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PROFICIENT DESIGNERS
A CHALLENGE TO ACADEMICAL EDUCATION

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1 Introduction and Motivation

Successful product development leads to competitive products and so safeguards the actual market position and the future of a industrial concern. The present market situation can be described by

- Shorter product life time
- Lower price expection for high standarts of quality
- Growing requirement for more specialized products
- Shorter product launch cycles

The conditions for a successful product under this demands is a complete holistic view of the total development process from market to product described with the technical term “Integrated Product Development”. The transfer technique of this development philosophy is fundamentally based on the creation of multi-disciplined project teams with the ability to quickly adept to the step changes in a dynamic market and to possible fundamental changes in the base techniques. This requires all the members of the development team to be personally identified with the development process and to be so organised, that all relevant data is to hand. Therefore new requirements are growing up to qualification, particularly to the combination and the weight of competence by design engineers. Required is an outstanding creative and flexible engineer, able to think integral and fitted out with management skills – a specialist with the ability to act as a successful generalist. Competence in fundamentals, social competence and methodological competence are the essential core qualifications of a design engineer which at least in this broadness are not taught in a traditional university education (1),(2). The university education of design engineers has to react upon this new professional requirements and an adequate professional competence must be generated. At the University of Karlsruhe the Institute of Machine Design and Automotive Engineering has constituted the new central subject called “integrated Product Development” in order to take of this challenges and to translate them into an educational concept. The lecture will present the fundamental contents and methodological approaches and will describe first experencies.

2 Education Aims

The education aims can be structured as follows according to the core competences for developers:

Competence in Fundamentals:

The university education provides a broad fundamental knowledge and offers specialisation, which borders must to be reconsidered and crossed from the viewpoint of an integrated process of development. For the developer it is necessary to work with technical, economical

and organisational systems in terms of complexities of the product requirement, heterogeneity of product components (mechanical, electronic, hydraulic, data processing etc) and their combination to superior products.
The ability to analyse problems, develop solutions, create and design processes is essential for the competence in fundamentals. The knowledge of product and material to be posted permanently under consideration of development relevant research- and market trends requires an efficient strategy for information procurement, data processing and the readiness for a Life-Long-Learning even beyond all "Comfort Zones" of individual specialisation. The split between a product specific specialisation on the one hand and the integrated development process on the other hand requires an efficient management. Internal processes regarding information, planning, decision making and execution are to be coordinated in order to avoid loss of time, misunderstandings and errors which could appear on that particular interface .The management task is not the job of the project manager by himself but part of the working process of the whole team.

Social Competence

A successful integrated product design is based on a goal-oriented and innovative culture of dialogs in enterprises, as for exapmple (1),(3):

Problem-solving culture:

Seeing problems as a chance and challenge to think of possibilities instead of difficulties

Creative culture:

Promoting flexibility in thinking, creating bases for cross-functional thinking, imagination

Fractal culture:

Employees as responsible, self-controlling, closed-loop control systems

A distinct communication behavior of employees is necessary for a dialog culture like the one mentioned above. Here the behavior of the participant set outwards in cooperation with other persons involved in the development process is decisive. The goals of education which cover all these requirements are:communication ability, cooperation ability and ability to solve Conflicts (1).

Methodological competence:

The Institute of Machine Design and Automotive Engineering defines methods as tools for the specialised and with social competence fitted developer to realise the transfer of the steps of the product development process into the development progress of the target product. For an efficient and transfer-orientated treat of development processes a support with these tools from the product idea via the product concept and -design to product manufacturing and -recycling is an important requirement. Therfore the following education goals are definde by the Institute:

Teaching approved methods in context to each process step

Teaching criteria for method selection and

Teaching application experience and -security

3. Conversion of educational goals.

The education model " Integrated Product Development" of the Institute of Machine Design is structured in three units: They are offered parallel in the wintersemester as a main subject.

3.1 Lectures (4 hrs / semester week)

The product development of enterprises is taught in lectures especially under consideration of the requirements of small and mid sized companies. Based on practical experiences and examples from industry, the theory of systematic design, account and control for the development and innovation process as a team-oriented insertion of effective methods is be shown from the sight as a problem solving process. Strategies of development and innovation management, system analyses and team leading is introduced and discussed. The lecture is set for a limited auditorium (est. 20 students). This offers the possibility for knowledge processing in form of discussions with the use of multimedia tools for the visualisation of teaching contents. The official time frame of a lecture could be opened for an open-end discussion if it is necessary.

3.2 Workshops (3 hrs / semester week)

Knowledge is activated and built up with first experiences at the workshop. This is achieved through conversion of the taught methods which are orientated on the development process and the simulation of group-dynamic processes by means of exercises. This determines a flexible timetable for the methodic and their application for each workshop.A total of 13 Workshops covers the listed topics:

Team processes

Hosting- and communication techniques

Product profiling, list of requirements, project design

Application oriented creativity techniques

Online-research

3D – hand drafts

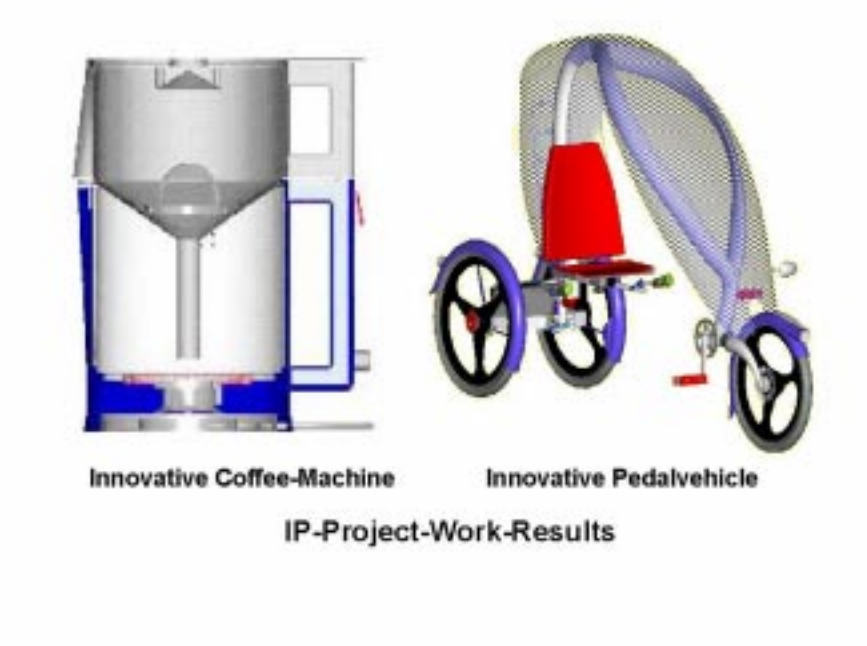
TRIZ, ARIS, Invention Machine

Introduction to patent law

Single workshops are accompanied by guests from industry as required. A 3D-CAD education is given supplemental to the workshop in a 5-day crash-course. The workshops are set up to the depression and extension of lecture knowledge and are not used for the direct concurrent support of the student project work running simultaneously.

3.3 Project work (120 hrs total)

The content in this project is the development of a product from the idea up to the virtual prototype (3D-CADModel) with an independent student development team. It is shown here as an example of an mid-sized enterprise at the Product-Development-Centre of the institute with attendance of the head of Inst. and his assistants as a formed management and its respective development teams Each team competes in a set up task, that was given by the management They get informations about the present position of the enterprise in the market at the same time. The communication to the management is set up by Email and there will be announced briefings in special cases. It is be reported and decided about thepresent develop progress and ongoing projects. (3 briefings / project). Hardware and software equipment (MS-Project©, Pre/Engineeer, Invention Machine,IM-Phenomenon, Access to the Internet/WWW and Databases) is set up in closed working areas for the project teams. Due to termination of the project a presentation is given in front of the management. In certain cases the management awards prizes for the best solutions. A valuation of their group performance and their team mates is done in a feed-back briefing. The results are handed to the management for a assessment (1).



4 Experiences

A tremendous interest on this educational model is present within the students, in spite of the massive manpower and expenditure. A selection has to be made. A high motivation and readiness is shown by most of the students development, the presentation occurred within newest professional standards and multi-medial support up to functional prototypes. Some of the presented projects had been patentable. The most innovative and unconventional solutions have surprisingly converted in concrete product notion. It shows, that graduates of this subject, who carry out their Diploma work in industrial companies, are able to convert their knowledge successfully. First Application showed a tremendous acceptance given widely through all kinds of industrial companies. Therefore it can be stated that this Karlsruhe originated education model promotes a professional competence for graduates.

[1] Albers, A., Burkardt, N., „Experiences with the new educational model „Integrated Product Development“ at the University of Karlsruhe’’, Proceedings of the 4th International Symposium on Product Development in Engineering Education in Lohmar, GKN International College of Engineering Lohmar Germany 1998, S.284.

[2] Albers, A., Birkhofer, H „Reengineering activities in Teaching Machine Elements at the University“ Proceedings of the 4th International Symposium on Product Development in Engineering Education in Lohmar, GKN International College of Engineering Lohmar Germany 1998, S.1.

[3] Albers, A., Burkardt, N., „Innovationen für morgen durch kundenorientierte, kreative und termingerechte E&K-Prozesse“, Wirtschaftsverband industrieller Unternehmen Baden e.V., Seminarunterlagen des Entwicklungs- und Konstruktionsleiterlehrganges 1999, Freiburg 1999.

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