Students learn to conceive, design, implement and operate

The School of Engineering at the University of Pretoria recently adopted a new approach to engineering education that aims to teach engineering students not only the technical fundamentals of their disciplines, but also non-technical skills. These skills include working in teams, communicating through written or oral presentation, considering their work in the context of society, and professional ethics.

Instead of emphasising analysis and problem-solving in a theoretical realm, students participate in team-based projects where they go through the cycle of conceiving, designing, implementing and operating (CDIO).

The CDIO Initiative is an innovative educational framework that has been adopted by the University of Pretoria to produce the next generation of engineers. The framework provides students with an education that stresses engineering fundamentals set in the context of conceiving, designing, implementing and operating real-world systems and products. Throughout the world, collaborators have adopted CDIO as the framework of their curricular planning and outcomes-based assessment.

CDIO is a return to engineering fundamentals. According to the worldwide CDIO Initiative, engineering education programmes offered students plenty of hands-on practice. Accomplished and experienced engineers taught courses that focused on solving tangible problems. However, as scientific and technical knowledge expanded, engineering education evolved into the teaching of engineering science. Teaching engineering practice received increasingly less emphasis.

Therefore, while graduating students are technically adept, they lack many abilities required in real-world engineering situations. To encourage schools of engineering to meet real-world needs and rethink their educational strategies, the American Accreditation Board of Engineering and Technology identified its expectations for graduating engineers. The resulting international reformation of engineering education has its foundation in the worldwide CDIO Initiative.

Universities throughout the world that implement the CDIO Initiative have adopted 12 standards that serve as guiding principles and create benchmarks and goals with worldwide application. These standards address programme philosophy, curriculum development, design-build experiences and workspaces, new methods of teaching and learning, faculty development, and assessment and evaluation.

The CDIO standards

- Adoption of the principle that product and system life cycle development and deployment (conceiving, designing, implementing and operating) are the context for engineering education.
- Specific, detailed learning outcomes for personal, interpersonal, and product and system building skills, consistent with programme goals and validated by programme stakeholders.
- A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal, and product and system building skills.
- An introductory course that provides the framework for engineering practice in product and system building, and introduces essential personal and interpersonal skills.
- A curriculum that includes two or more design-build experiences, including one at a basic level and one at an advanced level.
- Workspaces and laboratories that support and encourage hands-on learning of product and system building, disciplinary knowledge and social learning.
- Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and product and system building skills.

Graduates from the University of Pretoria are better prepared for the world of work.

- Teaching and learning based on active experiential learning methods.
- Actions that enhance faculty competence in personal, interpersonal, and product and system building skills.
- Actions that enhance faculty competence in providing integrated learning experiences, by using active experiential learning methods and assessment of student learning.
- Assessment of student learning in personal, interpersonal, and product and system building skills, as well as in disciplinary knowledge.
- A system that evaluates programmes against these 12 standards, and provides feedback to students, faculty members and other stakeholders for the purposes of continuous improvement.

Aligning the University's undergraduate programmes

When the University of Pretoria's engineering curriculum was evaluated, it was found to meet most of the CDIO standards. The one area in which it was found to be lacking, however, was the development of workspaces and laboratories that support and encourage hands-on learning of product and system building, disciplinary knowledge and social learning.

According to Prof Josua Meyer, chairperson of the University's School of Engineering, it was important to align the University's undergraduate programmes correctly and benchmark them with the best practices internationally. When the new engineering building was therefore planned, a particular instruction to the design team was to develop different study areas where students could work and collaborate informally: some where students could form informal groups between classes, and other quieter workspaces where students could work individually. The idea is to provide engineering students with a home away from home, where they can spend their time in a productive, student-friendly environment.

These workspaces will provide opportunities for students to engage in engineering reasoning and problem-solving through teamwork, with the added advantage that the University of Pretoria will be able to deliver engineering graduates who are better prepared for the world of work.

Reference

1. www.cdio.org