# CHANGING LEARNING METHODS OF CHEMICAL ENGINEERING – CDIO AND CHEMICAL PRODUCT ENGINEERING

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**Abstract**
Chemical Product Engineering is evolving at universities in response to the changing conditions in industry. Simultaneously, it facilitates adaptation of new methods of learning which are well aligned with the CDIO. We are introducing the subject of Chemical Product Engineering and Design as a discipline for Chemical Engineering students in order to prepare them for an innovation driven career, where development and invention of novel products is of high importance. The curriculum for the subject combines *wild* brainstorming for idea generation with *dry* quantitative engineering estimations for the final design of the products in question. This interactive presentation will present a simple game designed for dedicated engineering brainstorming and challenge the audience to undertake the task of generating a maximum number of ideas for the designing of some engineered products.

*Keywords: Chemical Product Design and Engineering, Innovation, Brainstorming.*

## Background and Motivation

This paper reports on the experiences gained from teaching classes and preparing a text book on Chemical Product Engineering. [1] At DTU this subject was introduced into the curriculum as dedicated classes in 2000. Over the last decade Chemical Product Engineering has evolved as part of the Chemical Engineering Curriculum at several universities in Europe and America. [2] Chemical Product Engineering is solidly based on chemical technical and engineering knowledge. Furthermore, the subject naturally calls for a holistic approach to teaching and learning and introduces elements which target transferable and professional engineering skills. Such skills are especially important in Chemical Product Engineering when dealing with open-ended problems, creative problem solutions, operating in a team working environment and exercising project management.

In 2004 the World Chemical Engineering Council (WCEC) conducted a survey on how chemical engineering education meets the requirements of employment of young chemical engineers. [3] The survey shows a discrepancy on what skills are the more important during education versus employment. Application of basic science and appreciation of the potential of research were the most relevant skills during education. However, completely different skills like team work and communication, ability to gather and analyse information, and self-learning were considered the most important abilities for employment. This gab between engineering education and

engineering employment is not unique to chemical engineering, and similar evidence is found in other engineering disciplines.

**The Course (Key Questions)**

In our course we emphasise team activities, formative feed back to the students as well as helping the individual to become more assertive and understanding of personal assets. All this is done within the technical framework set by the product or the problem area in question. These teaching elements included in Chemical Product Engineering represent a series of issues which are general to Chemical Engineering Education, and which must be discussed as the education is going to adapt to the changes of the surrounding world and a globalized society. In our course we present a method for chemical product design which follows the full life cycle of an engineering product. This is nicely described by the CDIO acronym. However, the course activities focus on the 'conceive' and 'design' parts of the product development. This is illustrated in Figure 1, where the development and creation of solutions is illustrated by the green ellipse.

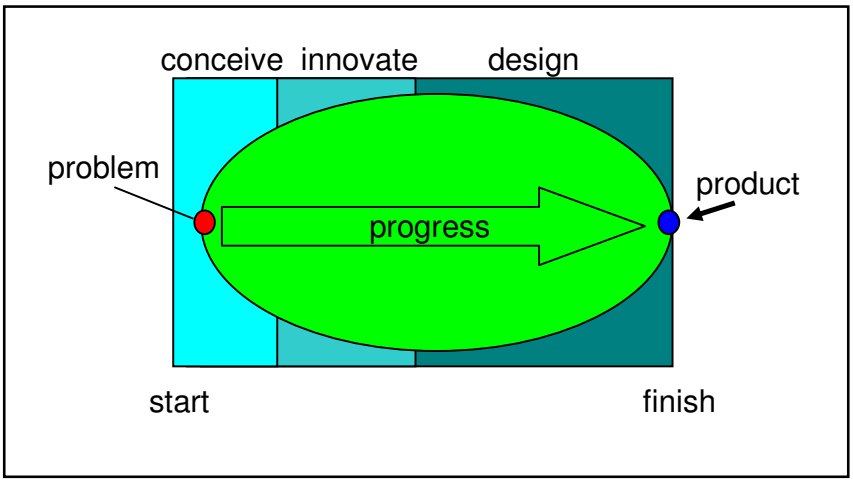


Figure 1. The bridge from problem to product illustrated by the space of ideas of solution (green).

The beginning of the product design process is often represented by merely a problem or something, which is not working well. This could be something like: (1) Why does the bath room mirror steam up, when I am taking a shower? (2) Why do my bananas always go brown before I can manage to eat them? (3) Why does my shoes get stained from walking the streets during the winter (at least when we had snow during the winters)? Such open-ended problems can lead to the development of novel product and is part of the initial process of the CDIO life cycle of an engineering problem/product. After realising the nature of the problem, and probably after having done some research and analysis into the problem, the next important step is to open up a large solution space of ideas, which can help overcome the problem.

**Generating Ideas (Interactions and Activites)**

Linus Pauling (a chemical engineer and Nobel Laureate) is quoted to have said: "a best way to get a good idea is to get a lot of ideas". This is what is illustrated in Figure 1 by the expanding section of the green parabola, which illustrates the quantity of ideas for problem solution.

Following the generating of ideas there must be a process cultivating – and finally selecting the best solution for the product. However, here the concern is the initial parts of generating ideas. It is not trivial to generate a lot of good ideas. Especially not for engineering students, which are trained in think in correct solutions and getting the answer right – preferably by the first attempt. Generating ideas is a completely different game. We have experience with students, who simply got stuck when searching for new ideas to create a new or improve and existing product design.

This paper presents an idea game which has been designed specially to help and guide brain storming for technical problems. It is based simply on using guided stimuli to think new thoughts. The game is played by a group of 3-5 people. There must be a specific problem or theme, which all group members have discussed, understood and agreed upon. This theme is the focus of the session. Group members take turns in drawing a card from a deck. On each card there is a word, and the player must immediately explain his first idea to the rest of the group when he reads the word. The idea is written on a post-it note or similar and saved. Other group members are welcome to elaborate or themselves verbalize their own first associations. After 10-30 minutes the session stops and all generated ideas are sorted out and organized to gain an overview of the *harvest* of ideas.

It is surprising the number of ideas which a group can generate this way. In honour of the host country for the *4th International CDIO Conference* this presentation will engage the audience in generating ideas for chocolate (which is not fattening) and beer (without alcohol), but also take on suggestions from participants.

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