthesis of International Experience

On the basis of the preceding tables and the international practices reviewed above, the following trends can be identified:

Curriculum agility. In the context of rapid industrial change, traditional curricula quickly become outdated. Since 2024, the CDIO community has discussed curriculum agility - the responsiveness and adaptability of curricula - as a proposed new standard. This standard is grounded in the continuous participation of industry representatives in the educational process.

Artificial intelligence and digital transformation. At the 2025 CDIO Conference, artificial intelligence and emerging technologies were identified as a distinct theme. This reflects a trend toward incorporating AI competencies into the CDIO framework.

Industry-Institute Collaboration Ecosystems (IICE). The Indian experience demonstrates that comprehensive industrial integration of CDIO standards not only improves graduate employability but also leads to the creation of intellectual property and new products.

Social and sustainable development orientation. CDIO is being applied not only to technical challenges but also to social problems, as illustrated by the Community Service Engineering model. This requires alignment with the Sustainable Development Goals (SDGs).

Student-centered and inclusive approach. At the Monash University conference, the student panel and CDIO Academy student projects played a central role. This strengthens the position of students as active participants in the CDIO framework.

Conclusion. The analysis of international experience identified five major trends in the development of CDIO and industry collaboration:

Curriculum agility - the ability to adapt rapidly to industrial change;

Integration of artificial intelligence and digital technologies - enriching engineering education with new competencies;

Formation of industry-institute collaboration ecosystems - long-term strategic partnerships between universities and industry;

A stronger social and sustainable development orientation - the social responsibility of technical education;

A student-centered and inclusive approach - active student participation in the educational process.

These trends are intended to integrate the theoretical and practical components of engineering education, enhance graduates' competitiveness, and meet the actual needs of industry. Experiences from Finland, India, Australia, the Netherlands, and Belgium demonstrate that comprehensive implementation of CDIO standards and systematic collaboration with industry produce strong results.

For technical higher education institutions in Uzbekistan, it is essential to study these international practices and adapt them to local conditions. In particular, it is recommended to establish project offices similar to theFIRMA, create IICE ecosystems, and incorporate artificial intelligence and sustainable development into curricula.

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