

THE CDIO CERTIFICATION PROGRAM

Overview

Abstract

The CDIO Initiative was developed in the early 2000's to respond to these needs and to, in effect, transform the culture of engineering education, producing a new synthesis of engineering science and practice, informed by scholarship on learning. By 2010, over 50 university programs have joined the CDIO Initiative. In some nations, the national standards, policies or practices are such that there are incentives for programs to adopt CDIO, or at least assert that they are adopting CDIO. This raises a central question of *quality control*. The specific objective of this paper is to develop a CDIO Certification process that would meet these requirements. The central idea of this Certification Process is to set up a three level recognition of programs that sets programs on a journey to full implementation of CDIO.

Introduction

The CDIO Initiative was developed in the early 2000's to respond to these needs and to, in effect, transform the culture of engineering education, producing a new synthesis of engineering science and practice, informed by scholarship on learning. CDIO programs have a goal of creating engineering graduates who will become well-rounded engineers who understand how to Conceive-Design-Integrate-Operate complex engineering products, processes, and systems in modern team-based environments.

In 2004, the CDIO Initiative was asked by industry, "how would I know a CDIO program if I saw it, and how would I differentiate a CDIO program from one that builds on similar practices?" To the extent that the CDIO approach is based on recognized effective practice and modern scholarship on learning, this is a reasonable question. Others working to reform their education could well have implemented similar practices. The conclusion at that time was that the differentiating feature of the CDIO approach was an integrated systematic implementation of a variety of coordinated aligned improvements, centered on making the product/system lifecycle the context of engineering education. These were captured in the CDIO Standards, which have become the principal framework for the Initiative. Any quality process should therefore build upon the Standards.

The central idea of the CDIO Certification Process is to set up a three level recognition of programs, that sets programs on a journey to full implementation of CDIO. Initially upon joining the Initiative, all programs become Collaborators (as they currently do). Programs can remain undifferentiated Collaborators, or voluntarily choose to obtain certification as CDIO Implementers and finally Certified CDIO Programs. There are two related reasons for such a certification process. First, many programs are calling themselves CDIO, but are not formally collaborators in the Initiative. This is especially the case where national standards suggest CDIO, or provide funding for its adoption. Here the tendency for programs that have no real connection to CDIO to call themselves CDIO programs may increase. Therefore, second, there is a need for CDIO as an organization to assert Quality Control over its *brand*, beyond self-evaluation.

CDIO quality assurance should be seen as a *certification* process that verifies conformity with the CDIO Standards and not an *accreditation* process that is intended to grant the right for an engineering education program to operate, which is described by U.S. federal officials as the gate keeping role of accreditation. Certification here is defined as being synonymous with *attest, confirm, declare, or verify the quality of*. That is, it is a way to declare that a program has achieved an expected implementation level and as such is a rather broad form of quality control. For example, a program may be a *certified* CDIO implementer at a variety of levels as described below based on a self-evaluation.

On the other hand accreditation is a more stringent form of quality control defined as being synonymous with *officially state, recognize, sanction, or authorize*. It often involves both internal self-evaluation, external review by peers, and then a formal designation by an accrediting body. It is a way to officially

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recognize an organization as having met a standard, to give an organization the authority to perform a function. For example, various local and national authorities and professional associations accredit programs including ABET Inc. for engineering and technology.

CDIO Certification Process

The *goal* of the proposed CDIO Certification Program is to establish an agreed upon certification process in order to assure the quality of the CDIO Initiative, consistency of approaches to adopting CDIO, and protection of the CDIO brand. The CDIO Certification Program specific *objective* is to create a certification process with *procedures, rubrics, evidence, and certification criteria* related to the CDIO Standards.

It should be made explicit and clear that the CDIO Certification Program is totally voluntary and that an institution/program can become and remain a CDIO collaborator never having engaged in this formal program. CDIO is a voluntary organization and, therefore, certification should be a voluntary process of self-evaluation on the part of collaborating engineering education programs. It should be a simple and transparent process, which supports the goals stated above.

However, the CDIO Council will continue to periodically authorize collaborator surveys to gather information about the status of collaborators relative to the Standards. This information will be used to monitor the overall level of adoption of the CDIO standards and not as an evaluation of individual collaborating programs. Participation in this periodic survey is considered an important aspect of a programs continued involvement in the Initiative, along with participation in regional activities.

Voluntary Certification Procedure

We propose the following CDIO Certification Procedure, consisting of four steps: 1) the self-evaluation by a program, 2) a review by the Regional Center, 3) approval by the Leadership Council, and 4) posting of the material for transparency. These four steps are virtually identical to those currently used to allow a new collaborator to join the Initiative.

Evaluation Rubrics

The newly-refined generic rubric for the CDIO Standards is a six-point rating scale (0-5). Unlike the earlier five-point scale listed above. This new rubric will be used as a guide for assessing levels of compliance with the Standards. The principal change between the older five-point and newer six-point scale is the splitting of the old level 4 into a new level 4 (which captures complete implementation) and new level 5 (which requires continuous improvement). Also the issues associated with planning and implementation in the old rubric have been disambiguated. The generic rubric suggests the type of evidence that would indicate compliance with each point on the scale.

Generic Rubric

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. Implementation of the plan to address the standard is underway across the program components and constituents.
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.

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In addition, the generic rubric has been specialized to each of the 12 Standards. This gives a university program a much more concrete basis for self-evaluation.

Certification Criteria

Three levels of certification of a CDIO program are proposed. The first is the null certification, in which a program has applied and been accepted as a *Collaborator*. The second is one of *Implementer*, and the third is a *Certified CDIO Program*.

All programs that have become members of the collaborative are automatically *Collaborators*. In order to remain as a collaborator, a program must continue to be involved with the CDIO Initiative, by attending meetings, and reporting on its progress, and must periodically report on its self-evaluation. This status is unchanged from existing policy.

An *Implementer* has developed a program self-evaluation that shows that it has reached a rating of **2** or higher on the required Standards (1, 2, 3, 5, 7, 9, and 11). This self-evaluation would then be reviewed and approved by the Regional Center and CDIO Council, as described above.

The final stage, *Certified Program*, requires a rating of **4** or higher on the required Standards (1, 2, 3, 5, 7, 9, and 11), and a rating of **2** or higher on the other Standards (4, 6, 8, 10, and 12). This self-evaluation would then be reviewed and approved by the Regional Center and CDIO Council, as described above.

Summary

In summary, the proposed CDIO Certification Program would:

- Create two new levels of certification – CDIO Implementer and Certified CDIO Program – in addition to the current default status of Collaborator.
- Key these new levels of certification to the essential standards and a new set of generic and Standard specific rubrics
- Provide a procedure for the university program to self-evaluate, and present evidence to the Regional Center and CDIO Council for review
- Post results to the university program web site with a link from the CDIO web site

Attachments

CDIO Self-evaluation Process
CDIO Self-evaluation Template
CDIO Regional Certification Program
CDIO Certification Self-evaluation Process
CDIO Certification Recommendation Form

CDIO PROGRAM SELF-EVALUATION

The goal of **CDIO Program Self-Evaluation** is give programs the opportunity to reflect on their implementation of CDIO and engage in continuous improvement of the learning experiences they provide to students.

All programs that have become members of the CDIO Initiative are automatically **CDIO Collaborators**. Within six months of joining the CDIO Initiative, a program should draw a baseline for its efforts by conducting a CDIO Program Self-Evaluation.

Thereafter, a program should perform a periodic self-evaluation at an interval of two or three years, reporting the results of the self-evaluation to the CDIO Initiative. This action is one of the few steps necessary to remain in good standing. If a collaborating program does not complete regular self-evaluations, the CDIO Council may inquire as to the health and status of that program as a continuing collaborator.

The central document for the self-evaluation process is **The CDIO Standards v 2.0** (with customized rubrics). This document lists the standard, a description, and the rationale for the standard. In addition, it contains a generic rubric on a 0 to 5 scale, and customizes that rubric for each of the 12 standards.

A useful accompanying document is **Examples of Evidence of Compliance with the CDIO Standards v 2.0**. This document gives examples of evidence that have been provided by collaborators drawn from their program documents. It is purely advisory, but very helpful.

The third document is the **CDIO Self-Evaluation Template**. This serves as a guide to the process, and a record of the results of the self-evaluation. As the template suggests, for each standard, a program does the following:

- Becomes familiar with the standard, its description, and rationale (using **The CDIO Standards v 2.0**)
- Gathers and records evidence of the level of compliance with the standard (guided by samples in the **Examples of Evidence of Compliance with the CDIO Standards v 2.0**)
- Assigns a ranking based on the six levels of compliance described by the customized rubric (found in **The CDIO Standards v 2.0**)
- Identifies steps that the program can take in the next year to improve in its level of compliance with the standards.

This last step is ultimately the most important as it provides concrete steps on how the program can improve over time.

A copy of the CDIO Program Self-Evaluation is then sent to the CDIO Council for their information. Results from individual CDIO programs are not posted, but may be used in publications in aggregate form to indicate the overall performance of CDIO programs.

**CDIO Self-Evaluation Template
Compliance with CDIO Standards**

Institution:

Program:

Evaluators:

Date:

	CDIO STANDARD	EVIDENCE OF COMPLIANCE	RATING	ACTIONS
1	CDIO as Context Adoption of the principle that product and system lifecycle development and deployment – Conceiving, Designing, Implementing and Operating - are the context for engineering education			
2	CDIO Syllabus Outcomes Specific, detailed learning outcomes for personal, interpersonal and product and system building skills, consistent with program goals and validated by program stakeholders			
3	Integrated Curriculum A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal and product and system building skills			
4	Introduction to Engineering An introductory course that provides the framework for engineering practice in product and system building, and introduces essential personal and interpersonal skills			
5	Design-Build Experiences A curriculum that includes two or more design-build experiences, including one at a basic level and one at an advanced level			
6	CDIO Workspaces Workspaces and laboratories that support and encourage hands-on learning of product and system building, disciplinary knowledge, and social learning			

7	Integrated Learning Experiences Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal and product and system building skills			
8	Active Learning Teaching and learning based on active, experiential learning methods			
9	Enhancement of Faculty CDIO Skills Actions that enhance faculty competence in personal, interpersonal and product and system building skills			
10	Enhancement of Faculty Teaching Skills Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning			
11	CDIO Skills Assessment Assessment of student learning in personal, interpersonal and product and system building skills, as well as in disciplinary knowledge			
12	CDIO Program Evaluation A system that evaluates programs against these twelve standards and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement			

CDIO REGIONAL CERTIFICATION PROGRAM

The goal of the CDIO Regional Certification Program is to establish an agreed-upon certification process in order to assure the quality of the CDIO Initiative, consistency of approaches to adopting CDIO, and protection of the CDIO brand. The CDIO Regional Certification Program's specific objective is to create a certification process with procedures, rubrics, evidence, and certification criteria related to the CDIO Standards.

All programs accepted as members of the CDIO Initiative are automatically CDIO Collaborators. It should be clear that the CDIO Regional Certification Program is completely voluntary and that an institution/program can become and remain a CDIO Collaborator never having engaged in this formal program. The CDIO Initiative is a voluntary organization and, therefore, certification should be a voluntary process of self-evaluation on the part of collaborating engineering education programs. It should be a simple and transparent process that supports the goals stated above.

Certification will occur at the regional level by the decision of the regional group. There is no international certification of programs. However, in order to provide consistency of certification standards and processes across regions, the following procedures have been developed.

The following procedures have been developed and approved by the CDIO Council as a means for a CDIO institution and/or program to seek certification.

1. CDIO Collaborator institutions and/or programs seeking certification notify their respective regional group.
2. The regional group appoints at least two reviewers who are independent from the program applying for certification. If there is no regional group, then reviewers may be designated at the discretion of the CDIO Council.
3. CDIO Collaborator institutions and/or programs submit a CDIO Collaborator Certification Self-Evaluation Survey to their regional group.
4. A rating of *4 or higher* on CDIO Standards 1, 2, 3, 5, 7, 9, and 11 is required for Certification. If one of these standards has a rating of 3, a program may petition for certification. In addition, a rating of *2 or higher* is required on the other standards (4, 6, 8, 10, and 12).
5. Based on the presented evidence and other knowledge of the program, the reviewers evaluate the CDIO Certification Self-Evaluation Survey information to determine whether they agree or disagree with the ratings. The reviewers submit their comments, observations and recommendations to the regional group using the CDIO Regional Certification Recommendation Form.
6. After reviewing the CDIO Regional Certification Recommendation Form, the regional group will determine if the Collaborator may be designated as a CDIO Certified.
7. The duration of the certification is decided by the regional group but, in general, it should be not less than three and not more than six years.

A program that is certified following these procedures has the right to call itself a *Certified CDIO Program*.

CDIO CERTIFICATION SELF-EVALUATION

All programs accepted as members of the CDIO Initiative are automatically **CDIO Collaborators**. If a CDIO Regional Center has adopted a certification process, a program may apply to become a **Certified CDIO Program**.

A **Certified CDIO Program** requires a rating of **4 or higher** on CDIO Standards 1, 2, 3, 5, 7, 9, and 11. If one of these standards has a rating of 3, a program may petition for certification. In addition, a rating of **2 or higher** is required on the other standards (4, 6, 8, 10, and 12).

In order to become a Certified CDIO Program, a program notifies the CDIO Regional Center, who will appoint at least two reviewers independent from the program.

The program will use the **CDIO Certification Self-Evaluation Survey** below to describe the program and its demographics. In preparing the self-evaluation, a program should use

- **The CDIO Standards v 2.0**
- **Evidence of Compliance with the CDIO Standards v 2.0**
- **The CDIO Self-Evaluation Template**

The appointed reviewers will validate the CDIO Certification Self-Evaluation Survey and make a recommendation to the CDIO Regional Center. The CDIO Regional Center will determine a program's designation as a **Certified CDIO Program**.

CDIO CERTIFICATION SELF-EVALUATION SURVEY

I. CDIO Program or Course of Study Demographics

Please identify your CDIO program or course of study and answer the following questions in relation to that program. If you have more than one CDIO program or course of study at your institution, and you would like them considered for certification, please copy the survey and use it to describe each program separately.

1. Institution: _____
2. College, school or faculty within the institution: _____
3. Program or course of study adopting CDIO: _____
4. In what year did you join CDIO as a collaborator? _____
5. How many years are required to **complete** your CDIO program/course of study?
 fewer than 3 3 4 5 more than 5
6. How many students are **currently enrolled** in your CDIO program/course of study?

Year of Graduation	2011	2012	2013	2014	2015
Fewer than 50					
50 – 99					
100 – 199					
200 – 299					
300 – 399					
400 or more					

7. How many students **have completed** (graduated from) your CDIO program/course of study?

Year of Graduation	2006	2007	2008	2009	2010
Fewer than 50					
50 – 99					
100 – 199					
200 – 299					
300 – 399					
400 or more					

8. How many teachers (all ranks) are involved in your CDIO program/course of study?
 - a. Number of teachers involved in **project-based courses**:
 Fewer than 5 5-9 10-14 15-19 20 or more
 - b. Number of **all other** teachers in your CDIO program/course of study:
 Fewer than 10 10-19 20-29 30-39 40-49 50 or more

II. CDIO Self-Evaluation Template (see attached document)

CDIO CERTIFICATION RECOMMENDATION FORM

Collaborating Institution/Program(s):

Point of Contact:

Reviewer:

Date:

Based on the evidence presented, do you agree with the proposed certification?

Yes No

Level of Certification Confirmation

a. Based on the self-evaluation evidence presented, do you agree with the proposed rating for each standard?

Standard 1	Rating:	Agree	Disagree	Comment:
Standard 2	Rating:	Agree	Disagree	Comment:
Standard 3	Rating:	Agree	Disagree	Comment:
Standard 4	Rating:	Agree	Disagree	Comment:
Standard 5	Rating:	Agree	Disagree	Comment:
Standard 6	Rating:	Agree	Disagree	Comment:
Standard 7	Rating:	Agree	Disagree	Comment:
Standard 8	Rating:	Agree	Disagree	Comment:
Standard 9	Rating:	Agree	Disagree	Comment:
Standard 10	Rating:	Agree	Disagree	Comment:
Standard 11	Rating:	Agree	Disagree	Comment:
Standard 12	Rating:	Agree	Disagree	Comment:

b. Overall observations related to self-evaluation.

c. Based on the evidence presented, please explain why the Collaborating Institution should be Certified, and if not, what conditions need to be met to achieve Certification.