INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'07
28 - 31 AUGUST 2007, CITÉ DES SCIENCES ET DE L'INDUSTRIE, PARIS, FRANCE

A WIKI BASED CONCEPT OF A GENERIC PROCESS MODEL OF IPD FOR UNIVERSITY TEACHING IN AN INTERDISCIPLINARY ENVIRONMENT.

Eike U. von Specht[1], Sándor Vajna[1] and André Jordan[2]
[1] Otto-von-Guericke-University Magdeburg, Germany
[2] Pingutec, Magdeburg, Germany

ABSTRACT

The integration of the approach of Integrated Product Development (IPD) as a graduate course of studies into the field of university teaching of the University Magdeburg will be portrayed. This is based on showing the limits of design methodologies and describing the necessity of IPD accompanied by a brief excursus to its history for creating the necessary basic knowledge.

Afterwards the need of a process view in product development is described, taking especially in account the generic IPD process model for supporting university project work in interdisciplinary student teams. Following the development philosophy of the IPD model of Magdeburg it forms a holistic way of proceeding that integrates and describes technical and industrial designing procedures in the context of all necessary aspects for a successful product development. But this generic product development process is neither rigid nor normative. It should rather be a smart form of support while conducting development projects of students in the framework of university teaching.

Currently, just a manual is available as a guideline for supporting the project work and for self-studies. It describes in detail a process driven procedure of IPD, goes into the bases of project and process management and additionally contains a description of a huge number of methods and tools based on the generic IPD process. However this form of knowledge documentation and mediation can only provide a snapshot and is therefore not flexible enough for handling with changing conditions and requirements in product development. That is why we decided to go for an own IPD wiki to support our students more effectively.

But which requirements does a wiki need to fulfil that is used in university teaching? What needs should be taken into account and which content shall be transported? The second part of the paper answers these questions and describes the actual experience with the wiki system. After a successful pilot phase with students, we plan to expand the IPD-wiki for the use in industry, especially focusing on the small business sector. For this purpose more research needs to be done.

Keywords: Integrated Product Development, university teaching, low effort supporting methods, industrial design, generic process, wiki, methods, tools and technology

1 INTRODUCTION

Based on the customer's demands, the parameters that influence shape and function of a product are determined in the early phases of product development. Always shorter times for development, increasing guidelines for costs as well as higher demands to function and quality form the framework conditions in product development. Nevertheless, we cannot look at the development of a product without keeping in mind the development process itself.

Here, the process of drafting and designing is a process of problem solving, unique for each product developer. During this process the product developer uses his cognitive resources for representing the field of problem and to develop solutions. Due to an always-increasing complexity of products and processes, products are developed in interdisciplinary teams that are partly spread inside and outside of a company.

Numerous methods and tools have been developed for supporting product developers and interdisciplinary teams. Some of these methods have been developed for relieving the memory by recording ideas (i.e. by drafts or models made by hand), for intellectual solution development (i.e. VDI 2221) or rather for co-operative solution development (i.e. team work).

1.1 Limits of "Classic" Design Methodology

A basic approach for supporting design processes was the development of design methodologies. Basic goals of developing design methodologies have been standardisation and economisation of procedures in the practice of design as well as the substitution of general problem solving processes by constructive activities connected with detailed directives of procedure for the constructing engineer. These goals determined during decades the educational concepts for the urgently needed engineers [2].

Design methodologies like VDI2221 define sequential phases of an individual product solving process. Each phase results in an abstraction respectively a concretion level of the product, which is defined as a technical system, and represents these results in a product model [19]. Especially gradual methods (like requirement lists, function structure, searching for active principles, morphologic boxes for varying and evaluating partial solutions, choosing and combining to complete solutions) are available for seeking solutions. Some researchers tried to represent these methods by algorithms in IT systems but these attempts remained unsuccessful.

In addition, practice and education showed over the years that design methodologies did not bring the wanted effects regarding finding new and innovative product ideas. According to bender the following reasons might be quoted [2]:

- Design methodologies are not sufficiently based in empiricism currently.
- The phase models and action schemes are rigidly linear. Discursive iterations, rebounds and loops are missing.
- Cognition-ergonomic results concerning individual patterns of thinking and acting of product developers are missing.
- The basically rational and gradual forms of notional problem solving strategies impede creativity and innovation. They limit the space for solutions.
- The de-compositive procedures are not complex enough for complex design problems: „The ensemble is more than the sum of its different parts".
- Organisational and economic aspects as well as management aspects for co-operative product development are missing.
- Design methodologies can only be applied on a high abstraction level to other fields of development like Mechatronics or software.

Basics criticism is that design methodologies are founded mainly on descriptive observation and originate from a time when the focal point of development was creating mechanic assemblies. A special problem is the prescriptive, linear-sequential description of design procedures. These procedures impede individual thinking and acting by e.g. heuristic or evolutionary characteristics and therefore disturb creativity and innovation.

By separating design problems to single parts and afterwards finding partial solutions, a main solution is generated that is often unbalanced because decisive product characteristics haven't been adequately represented in the creation process. Often, ergonomic, industrial design and ecological product requirements are simply „forgotten"[8].

Another problem is the adaptation of design methodologies to the individual. Increasing product complexity as well as the increasingly spatial separation between development and design, often even crossing borders, results in a separated product development in interdisciplinary teams. These new forms of organisation that are supported by new communication and product data management tools are not yet represented in design methodologies.

Finally, product complexity itself as the decisive element in developing methods and procedures is subject to rapid change. New requirements of product development processes excite consideration of new forms of support for design practice and serve at the same time as approach for making an adequate mark in education.

1.2 The Necessity of Integrated Product Development

Due to the growing dynamic of the market, a holistic product development is of more and more importance. The companies are especially subject to changing paradigms and principles of acting. That is how for instance a higher pressure of competition and the increasing market saturation lead to a growing price differentiation, a shorter product life cycle and therefore, to shorter periods of amortisation. Another obvious effect is that the innovation process is gaining more and more speed [3].

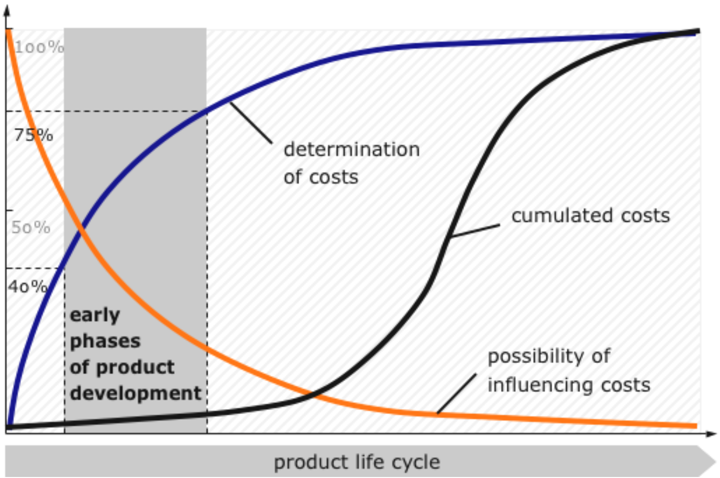

Figure 1: Course of costs in product development [22]

Product development has a pole position in the product life cycle by defining the product, because it is exactly the early phases in which decisions have to be made that determine future product characteristics nearly completely. These determinations have to be made although there is a high uncertainty and a lack of information in the beginning. Here, the engineer's experience and knowledge from former projects are an advantage for a successful project development. An improvement of the product development process influences the production costs decisively. 75 percent of the total costs are determined in this early phase (figure 1). This shows the high responsibility for the costs in product development. Especially in the early phase, the possibility of influencing the costs is very high, because here, adaptations and changes of the product can be realised with a relatively low financial effort. This possibility is declining decisively the more detailed the product becomes during the progressive product development process.

Taking these points into account, the current adaptation and changing of product development processes is gaining more and more importance. These changes are decisive for the economic success of each company. Therefore, next to the development of innovative products, the systematic and methodical support of the product development process is essential for increasing the flexibility and efficiency of a company in a market.

Due to the described starting situation, holistic concepts are needed that bring an improvement concerning costs, quality, and time. If possible, all aspects of the product development process should be taken into account in this context. The objectives and need of information of all departments have to be co-ordinated in the best possible way. A very good result can be reached by using synergies [4].

1.3 Brief Excursus to Different Approaches of IPD

Product development today faces new challenges due to the increasing market dynamic with every time more complex demands to human and technology as well as the need of shorter development times [12]. Only new strategies and holistic approaches can handle these challenges. Three models for this purpose will be explained here briefly.

All models have in common that the human is seen as the driving force in product development and therefore as the centre of interest. By integrating the employees of different sectors into the problem solving process, the often quite rigid patterns of activity can be opened. A strongly result-oriented working culture with an appropriate combination of self-organisation and organisational work provides the necessary framework conditions. The aim is to create an atmosphere of holistic thinking, while rejecting the thinking on department levels. That is how frictional losses can be minimised and development periods reduced while at the same time the quality of solutions increases.

In such a human-centred approach the human forms the most important part in integrated product development. That is why engineers in the future need (in addition to solid knowledge of sciences, mathematics and technology) more and more interdisciplinary competencies. Some of these competencies are for instance self-competence as well as methodological competence, which contains not only the choice of the methods, but also the choice of the moment of their integration and their application.

Of additional importance for a good product developer is the ability of seeing tasks holistically and not losing time in too many details. Next to special competence, social competence is very important, especially when working in interdisciplinary teams. It is also important to show the ability of working in teams as well as taking responsibility, not only as a member of a team, but also when leading a team. Communication competence is of special importance in this context.

1.3.1 Product Development according to ANDREASEN and HEIN

The basis of integrated product development of ANDREASEN and HEIN [1] is the progressively advanced design theory, which goes back to the already formulated ideas of OLSSON [11]. An idealised model for the whole product development process contained the holistic handling from the different points of view of the market, the product, and its production. The main purpose of integrated product development should be according to ANDREASEN and HEIN the optimisation of economic success. Next to the holistic approach, three other integrative approaches concerning the dependence in context and the chronological sequence of product development activities exist. These are co-ordinated activities that take place at the same time, interdisciplinary co-ordination and control as well as the collaboration of the departments and sectors concerned.

Product development of today differs mainly in the point that by taking into account several influencing factors in the early phase of product development, solutions of higher quality can be gained. The model is divided into phases and starts with the first recognition of a demand. The model consists of five different phases: Analysis of demand, conception, detailing, preparation, and realisation. The activities of marketing, sales, production as well as design and development pass the phases parallel.

For implementing the model, it is absolutely necessary to start with the analysis of the demands, even if this means handling concrete aspects of an already existing product or production process. It is very important in this context that the results concerning the market, the product and the production keep up with each other. The product development according to ANDREASEN and HEIN forms a holistic and interdisciplinary approach with a strong emphasis on design [1].

1.3.2 Product Development according to EHRLENSPIEL

The human centred approach of EHRLENSPIEL [6] puts the human as the one who solves the problems into the centre of attention and provides a methodology for overcoming the problems of product development, which is still marked decisively by the division of labour. The approach is characterised by holistic and integrative thinking and acting and describes the role of the human being in a socio-technical system. The approach focuses on an improvement of quality and a reduction of both costs and processing time. The IPD approach of EHRLENSPIEL is mainly aimed to support the close collaboration of all parties involved in the development process.

This type of integrated product development is strongly marked methodically and contains personal, informative and organisational integration approaches. The approach covers product development starting from the receipt of order up to the product delivery and offers a holistic view of the product and production process.

One important feature is the demand of the close collaboration of all parties involved in the development process. The aim is not to reach minor results within each department, but to pull down the mental walls between the different departments and focusing on the product as a whole as well as on a global success [6].

EHRLENSPIEL therefore uses the basics of design methodology, the psychological research in the field of thinking, numerous empirical surveys as well as systemic thinking. The connected elements of his methodology can be combined differently due to the kind and complexity of the process. The smallest of these elements is the TOTE scheme. Its circular procedure reflects most unconscious thinking processes. This scheme is run through until a solution according to the aim is found. Another element is the self-similar, uninterrupted cycle of procedure that uses smaller procedure sub-cycles for finding solutions for only parts of the problem. These are left behind only after reaching the aim and are structured into smaller tasks, which are elaborated in parallel and sequentially. These smaller tasks are clarifying the task, searching for solutions, choosing a solution, and realising it. These tasks are fulfilled by a sequence of, if necessary, recursive steps. Additionally, a toolbox of methods provides systematically structured methods. In addition to this extensive collection of methods, information concerning the appropriate use of the methods and the connection of different alternative methods are combined. A suitable proceeding plan describes the focused use, adaptation or description of a method more in detail. Exactly like in the TOTE scheme, this smallest element is the character of circuit. Therefore, the proceeding plan is situated between the methods and the operational development.

The organisation of collaboration described by EHRLENSPIEL focuses especially on shaping the organisation of assembling and sequence. It puts an emphasis on integration and co-ordination of the single persons and groups for reaching the common goal.

1.3.3 The Magdeburg Model of IPD according to BURCHARDT and VAJNA

The Magdeburg Model according to BURCHARDT and VAJNA [4] uses the initially described approaches of a holistic product development and advances them partly. The most important difference to other approaches is that the Magdeburg Model does not interpret the term of integrated product development as development method or as idealised model of product development, but as a holistic development philosophy.

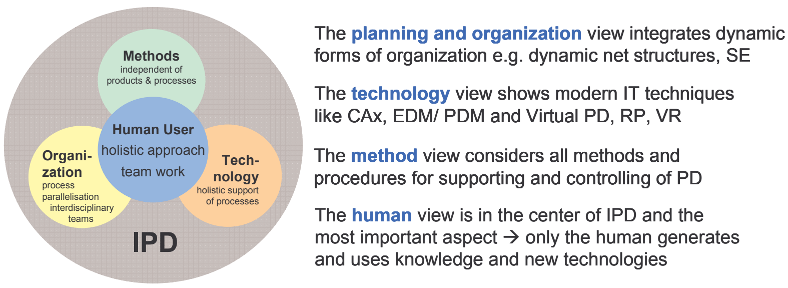

Figure 2: The four views of IPD according to BURCHARDT and VAJNA [4]

This philosophy contains four views: Planning and organisation, technology, methods and processes (especially with the inclusion of Industrial Design), and human user (with the inclusion of Ergonomics and Working Psychology). This is how it integrates all required factors for a successful product development, and, above all, fosters to take appropriate decisions with the right participants at the earliest possible time. The evolutionary and human centred approach of BURCHARDT and VAJNA supports sustainable development for technologies and products and influences therefore the social and cultural development of mankind positively and sustainable.

1.4 Integrated Product Development as a Course of Study

The ex ante described demands can't be fulfilled completely with the existing offers of study courses in the field of Engineering. That is why Integrated Product Development (IPD) was developed at the Otto-von-Guericke-University Magdeburg/ Germany (OvGU) as a new graduate course of studies according to the “Magdeburg Model” [4, 21].

Another point was the need of integrating all sectors involved in product development and the necessity of overcoming organisational structures that are based on the division of labour. Additionally, the participants should not only focus on the solution of technical problems but also on the corresponding procedures. In this approach, the human being as the one who solves problems creatively forms the centre of all considerations concerning the product and the development process. The developer is integrated in flexible organisational structures (teams) and is supported holistically by applied methods and the most advanced tools [16].

For creating a standardised view of IPD and advancing this approach, workshops have been carried out regularly in Magdeburg since 1996. During these workshops, at first the numerous different IPD approaches that have emerged independently were checked concerning points they have in common. Based on these findings, a human centred integration approach was defined that provides models of procedures on the executive level and supports the interdisciplinary development work of teams as well as of single developers systematically. Next to the question concerning the contents, today the issue of implementing this approach in industry is discussed. One result of these discussions was to initiate the development and the installation of the IPD graduate study course and especially the collaboration of university and industry in the framework of student development projects [21].

For about six years more than 70 graduate students of mechanical engineering have chosen the IPD study course as specialisation. Most of them are convinced of the modern integrated approach that represents an interdisciplinary education process, because here they can concentrate on the holistic development of new and innovative products. For choosing the subjects this means the integration of economic, operational and social subjects as well as classic and new subjects of product development, with a special emphasis on technical design and product ergonomics. This forms the basis for a close integration of procedures in design, ergonomics and engineering. Therefore, ideas are found by using only a pencil before the work with the computer starts [12], and interim models are created later in the process by using cardboard and plaster.

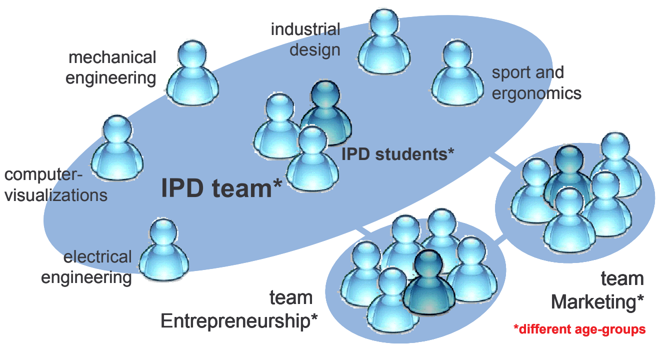

Figure 3: Team combination in IPD student projects [21]

The IPD approach was transferred successfully into teaching in the year 2000 when it was introduced as a graduate study course at the Otto-von-Guericke-University Magdeburg. This was the first time at least in German-speaking countries, that an engineering design study course was offered that integrates all possible participants during the product life cycle. Whereas teaching is mostly performed as classical lectures (although new approaches like E-Learning platforms are being tested) [17], the main attributes of this course have been multi-disciplinary teaching and the focus on student project work for which the tasks are provided completely by industry.

The core of the integrated IPD studies are the interdisciplinary student development projects in collaboration with regional companies and international partner universities, that are implemented into the course of studies next to a well founded special education in lectures and seminars. Especially, regional companies that lack own development capacities benefit from the innovative solutions found during the projects. Additionally, transfer of knowledge concerning the use of the latest CAx-, EDM/PDM- and communication tools from university to industry takes place.

The IPD projects run between 14 and 16 weeks. They start with a kick-off-meeting and end with a common final presentation of all projects of the current semester.

The current evaluation of the project progress of the single projects takes place during milestone meetings that are hold with the respective team. Here, the students present and defend the provisional results of their work. The product development process the students go through during the development is described using a generic process that is based on empirical studies. This generic IPD process is phase-controlled and forms the base of project work. The single project phases are: Defining the task in detail, conception, going into detail and designing a prototype. Different part processes that are composed of process elements build the generic process. That is how the students go through and live all phases of product development, starting with the first idea, over the designing process up to an operative prototype. The single process elements are the smallest described entities in the process and connected with methods and tools [7]. The IPD approach integrates the classic technologies of designing and representing as well as modern technologies like rapid prototyping especially in the early phases of product development that are decisive for performance.

Currently we offer our students a project manual for supporting them during their project work and for self-studies. It contains and introductory chapter concerning IPD, the development process, project and process development. Furthermore, it contains important methods, tools, and technologies. This information is represented in form of a book and illustrated by an example from practise.

2 THE GENERIC IPD PRODUCT DEVELOPMENT PROCESS

Successful companies with world-wide known brands have already recognised that only improved product development processes lead to competitive advantages. To reach and extend this level, highly qualified engineers with new qualification profiles are needed. These qualification profiles contain a broad knowledge of the basics of engineering, specialised abilities in development and design as well as the capability of understanding and being able to handle the growing complexity of distributed product development. Distributed development demands not only the creation of new solutions in interplay of creativity and systematic acting, but also the collaboration in interdisciplinary teams and the dealing with the methods of project and process management [8]. In addition, it only works in interaction of creative problem solving, application of suitable methods for process support, choice of the best form of organisation, use of efficient tools as well as the availability of corresponding knowledge or rather access to information.

Especially, the integration of industrial design and ergonomics are focussing already during the production process on the surplus of a product for the user. New questions like technical possible product complexity or solutions suitable for individuals need to be re-thought and answered again and again with the current problem. In this context it is quite interesting that during education classic methods of designing (like hand drafts and -models) are rediscovered for design practice. This means that capabilities are rediscovered that have been proven to support mental processes and creativity. In general, all technologies that are integrated in the design process (i.e. drafts, e-drafts, 3D CAD, CAID, VR, AR, RP) should guarantee a free change of conditions for mentally represented solutions while avoiding infringements of media. Each function for developing solutions needs to respond to demands of ergonomic cognition and must not be limited by descriptive models or framework conditions of information processing [13, 21].

Current process models and IT systems support the process of product development insufficiently. They especially limit the mental processes while thinking with the hands that influence decisively the solution and therefore the later costs.

2.1 IPD Development Ambiance

One declared goal of IPD is an increase of quality in development processes. Experience shows that there are huge differences in procedures between technical development/ design and industrial design, which disturb processes and therefore have negative influence on the costs. The reasons are among others justified differences in proceeding. Whereas e.g. an industrial designer prefers developing a complete unit very quickly (geometric-substantial and functional wholeness) for being able to develop a usable shape, the engineering designer prefers to go from the specific unit to a whole device. Quite interesting, that these differences are not represented in design methodologies [8].

In addition, a tendency to always more complex products with new function or a higher level of quality require new approaches in product development processes. Here the main focus is on increasing process quality by increasing transparency and decreasing redundancy during sub-processes and activities, acceleration of process speed by parallel collaboration of all participants as well as lowering the process costs in using data, information, tools and technologies during scientific analysis, research and change imagination.

Experience shows that the quality of development and design processes form a disproportionate share in cost development of a product. That is why highest attention needs to be paid to fostering creative potential in development and design processes.

2.2 The Generic IPD Process

Base of the process-driven procedure model of IPD is the observation of the whole product lifecycle. It starts with the first idea or requirement for a new product and ends with the release for series production. Usually, now all necessary information of a virtual or real product model is available. The generic IPD process has to be understood as a global reference process that aims to support project and process management holistically during a process driven process development. This process is complex and consists of single, closed and complementing phases that are amplified by parallel working (global) sub-processes (like communication, data management) and that in total represent an ideal reference project. However it cannot be understood as a rigid prescriptive procedure model, but as a flexible manual for application and adaptation to specific and dynamic needs of a certain product development process.

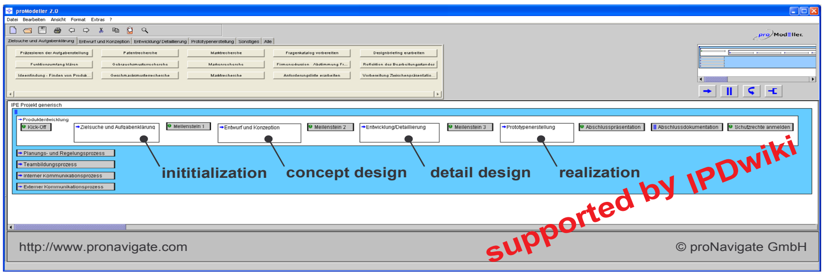

Figure 4: Simplified model of the generic IPD process [20]

The generic product development process of IPD is a result of a number of case studies from the field of product development and industrial design in the framework of student development projects. The goal was to develop common characteristics for a general process model that can be applied in general to product development by focussing on similarities of the different fields.

Following the Stage-Gate-Theory [12], the generic IPD process is divided into the four main phases *initialisation, concept design, detail design* and *realisation* (figure 5). These main phases are described in detail by connected sub-processes (sequential, parallel, alternative or iterative) and work packages as smallest process unit. Each work package is supported by methods, technologies and tools [compare to 7] as well as a short and a detailed description and examples. Each project starts with a kick-off and ends with a final presentation. The single project phases are verified and closed at the gates by consecutive project verifications. An integrative procedure within the single project phases is wished and activated.

The generic IPD process model is a detailed described reference process and forms the base and information platform for education in the framework of the graduate course of studies IPD and the interdisciplinary project work within this course of studies. The reference process supports, fosters and guarantees continuous product data modelling. It combines the procedures of different subjects from a design and design ambiance as well as former IPD projects.

In addition, the use of methods (in combination with tools and technologies) can be adapted more flexible and individually. Among others it is about the practical experience of which method supports the solution finding in which way and when a method can be left behind for finding a creative solution.

Requirements to industrial design and ergonomics mainly result from the later use and are planned during the phases of *concept design* and *detail design*, and usually objectified in a model. The generic IPD process respects and supports the needs of the different subjects and offers, as a hybrid approach, a development ambiance in which for example tasks of industrial design and engineering design can be combined directly instead of a sequential procedure. The main strategies for increasing process quality decisively are interdisciplinary collaboration, communication, operative project and process management as well as a common product data model.

3 GENERIC IPD PROCESS GOES WIKI

Currently a manual is available for our IPD students and participants in projects as a guideline for support and self-studies. It describes in detail a process driven procedure for project work, goes into the bases of project and process management and additionally contains a description of a huge number of methods and tools for supporting project work. It is based on the generic IPD product development process that is complemented by a descriptive example from IPD project work. However this form of knowledge documentation and mediation can only provide a snapshot and is therefore not flexible enough for handling with changing conditions and requirements in product development. In addition, we realised that this more traditional form of support is only partly accepted by the students. This was the reason to consider wikis as an information carrier for the generic IPD process.

3.1 Wiki and Semantic Wiki

A wiki is a collection of pages on the Internet that are connected with each other by hyperlinks. The name „wiki“ comes from Hawaiian language and means „quick“ in this context. Unlike to usual web-sites, the user can both read and edit wiki-sites [14]. The pages are modified directly in the browser. The necessary software is usually implemented on the server so that the technical requirements for the user can be minimised.

A wiki can be used in many different ways. They were developed in the field of software development where they served for documentation [10]. In general, wikis are useful for administrating large amounts of texts that need to be edited from time to time. But as modern wiki system also allow the upload of many different data, the range of used amplified decisively. Wikis are used for building up encyclopaedias, serve as tools in project management, are suitable as content management system (CMS) and much more. Due to broad range of applications as well as the possibility of integrating further applications by the application programming interface (API), wikis are used more and more in companies [15].

Wiki pages are collected with a special syntax. This is a simplified hypertext format that can be learned quickly [14]. For example in HTML one page is linked to the page [[topics]]by the following format: topics. In wiki syntax “topics” is enough for linking pages. That is how the word itself becomes a link leading to the respective page. If there is no page with this name, the system automatically creates an empty page. Due to the simplified syntax, a large number of people, especially computer layman, is attracted to use the wiki.

The free and unlimited editing of content is the main characteristic of wiki-culture and leads to effective collaboration of the participants [15]. At the same time most wiki systems support access and revision control. That is how vandalism on the pages can be avoided and mistakes can be corrected. In the unusual case of vandalism the community takes care of repairing the damage.

Semantic wikis are a further development of existing wiki concepts. In „usual“ wikis the pages do not have a given structure. Links to other pages are defined liberally by the user. This makes an automatic evaluation difficult, as the search algorithms cannot understand the meanings of the links. Semantic wikis on the other hand save both the contents of a page and the specific meta data. Usually this happens by commented relations [14]. That is how e.g. two pages „gearwheel“ and „shaft“ can be described by „is_fixed_on“ (.figure 6). In addition to commented relations to other pages, wiki pages can be defined by adjunctions. This makes especially sense when information is added that does not require an own site [18]. Figure 7 gives an example. It is obvious that it does not make sense to enter a new page for the weight of each component. This would lead very quickly to a huge number of useless pages and impede transparency of structure.

Semantic relations can be used in many different ways. They can help for example to link menus dynamically with relevant pages. That is how semantic relations contribute to improving navigation between pages and content. Moreover they can be used as filter for advanced search [14]. The sign chains are not only compared concerning matches, but synonyms are recognised and analysed by semantic relations. Due to semantics search algorithms are able to „understand" the meaning of a search and can find correct results for questions like „How many gearwheels with a reference circle diameter are fixed in a shaft?".

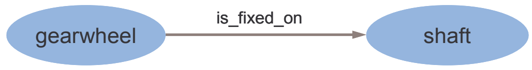

Figure 6: example of a semantic relation

The base for the notation described above is the Resource Description Framework (RDF) standard[1]. The RDF notation describes relations in form of a triple containing the resource, the characteristic and the object and forms the so-called statement. For the illustration a graph can be used like in the figure above. For automatic analysis the triple is often described by an XML syntax.

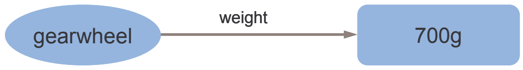

Figure 7: example of a relation to an adjunction

The RDF standards have been amplified by the Web Ontology Language (OWL) specification. Usually, ontologies form network structures. They are not necessarily composed hierarchically. The OWL specification adds the possibility of describing classes, characteristics and entities to RDF [5]. A class (often referred to as concept) refers to a group of objects with common characteristics. An object is the entity of a class. Like object oriented programming OWL specification allows to create hierarchies of classes and characteristics by inheritance and this way to describe complex structures.

Structures that are specified by concepts and relations are described as ontologies in the field of knowledge representation in Information Technology. Figure 8 shows an excerpt of a simple, hierarchical ontology. On top the class „machine_element" is situated. The characteristic "durability" has been assigned to this concept. The concepts „bearing" and „gasket" are derived from the class „machine_element". They combine entities with the same functionality. As these concepts have been derived from the class „machine_element", their entities too have the characteristic „durability". Furthermore, additional characteristics can be defined in a sub-class. For example one could assign the characteristics "dynamic load rating" and number of degrees of freedom" to the class "bearing".

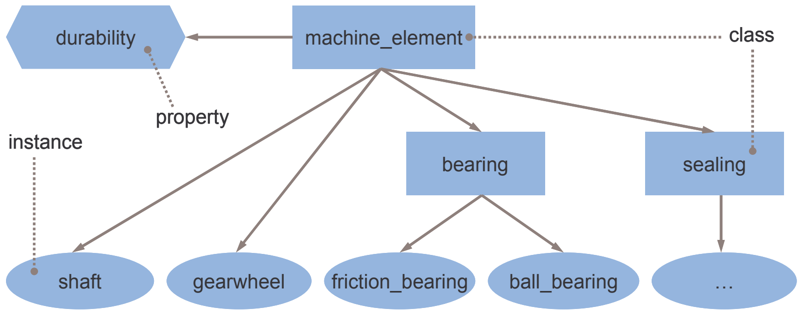

Figure 8: example for a class hierarchy

The demonstration shows that RDF and OWL are formal languages that can be used to save in website information concerning the content of the side as well as concerning its relation to other sides. The information can be analysed automatically as they have been achieved by logic [9]. A concept for a semantic wiki for IPD will be developed, in which information for product development will be saved in a structured way.

[1] RDF Core Working Group and Specification Development according to web platform www.w3.org/RDF/

3.2 How a Wiki that is used at the University should look like

In a first step suitable criteria need to be developed and verified for finding a suitable wiki system for IPD among the large number systems currently available on the market. Requirements for such a wiki can be assigned to different topics and combined like follows:

I. Administration

- Installation on the own server (local software limits availability and number of users)
- Server needs to fulfil the requirements of the wiki system (e.g. PHP, MySQL)
- Compatibility of the server needs to be taken into account
- Data bank systems should be preferred in comparison to file-based systems (system access)
- Determined, personal responsibility for hard- and software maintenance
- Providing sufficient resources (disk space for data)
- Easy and save installation and administration of the system
- High degree of development, running stability of the system

II. Perspective

- Possibility of update to newer versions
- Possibility of amplification to a semantic web

III. Access

- permanently online in the World wide web (intranet for pilot)

IV. Graphic User Interface (GUI)

- cognition ergonomic GUI (controllability, conformance with expectations)
- implementation of pictures and tables
- using wiki standards
- ideal: no fault tolerance
- sufficiently adaptable to individual needs

V. Handling

- Toolbar for text formatting
- Page preview while editing
- Comment (discussion page)
- Printer friendly
- Full-text search
- Allocation of sites to categories

VI. Free of Barriers

- By web surface basically compatible with all systems
- Only upload of format-neutral files (lpdf or jpg), for not needing a viewer or specific software
- Languages German and English

VII. Security

- Recovery-function, importing of older back-ups (e.g. in the case of vandalism)
- Complete data storage, back-up possibility
- User group management (assigning of rights)
- Content protection by authors control and releasing mechanisms
- Own server has to be preferred instead of hosting (higher security and control)

VIII. Costs

- free and open source (FOSS)
- general public licence (GPL/GNU)
- Semantic amplification can cause license costs

3.3 Selection of a Wiki System

The number of available wiki systems is very high. As high as this number is the number of differences between the systems. Starting with a choice of 77 selected systems, the number has been decreased step by step by using the defined criteria for a suitable system[2]. Finally, the decision was based on the state of development of the system as well as the possibility of integrating semantics in the system. The winner was the MediWiki with semantic extension. It has been the only one that fulfilled the defined criteria. MediWiki is based on the best-known wiki platform, which is used by www.wikipedia.org, too. As MediWiki has been existing already for longer time it has left the early stages of development behind. It provides a history function to avoid vandalism and SPAM attacks. For this wiki platform an add-on with semantic character has been released (semantic media wiki).

Alternatively other wiki systems have been installed and tested. Briefly the following are mentioned:

- UniWakka – especially adapted for the needs of universities (formulas, LateX, etc.)
- EditMe – fantastic possibilities for editing, perfect WYSIWYG
- IKE-Wiki – semantic wiki, that is still in its infancy.

The selected MediWiki with semantic amplification is easy in handling and due to is similarity with the well-known platform wikipedia most users are familiar with text formatting in the system. Semantics is reached in this wiki by the requirement that in the single texts the needed data has to be described by special text formats, which is not that transparent and comfortable in use. Alternatively, one has the possibility of creating semantics beforehand and integrates it to the wiki.

3.4 IPD Wiki as a lexical-semantic Learning Platform

We are working on that learning becomes more flexible and effective for our students and that development processes become more transparent and better in quality by providing knowledge based on a wiki system, especially MediWiki. This should in addition increase the quality of solution and by that improve IPD project work in general. Figure 9 shows the main components of the IPD wiki.

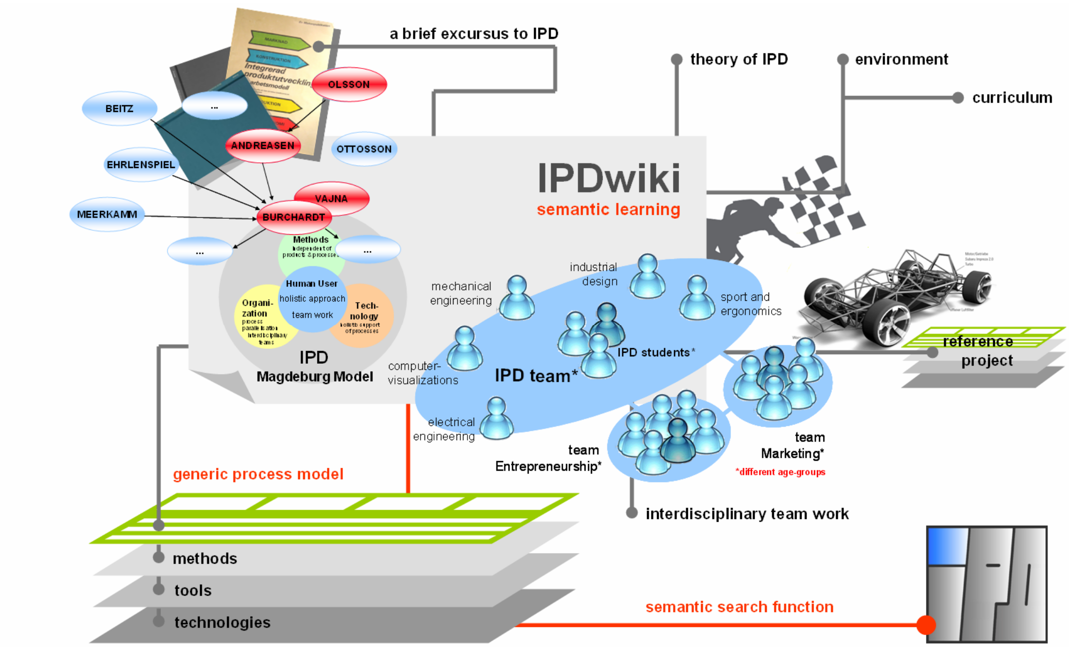

Figure 9: IPD wiki as a lexical-semantic learning platform

The high number of possibilities for showing and connecting information requires a comprehensible presentation that represents characteristics in their hierarchies and relation to each other. Here the

2 Very helpful was the web platform www.wikimatrix.org, as it always provides the latest information about available wiki systems and offers a comparison function.

semantic amplification of the wiki helps. As the content in this case is needed for education students should be able to find out where to find information in the wiki (search function). Therefore, the necessary knowledge has to be treated according to the requirements of the semantic web. Implementation of knowledge that the students provide will take place by using the discussion pages for each article. These discussion pages can be implemented for instance by the project leader of each project so that author control is possible in its widest sense.

By the implementation of an IPD wiki we do not only want to replace the known IPD project manual, but we also want to amplify its content. That is how we want to create a well arranged, dynamic guideline for supporting project work that contains a collection of method and technology explanations as well as their integration in the generic IPD process.

With clear responsibilities respectively clearly defined author rights we want to guarantee that only authorised content is published respectively that only authorised authors can publish content. That is how transparency increases and the reliability of the IPD wiki, which is urgently needed as the content in education, can be maintained. This limitation of the original wiki spirit is on the one hand contradictory, on the other hand wanted.

During the pilot the user group of the IPD wiki firstly will be limited after installation of the system and integration of the first sets of data. All employees of the chair of computer applications in mechanical engineering, all IPD students as well as all persons that participate in IPD projects will get access to the system. The amplified access that includes all administrator and author rights remains with those persons who develop the wiki until the final release. All students involved in project work can use the system in a limited version before it is released. This means that they do not have access to all information saved in the system. They can create new pages and edit existing ones, however these pages are controlled before release. This takes place in the framework of a pilot program.

In the future we plan to offer the IPD wiki as a semi-open information platform to a broader public. Here, we mainly focus on small and medium-sized companies.

4 CONCLUSION

As the goal was to offer the IPD students a well-structured and detailed presentation of knowledge in a modern form and sufficiently detailed, the idea of providing a wiki system for IPD project work came across. Such wiki systems are already used by other universities for providing the content of lectures and keeping the content up to date. The final choice was the MediWiki with semantic amplification.

The holistic approach of Integrated Product Development is able to satisfy the needs of product development processes in research and education. For communicating the contents of teaching it is planned to introduce the wiki system as information platform in a first pilot program for the next semester. For developing further the generic IPD process model that has been amplified by presenting activities, the analysis and development of suitable designing methods has to be deepened by empirical research in projects close to practice. That is how the individual has creative space for generating solutions whereas the collaboration in working on constructive problems should be fostered too. Therefore, new views and amplified planning methods are needed that are based on combined, systemic thinking and allow acting adapted to the individual level of information.

Teaching in the course of studies „Integrated Product Development“ is based on these thoughts. The students are encouraged to think process oriented, while the product and the later product use always form the centre of thinking.

REFERENCES

[1] ANDREASEN, M. M.; HEIN, L.: Integrated Product Development, Springer Verlag, Berlin New York 1987
[2] BENDER, B.: Erfolgreiche individuelle Vorgehensweise in frühen Phasen der Produktentwicklung, Dissertation, Berlin, 2004
[3] BULLINGER, H.J. et. al.: Integrierte Produktentwicklung. Zehn erfolgreiche Praxisbeispiele, Wiesbaden: Gabler Verlag, 1995.

[4] BURCHARDT, C.: Ein erweitertes Konzept für die Integrierte Produktentwicklung. Schriftenreihe Integrierte Produktentwicklung (edited by S. VAJNA), Band 3, Otto-von-Guericke-Universität Magdeburg 2001
[5] CREGAN, A.; MOCHOL, M.; VRANDECIC, D.; BECHHOFER, S.: Pushing the limits of OWL, Rules and Protege. A simple example. URL http://www.aifb.uni-karlsruhe.de/WBS/dvr/publications/rove.pdf, 14.08.2006
[6] EHRLENSPIEL, K.: Integrierte Produktentwicklung. Denkabläufe, Methodeneinsatz, Zusammenarbeit, München Wien: Carl Hanser Verlag, 1995.
[7] FREISLEBEN, D.: Gestaltung und Optimierung von Produktentwicklungsprozessen mit einem wissensbasierten Vorgehensmodell. Schriftenreihe Integrierte Produktentwicklung (edited by S. VAJNA), Band 2, Otto-von-Guericke-Universität Magdeburg 2001
[8] GATZKY, T.; NAUMANN, T.; Industriedesign und Arbeitswissenschaft im Integrierten Produktentwicklungsprozess. Proceedings Kolloquium 40 Jahre Arbeitswissenschaft an der Otto-von-Guericke-Universität Magdeburg, 2004
[9] MCGUINNESS, D. L; VAN HARMELEN, F.: OWL Web Ontology Language. URL http://www.w3.org/TR/2004/REC-owl-features-20040210/, 15.08.2006
[10] MÖLLER, E.: Schreibkollektiv. MediWiki installieren und warten. URL http://www.linux-magazin.de/Artikel/ausgabe/2004/04/064_MediWiki/MediWiki.html, 14.08.2006
[11] OLSSON, F.: Integrerad Produktutveckling (in Swedish), Mekanförbundet, Stockholm, Sweden, 1985
[12] OTTOSSON, S.: Dynamic Product Development - Findings from Participating Action Research in a Fast New Product Development Process, Journal of Engineering Design, Vol 7 No 2 1996, pp 151 – 169
[13] SACHSE, P.: Idea Materials: Entwurfsdenken und Darstellungshandeln, Über die allmähliche Verfertigung der Gedanken beim Skizzieren und Modellieren, Logos Verlag, 2002
[14] SCHAFFERT, S.: IkeWiki: A Semantic Wiki for Collaborative Knowledge Management. URL http://www.wastl.net/download/paper/schaffert06_ikewiki.pdf, 14.08.2006
[15] THOENY, P.: Neue Wege. Wie Sie TWiki im Unternehmen einführen und eine neue Kommunikationskultur schaffen. URL http://www.linux-magazin.de/Artikel/ausgabe/Sonderheft_2005/02/twiki/twiki.html, 14.08.2006
[16] VAJNA, S.; NAUMANN, T.; GATZKY, T.: Integrierte Produktentwicklung als Ausbildungskonzept. CAD-CAD-Report Nr.2/2004
[17] VAJNA, S.; ZIRKEL, M.: Pro-Teach-Net - An E-Learning Platform for Product Development. In: Norell, M. (Editor): ICED03, Research for Practice - Innovation in Products, Processes and Organisations. Pres 1387, Design Society 31, Stockholm 2003
[18] VÖLKEL, M.; KRÖTZSCH, M.; VRANDECIC, D.; HALLER, H.; STUDER, R.: Semantic Wikipedia. In: Proceedings Of The 15th International Conference On World Wide Web, WWW 2006. Edinburgh, Scotland, 2006
[19] VDI 2221: VDI-Richtlinie 2221 - Methoden zum Entwickeln und Konstruieren technischer Systeme und Produkte; VDI-Gesellschaft Entwicklung Konstruktion Vertrieb, Düsseldorf 1993
[20] VON SPECHT, E. U.; VAJNA, S.: Integrated Product Development, in: PLM-World 2005 (CD-ROM publication)
[21] VON SPECHT, E. U.; VAJNA, S.: Integrated Product Development as a design philosophy in university teaching, Proceeding of IDETC/DED 2006, ASME International Design Engineering Conference 2006 (CD-ROM publication)
[22] WIENDAHL, H.-P.: "Funktionsbetrachtungen technischer Gebilde - Ein Hilfsmittel zur Auftragsabwicklung in der Maschinenbauindustrie. PhD Thesis Aachen, 1970

Contact: Dipl.-Ing. Eike U. von Specht | Univ.-Prof. Dr.-Ing. Sándor Vajna
Otto-von-Guericke-University Magdeburg
Information Technologies in Mechanical Engineering
Universitaetsplatz 2
D - 39106 Magdeburg | Germany
Phone: + 49-(0)391-6711726
Fax: + 49-(0)391-6711167
e-mail: eike.vonspecht@mb.uni-magdeburg.de
http://lmi.uni-magdeburg.de