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INDUSTRIAL DESIGN ENGINEER – THE FUTURE OF TRADITION IN ENGINEERING EDUCATION

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1 Introduction

Technology, more precisely the technology space involving machine design is, on one side, part of the human culture, on the other side, culture shaping potential. It is a characteristic of creative spaces that components of socio-cultural system can be found at the same time and are influencing the other's probability of genesis existence. Therefore, technology always has social, political, economical, and ecological interrelations, which are needed to be considered through the creation and application of technical works with all the influences; that needs a comprehensive knowledge in itself. Contemporaneously the paced-up development of technology, technological systems emergent from the separation of technology and its cultural evolution show an increasing complexity, which become perplexing not only for the spectators, the users, but for the creators, engineers of a specific field. Because of the partly new requirements demanded by the above mentioned and the products of the future, e.g. new technical function, saving consumption of material and energy, high specific performance, automatization, environment-friendliness, etc., and the changing of the resources of the design and the emerging of new product-production philosophies, the concept of the product and machine design has widened, its structure, approach, methodology, and necessarily its education has changed.

2 Paradigm of Integration

The paradigm of differentiation and specialization, which was dominating until the middle of the 20th century in the engineering work was switched over to the paradigm of integration from the eighties. The paradigm changing in design goes with the evolvement of new design theories and methodologies, the application of mutually matching new techniques and methods, and the evolvement of new forms of cooperation.

The paradigm of integration, conversely the classic design process, assumes the collective, goal-orientated work of the participants, their cooperative creativity, and assumes the achievement of the personal, informatics, and organizational integration. The actions taken on different fields remain insufficient if they do not couple with adequate methodology and modes, and if they do not become a common approach, a manner of working.

The Integrated Product Development (IPD) is not a monolithic system of design methodology, but a design philosophy consisting of a number of well known procedures, design tools, of different goals and approaches, elementary and complex ones, and the concept of the education of experts to have the appropriate competence profile for the accomplishment of that.

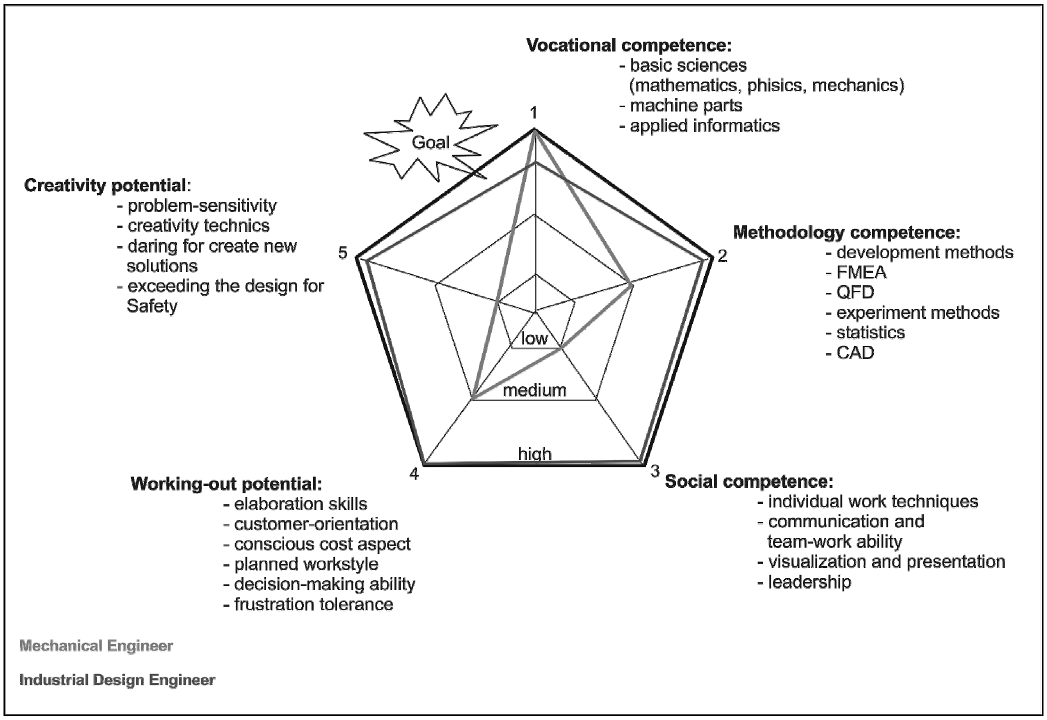


Figure 1. The Competence Profile of a Product Engineer

3 IPD in University Level Education

Product development plays a determinative role in the product producing process, which the efficiency of is determined by numerous factors. Out of these, considering both the creation and application of the support tools and methods for the design process, and the competitiveness and novelty of the borning product, the designer having the appropriate competence profile has significant importance. The expectations required of the designer can be divided into five categories (Figure 1.), which the achievement of, in most cases in traditional engineer programs, is not guaranteed on even levels. By the experiences of almost 10 years on the Industrial Design Engineer program of the Budapest University of Technology and Economics, the graduates of this program are approaching the needed requirement profile, implied by the philosophy and concept of education distinct from the conventional engineer education. As the reader will see, the gestors determined the curricula to train generalists instead of specialists – unlike the European practice.

The Industrial Design Engineer program was founded in 1995. The creation of this program was motivated by the recognition, that Hungarian industrial products, though in many cases they are not behind the foreign competitors considering the technical parameters, they have a market lag for their unfinished exterior. The industry and the cultural government recognized that this problem cannot be solved successfully involving designers, who do not have knowledge about manufacturing, market positioning, management aspects of the product. That was the reason why this – incomparable in the Hungarian technical higher education - program was come into existence.

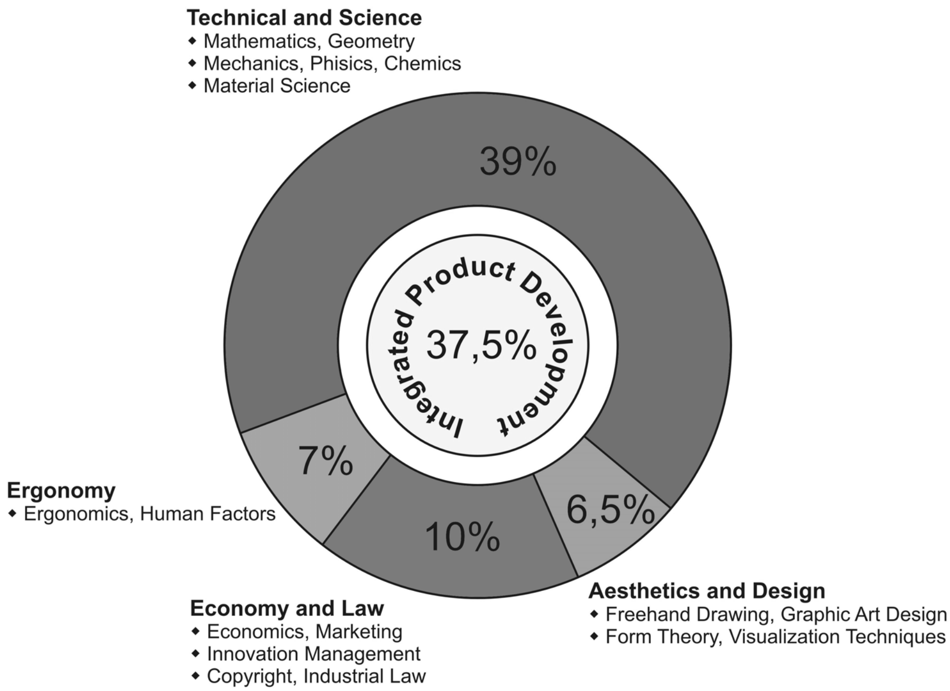


Figure 2. The Pillars of the Industrial Design Engineer Program

During the program students acquire knowledge of four fields: technical design studies, product and system ergonomics, industrial design studies, product planning and management. These fields of knowledge are integrated vertically and horizontally, through the whole duration of the program, in Integrated Product Development projects.

The aim of the course is to train such engineers, who:

- are flexible and effective in reacting for the challenges of the market, especially in little and middle company frames,
- have the ability for individual and creative working in any phases of the product development process due to their knowledge and skills on technology, aesthetics, humanities, economy,
- have the ability to manage the innovation process of the product development, to manage the material, organizational, human resources needed for the product development, and to manage certain periods of product life cycle,
- are conformable for formalizing products, services, systems in a way that expresses its complexity and coherent with it,

on the fields of design, manufacturing, sales of industrial products.

The Industrial Design Engineer (IDE) is a technical expert who can basically be characterized by the features sketched above. Mainly they use their knowledge and skills successfully on a variety of industrial products, through their activity they embrace the whole innovation process, the product life cycle, from the origination of the product idea, through the planning and realization, to the market launching, even to the recycling.

The Industrial Design Engineer is not an Industrial Designer. The industrial design studies are just a part of the knowledge and skills that an IDE is supposed to acquire. In the IDE program a strong emphasis is put on those subjects, which establish the ‘engineer approach’, furthermore all those information, which bear upon the product’s technical construction, manufacturability, quality, user and environment friendly feature, economy, competitiveness, etc.

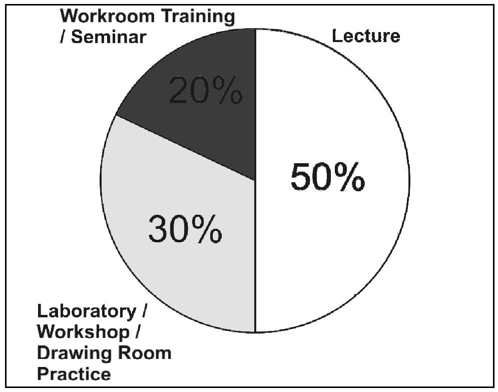


Figure 3. Proportions of Theory and Experience

One basic feature of the IDE course is its strong experience-orientation, built upon the so called ‘learning by doing’ principle. According to this the students work on individual projects (including planning, designing, modelling, even prototyping) from the beginning of the program, they work out the strategy of market introduction, make economy studies, etc.

The methodology basis and background is given in the first semester in a subject called ‘Methodology of Product Engineering’, which overlooks the whole product development process according to the ‘Reference Model of the Product Development Process’ (Figure 4.).

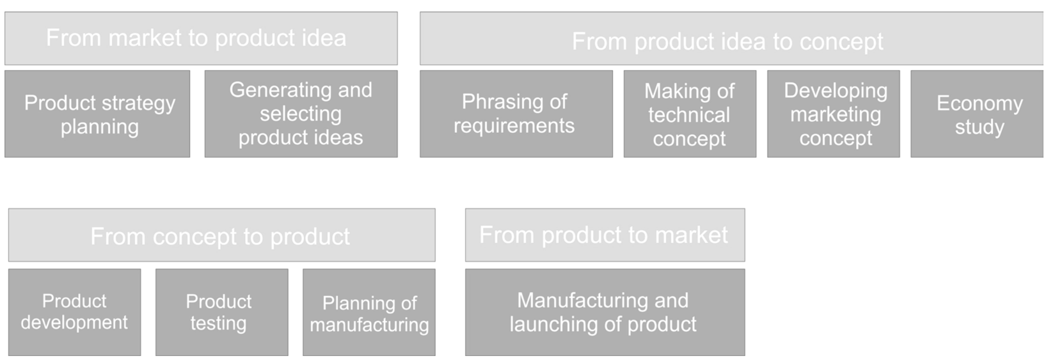


Figure 4. Reference Model of the Product Development Process

3.1 Examples of IPD projects

The drilling and integration of the acquired knowledge is ensured by the IPD I to VIII. projects and the diploma piece project. Through the working-out of the projects the members of teams of 3 or 4 have to trace the complete development process each time. In differently marked IPD projects, the emphasis is laid on different development phase, depending on the educational purposes. In the following we show a few outcomes of those IPD projects.

Table 1. Product Proposal

	Strong emphasis is put on:
	problem understanding, idea finding, product development process step by step, from market to product idea, teamwork, general technical-market understanding, creative techniques, brain-aided design, pencil-aided design, documentation *areas of knowledge integrated:* design methodology, basics of ergonomics, informatics, mathematics, materials science, mechanics, freehand drawing, technical drawing

Table 2. Design of mobile product display

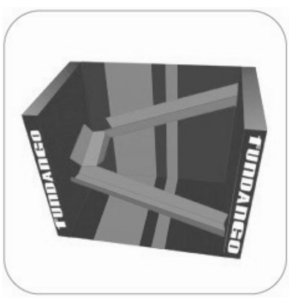
	Strong emphasis is put on:
	product idea, from market to product, product environment, product image, advertisement, paper as a material, adequate manufacturing, model aided design, individual work, elaboration, evaluation: 3P (product, process, presentation) *areas of knowledge integrated:* physics, programming, freehand drawing, materials science, models in mathematics, economics, manufacturing, machine design, mechanics

Table 3. Design of skill developing toy for children

	Strong emphasis is put on:
	product planning, market research, market segmentation, benchmarking, UP, information on cognitive and motoric abilities, information on ergonomics through technical to normative, setting up requirements, natural materials and adequate technologies, modeling technologies on any materials, alpha-beta tests *areas of knowledge integrated:* physics, chemistry, machine design, electronics, form theory, graphic design, ergonomics, marketing, management

Table 4. Design of a simple industrial product, model and technical documentation

	Strong emphasis is put on:
	art design, selection design, physical product environment, DFM, CAD, total technical documentation, virtual model, different modeling techniques (foam, gypsum, clay, RPT) *areas of knowledge integrated:* graphic design, ergonomics, marketing, thermodynamics, fluid dynamics, CAD/CAM

Table 5. Design of equipment, object of metal

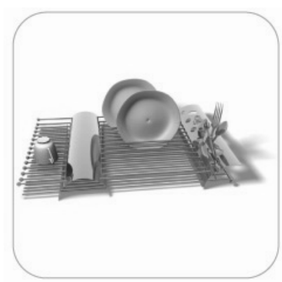
	Strong emphasis is put on:
	product idea, innovation, industrial law, DFC, packaging, 3D visualization, metal modeling, metals and adequate technologies *areas of knowledge integrated:* CAD/CAM, presentation techniques, packaging, copyright, special manufacturing, innovation management

Table 6. Design of furniture, interior objects

	Strong emphasis is put on:
	art design, configuration design, furniture design, finding novelty, human environment, ergonomics, virtual and downscaled real model *areas of knowledge integrated:* ergonomics, special manufacturing, innovation management, DFE, mechatronics, product safety, TQM

Table 7. Redesign of a vehicle

	Strong emphasis is put on:
	redesign, QFD, anthropometrics, prototype, FEA, FMEA, standards, product safety, feasibility study, visualization, functional model *areas of knowledge integrated:* any other subjects taken from the list of specializations (either Technics, Ergonomics, Economics, Aesthetics spec.)

Table 8. Design of dynamic equipment

	Strong emphasis is put on:
	virtual industrial environment, simulation, complex technical system, mechatronics, electronics, new product and proposal for realization *areas of knowledge integrated:* any other subjects taken from the list of specializations (either Technics, Ergonomics, Economics, Aesthetics spec.)

Table 9. Solving industrial design problem in virtual/real company environment

	Strong emphasis is put on:
	real company environment, total development process, teamwork, documentation *areas of knowledge integrated:* any other subjects taken from the list of specializations (either Technics, Ergonomics, Economics, Aesthetics spec.)

Table 10. Solving industrial design problem in real company environment

	Strong emphasis is put on:
	individual work, full documentation, prototype *areas of knowledge integrated:* hoping that all until recently

4 The Concept of the Bi-Level IPE Education

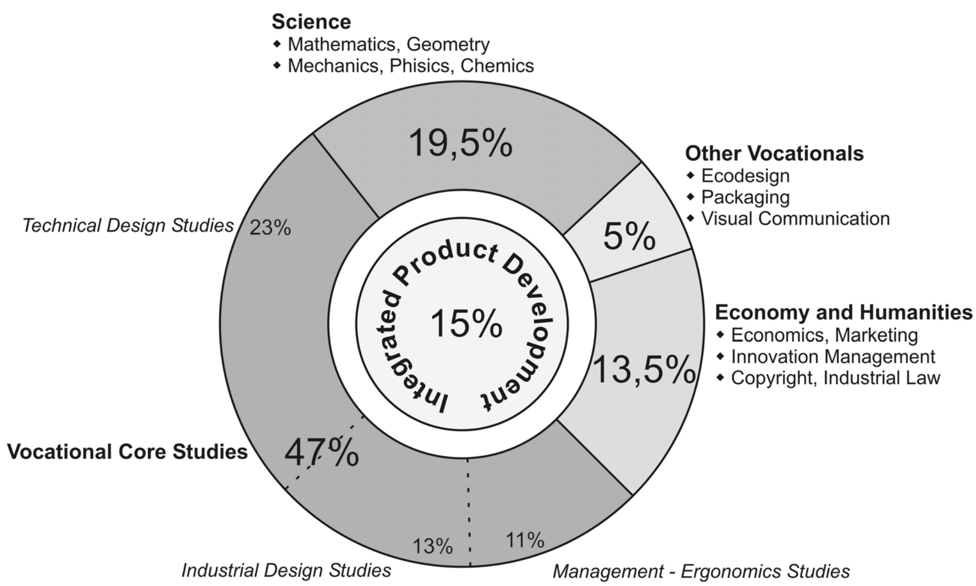


Figure 5. The Restructured Curriculum on BSc Level IPE Education

Consequent upon the Bolognian procedure the 7 semesters (210 credit points) BSc, and the 4 semesters (120 credit points) MSc programs begin in September 2005. Leaving the purposes of the education settled – according to the Hungarian regulations – on the BSc level, the architecture of the curriculum is restructured (Figure 5.), beside the changeless amount of theoretic education, by advancing virtual product development, the ratio between the seminars and the laboratory practices is changing in the unacademic field of education (Figure 6.).

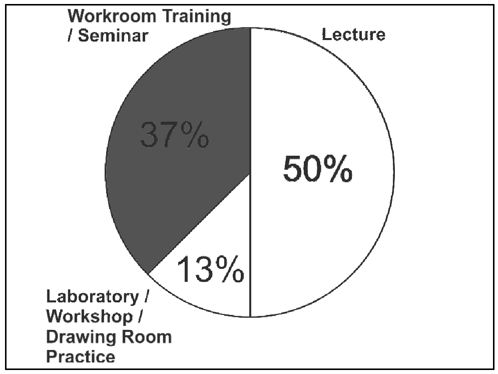


Figure 6. BSc; Changing Proportions in Unacademic Fields

The structure of the Bachelor curriculum is shown on Fig.5. The typical domains are:

- within the Science core studies students are familiarized with mathematical basics of engineers' work, basic physical effects connected with product development, basic chemical, thermodynamic, hydrodynamic, and mechanical laws, paying special attention for measuring them;
- in Economy and Humanities students gain knowledge on micro- and macroeconomics, basic innovation, marketing, industrial law studies, considering their expected jobs mainly in small and medium enterprises;
- the Vocational Core Studies imply the following main areas, according to the interdisciplinary character:

- science and technical design,
- industrial design, aesthetics, communication,
- economics, humanities, ergonomics, management studies.

The purpose of the subjects is through their store of learning to establish and support the projects of Integrated Product Development in practice, and also to support the communication, cooperation, the effective teamwork with co-professions, e.g. mechanical engineers, designers, technology managers. In the center of the Differentiated Studies, as in all directions of specialization, there is the series of Integrated Product Development projects in the case of the Product Design and Development Specialization. The projects, which are mainly built on economic and vocational knowledge, are aiming the integration and achievement of practical application of the studies according to the curriculum. The most important character of the major is the consistent achievement of the 'learning by doing' principle by the projects accomplishing the forming and developing of skills needed for the IPD through 5 semesters. The major maps the process of product development in a didactic way, and represents the most work in credit points. The complexity of the design tasks is getting higher from semester to semester, and in different semesters the emphasis is put on different elements of the innovation process.

By the above mentioned and the specific capabilities and potentialities of each institution the other subjects of the Vocational Core and the Differentiated Studies are supporting the characteristic, e.g. wood industry, silicate industry, etc. product design and development projects.

The studies of the Product Management Specialization are built on the formerly achieved knowledge of economics, management, marketing, and ergonomics, and the specialization deepens the knowledge of the students in human and organizational aspects of product development. Furthermore, workroom and exterior trainings, and the projects of the Integrated Product Development major help in developing the skills, which are necessary in a real company environment to manage the product development successfully, for the proper interpretation of the user information (interactions), or the practical usage of which might increase the competitiveness of the products. The knowledge and practices of the Design Specialization support efficiently the aesthetical outcomes of the IPD projects.

As a result of the BSc level education on the three - Product Design and Development, Product Management, Design – specializations it is expected from the BSc graduates to be able:

1. to efficiently use the known analyzing, synthesizing, design and surveying techniques on their academic fields;
2. to critically analyze the arguments, assumptions, the abstract concepts and data, to form an estimation and assist solving complex problems;
3. to understand the concept of the work on their specific field in an unforeseeable environment, to have the ability and skills to describe and judge the special aspects of a given task;
4. to use the learned methods and techniques to revise, strengthen, expand, and apply their knowledge and understanding;
5. to initiate and carry out projects in teamwork, primarily in multidisciplinary environment;
6. to get information, ideas, problems, and solutions across both to expert and non-expert public, even in international environment;
7. to study, having the gained knowledge, further, at a higher level (e.g. MSc), to extend their learning.

Beyond the expectations above, they have the special competences of the Industrial Design Engineers, namely they are:

1. able to design a product at a relatively complex level, taking requirements of aesthetics, usage, market, durability, safety, and manufacturability, etc. into consideration;
2. able to define, document, visualize, and present the object;
3. able to reason the decision made in connection with the designed object, to test them, and to support them with results and methods of technology and applied scientific research;
4. able to analyze their design projects using design methods and to methodologically reason the applied routes;
5. able to elaborate a design project (planning, distribution of tasks, teamwork, cooperation, etc.);
6. conscious about the historical, cultural, socio-economic and industrial environment of industrial design and product engineering; and
7. able to incorporate the manufacturing aspects.

5 Conclusion

Due to the development on the fields of culture and technology, an evolutional change eventuated on the fields of design science and education, too. The change in design's objects and resources, the satisfaction of requirements towards designer's activities, the philosophy of the integrated product development, and the need of global computer aid for design and for virtualization caused a palpable paradigm shift in the education and the designer practice. A sensitive balance has to be found between the industrial needs and the education spectrum, and this is a matter of leaving some portion of the 'traditional specialist engineering' sciences, and instead, concentrating on training generalists with an integrated overview on design. The real accomplishment of the integration would need the methods and tools to be developed in an expedient way, would need the features of the design process to be analyzed further, and would need the education to be revised and modified according to the changing of the environment.

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