

# IMPLEMENTING CDIO – REVOLUTION OR EVOLUTION ?

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## **ABSTRACT**

While the CDIO standards and syllabus give a strong framework upon which to develop good quality engineering programmes, the exact means by which Universities and Colleges implement these is often less clear. Within the UK and Ireland CDIO region most institutions have gradually evolved their programmes to meet the CDIO standards. At Aston University we have instead, for local reasons, opted for a rapid step-change to create a swift and revolutionary change within our programmes. This was done for a number of purely educational reasons to ensure our students could get an enhanced learning experience from a very early stage. There were also however other considerations which influenced the nature of our approach including being able to make a bold statement of intent to academic and executive staff within the University. While this methodology has reaped significant rewards it has not been a painless experience. This paper will outline some aspects of our own experience and the decision making processes used while examining a number of other strategies from around the CDIO community.

## **KEYWORDS**

CDIO implementation, program design, curriculum development, support networks

## **INTRODUCTION**

At the heart of the CDIO philosophy are a set of standards and a syllabus which helpfully describe the end outcomes of CDIO implementation, the route to achieving these and the degree to which they may be planned to be implemented in each case is often less clear (Figure 1).

At one extreme there can be a highly evolutionary approach whereby existing degree programmes are changed incrementally with only one or two modules changed at any one time and evaluations performed at each stage to compare new and old versions before making further changes [1,2]. By contrast, at the other extreme, a revolutionary approach involves a major restructuring of programmes, teaching methods and resource utilisation over a short period of time. Each method has merits but can also incur risks and the choice of approach is often a complex mix of educational aspirations and local factors.

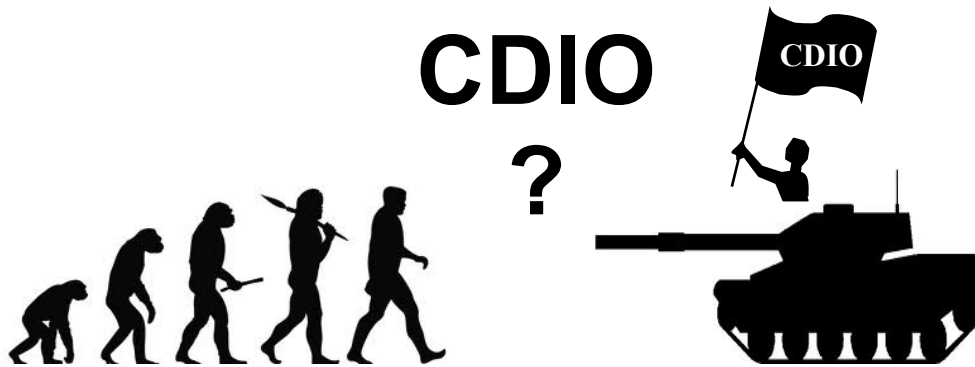


Figure 1 Evolution or Revolution as a route to implementing CDIO ?

The CDIO website resource pages offer a basic structure to help implement CDIO (Figure 2). This is termed the “Adoption process diagram” and points academic teams toward the sort of tasks they need to do and considerations they need to make when implementing CDIO. Among the attractions of CDIO in comparison to say accreditation by a professional body is that it is not a prescriptive standard. Universities and colleges must decide for themselves how they interpret the standards, how far they intend to implement them and how they will get to the position of implementation.

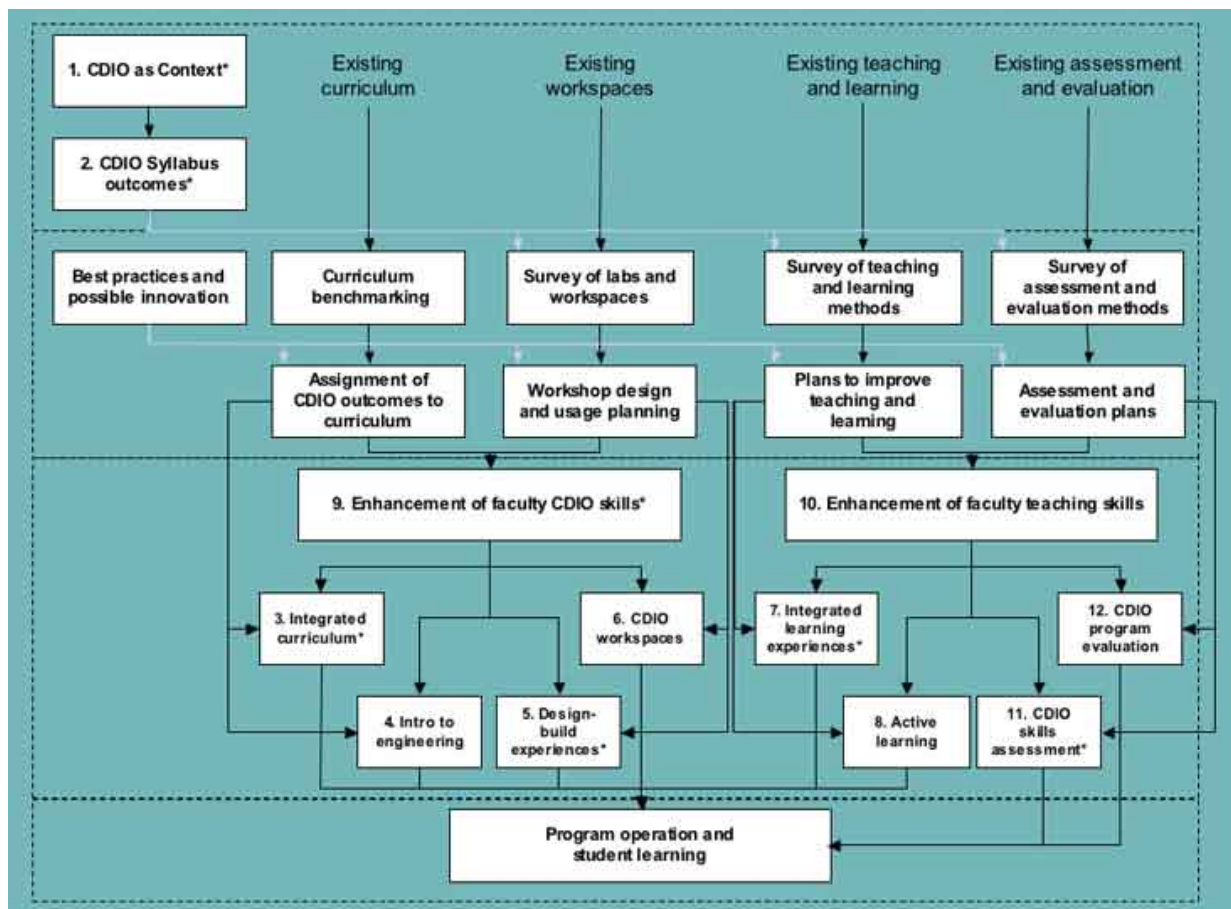


Figure 2 : Adoption process diagram (from <http://www.cdio.org/implementing-cdio-your-institution/adoption-process>)

For many, the pedagogical decision to move to programmes structured around CDIO is a relatively easy task, with the decision to change typically associated with the need to produce more rounded and industrially capable graduates being a major driver, along with addressing recruitment and retention concerns. Determining the desired state of a programme following the change may also be relatively straightforward. Turning this into reality and the pace at which this should happen is however a much more complex issue.

## **DECISIONS AND CONSTRAINTS**

The decisions as to how to implement CDIO and the rate at which this happens are complex and are determined by a range of interlinked factors.

### ***Degree of change***

The degree of change from the current state of affairs within a programme to one in which CDIO has been implemented may or may not be large. Some programmes, even in their existing form, naturally follow many of the CDIO standards. As a result the temptation here is to adopt an evolutionary approach bringing in only one or two new modules with modest tweaks to others. This allows for a relatively untraumatic change with limited impact in terms of resources or upheaval among the teaching team. The risk however could be that opportunities are missed and there is a reluctance to change modules which worked well in the old model but may be less effective in the new degrees.

In my own institution our existing programmes were very traditional and significantly different from where we intended them to be following CDIO implementation. Incremental, evolutionary changes could have been possible but the time frame would have been unacceptable and we may have been left with tricky anomalies whereby a mix of old and new philosophies existed in a single year. Thus a much more radical approach was required with around half of content in each year being created entirely from scratch with a number of other changes elsewhere. While this approach causes significant upheaval it does allow a clean sheet of paper approach to programme development.

### ***Funds available***

Most academic departments will receive modest teaching grants each year to cover consumable costs, minor equipment purchases and infrastructure changes. These funds are however unlikely to be enough to cover major developments such as creating a new mechatronics lab for example which will generally need more major financial support from a higher level in the University. With conflicting demands from elsewhere within an institution it may not always be possible to get the funding required for major change and a more incremental approach may have to result.

### ***Current infrastructure***

Again most CDIO implementations may require development of laboratory or workshop space in particular to meet CDIO standards 5 and 6. This will not only have financial implications but may also have practical considerations such as having space in the first place, or having sufficient down time for the space, to enable changes to be made. Delays here may limit the rate at which CDIO can be implemented. That being said, our own experience has been that effective teaching can be carried out in modest generic bench labs which require little by way of investment in fitting out.

### ***Academic staff attitudes***

When making any curriculum change, the opinion of teaching staff will vary from those driving the change and keen to see the adoption, those ambivalent and others who may be hostile to changes [3]. In academic teams with significant numbers of ambivalent or hostile team members an incremental approach, with early positive outcomes, is likely to be more productive than a revolutionary step change.

### **Senior staff attitudes**

Senior staff, while not having a direct role in the deployment of CDIO into a degree programme, will often play a key role. The support of key senior staff is obviously important in helping free finances and other resources but possibly more importantly they also have the ability to encourage staff to put effort into the activity through career progression [4]. Where senior staff give only limited support to a programme it is likely that only an incremental roll-out will be possible as staff, even if ideologically committed to a programme changes may have to limit their activities in this area.

### **Student attitudes**

We obviously intend CDIO programmes to be better than what went before. Having students willing to adopt new methods is of great concern and while students have in our case been generally supportive of our rapid, revolutionary approach some have struggled to adapt to the new learning style. A common concern among our first cohort was that because they were not being fed facts via a lecture, they were not learning but these attitudes generally changed as they settled into the course.

### **Statement of change**

While not a key driver in determining the pace of change toward CDIO, a more revolutionary change gives a clear signal of intent to staff, academic and management staff, which can be used to provide initial momentum, internal and external publicity and leverage funding.

### **External factors**

Academic programmes do not exist in isolation from the outside world and curriculum change may be dictated, delayed or brought forward in relation to external factors. Typically this may relate to factors such as external review by accreditation bodies or major building or infrastructural change within a university. With CDIO in certain regions of the world possibly moving toward certification of compliance [5], this may also put pressure on more rapid implementation. In our case, the need to have a clear plan for our programmes to ensure our expiring professional body accreditation would be renewed, helped determine our rapid change.

## **DISCUSSION & CONCLUSIONS**

The pace of transition to CDIO is a complex decision to make and is one based on a wide range of factors. Rapid and radical change can offer a high level of momentum, a statement of change, a rapid transformation to the new programme and an opportunity to address all needs of the students from a ground up approach. It does present risk however, academic pressure is high due to the high degree of change, staff and students may struggle to adapt to the new teaching styles and infrastructural change costs may be difficult to manage. A more gradual and incremental approach mitigates many of these risks, however the time taken to change can be excessive, transition could be tricky with old and new programmes running simultaneously and a more conservative approach allowing less than optimum elements of the programme continuing through to the new programme.

In our case we went for a rapid revolutionary approach to ensure we could make the significant levels of changes planned completed in a timely manner, so we could meet our accreditation obligations and to make a strong statement of commitment to CDIO to our students and academic and managerial colleagues. We accept this approach will not be suitable for all organisations but are keen to hear the views of recent implementers to help share experiences.

## REFERENCES

- [1] McCartan C. et al. "The Systematic Development of a New Introductory Course" 3<sup>rd</sup> International CDIO Conference, MIT, Massachusetts, June 2007
- [2] Ping C.S., Chiang C.K., Teoh C., Chow P., "Integrating CDIO Skills and Technical Knowledge from Different Modules in a Project" 6<sup>th</sup> Annual CDIO International Conference, Ecole Polytechnique Montreal, June 2010
- [3] Lundblad J., Kari L. and Ostlund S., "Integrating CDIO experiences into a new program environment" 3<sup>rd</sup> International CDIO Conference, MIT, Massachusetts, June 2007
- [4] Christiansen B.L., Jensen L.B., Krogsboll A, Willumsen L., "Sustaining Momentum when Implementing CDIO in a Set of Study Programs", <http://www.cdio.org/knowledge-library/documents/sustaining-momentum-when-implementing-cdio-set-study-programs>
- [5] Crawley E, Gray P., Malmqvist J., Goodhew P., "CDIO Standards Update & Certification Paper", 6<sup>th</sup> Annual CDIO International Conference, Ecole Polytechnique Montreal, June 2010

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Gareth Thomson is the course director for Mechanical Engineering undergraduate degrees at Aston University, Birmingham, UK. He has particular interests in systems design and evaluation. .

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