# FRAMING DESIGN STUDENTS, RE-FRAMING DESIGN EDUCATION

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## ABSTRACT
Industrial Design Engineering is an inherently complex discipline, bringing together a variety of knowledge and skills. To aid the students of our new bachelor programme in navigating the complexity of their future discipline we created a first module that 'frames the students as future Industrial Design Engineers with both the language of engineering (=mathematics) and the language of design (=visual)'. Because our programme at the University of Twente is rooted and located in a faculty of Engineering Technology and at the same time benefitting from the influx of knowledge from the faculty of Behavioural, Management and Social Sciences and our sister faculty of Electronic Engineering, Mathematics and Computer Science, the bachelor comprises of gamma- and beta topics, envisioned by the former marketing slogan of our university "High Tech - Human Touch". In this context we developed an integrated full-time module of fifteen European Credits. Keeping in mind that this first encounter of the freshmen would set the standard for the rest of their studies we set our selves the task to develop an agile module that offers the scope of topics and integrates them directly in short design sprints. Inspired by the frame-creation method by Dorst we decided to adopt a strong frame for the new module. In line with the slogan of our university and the applied character of engineering we settled for 'making technology available for people'. We argue that for the students to be successful in this task, they should become 'bilingual'.

*Keywords: Industrial design engineering education, curriculum design, reframing, language of design, design sprint*

## 1 INTRODUCTION
Industrial Design Engineering is an inherently complex discipline that brings together knowledge and skills from a variety of backgrounds [1, 2]. As an engineering discipline, our programme at the University of Twente is rooted and located in the faculty of Engineering Technology, effectively housed together with Mechanical Engineering and Civil Engineering. At the same time our programme is benefitting from the influx of knowledge from the faculty of Behavioural and Management Sciences and our sister faculty of Electronic Engineering, Mathematics and Computer Science. This offers the opportunity to effectively bring together knowledge and skills from both gamma- and beta studies, as envisioned by the former marketing slogan of our university "High Tech - Human Touch" [3]. Against this background we were recently asked to develop an integrated full time teaching module of fifteen European Credits for the very first quartile of the Bachelor. Keeping in mind that this would be the first encounter of the freshmen with their future discipline and that this module would set the standard for the rest of their studies we set our selves the task to develop an "agile module that challenges students and faculty to passionately engage in the process of creative exploration."
In this paper we will further explain the setup of the module with the contents of the theoretical subjects and how they are applied in design sprints. The module caters for the development of the students on three levels [4]; the practical (what do I have to as a designer), the theoretical (why do I do that as a designer), and the reflective (what does it mean that I do that as a designer).

## 2 CURRICULUM DESIGN
As mentioned in the introduction, Industrial Design Engineering (IDE) spans a wide range of topics. This is also reflected in the so-called Domain specific reference framework that forms the basis of accredited academic programmes in our country. The Domain specific reference framework describes "the quintessence of IDE" [5, p.39] as "The Industrial Design Engineer is an academically educated product designer who can integrate knowledge from different fields of technology with human factors,

can see signals from the market and can generate creative ideas with new solutions." [5, p.39]. Thus, referring to four domains: technology, human factors, marketing (or society), and creativity.
One difficulty in learning Industrial Design Engineering is that the knowledge and skills from this diversity of subjects requires also different competences. Technology is strongly rooted in the beta-domain, while marketing, society and creativity are generally related to the gamma-studies. Human factors are both beta (physical ergonomics, perception) as well as gamma (cognitive ergonomics, user testing). For a lot of students, it is challenging to perform well in such differing tasks as calculating strengths and stiffnesses, building prototypes, interviewing target users, and communicate and develop interesting and original ideas in a creative process at the same time. A second difficulty is that it has no use to teach all the different subjects separately, as design relies on the effective integration of all these aspects in the design process [6]. In her recent study on the evolving field of design, Valtonen [7] concludes that the basis of all design practices lies in aligning theory and practice, or in other words, combining thinking with making: "What most of design practices have in common, whether speculative design inside a company or creating a new approach for better water management in Timor, is that they combine a thought process with hands-on, practical design work. This might show itself as designing a pizza menu to show how climate change has influenced our food habits, or by facilitating a mock meeting to explore how an organisation might manage resources and make decisions." [7, p.523]
In our opinion, designing a design programme is therefore always a balance between teaching the separate subjects efficiently and in-depth on the one hand ('thinking') and practicing the integration effectively on the other ('making') [8]. This is also reflected in the Domain specific reference framework as it states: "Furthermore, the IDE curriculum is a programme that provides a balance between the formation, processing, application, integration and contemplation of theory and skills. The Design Projects are the core of the curricula. The other building blocks are taught and integrated in the Design Projects." [5, p.41]

## 3 MAKING TECHNOLOGY AVAILABLE FOR PEOPLE

To aid the students in navigating the complexity of their future discipline we decided to create a strong frame for the module, based on the frame-creation method by Dorst [9]. According to our Domain specific reference framework again, the Industrial Design Engineer is "an academically educated product designer". Although there are also a lot of other competences mentioned, one could say that the frame is that the graduate "designs products", where the concept of product has righteously expanded over the years [1, 10]. However, from theories in Science & Technology Studies we learn [11] that the development of new technology cannot be meaningful unless there are users that successfully adapt the products and services to their own lives [12]. The focus should therefore not lie on the object itself, however on the *relationship* between the technology and the user [13]. Where the user can be an individual, but also a group of users or society at large [3, 7]. Therefore, in line with the High Tech - Human-Touch slogan and the applied character of engineering we formulated the new frame for the development of the Industrial Design Engineer in "making technology available for people" as the central objective.

## 4 LANGUAGES

In order to be able to make technology available for people, students should understand both technology *and* people. The understanding of technology starts with the engineering subjects in the programme (statics, materials, production techniques), that in their turn heavily rely on mathematics. To quote our former director of education: "mathematics is the *language* of engineering" [14]. Therefore, a large chunk of the first module exists of introduction to mathematics and calculus (4EC). However, mathematics is not a language that everybody understands, let alone a language that is easy to 'read'. To be able to make technology available for people designers should be able to communicate their engineering work to their stakeholders. Whether these stakeholders are users, co-designers, test persons, financers or government. Enter design sketching as the 'language of design' that is particularly suitable for the expression, development and synthesis of new ideas [15, 16, 17, 18]. Moreover, with visual thinking and communication "with its ability to succinctly express 'strategy,' 'interaction,' 'relationship,' 'narrative,' 'service' and 'context" [19, p.1] design sketching has also expanded as a field and has developed itself together with the expansion of the concept of 'product' that we acknowledged earlier [20]. Although design visualisation also includes technical drawing, CAD modelling, mood boards, renderings and Virtual Reality -to name a few- "design sketching remains central as a design

language for communication, imagining, thinking, researching, prototyping, futuring, design fiction, and philosophising." [19, p.9]
For our first module, effectively combining the basics of engineering with the basics of design, the vision thus became 'framing the students as future Industrial Design Engineers with both the language of engineering and the language of design' (figure 1). The crux for the successful development of the future industrial design engineer therefore is to be able to seamlessly translate between the two languages, which directly implies to become 'bi-lingual'.

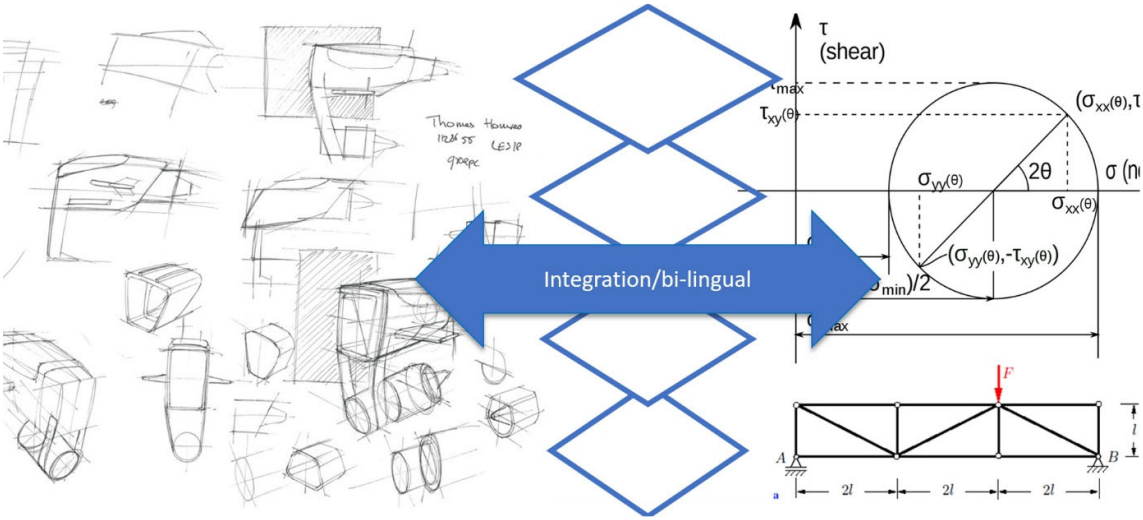


*Figure 1. The languages of design (visual) and engineering (mathematics). The two are brought together with the aid of the design process (metaphorically depicted here with the basic scheme of diverging and converging)*

## 5 AN AGILE MODULE

In learning any language, there are two basic approaches. One could start with thoroughly studying the theory of grammar and vocabulary to prepare for quality in reading and speaking. One can also start with the practice of speaking and listening and induce the rules of the game from there. This very much looks like the trade-off between 'thinking' and 'making' we acknowledged above. For our freshmen module we tried to overcome this dilemma by splitting both sides into smaller chunks to alternate between the two with fast iterations. Instead of one larger project covering the whole module, we introduced shorter assignments which we called 'design sprints' inspired by agile working methods (figure 2).

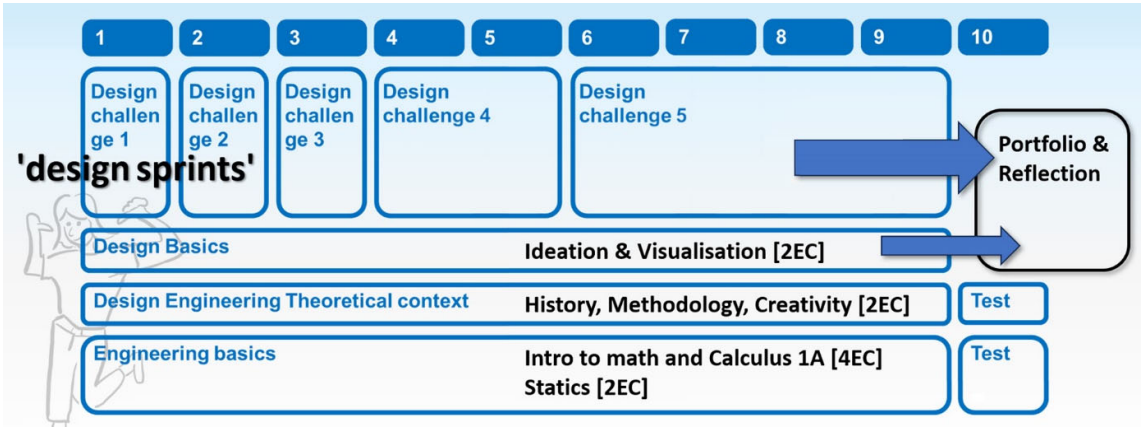


*Figure 2. Overview of the 15EC module with ten weeks, five design sprints and three topics*

By having short and intensive design sprints in the second half of each week, the students are forced to immediately apply what they have learned in the knowledge and skill-based lectures from the first half. Or the other way around, they can reflect on their design experience with the theoretical insights that they are offered the week after. This is facilitated by the design theory course (of 2EC) that informs the

students about design history [21], methodology, and creativity [22]. Having a strict roster structure, that is the same for every week of the module caters for an effective learning experience (figure 3).

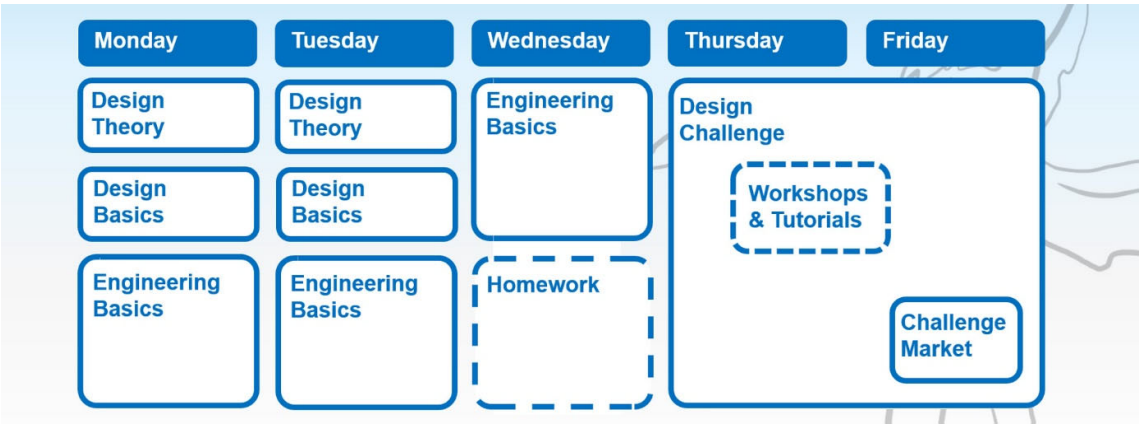


*Figure 3. Overview of the persistent weekly schedule*

A carefully crafted set of individual and group challenges then touches every aspect of IDE with increasing complexity. The first two-day sprint is “Designing a healthy Breakfast". Which was chosen as it is particularly suitable for getting to know each other [23], especially in our student population with different cultural backgrounds. It is also about the basics of requirements (what is healthy?) and working in and with a group (of eight students), catering to the academic skills course aims of ‘diversity’ and ‘collaboration’. The second sprint is about designing a wearable to withstand the weather in our country, which adds to the requirements development and also to the ‘human touch’ part of the programme. In the third sprint the students develop a design for a wooden toy individually. This to challenge their individual capability for idea generation. That the toy should be from wood is to connect directly to the skills they have learned in the design basics course up to then: sketching basic shapes. The same holds for the fourth sprint where the groups have to design a gripper to pick something from the ground. Connecting to ergonomics, however more importantly also directly to the engineering basics course on statics, focussing on two-dimensional mechanisms and forces. This sprint covers two weeks to allow for optimising the design with the aid of cardboard models and statics calculations, and more elaborate prototyping opportunities with laser cutting. The last and most elaborate sprint of the module is about designing a seating element (or chair if you wish).

*Figure 4. Students in the ‘studio’ classroom working on the ‘gripper’ assignment, combining the language of design with the language of engineering. From left to right, discussing ideas with the tutor, making cardboard prototypes, and demonstrating at the challenge market*

Each Thursday and Friday the students spend the whole day in the same classroom (figure 4). We set up a studio-like environment where they could work non-stop on the challenges, while supported by additional short workshops and tutorials, specific for the topics of the challenge. Every Friday afternoon the students present, either to their peers or at the end of the challenge to the tutors in a so-called ‘challenge market’. A term that we adapted from the concept of the ‘project market’ [8] which proved itself as an efficient method for grading design work [24].

## 6 DISCUSSIONS

With our combination of subjects and the fast alternating between 'thinking' and 'making', the module caters for the necessary development of the students on three levels [4]. The practical (what do I have to as a designer), the theoretical (why do I do that as a designer), and the reflective (what does it mean that I do that as a designer). The practical is addressing the students at the level of novices in design [25], where much guidance is needed as the students have to become acquainted with the 'rules of the game' [26]. The theoretical knowledge on design history, methodology and creativity should help them in actively identifying these 'rules' from their design experiences in the sprints. This showed in the evaluation of the module with a survey (n=75) where 96% of the respondents agreed or strongly agreed on the statement "I understand how the courses and the project of this module relate to each other."

In the evaluation of the module the teachers and tutors were particularly positive about the students: many students were present and active, they were kind and motivated, and there was generally a positive vibe in the classroom. This acknowledges the effect of having the students work on their design projects on-site in an environment that they could make their own [27]. Although one tutor righteously commented that the environment was "not for introverted students".

Moreover, Dorst [26] criticises the educational concept of the studio, amongst others for not living up to its expectations of mimicking practice and not being effective in transferring knowledge. We think we have successfully overcome the latter with the quick iterations between the design practice in the studio and the theoretical courses in the remainder of the week. This also helps in staying away from the problematic master-apprentice model. The quick iterations and multiple design sprints also allow for making mistakes, as Dorst also acknowledges learning from failure beneficial for gaining design experience [26]. A secondary benefit of having multiple sprints is the diversity in team compositions. By having different groups and group sizes the students work with different people, have to pursue different roles and encounter multiple teamwork situations. As Persaud, Flipsen and van Hinte [23] state about challenges within design teams: "While some issues relate to project management and technical content, the most significant one's stem from the diversity in cultures, educational backgrounds, emotional dynamics, and individual competences among team members." [23, p.8]

## 7 CONCLUSIONS

With this educational concept of framing the students with both the *language of engineering* and the *language of design* we think we have combined the positive aspects of learning the basics of design practice in a studio environment with the benefits of reflection on the experience from design theory.


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