

# **FIRST YEAR EXPERIENCE OF CDIO ADOPTION INTO AN INFORMATION TECHNOLOGY PROGRAM**

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## **ABSTRACT**

The Faculty of Information Technology, University of Science has been selected and supported financially by the Vietnam National University – Ho Chi Minh to adopt CDIO into its program. The 7-year CDIO adoption project has been set up and started to improve the teaching and learning quality at the school. However, it is a big challenge due to the fact that the adoption process will be carried out for the whole school with 4 departments, over 2000 students, and 150 faculty members. Although all departments are IT-related, their teaching and learning styles are a bit different. Two are research-oriented and the others are industry-oriented. In addition, although CDIO has been introduced for over 10 years now, the number of documents on the CDIO website to instruct you how to adopt CDIO into school programs are very limited. The documents tell you very briefly and generally about the adoption process. Thus, as a newcomer, we found it quite difficult to follow. This paper describes steps that the school has gone through and difficulties encountered during the 1<sup>st</sup> year of the process. After one year adoption, we have built up a new CDIO-based learning outcomes and the CDIO-based curriculum structure to an existing program. We also did self evaluation based on the rubrics analysis within the 1<sup>st</sup> 4 months and did it again at the end of the 1<sup>st</sup> year to see the progress.

## **KEYWORDS**

CDIO adoption, program learning outcomes, CDIO-based curriculum structure

## **INTRODUCTION**

In December 2009, the Faculty of Information Technology (FIT) has been assessed externally by the ASEAN University Network (AUN-QA) [2] at program level. Even though the

assessment results showed good on 12 criteria (including 71 sub-criteria), equivalent to other programs in the ASEAN region, there are remaining problems that need to be improved. The 2 biggest problems are the program learning outcomes and the curriculum structure.

The existing FIT learning outcomes and the curriculum structure have been built based on the framework proposed by the Ministry of Education and Training, the references of ACM/IEEE training program and the curriculum of well-known universities, such as MIT and Stanford. However, the process of building the learning outcomes and the curriculum structure is based on personal experience and skills rather than a methodology. In particular, the learning outcomes were listed only at one level, which sound very general. Thus, when reading the CDIO syllabus and the process of adoption, integrating personal, interpersonal and CDIO skills into the curriculum [3, 4, 5, 6, 7], we realized that it is the methodology to improve the teaching and learning quality at the FIT.

The CDIO approach is used to improve the teaching and learning quality in engineering education introduced by a group of 4 universities, including MIT in the US, Chalmers, LiU, and KTH in Sweden [4, 7]. Currently, there are over 50 universities from all over the world which are participating into the collaboration.

In 2010, the Vietnam National University – Ho Chi Minh decided to select 2 programs to adopt CDIO as pilot programs before carrying out on all of the technical and engineering schools. FIT was selected as one of them. The project will run for a total of 7 years to carry out the whole process of adoption and improvements after a couple of graduation batches. It is a big opportunity for FIT to reform its teaching and learning program based on a well-known methodology. The school has decided to form up a CDIO task force to manage and control the project. In the first year of adoption, FIT planned to revise and update the learning outcomes and the curriculum structure of the school based on CDIO. The participating groups are listed as follows:

1. Managing board: in charge of managing and monitoring the pilot program
  - a. The Vice Rector of the university
  - b. The Dean of the Faculty
  - c. The manager of the CDIO pilot program (Vice Dean)
  - d. Secretaries
2. The main CDIO groups:
  - a. Group 1: in charge of building the new CDIO-based program learning outcomes of the faculty.
  - b. Group 2: in charge of building the surveys
  - c. Group 3: in charge of analyzing the surveys
  - d. Group 4: in charge of adopting the current curriculum structure to reflect the CDIO skills and the results from stakeholders' surveys. There are 4 small groups. Each consists of leaders of each program tracks of the faculty.
  - e. Group 5: in charge of developing pilot courses with design-build experiences. Four courses were selected for pilot implementation. There are 4 small groups. Each consists of all lecturers/professors who have experiences in teaching the selected courses.
3. The faculty scientific committee: in charge of verifying, approving and making recommendations to the development of the new CDIO-based learning outcomes and the faculty curriculum structure.
4. Others: all lecturers, alumni, students and industrial partners

The next section describes the existing learning outcomes and curriculum structure at FIT. Then, the CDIO process for the first year of adoption will be discussed in details in the section after that. The new CDIO-based learning outcomes are then discussed. It is followed by the curriculum structure section where the process and difficulties are mentioned. Another

section will describe the self-evaluation based on rubrics in the first 4 months of adoption and after 1 year. Finally, the conclusion and remarks close the paper.

## THE EXISTING LEARNING OUTCOMES AND CURRICULUM STRUCTURE

Before applying CDIO, the FIT has the following learning outcomes, listed in Table 1. The learning outcomes describe generally all the main aspects that a FIT student will achieve when he or she graduates. However, the existing learning outcomes are not specific enough to integrate into the curriculum structure or course syllabi.

Table 1  
The FIT learning outcomes before adopting CDIO [1]

A	Understanding of the country's current state, responsibility, and ethics
B	Know how to apply soft skills
C	Ability of professional development and inheritability
D	Ability to apply basic and academic knowledge
E	Ability to analyze, design and implement computing systems
F	Ability to test, operating, evaluating, and maintain computing systems
G	Ability to use computer-based supporting tools

In addition, the learning outcome development was based on personal experience and skills with the reference from other well-known universities and resources. Those learning outcomes have not been verified by any stakeholders except the Board of Deans and some experienced lecturers.

Besides the learning outcomes, the curriculum structure has similar problems. The school has revised and improved the curriculum structure every 3 years. However, the process of building and improving the curriculum structure is also based on personal experience of the teaching staffs and the Board of Deans. It did not follow any formal methodology. Thus, the curriculum structure does not guarantee to cover all the aspects of the school learning outcomes, to avoid the overlapping between courses and to have a smooth flow of the courses along the 4 years of the program.

Figure 1 shows an overview of the existing curriculum structure with the course names. FIT has been carrying out the teaching and learning program based on the mission and vision of the school and the framework of 140-credit program proposed by the Ministry of Training and Education. The program covers from the general knowledge, fundamental professional knowledge and major knowledge to graduation.

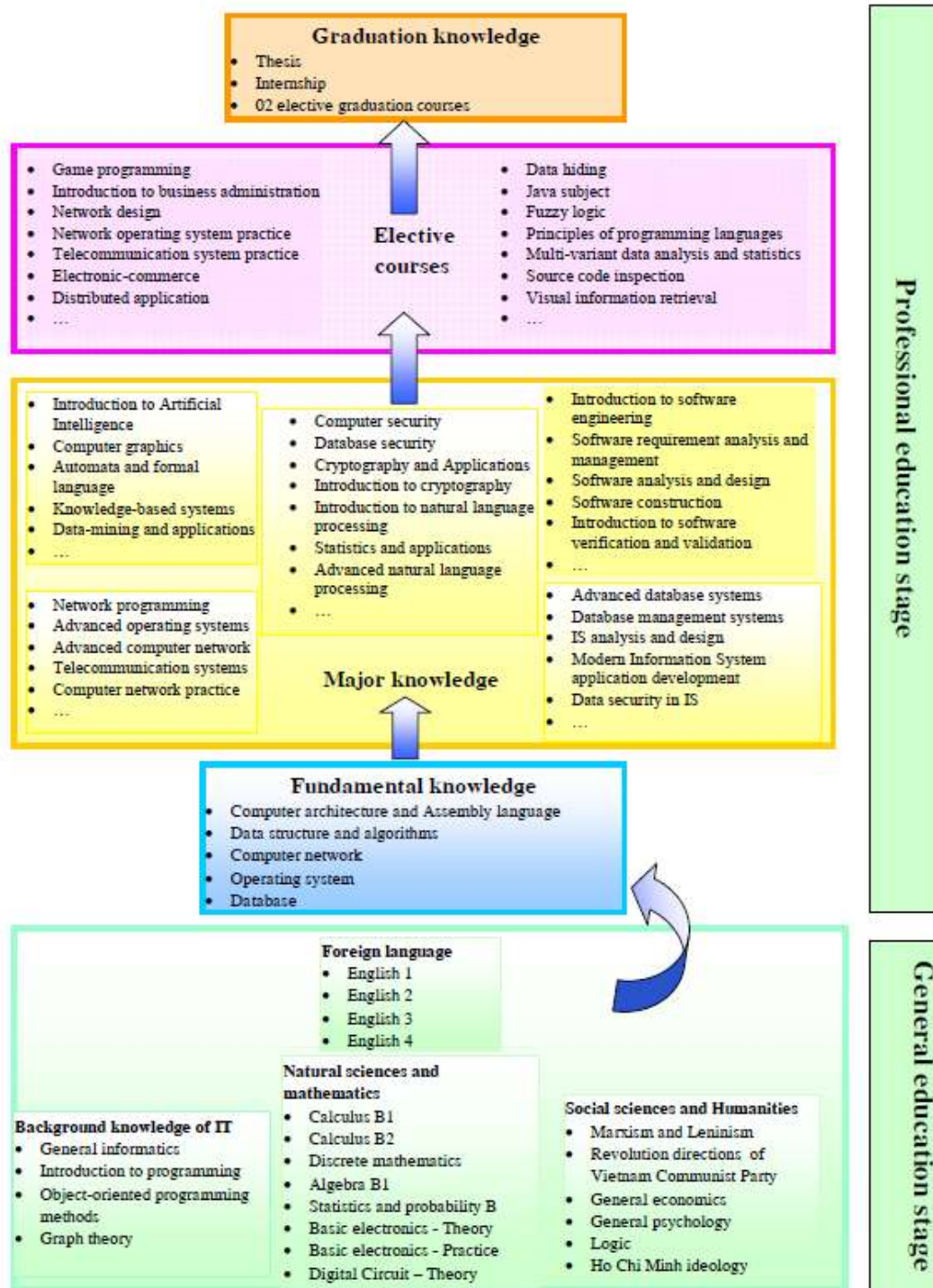


Figure 1. An overview of the existing FIT curriculum structure [1]

## CDIO ADOPTION: THE PROCESS FOR THE FIRST YEAR

The whole project will last for 7 years. In the first year, the main objective is to build a new CDIO-based learning outcomes and curriculum structure based on the existing one. In addition, a pilot program of integrating personal, interpersonal and CDIO skills into 4 courses

is carried out. Figure 2 shows the process of forming up the new learning outcomes and curriculum structure for FIT.

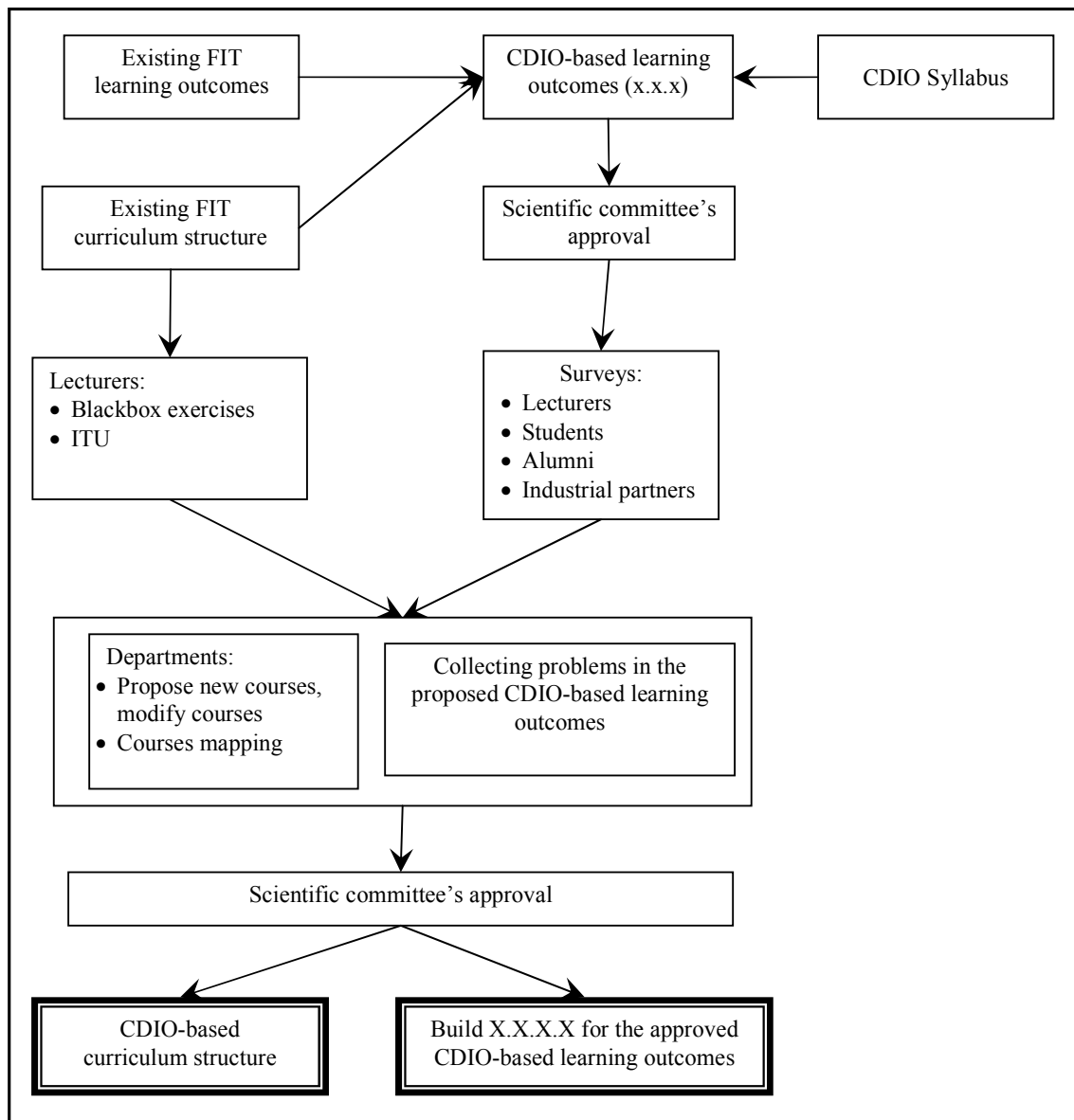


Figure 2. The process of building new CDIO-based learning outcomes and curriculum structure

**Step 1:** FIT collects the existing learning outcomes A-G, curriculum structure and the CDIO syllabus.

**Step 2:** Based on the existing FIT learning outcome, the curriculum structure and the CDIO syllabus, the CDIO task force proposes the first draft version based on the nature of teaching and learning of FIT. The first version is built up to level x.x.x

**Step 3:** Present and discuss the learning outcomes in front of the Scientific Committee. The committee verifies and approves the learning outcome version 1, which is ready for surveys.

**Step 4:** Doing the surveys for all stakeholders, including staff members, students, alumni and industrial partners. In this step, we particularly concentrate on the survey outputs of the staff members and industrial partners. In addition to the surveys on learning outcomes, we ask lecturers to do the ITU and blackbox exercises for all the courses in the program and

mapping with the learning outcome at level 3. It is the basis for forming up the new CDIO-based curriculum structure.

**Step 5:** Collecting the outputs and proposing the new CDIO-based learning outcomes and curriculum structure of the FIT.

**Step 6:** Scientific committee and Heads of Departments will revise, discuss and give final approval.

**Step 7:** The final version of the new CDIO-based learning outcomes and the new CDIO-based curriculum structure for the FIT.

## CDIO-BASED LEARNING OUTCOMES

Based on the current FIT learning outcomes and the nature of teaching and learning of the school, the CDIO adoption team has investigated the CDIO syllabus and picked up the related topics up to level x.x.x. The list has also been modified in order to reflect the group of learning outcomes that FIT focuses. Figure 1 illustrates the FIT CDIO-based learning outcomes at level x.x.

Learning outcomes of the Faculty of Information Technology (HCMUS)			
L1	L2	L3	
<b>1</b>			<b>Fundamental knowledge</b>
1	1		Fundamental knowledge of basic sciences
1	2		Fundamental technical knowledge of computer science
1	3		Advanced technical knowledge of computer science
<b>2</b>			<b>Professional skills and development</b>
2	1		Analytical reasoning and problem solving
2	2		Experimentation, Investigation and knowledge discovery
2	3		System thinking
2	4		Self-study and life-long learning
2	5		Project management
<b>3</b>			<b>Context, responsibility, and ethics</b>
3	1		External, social, economical and environmental context
3	2		Enterprise and business context
3	3		Ethics, responsibility and core personal values
<b>4</b>			<b>Personal and inter-personal skills (soft skills)</b>
4	1		Personal characteristics
4	2		Teamwork
4	3		Communications
4	4		Foreign language skills
<b>5</b>			<b>Conceiving, analyzing, designing and implementing computing systems</b>
5	1		Supporting tools and technologies
5	2		Requirements
5	3		Design and formulation
5	4		Implementation
<b>6</b>			<b>Verification, validation, operation, maintenance and evolution computing systems</b>
6	1		Verification and validation
6	2		Operation and maintenance
6	3		Evolution and disposal

Figure 3. The FIT CDIO-based Learning Outcomes

In the new FIT CDIO-based learning outcomes, section 1 still contains the fundamental knowledge. Section 2 mentions the professional skills and development. Context, responsibility and ethics are listed in section 3. Section 4 covers the personal, interpersonal

skills. Instead of keeping CDIO skills in one section as in CDIO syllabus, we decided to break it into 2 sections, one is for conceiving, analyzing, designing and implementing computer systems and the other one takes care the verification, validation, operation, maintenance and evolution of the system. The new organization of the sections is based on the nature of the teaching and learning at FIT.

The new CDIO-based learning outcomes have been reviewed by the scientific committee and gone through a list of surveys from all stakeholders, including staff members, alumni, and industrial partners. The output of the surveys and revision are then discussed in more details in the scientific committee before finalizing the new CDIO-based learning outcomes. An example of the result for the surveys from alumni and industrial partners on the new CDIO-based learning outcomes is shown in Figure 4.

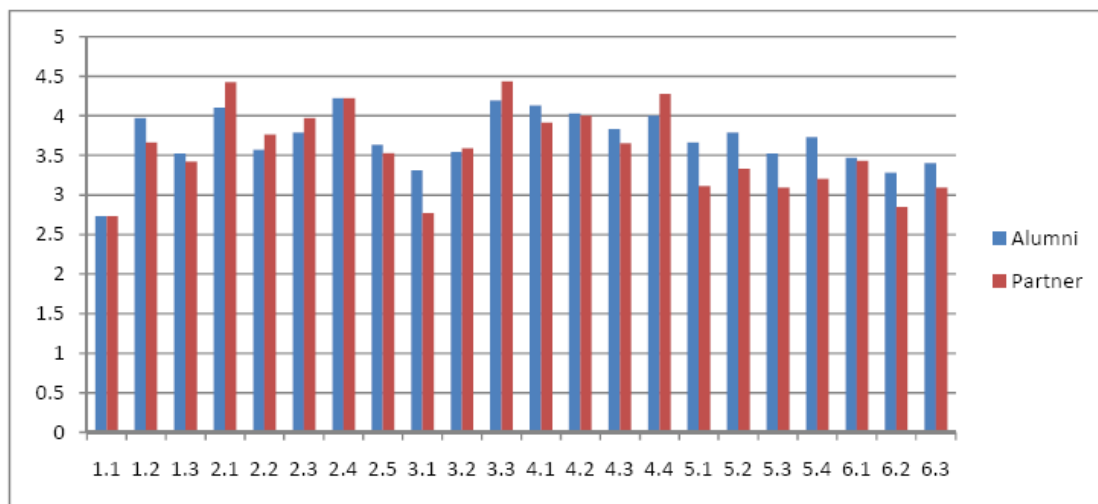


Figure 4. The expectation from the alumni and the industrial partners

## CDIO-BASED CURRICULUM STRUCTURE

Currently, the existing FTI curriculum has 140 credits, including fundamental knowledge, professional knowledge and graduation. However, when mapping and comparing with the new CDIO-based learning outcomes, we found out that there are a lot of things that need to be improved and changed.

Lecturers are asked to perform the ITU mappings and blackbox exercises for all courses that he or she has taught. The work has shown some broken links in the curriculum structure and some overlaps in the courses. The Head of Departments and the Scientific Committee are responsible for resolving these problems. There are some possible solutions:

- Open a new course to cover the missing parts or broken links
- Modify the syllabi of courses to guarantee the connection between courses and avoid the overlap. Also, it is built to guarantee the level contribution of the course to the learning outcomes.
- Scientific Committee is the last to revise and approve the outputs.

## RUBRICS

During the process of CDIO adoption, FIT is aware of taking self-evaluation based on the rubrics of 12 criteria provided by the organization. At the 4<sup>th</sup> month of CDIO adoption, we have carried out an initial self-assessment as in Table 2. In this table, most of the criteria are rated as the lowest level where there is nothing much in the school relating to CDIO, except the awareness of all staff members and students about the starting of CDIO adoption.

Table 2  
Rubrics self-evaluation in the first 4 months of CDIO adoption

	<b>CDIO STANDARD</b>	<b>EVIDENCE OF COMPLIANCE</b>	<b>RATING</b>
1.	<b>CDIO as Context</b>	There is an agreement among faculty members that the CDIO principle is important and the basis for the program reform.	1
2.	<b>CDIO Syllabus</b>	We plan to adapt our current learning outcomes to the CDIO syllabus	1.5
3.	<b>Integrated Curriculum</b>	We started to have some awareness of CDIO principles. We have plans to carry out workshops on evaluating the current curriculum, learning outcomes with the CDIO principles	0.5
4.	<b>Introduction to Engineering</b>	There is no introductory course for the whole program. There is a similar course for a couple of program tracks but not for all.	0
5.	<b>Design-Build Experiences</b>	There are few design-implement courses in the current program. However, they are not planned to link together.	1
6.	<b>Engineering Workspaces</b>	Workspaces are inappropriate to support design-implement activities.	0
7.	<b>Integrated Learning Experiences</b>	There is a plan to carry out an evaluation of current courses on personal, interpersonal and CDIO skills.	0.5
8.	<b>Active Learning</b>	We are aware of the need of active-learning in the courses. Some courses have applied active learning methodology but still based on lecturers' experience.	0.5
9.	<b>Enhancement of Faculty CDIO Skills</b>	Young lecturers are asked to take part in professional courses to improve skills.	0.5
10.	<b>Enhancement of Faculty Teaching Skills</b>	All lecturers have to study and pass a course on teaching skills. Each year, there is a workshop for lecturers to discuss about the teaching skills and methodology.	0.5
11.	<b>Learning Assessment</b>	There are assessments on personal, interpersonal and CDIO skills, but they are not detailed enough to evaluate all the aspects of	1



		the CDIO principles.	
12.	<b>Program Evaluation</b>	A program evaluation has been done a couple of times now by the external people. It shows where we are and what we should do to improve.	1

After a year of adopting, mainly dealing with the FIT learning outcomes and curriculum structure, Table 3 shows another self-evaluation at the end of the year. During the time of building the learning outcomes and the curriculum, there has been a pilot implementation of 4 courses to integrate personal, interpersonal and CDIO skills.

Table 3.  
Rubrics self-evaluation after 1 year of CDIO adoption

	<b>CDIO STANDARD</b>	<b>EVIDENCE OF COMPLIANCE</b>	<b>RATING</b>
1.	<b>CDIO as Context</b>	CDIO was accepted as part of the program reform plan. New CDIO-based curriculum has been approved. 4 courses have been revised to integrate personal, interpersonal and CDIO skills.	2
2.	<b>CDIO Syllabus</b>	The CDIO-based learning outcomes have been introduced in an alignment with the mission, vision and the specifications from the Ministry. The new CDIO-based learning outcomes were validated by the stakeholders.	3
3.	<b>Integrated Curriculum</b>	Curriculum has been re-designed to integrate personal, interpersonal and CDIO skills. Courses have been revised to ensure the smooth link between courses along the 4-year training. The first 4 existing course syllabi are adopted to integrate personal, interpersonal and CDIO skills. There is a plan to run these new syllabi in the next semester.	1.5
4.	<b>Introduction to Engineering</b>	The plan of adding a new introductory course was submitted to the university for approval.	1
5.	<b>Design-Build Experiences</b>	There is a plan for all first year students to take the introductory course. There is plan to arrange the courses so that the students can take basic and advanced design-implement courses in their later years.	2
6.	<b>Engineering Workspaces</b>	There is a plan to re-design an existing lab and equip it to support the design-implement activities.	1
7.	<b>Integrated Learning Experiences</b>	All the courses have been evaluated to find out the missing personal, interpersonal and CDIO skills. The first 4 courses have been adopted to reflect the CDIO principles.	1.5
8.	<b>Active Learning</b>	We are aware of the need of active-learning in the courses. Some courses have applied active learning methodology but still based on lecturers'	0.5

		experience.	
9.	<b>Enhancement of Faculty CDIO Skills</b>	Young lecturers are asked to take part in professional courses to improve skills.	0.5
10.	<b>Enhancement of Faculty Teaching Skills</b>	All lecturers have to study and pass a course on teaching skills. Each year, there is a workshop for lecturers to discuss about the teaching skills and methodology. There is annual plan for surveying and teaching lecturers about the implementation the new CDIO-based syllabus.	1
11.	<b>Learning Assessment</b>	There are assessments on personal, interpersonal and CDIO skills, but they are not detailed enough to evaluate all the aspects of the CDIO principles.	1
12.	<b>Program Evaluation</b>	A program evaluation has been done a couple of times now by the external people. It shows where we are and what we should do to improve.	1

## CONCLUSION

After adopting CDIO for over a year, we have built a new FIT CDIO-based learning outcomes and curriculum structure. They are the basis for the quality improvement of teaching and learning at the University of Science, Vietnam National University – Ho Chi Minh in the coming years. Although the project is still ongoing, the positive effects have been seen by many stakeholders. We have also formed up a detailed process of how to build a new CDIO-based learning outcomes and curriculum structure based on the existing one. Especially, we have done rubrics self-assessment for a couple of times, which helps us much in identifying where we are and what we will do next. In short, we have found that the CDIO methodology is very suitable to apply into the existing program at FIT to improve quality of teaching and learning. The CDIO syllabus and processes are highly valuable for the improvement process at the school. We have also learnt a lot in building up a high-quality teaching and learning program based on the methodology provided by CDIO organization.

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### ***Biographical Information***

Dr. Tien Ba Dinh is currently the Head of Software Engineering Department, Faculty of Information Technology, University of Science, Vietnam National University – Ho Chi Minh city. He graduated from the University of Huddersfield, United Kingdom in 2007. He is one of the key members of the CDIO team of the school who participates in a 7-year project with the goal of teaching and learning improvement.

Prof. Bac Hoai Le is the Vice Dean of the Faculty of Information Technology. He is monitoring and controlling the progress of the project and the deliverables. He is an active member in adopting CDIO in FIT. Prof. Bac research interests are in Data mining, soft computing and expert systems.

Prof. Thu Dan Tran is the Dean of the Faculty of Information Technology. His current research is on Software Engineering processes and management, and design patterns. He is also interested in improving teaching methodology and course syllabus to encourage students in learning and practising.

Prof. Duc Anh Duong is the Vice Rector of the University of Science, Vietnam National University of Ho Chi Minh city. He is very interested in education reform to integrate personal, inter-personal and CDIO skills into the curriculum. He is currently the manager of the 7-year project of the school for CDIO-based education reform. His research interests are Computer Vision, Pattern Recognition and GIS.

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