

# Designing project assignments; Experiences and recommendations from PLE-practice in engineering education

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## 1. Introduction

The University of Twente is a relatively small university in The Netherlands, with approximately 8500 students and 2500 staff members, divided over 6 faculties. The faculty of Engineering Technology is one of the larger faculties and offers three programmes: Mechanical Engineering, Industrial Design Engineering and Civil Engineering. Since 1994, Mechanical Engineering has adopted PLE (Project Led Education) as its leading educational philosophy, structuring the educational programme by themes that cover the whole subject matter and introducing one project per theme to induce learning activities (Ponsen, Ruijter, 2002). Both programmes have more than 100 first year students starting to learn with PLE.

At Industrial Design Engineering, PLE was implemented as educational philosophy right from the start of the programme in 2001. Both programmes have gained a lot of experience with Project Led Education (PLE) over the years (van Houten, 2002).

The programmes of Both Mechanical and Industrial Engineering are divided into themes with their own project and project courses. For every theme, one new project assignment is designed each year. All students work on the same project assignment. The themes that constitute the programme are assigned to two research groups to ensure the multidisciplinary of the project assignments.

In this paper, we describe the criteria teachers use for designing new project assignments. Having years of experience in putting PLE into practice, what is their approach when designing a project assignment? What do they perceive to be the most important success and fail factors for project assignments? How does this relate to the original PLE philosophy as was implemented 16 years ago and what recommendations can we derive from this that can be used to strengthen project education at the faculty?

## 2. Research method - what did we do?

The initial idea for this extended abstract was to find the success factors for a good project. From a quick scan of available literature it became clear that numerous papers have already been written about this subject. In the book 'Project-led Engineering Education' (Powell & Weenk, 2003) an elaborate list of important features of a good project is given. The characteristics are divided in three categories:

- Academic issues (e.g. compliance with semester aims, task complexity, room for creativity)
- Reality issues (e.g. reality of problem and context, relevancy)
- Student activity and behaviour issues (e.g. motivation, challenge, responsibility, suitability for teamwork).

These characteristics being known, it then becomes interesting to see how teaching staff deals with this subject in daily practice. How does a teacher in the Engineering faculty come up with a design for a project assignment? What factors are taken into account? What choices are made and why?

To find out what is being done in practice, we interviewed 10 teaching staff members (project coordinators) from both programmes; five from Industrial Design Engineering and five from Mechanical Engineering. We also interviewed the programme director who has been involved in PLE at the Engineering faculty from the start of the implementation process.

Interview questions for the project coordinators were:

- What do you perceive as the added value of project education? How does it contribute to the learning process of the students?

- What are the conditions to be met by a project assignment?
- Consider a successful project. What made this particular project successful?
- Consider a less successful project. What made this particular project less successful?
- A new colleague has been given the task to design a project assignment for the first time. What tips would you give him or her?

Finally, we asked the programme director to give us his vision on PLE and good project assignments. He is familiar with the original vision behind PLE as an educational philosophy in the faculty and knows the differences between PLE practice in both programmes.

### **3. Outcomes: design criteria for project assignments**

When interviewed about the added value of PLE for student learning, the teachers gave varied reasons for practicing PLE:

- Students learn to cooperate in a (multidisciplinary) team
- The possibility to offer larger and more complex subjects to students
- Coherence of the programme, integration of subject matter
- Simulation of the professional practice
- Applying theoretical knowledge to a design
- Motivating students, keeping them engaged by active learning in a realistic context.

This section describes how teachers translate this added value into criteria for project assignments.

#### **3.1 Learning goals and feasibility**

Ten teachers were interviewed. All teachers unanimously indicated that when designing a project assignment, they take the theme (main goal plus context) of the project as a starting point. These themes together cover the engineering discipline of the programme. The context is related to the special role in the programme. For example the function of the KOP project being the first project at Industrial Design Engineering programme, is to get students acquainted with PLE and to orientate them on the Industrial Design Engineering programme.

The theme of project O, which takes place in the second year, is to design a product for a specific target group. Teachers take this theme as a basis for the project assignment and then look at the boundary conditions of the project: the specific content to be learned, the prior knowledge of the students, the time available, materials to be used, availability of workshop facilities, etcetera). The theme determines the direction of the project design. A good project assignment is designed to integrate several aspects of the theme within the solution of the problem. An example of Mechanical Engineering assignment that fits this requirement is designing a crane: designing a crane automatically requires students to do stress and strain calculations, use of bearings, etcetera; several aspects of the theme 'design and construction'.

#### **3.2 The 'fun-factor'**

Teaching staff also indicate that the 'fun-factor' is very important for a good project assignment. Nine out of ten teachers find it important that the subject of the project assignment (the type of product the students have to design) is attractive and engaging for students, keeping them motivated to complete the assignment. To optimize the 'fun-factor', teachers mention different possibilities:

- Connect with the interests and environmental perceptions of the target group. For example, the start-up projects in the first year of the ME programme are perceived as 'fun' when the assignment implies a so called 'demolishing device' (e.g. a can crusher).
- The added value of the solution to be designed has to be clear to students. It should be a product that has a clear potential to be used in the near future. An example of a less successful project is an assignment for which students had to design a shoe polishing machine. This is something that can be easily done by hand. Students didn't see the usefulness (feasibility) for such a machine.
- Connect with actuality or a so called 'hot item'. Sustainability for example is a theme that is perceived as relevant by Industrial Design Engineering students.
- Manufacturability. Especially for students in the first year of the programme, it's motivating to design a solution that can be made into a working full-scale prototype. Often, the project will be closed by a

contest or competition, in which the functionalities of the prototypes will be tested: battle robots, baking sausages on barbecue designs, etcetera.

Apart from student motivation, the fun-factor is also important to the teaching staff involved in the project. Doing the projects year after year, they also find it important that the project assignment is original and appealing to them in order to keep them engaged.

### **3.3 The 'new-factor'**

Besides the fun-factor, the novelty-factor is also mentioned as important by several teachers. A product that isn't available on the market yet makes copy cat behaviour less probable. Students do not have the opportunity to Google for solutions. Also creativity of students is stimulated more, because a new product doesn't make them think of existing solutions. For example, designing a new type of bike would be a less successful assignment, because it is a very familiar product that students have many associations with.

### **3.4 The challenge**

What is also important according to teachers is the balance between too complex and too simple. A project assignment has to be an ill-defined problem that offers a challenge to students. This challenge is to meet the criteria within the boundary conditions that are set. The problem should not be too difficult for students, because it will leave them frustrated and motivated. When it's too simple however, students aren't motivated either, because the challenge of finding a solution by themselves is taken away. Moreover, when their perception is that the problem is simple, they will not give the assignment sufficient priority. This is the dilemma that teachers face when setting up the criteria and boundary conditions for a project assignment. In order to prevent students from getting lost, some boundaries are set; for example by giving a shortlist of materials that can be used or by giving clues on how to tackle the problem.

### **3.5 Reality check**

An aspect on which teachers differ in opinion is the reality factor of the project assignment. Some teachers find it very important that a project assignment resembles real life as much as possible to enable students to experience the professional practice. Cooperation with stakeholders from industrial companies is functional for this. Other teachers indicate this as a high-risk factor for project failure, because it can mess up the controlled learning environment that is set up for students and interfere with learning goals. After all, the company's goals might overemphasize the value of the product over the learning objectives.

## **4. Conclusions and recommendations**

In this section, conclusions are drawn from the above and translated into recommendations for strengthening PLE at the faculty.

### **4.1 Insight in PLE and its effects on learning**

Though all teachers interviewed are positive about PLE and have a clear opinion of the added value it has for student's learning, none of them seem to have a comprehensive view on the benefits and effects of PLE. All reasons mentioned substantiate the choice for PLE and are still valid, but they only provide a limited view. PLE was implemented years ago in both programmes. Since then, formal instruction on this education philosophy hasn't taken place. Over the years, the original PLE philosophy has faded away a bit. This is even more so for new teaching staff that can only rely on their more experienced colleagues to introduce them into PLE. We recommend an annual PLE focus session and a introduction course on PLE for new teaching staff to optimize PLE practice in the faculty.

## 4.2 It's about the process, not about the product

It's important to convince teaching staff of the idea that it's not the end-product that matters most in a project assignment, but the process that students engage in to find this final solution. This process yields the intended learning results. Most teachers are aware of this, but at the same time it's very tempting to focus on the fun-factor in order to keep students motivated. The real motivation however, can be induced by the challenge presented to students. This can be done by adding context. An example of this is an assignment in which students are asked to design an egg-boiling device. Not a very motivating and challenging subject. However, when context is added, the problem becomes more complex and more interesting: "Air France – KLM wants to offer their first class passengers on intercontinental flights a fresh boiled egg. Design a system to boil eggs in a reproducible way using a microwave."

## 4.3 Cooperation with industry

Cooperation with industry is possible and in some cases even recommendable. The advantage of involving real stakeholders is that it enhances the sense of reality of a project assignment. The value of designing a solution becomes very evident to students when a real company is the customer. It's also a risk-factor however, because companies having a real interest in the outcome of a project can lead to too much emphasis on the end-product, endangering the process and the learning effect. For example when a company introduces too many restraints (choice of materials, costs, etc.), this reduces the range of possible solutions. To prevent this from happening, it is important to have clear understanding about expected results and time investment from both parties. Commitment should be based on effort, not on possible outcomes.

## 4.4 Project complexity

A project can hardly be too difficult or too complex. A good project (Powell & Weenk, 2003) offers students a complex, open-ended and multidisciplinary task that requires task division and cooperative work. Though teachers are aware of this, there is a tendency to avoid making projects too complex, because students could be lost and frustrated. When designing a project assignment, one can make it rather too complex than too simple. It's always possible to make an assignment easier by giving hints or extra guidance to students. Making an assignment more complex will be perceived as 'changing the rules during the course of the game' and will frustrate students.

## 4.5 Project design as a team effort

It is recommendable to design project assignments in design teams of three or more people with different fields of expertise. This prevents people from 'riding hobby horses' or putting too much emphasis on a too narrow part of the sub-discipline. Also, it creates support within the team that will be involved in the project as teaching staff and tutors. Also, this is a good way to introduce new teachers into PLE, giving them the possibility to get acquainted with different points of view regarding PLE from their colleagues and preventing a one-sided conceptualization of the educational philosophy.

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