Towards a vision for Industrial Design Education

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INTRODUCTION

The department of Industrial Design of the Technical University of Eindhoven is facing severe challenges. The student numbers are growing, the staff-student ratio is decreasing, department has faced a financial loss and the educational program needs to habituate to the context of an institutional educational innovation. Against this background, the Department of Industrial Design of Eindhoven University of Technology has started a large project that aims at proactively approaching an educational transformation towards taking the best of the current approach, innovating it based on educational trends and best practices and offering it without overhead to growing numbers of students. In short, the overarching research question of this large project is, how to shift and transform higher education in Industrial Design for Bachelor programs.

This paper reports on the first phase of the large project and aims to: (1) describe the intended characteristics of a self-directed and competence centered educational program for Industrial Designers and its context; (2) determine the strong and weak points of such an educational program based on results from an assessment by an accreditation committee, student evaluations of the curriculum, external advisory reports, and taskforce reports; (3) derive promising insights, trends and developments by describing which innovative and potentially useful educational concepts exist in the global design education. All in all, this results in formulating a preliminary direction for a new vision of the educational program. The paper adds to the knowledge base about designing design programs and provides input for formulating visions on design education.

The paper is structured as follows. First we present the intended characters of a self-directed and competence-centered educational program. Second, we describe how this program was implemented and perceived by its' users and valued by the accreditation committee. Followed by an overview of important trends found in design programs. Finally, we integrate the findings and provide directions for the future of this Industrial Design program.

1 THE EDUCATIONAL PROGRAM OF INDUSTRIAL DESIGN

1.1 The Bachelor of Industrial Design: Mission and vision

The Mission statement of the department of Industrial Design of the Technical University of Eindhoven expresses a focus on intelligent systems, products, and related services in a societal context [1]. The educational program is characterized by a self-directed and competency-centered learning approach [2]. In this approach, competencies are defined as 'the individuals ability to select, acquire, and use knowledge, skills and attitudes that are required for effective behavior in a specific professional, social or learning context [3].

The study guide of the program explicates several implications of the competency centered approach. The programs offer learning environments that are as *authentic* or realistic as possible reflecting the future professional practice of designers. The authentic element returns to the program via the use of clients for projects and

coaches that bring in the professional design experience. The program takes *differences between students* into account. Students choose their program based on their own learning needs. This makes the program demand-driven. The choices are discussed with their competence coach and formulated in their personal development plan (PDP). In that sense, students need to *take responsibility* for their learning. The claim is that the responsibility provided to students is much bigger than in other programs. Dealing with responsibility, determining own learning needs and learning to design *asks for reflection*. Reflection is a necessary tool for self-directed learning.

There are some important features of the program that are not directly related to competency centered learning or self-directed learning, namely: vision, identity and the student as a junior employee. Students need to develop a clear and distinguishing vision on designing, need to develop a clear insight on how they view their identity as a designer and on how they want to transform the world through design. During their study students are considered as junior employees.

1.2 The Bachelor of Industrial Design: the curriculum

At the beginning of each semester, students make their PDP in which they describe their vision and identity, explicate where they are in their learning and formulate learning goals. Also, they choose learning activities they want to follow to gain knowledge and skills. During the semester students work on these learning activities, including a project, follow workshops, assignments and consult experts to realize their learning goals.

The projects are the backbone of the curriculum. Students are coached while working on their projects and receive competency coaching to reflect on their learning experiences, explicate their learning and formulate new intentions for learning. These new intentions for learning are formulated in new versions of their PDP. To foster learning students receive written feedback after assignments and projects. Verbally students also receive feedback during the coaching and assignments. During the semester students collect learning evidence, reflect on this evidence and store and communicate the evidence and reflections in a showcase portfolio. Students reflect on their deliverables, their competency development, design process and learning process. At the end of the semester, students are assessed on their overall competence of designing, vision on design and growth as a designer.

In the course of the semester, several elements of an assessment procedure are performed. First, a demo-day is organized to make students exhibit and pitch their work. Next, the showcase of a student is reviewed by the teacher to answer the question whether the student demonstrates sufficient development. Then, an assessor student meeting takes place in which students are questioned about the content of their showcase. This is a moment for clarification or discussion. Finally, an assessor meeting takes place. This meeting can be considered as a sort of peer-review procedure performed by qualified assessors. During the meeting, a verdict is brought in and explained by an individual assessor and discussed with the others till a consensus is reached. It is decided whether the student has developed sufficiently during the semester. To determine whether the amount of development is sufficient, levels of growth are used: awareness, depth, expertise and visionary [1]. These levels are funded in theory on skill acquisition [4]

1.3 Context of the Bachelor College: mission and vision on education

The TU/e's educational mission is to educate engineers who will be able to make significant and innovative contributions to society throughout their career [5]. To realize this mission, the Eindhoven University of Technology (TU/e) has gone
Through a major reform of its bachelor education over the past three years. Grounded in an analysis of the engineer of the future several ambitions were formulated [6, p. 9]. The new Bachelor College should educate the engineers of the future with a firm disciplinary basis and a broad skillset. The skill set should include collaborative and communicative skills, an entrepreneurial attitude, lifelong learning skills and the ability to work in a multidisciplinary team. The graduates should, therefore, have divers profiles ranging from students with in-depth mastery of a discipline to students with a broad and multidisciplinary profile and the application of technology within the societal context. Also, the students graduating should have diverse profiles ranging from those with an in-depth mastery of the discipline to those with particular strength in multidisciplinarity and the application of technology within the societal context. Finally, a graduate should be able to identify and address the problems caused by the impact of science and technology on society.

Meijer and Den Brok [5] formulated the vision underlying the major reform in their essay on education at the Tu/e in 2030 for the engineers of the future. The trends the authors describe in their essay informs the potential redesign of the Bachelor Program since they provide the context and frame of such a redesign. They formulated a vision for the following core elements [5, p. 7]. The Tu/e should choose for small-scale education and master-apprentice interaction as key components of academic education. Furthermore, teaching should be driven by student demand for a stronger tutoring role for the teaching staff. ICT should fulfill a major role in teaching large groups of students and in lifelong learning. Also, a greater emphasis should be put on multidisciplinarity and output qualifications in education and educational quality assurance. Finally, a considerable expansion of TU/e education aimed at lifelong learning and a substantial involvement in the business world. The elements previously mentioned have been (partially) implemented in the Bachelor College innovation.

1.4 The Bachelor College: the content

The Bachelor College is a so-called broad bachelor program. All bachelor students of the university have to follow basic courses. Students have to follow basic courses in Mathematics, Applied Natural Sciences, Modeling, USE, design and professional skills. With core courses in engineering, a solid knowledge base is provided. So-called USE learning lines are organized to show that technology will always be used in a large (societal) context. In each use learning line, there is one subject. This subject makes the interaction between technology and the surrounding environment clearly visible and focuses on one or more USE perspectives. Students also have to choose electives. Each department of the TU/e offers electives. Choosing electives will broaden and deepen the skills students possess. Next to that, students receive so-called coaching in which they are coached in their choices for their (individual) study program. Coaches also foster the (implicit) identity development of students.

Now we have described the vision of education and the content of the bachelor program of Industrial Design and the vision and the content of the Bachelor College we proceed with an evaluation of the Industrial Design program.

2 EVALUATING THE BACHELOR PROGRAM OF INDUSTRIAL DESIGN

In this chapter we summarize how the educational program of ID is evaluated by the accreditation committee (paragraph 2.1), by students (paragraph 2.2) and we describe the advice of an external researcher and a follow-up taskforce about education (paragraph 2.3).

2.1 Appendix summary accreditation outcomes Bachelor's program Industrial Design

In the October 2013 our department was assessed by an accreditation committee of the Dutch NVAO, consisting of international experts [7]. In this section, the main results are shortly summarized. The educational programs were scored on three standards. One standard one, the intended learning outcomes it was expressed that the Committee appreciated the clear focus (intelligent systems) and the objective of a new profile for industrial designers. The integration of learning outcomes in the frequently updated competence framework was also appreciated. Next to that, the focus on personal development was considered valuable. Keeping in touch with stakeholders was considered to be of main importance because a new type of designer is introduced. The stages of growth were considered as a point of improvement. The descriptions could be made more concrete in terms of expectations for students.

The second standard, teaching-learning environment was considered as good. It was greatly appreciated that the ID-programmes at the TU/e had chosen a different educational model. However, the committee emphasized that running such a model required vision, drive and effort in both planning and execution. The committee was quite enthusiastic about the curriculum that allows for choice and reflection. The amount of feedback students receives was also valued but the committee was of the opinion that the consistency of the feedback could be increased. It was also advised to make work on the further integration of the required Bachelor College (BC) elements in its curriculum.

Standard three about assessment and achieved learning outcomes was judged as being of sufficient quality. The committee was of the opinion that the system that is in place is adequate and follows the educational concept. The quality control in this system is evident and especially values the peer-review system to calibrate the final verdicts was considered as valuable and important. The committee did find that transparency of assessment criteria should be enhanced.

2.2 Results of National Student Questionnaire

The National Student Questionnaire is annually distributed among students of all higher education programs in the Netherlands and asks students to express their opinion about the programs. For the department of Industrial Design around 40 % of approximately 420, bachelor students completed the questionnaire. The students could indicate their answer on a five-point scale ranging from unsatisfied (1) to very satisfied (5). It was found that students are satisfied with their learning outcomes in terms of generic skills (mean of 4.4), are satisfied with the teachers (mean of 3.9) and the groups-size in educational settings (mean of 4.0). The content of the program was also highly valued (4.0). The quality assurance of the educational program was appreciated less positive (mean of 3.2). Also the study load (mean of 3.3.) and the testing and assessment provided room for improvement (mean of 3.6). Furthermore, students were not that satisfied with their scientific skills (mean of 3.4).

According to the students, the program did prepare them well for their future career (mean of 4.3) and offered an excellent study environment (4.5).

2.3 External advice and taskforces

For various reasons, the board of the department has asked an external advisor to map the current strengths and weaknesses of the department and its education [8]. The researcher advised to reformulate the vision on education in such that it is it is in line with the TU/e vision on education including the Bachelor College. Next to that, the vision should explicate what the role of engineering (science and technology) is in the education and which final qualifications are required with respect to (engineering) knowledge and skills. Also, the researcher advised to redesign the educational programs to make it doable and scalable. Exchange with the other programs at TU/e should become possible, and the strengths and weaknesses of the current program, and its attractiveness for potential students should be maintained.

2.4 Summary of strengths and weaknesses

Table 1 outlines and summarized the strengths and weaknesses of the Bachelor Industrial Design as distinguished in section 1.0-2.3. The list is not exhaustive.

Strengths	**Weaknesses**
• Learning environment (small-scale, free-choice, reflection, frequent feedback) • New profile of Industrial Designer • Teaching skills of staff • Content of the program • Generic skills • Preparation for the future • Alignment between goals, learning and assessment • Vision on education (competence-centered, project-based, self-directed learning, learning from experiences, educational concepts of vision, identity and junior employee)	• **Workload of the staff** • **Study load of the students** • **In transparency of the assessments** • **Inconsistency of feedback** • **Integration with the bachelor college** • **Vague end-terms and criteria** • **Scientific skills** • **Feasibility and scalability of the program** • **Visible knowledge and engineering components**

Table 1. Strengths and weaknesses of the Bachelor Industrial Design

3 TOWARDS ELEMENTS OF A NEW VISION FOR THE BACHELOR PROGRAM OF INDUSTRIAL DESIGN

3.1 Follow up: Taskforce education

As a follow-up of the advice of the external advisor [8], the departmental board asked a taskforce to provide expert advice to the departmental board on education [9]. The taskforce education formulated requirements for a new vision of education.

The new vision of the ID program has to be in line with the mission of the Tu/e. Furthermore, it was deemed important to define ID as an engineering program and to this differentiates with programs in Industrial Design that more relate to art. In a new vision, Design should be considered as an integrated field integrating different

disciplines and addressing societal or business requirements. Students should be able to select profiles that align with the job market requirements as well as with follow-up programs in the graduate school. The bachelor program should provide students with a common basis for these different tracks. Students should be prepared to become Interaction Design Engineers. To become these designers students should be enabled to learn to creatively and professionally integrate knowledge and skills in authentic projects that should be partly developed in collaboration with clients, who could be possible future employers. The projects should enable students to advance towards self-directed learners and communicative team players with analytical skills and a hands-on attitude. The program should be designed in such a way that the openness of the challenges in the projects should be systematically increased.

The taskforce also came up with suggestions to implement such a vision. In particular the taskforce made suggestions on how to support students in becoming successful self-directed learners. SDL should increasingly become the responsibility of the student. Also, individual learning goals should be benchmarked more against the levels of growth. Furthermore, it was advised to enhance the elements of multidisciplinary teams in which people from different subject areas work together.
Finally, the taskforce advises the Board of Industrial Design and the educational directors to formulate tutoring a design team as a final attainment level of the Master and define tutoring of Bachelor students groups as the way to address this competency.

3.2 Follow up: studying promising and innovative design programs

To build on the advice of the taskforce we studied promising and innovative design programs. We have analyzed the leading design or design-related programs in regions that have played an important role at the forefront of design, United States of America and Nordic Europe. In addition, we have looked more specifically at trends in our own country, The Netherlands.

Various design programs can be distinguished, ranging from art schools to academic programs and focusing on topics such as Industrial Design, Design Engineering, Interaction Design, User-centred Design or Strategic Design. Recently, the focus of Design as a discipline has undergone a paradigm shift [10]. Whereas traditionally design programs focused on proposing solutions to problems by means of artifacts, the way that designers work has been used to tackle larger societal problems. The role of the industrial designer has consequently gone through many changes [11]. Thereby the focus has been extended from products to systems, services, and experiences. The approach, which is often addressed for this new view on design, is often labeled as Design Thinking.

Design education emerged from studio-based programs such as the Bauhaus, which started from the arts and crafts and viewed product development as form giving [12]. Examples still exist in art-school driven programs such as the Parsons School of Design, the Aalto School of Arts, Design and Architecture or the Design Academy Eindhoven. Consequently the School of Ulm, which focused strongly on the analytical perspective by integrating science and art and teaching a structured problem-solving approach [12] inspired design education in engineering schools such as Industrial Design Engineering TU Delft, Carnegie Mellon’s School of Design or Industrial Design at Aalborg University.

Today, design programs are more and more addressing increasingly complex global, social, and business innovation challenges e.g. Stanford School of Design, Copenhagen Institute of Interaction Design or Industrial Design TU Eindhoven. Thereby, design is extending its integrative approach by connecting engineering, business, social sciences and arts. Furthermore, the increasing amount of technology in society has also led to more technology driven "design" programs emerging from schools in Computer Science such as Digital Design Aarhus University, MIT MediaLab or Creative Technology UTwente. The latest trend in design education goes actually beyond programs, as they are not offered in unique departments, but they become central schools are setup in universities where various programs work in a multidisciplinary setup e.g. Stanford D-School, UCSD Design Lab, Aalto Design Factory or UTwente DesignLab. In these schools, students from diverse backgrounds are trained in Design Thinking, which could be considered as the engineering approach to 21st Century Skills. Students work in multi-disciplinary teams on finding creative solutions to "wicked" problems offered by authentic clients (companies, non-profit organizations or NGOs). Not only do these schools support collaboration between students, researchers from different programs, they often also involve the industry and businesses actively in their teaching. Design Factory e.g. argues that it "is made for finding, incubating and realizing new ideas". While in the D-school "all of the classes are team taught by a robust mix of faculty and industry leaders".

What all programs have in common is a strong focus on project-based learning and learning by experience. There is a strong focus on making in studio-like environments to support and stimulate creativity. Furthermore, although the term Design Thinking may suggest otherwise, the facilities that enable rapid-prototyping are fundamental to design. An example is Stanford's Product Realization Lab (PRL) that supports students with facilities including: Laser Cutting, Additive Manufacturing, Casting, Machining, Welding/Forming, Woodworking, Electronics, Finishing, Plastics, Sewing or Vinyl Cutting.

Finally, although prototyping, building and distributing hardware has always played a central role in design education we foresee a new trend. As new manufacturing techniques are becoming so easy to use, current design practices are reaching the same democratization of innovation that software and media had in the early 00s. Consequently, the focus of the design field may soon move towards Biotech, as suggested by the head of MIT's Media Lab Joi Ito (2012) or Chemical Engineering. Consequently, we should be aware that technology is not the only driver for design, and should be considered mainly as an enabler. Basing programs on one technology only may eventually, given the strong developments in the field, reduce the flexibility of the graduates. The focus should, therefore, lie with the (creative) process and understanding how to communicate and convince people and industry about technological innovations.

4 THE FUTURE OF THE BACHELOR PROGRAM OF INDUSTRIAL DESIGN PROGRAM AT THE EINDHOVEN UNIVERSITY OF TECHNOLOGY

The main assignment for the upcoming years will be to redesign the Bachelor program of Industrial Design to enhance the integration with the Bachelor College

while maintaining its strengths, addressing the weaknesses and keeping the vision and frame of the Bachelor College as a starting point. In this section we would like to compare the visions, relate it to strenghts and weaknesses and identify elements of a future vision for the bachelor program of Industrial Design.

A first claim we would like to make after integrating the results described the vision and content of the ID program and the Bachelor College program would be that the visions underlying the Bachelor College and Industrial Design show a lot of similarities. Both visions include the strive for small-scale, student-centered and demand-driven education with a focus on multidisciplinarity, lifelong learning, collaboration, and communication. Both visions also explicate the need for diverse profiles of students. Next to that, both visions acknowledge the importance of tutoring, coaching, and frequent feedback. Thus, a part of the vision of ID is already outlined.

A second claim we make is that this study provides potential explanations for the lack of integration of ID with the Bachelor College. This lack of integration is partly caused by a different design of the content of the programs and the greater emphasis of the Bachelor College on a strong knowledge component and the importance of outcomes as compared to ID that emphasise development. The Bachelor College starts with providing a firm knowledge base in engineering and smoothly switches to use of knowledge in context and provides students with less opportunity to chose at later moments in time. Thus, there is a gradual transition from knowledge to the application and a gradual increase in students' responsibility for learning. The ID program, on the other hand, was arranged according to 'discovery-oriented principles in practice'. A new ID vision should be inspired by the principle of fading in which responsibility for learning gradually shifts from teacher to student, in which projects are formulated less and less prescriptive and become freer and more complex placing more demands on the choices of students over time. Also, students should be provided with a clear knowledge base in engineering, engineering aspects of design and design itself. This requires defining a knowledge base and a theory on how learning should progress. The latter should also be formulated for self-directed learning. Based on such theories on the progression of learning the curriculum should be designed. Finally, improving the integration will likely result in a decrease in study load for students and workload of staff. A better fit requires less investment in terms of effort and time.

The vision of the BC also provides directions for improvement for ID. However, whereas the Tu/e vision acknowledges the importance of ICT for large groups and lifelong learning acknowledges we would add to that. The ICT trends, for example, provide opportunities to enhance the consistency of feedback, the transparency of assessments, to reduce the workload and to address quality assurance issues [13, 14]. Also, it is a potential means to provide small-scale and personal education by adding personal goals [15]. Next to that, it will provide a means to introduce forms of self-assessment and formative assessment. These forms of assessment are attractive because feedback is generated without the involvement of teachers, it enhances the efficiency, potentially reduces workload and it also has positive effects on learning.

Additionally, we defined elements of a vision that should be preserved. The program should remain focused on self-directed learning, learning by experience, and it should be competence-based with multidisciplinary and authentic projects with real

clients as the core of the curriculum. It should also fit with the trends in design education as described in the previous section. For example, design thinking should be made more important and should be placed at the forefront of the program.

Another point to be kept and included in the vision of ID are the concepts of identity and vision. Explicating these concepts and systematically integrating them into the curriculum has several advantages. The professional identity and vision are important tools to stimulate individual learning trajectories. Also, including the concept of identity and vision will enhance reflection, potentially stimulate self-knowledge and, therefore, enhance informed decision-making, enhance the motivation and make learning more personal and its results more sustainable. To go short, it has the potential towards unique professionals and to enhance self-directed learning.

REFERENCES

[1] Bruns Alonso, M. & Diggelen, M.R., (2014), *Study guide Industrial Design, academic year 2014-2015*. Eindhoven University of Technology.

[2] Hummels, C., Vinke, D., Frens, J., & Hu, J. (2011), Competency-centered education for designing interactive and intelligent products. *Creation and Design*.

[3] Voorhees, R. A., (2001), Competency-Based Learning models: A necessary future. *New directions for institutional research*, 110, p. 5-13.

[4] Dreyfus, S. E., (2004), The five-stage model of adult skill acquisition. Bulletin of science, *technology & society*, *24(*3), 177-181.

[5] Lemmens, A.M.C., (2015), Intreerede. TU/e Bachelor College: well-founded innovation in education. Technische Universiteit Eindhoven.

[6] Meijers, A & Den Brok, P., (2013), Engineers of the future. An essay on education at TU/e in 2030. Eindhoven, 2013.

[7] Authors, (2014), Report on the bachelor's programme Industrial Design and the master's programme Industrial Design of Eindhoven University of Technology. Quality Assurance Netherlands Universities (QANU). ©2014QANU

[8] Mouwen, K. (2014). Internal document, presentation. ID kan zoveel beter. Bevindingen, conclusies en aanbevelingen.

[9] Authors, (2014), Advice report taskforce education. Internal document. Eindhoven University of Technology

[10] Findeli, A. (2001). Rethinking design education for the 21st century: Theoretical, methodological, and ethical discussion. Design Issues, 17(1), 5-17.

[11] Valtonen, A. (2009). Six decades–and six different roles for the industrial designer. Nordes.

[12] Resiliency, Risk, and a Good Compass: Tools for the Coming Chaos (2012) http://www.wired.com/2012/06/resiliency-risk-and-a-good-compass-how-to-survive-the-coming-chaos/

[13] Funk, M., Van Diggelen, M. (2014), "Feeding a monster or doing good? Mining Industrial Design Student Feedback at Large". In: Proceedings of the 2014 Workshop on Interaction Design in Educational Environments (IDEE). ACM, New York, NY, USA.

[14] Van Diggelen, M. & Funk, M. (2014). Feedback Conversations: Creating Feedback Dialogues with a New Textual Tool for Industrial Design Student Feedback. In Communications in Computer and Information Science (CCIS), Habib M. Fardoun and José A. Gallud (Eds.)

[15] Van Diggelen, M. & Funk, M., (to be published), Stimulating feedback conversations: Evaluation of a Textual Feedback Tool for Industrial Design Education. Sefi 2015, Orleans.

APPENDIX

List of sources consulted in studying promising design schools implicitly referred to in the text:

http://ciid.dk
http://designlab.ucsd.edu
http://dschool.stanford.edu
http://designprogram.stanford.edu
http://www.newschool.edu/parsons
http://www.designacademy.nl
http://www.utwente.nl/designlab
http://www.utwente.nl/create
http://www.ide.tudelft.nl
http://design.cmu.edu
http://industrialdesigner.dk
http://design.aalto.fi
http://www.aaltodesignfactory.fi
https://productrealization.stanford.edu