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TED - Experience from interdisciplinary design projects with students of industrial design, engineering design and economy/marketing

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Abstract

Teamwork is a key factor for success in industrial work. Industrial Design should be integrated in the product development process, rather than being a separate activity of cosmetic nature at the end of a product design project. In Stockholm, a co-operation during subgraduate education, between Engineering students and students of Industrial Design and of Marketing was introduced in 1994. Joint interdisciplinary project groups are formed, to carry out fairly openly formulated tasks, including market analysis, establishing of a business idea and a product concept. The objective for this TED (Technology-Economy-Design) co-operation is multi-fold. It is of utmost importance, that persons with different background and representing different specialities, can communicate. This is not only a matter of formal communication, a deeper understanding of other profession's "languages" and different views is essential for success. It is also beneficial to provide students mutually basic knowledge of the roles, working methods and constraints in industrial design, engineering design and marketing, as a basis for future team formation and co-operation in industrial product development. The student groups have to a large extent been self-organising. Particularly interesting is the students groups capability of solving conflicts themselves and, usually, turn the conflicts into something positive that brings the project forward. TED is really one example of Design in Context; Industrial Design is in this case integrated in product development projects where Concurrent Engineering is practised. This form

- so far experimental - of interdisciplinary co-operation has been very stimulating, for students as well as for teachers.

1 Background

1.1 Design teaching at KTH

At the Royal Institute of Technology - KTH in Stockholm, we have a long tradition, since the late 60-ies, of training subgraduate students of Machine Design in applied project work. This introduction of Problem Based Teaching, in the form of design projects in co-operation with industry, was something very unconventional at that time. Traditional lectures and exercises then constituted the predominating pedagogical method. The curriculum for the MSc degree in Engineering (180 credits, ”Civilingenjör” in Sweden) was then concentrated to subjects within classical engineering sciences. The classical subjects in engineering education are primarily directed towards analysis, i.e. training in methods for analysis (e.g. mathematics, numerical methods) and understanding of basic phenomena (e.g. statics and kinematics of rigid bodies, strength of materials, thermodynamics, fluid mechanics, machine elements etc.) in natural sciences and engineering sciences. When the subject of Machine Design was established during the 60-ies at KTH in Stockholm and at LTH in Lund, it was natural to introduce more of applied engineering and product development work in addition to the basic theoretical studies and provide

students training in applied engineering during their last year of studies. Presently, most specialisations (competence profiles) within the subgraduate teaching programs in engineering at KTH include some type of applied project work.

The syllabus of Machine Design covers much of the applied problems in industrial development and is frequently updated according to new scientific results, industrial standards and computer tools. Major subjects are the Product Development and Design Processes and product synthesis in particular, product specification, creativity techniques, design support methods, computer tools, quality assurance, environmentally adapted design, etc. The wider scope of Product Development is then covered, even if Engineering Design, i.e. the technical part of the product development process is the main focus. As text book at subgraduate level, [Ullman 92] is used at KTH. (On graduate level, for PhD students, an overview of current research within Engineering Design and Product Development is given to get the students acquainted with the different ”schools”, e.g. according to [Andreasen, Hein 87], [Hubka 76], [Pahl, Beitz 77], [Pugh 91], [Roozenburg, Eekels 95], [Clausing 94], [Ulrich, Eppinger 95], [Boothroyd, Dewhurst 89], [Suh 90], [Altshuller 84]). Projects in subgraduate courses are usually based on real industrial problems. The various projects could be focused on different phases of the product development process: feasibility studies and product concept development; or detailed design work including CAD-drafting, mathematical modelling / computer simulation for product

performance prediction as well as prototype construction and testing. As Industrial Design is usually an important part in product development, concerning consumer goods as well as industrial capital goods and heavy machinery, it has been natural to include at least some orientation of Industrial Design in the Machine Design curriculum at KTH. After some early experience of co-operation between professor Folke Blomberg at KTH and professor Lars Lallerstedt at ”Konstfack” (University College of Arts, Design and Craft, in Stockholm) during the seventies and eighties, a more permanent co-operation between KTH-Machine Design and Konstfack-Industrial Design was established in 1992. For the 3rd or 4th year students, mixed project groups with students from the participating schools were formed. As knowledge in marketing and economy are essential in product planning, in market driven product development and in commercialisation of new technology, the co-operation was extended in 1994. Students of marketing, from the Market Academy at Stockholm University - School of Business then also became participants in the joint project groups ”TED” (Technology-Design-Economy). Engineering students also do pure engineering design projects, besides the TED project which is more of idea and concept generation. Within the Department of Machine Design at KTH, parallel competence profiles with project-oriented courses for the last year students are also given in Machine Elements, Mechatronics, Integrated Product Development (towards psychology and management) and Internal Combustion Engines.

Separately, a 4 credit subgraduate introductory course in Industrial Design, open for all students within Mechanical, Vehicle and Materials Engineering was established at KTH in 1996. During the last few years, a number of education programs in Industrial Design, as well as Industrial Design specialisations for engineering programs, have been introduced at the Swedish regional University Colleges and at the Technical Universities.

1.2 Industrial Design teaching at ”Konstfack” (University College of Arts, Design and Craft in Stockholm)

This is a four year (170 credits) program, characterised by:

- Combined theoretical subjects and applied product development project work
- Function analysis
- Aestetics
- Ergonomy and man-machine interface
- Environmental considerations
- Techniques for presentation and visualisation
- Workshop practice, materials
- Computer tools, CAD

In the curriculum are also included basic courses in e.g. form and colours, common for all Konstfack students. Different forms of co-operation between Konstfack and KTH are well established since long. The 3rd year

students participation in the TED-projects represents one connection, engineering courses are also given by KTH for the students of Industrial Design.

1.3 Teaching at Stockholm University, Scool of Business - the Market Academy

The Market Academy runs two final years specialising in marketing, as part of Bachelor (80 credits) and Masters (160 credits) programs at Stockholm University - School of Business. These programs were introduced in 1991 and are characterised by a high degree of problem based teaching and training in group work. Other characteristics are:

- A scientific approach as well as real applications
- Students active participation in aquiring and developing basic marketing knowledge
- Pedagogical methods that stimulate student´s critical view, creative problem solving ability and personal development
- close cooperation with companies

Since 1994, twenty students, from the class of sixty 3rd year Master students, participate in the TED project groups. This form of interdisciplinary project work meets very well the general objectives for the Market Academy educational programs.

2 TED objectives

Team-work is a key factor for success in industrial work. Many companies presently apply the principle of Concurrent Engineering, i.e. close co-operation and early data transfer in development projects, between different functional groups in an organisation. In fact, this in nothing entirely new. However, it is of utmost importance, that persons with different background and representing different specialities, can communicate. This is not only a matter of formal communication, a deeper understanding of other profession's "languages" and a capability of accepting views and opinions of persons with a different background and reference frame, is essential for success. The author has, during many years industrial work in various companies, seen several examples of exclusivism among different functional groups. This problem could be seen even among engineers, e.g. between designers and computational specialists, between designers and production engineers, etc. and between engineers and economists, persons within marketing and sales, etc. It is then important to avoid "cementing" of too narrow group thinking already during education.

To support future co-operation between different specialists, it is also beneficial to get students acquainted with thinking and methods within other fields.

The objective for the TED co-operation is then multi-fold:

- To provide mutually basic knowledge of the roles, working methods and constraints in industrial design, engineering design and marketing, as a basis for team formation and co-operation in industrial product development.
- To get engineers in particular acquainted with designers techniques for visualisation: sketching, 3D-models, etc.
- To get industrial designers and marketing students aware of basic phenomena in natural sciences and engineering
- To give engineers and industrial designers basic understanding of economy, market analysis, market introduction and marketing
- To train students in co-operation within interdisciplinary groups, to avoid exclusivism and too narrow views

3 Organisation of project work and examples of projects

The TED project is an activity over seven to eight weeks only. This limited time is due to planning problems considering other activities within the different educational programs. All 20 - 25 fourth year students of Machine Design, 20 (of totally 60) third year students of Marketing and all 7 - 12 third year students of Industrial Design are participating. Five or six project groups are then formed, with an even distribution from the participating schools. Each group runs a separate project, some years a subject has been duplicated.

Two models for defining project tasks have been tried so far:

The original approach was that the TED projects were given to the students as very open tasks. Usually, a business idea and a product concept should be established within a fairly wide sector within the society. Typical examples of target sectors have been:

- Package-less distribution of food to the end-consumer
- Equipment for rehabilitation and training of disabled people
- Compact living
- Safety equipment
- Household appliances and equipment for daily maintenance in buildings
- Parents with small children

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For the TED projects in 1997, another model, with project tasks based on specific company contacts, was used. Participating companies, usually smaller enterprises, had in common a need to diversify, to extend their product range or to carry out a major redesign of current products. These company contacts were initiated from the Schools, by utilising the network within the Swedish Foundation for Industrial Design.

During the first day of introduction, the participating schools give brief presentations, followed by a students groups presentation of one representative project from the previous year. Project themes and/or participating companies are then presented and project groups are formed.

An informal party, to initiate the social contacts, will conclude the first day. Introductory lectures on Industrial Design, Marketing and Engineering Design are given during the beginning of the TED period. Different forms of instructor support has been tried. Scheduled project meetings at the different schools, with separate instructors for each project and from each school participating, has been tried. This model was found to be a bit over-organised, also considering the limited time available. In some cases, instructors from the different schools presented conflicting opinions (also part of reality) to the groups. We have then turned to self-organised meetings at the most convenient time and place for the individual project group, with one instructor allocated for each group, that could be called upon when needed. All teachers, with their different background, are of course also available when needed. A formalised common mid-time project presentation has been tried, but was found to be a bit discouraging for some of the groups, as the time for initial market studies and final decision on a product idea differed a lot between the groups. Workshops at Industrial Design and Machine Design are available for construction of models, mock-ups and function prototypes. Project work and results should be documented in a common report and presented at a final TED seminar. Some weeks after finalising the projects, students and teachers meet for a common discussion. This is not a formal course evaluation, but rather a possibility to get two-way feedback.

Examples of projects:

- Endoscopic surgery - stereoscopic display
- Package-less bulk food retail distribution
- Carriage for professional indoor cleaning
- Golf bag / carriage
- An easy-to-handle locking device for Euro-pallets
- ”Second Hand” - a kitchen supporting device for partly disabled people

4 TED experience and students response

Group dynamics is one of the most interesting experiences of these joint projects. It is not only three different disciplines that meet and should be merged to perform a common task. In fact, three different types of persons, with different views and reference frames meet and should work together. Different personalities are usually attracted by different types of education, hence already before university studies a selection has been made. A completely problem-free co-operation in project groups could then not be expected. Particularly interesting is the students group’s capability of solving conflicts themselves and, usually, turn the conflicts into something positive that brings the project forward. One important experience for the students is then, that conflicts are not necessarily negative only! In some cases, instructors have supported in conflict handling. Of course, during the years, we have seen a few cases with groups that have failed more or less

completely. But in fact, an astonishingly high share of the projects have generated results of very high quality, despite this type of very wide and openly specified tasks and despite the potential for conflicts. The groups have to a large extent been self-organising, the tasks have involved basic market investigations, establishing a product concept and setting the goals, organising and carrying out the work, and finally documentation and presentation. Students have themselves taken the necessary contacts, within and outside the schools.

With the type of very wide tasks used in the beginning of the TED-cooperation, the project work has been a bit splitted. During the first phase, students of marketing have been the most active, performing market analysis e.g. by means of FOCUS-groups. When a more narrow area of application and a product idea has been established, designers and engineers take the lead. During the last phase, market introduction and sales planning is one important subtask. Students representing all the different disciplines have participated in the frequent project meetings, however, for brainstorming, project planning and design reviews, etc. According to the experience so far, a bit narrower tasks e.g. based on company contacts, have been beneficial to get a more even distribution of workload for all participants throughout the projects. With company and/or product based tasks, a longer share of the limited project time will be available for real product development work.

In several cases, continuing contacts between students from the participating schools have been established. TED then becomes part of the personal networking, very important for their future career. In some cases, project work has also continued after the courses, in cooperation with industrial partners, to commercialise a product concept developed in a TED project. A number of projects have resulted in applications for registration of design or patent applications.

The co-operation could be seen as part of the individual maturing process, also increasing the general knowledge base. Despite the TED co-operation being an experimental activity, virtually all students have appreciated this form of training. Some students have commented upon the TED co-operation as being the most stimulating activity within their education.

5 Conclusions

TED is really one example of Design in Context; Industrial Design is in this case integrated in product development projects where Concurrent Engineering is practised. This form of interdisciplinary co-operation in mixed student groups has been very stimulating, for students as well as for teachers. The TED co-operation has been of experimental character and we try continuos improvement based on the further experience gained each year.

6 References

[Andreasen, Hein 87] Andreasen M M, Hein L, *Integrated Product Development*, IFS Publications Ltd, ISBN 0-948507-21-7, London, 1987

[Altshuller 84] Altshuller G S, *Creativity as an exact science*, Gordon and Breach Publishers, ISBN 0-677-21230-5, Luxembourg, 1984

[Boothroyd, Dewhurst 89] Boothroyd G, Dewhurst P, *Product Design for Assembly*, Boothroyd Dewhurst Inc., Wakefield RI, USA, 1989

[Clausing 94] Clausing D, *Total Quality Development - a step-by-step guide to world-class Concurrent Engineering*, ASME press, ISBN 0-7918-0035-0, New York, 1994

[Hubka 76] Hubka V, *Theorie der Konstruktionsprozesse*, Springer, Berlin, 1976

[Pahl, Beitz 77] Pahl G, Beitz W, *Konstruktionslehre*, Springer, Berlin, 1977

[Pugh 91] Pugh S, *Total Design*, Addison-Wesley Publishing Co., ISBN 0-201-41639-5, Wokingham, UK, 1991

[Roozenburg, Eekels 95] Roozenburg N F M, Eekels J, *Product Design: Fundamentals and Methods*, J. Wiley & sons, ISBN 0-471-95465-9, Chichester, UK, 1995

[Suh 90] Suh N P, *The Principles of Design*, Oxford University Press, Oxford, 1990

[Ullman 92] Ullman D, *The Mechanical Design Process*, Mc Graw-Hill Inc., ISBN 0-07-065739-4, New York, 1992

[Ulrich, Eppinger 95] Ulrich K, Eppinger S, *Product Design and Development*, McGraw-Hill International Editions, ISBN 0-07-065881-0, Singapore, 1995