INTRODUCTION

This volume contains papers accepted to 3rd International Seminar and Workshop **'Engineering Design in Integrated Product Development'**, ***EDIProD'2002***. Since it is 3rd, I would like to recall the short history of these Seminars.

The first took place 8-10 October in Sobótka, near Wroclaw. Papers were presented by experts from Germany, Great Britain, Holland, Hong-Kong, India, Poland, Sweden, and USA, all having distinguishing scientific works and broad experience in industry. The aim of that first Seminar was to disseminate current developments in engineering design methodology and to discuss some of its key issues. The papers provided a good introduction to the extraordinary broad field of engineering design.

The conclusion was drawn from the first Seminar that we should concentrate on some selected fields of the discipline. Consequently, the second EDIProD Seminar had been intended to focus on critical issues of design theory and methodology as well as on their relevance to the industrial practice. Two volumes of the EDIProD'2000 Proceedings provided a balanced sample of emerging problems and a good introduction to underlying methods that support integration of the variety of demands on the product characteristics. Again, among authorities who contributed considerably to the success of the Seminar there were representatives from Denmark, Germany, Holland, Poland, and USA. It was strongly emphasized during the debates that the most critical issue of design theory and methodology is its relevance to industrial practice. In fact, numerous conferences on engineering design have stressed the importance of improving engineering design practice in industry to create better and more competitive products. The question arises how this, generally accepted, objective has been accomplished so far?

According to Professor Tony Medland, considerable effort has been put in over the last decade into the creation of approaches to design by the design research community. However, very few of these methodologies have ever found their way into industry and have had little to no effect on the creation of new products. His observation is strongly supported by Professor Alex Duffy, who state that although there has been increased activity in the research, management and application of design, and the impact and importance of design on society is becoming ever more recognised and prominent, nevertheless it is doubtful whether we have applied what we have learned of the design process.

Their statements have been supported by many reports that as well academics as companies are far from being satisfied. Undoubtedly, there is a salient gap. Why and what? One attempt to answer this question may be to consider the design as an integral part of the product realisation process. That is why ***'Design Methods that Work'*** seems to be the appropriate motto for the 3rd Seminar EDIProD'2002.

What issues are essential to increase the effectiveness and applicability of the design methods for both the product quality and production process? It seems that no definite answer has been found by now and, perhaps, it does not exist at all. However, there is no doubt that it is our duty to strive to contribute hereto.

The Proceedings of EDIProD'2002 present views of the distinguished experts on the immense matter in question. I deeply believe they make essential contribution to the matter in question. Let us have a look to the papers.

The first group constitutes papers, which most directly attempt to discuss what features the design methods should have to be useful in engineering practice

Professor **Mahendra S. Hundal** in his ***Life Cycle Engineering: the Ultimate Aim of Product Development*** makes an important reflection that, since most of the downstream decisions are made at the design stage, when we speak of `design' we often imply the complete product development process. His paper looks at product development from a life cycle perspective, i.e. developing product requirements, including environmental requirements, design solution and implementation, evaluation of alternative designs, the decision matrix, using technical, economic and environmental criteria. In

the final analysis, companies are concerned with product costs. According to Professor Hundal, it is generally (and falsely) believed that environmental requirements lead to higher costs. Several examples are cited in the paper which show where companies have applied innovation to both the product and the process to achieve an improved product, as well as a `greener' image, which lead to market advantages.

Professor **Herbert Birkhofer et al.** consider ***Why Methods don't Work and How to Get Them to Work.*** Their paper presents and discusses an experience-based analysis of why methods don't work. They underline that in order to improve the use of methods, the whole context in which methods are applied must be taken into account. Influential factors for increasing the effectiveness of methods applied in design projects are: education, designer's skill and knowledge, and design process organization and management. The authors exemplify their outlook by an research-project accomplished at the Department of Product Design and Machine Elements at the TU-Darmstadt.

Professor **Alex Duffy** in ***Designing Design*** emphasizes the need of developing methods of designing the design activity. It presents ongoing work being carried out at the University of Strathclyde to model, manage, control and improve the design development process. His paper presents the design process from the perspectives of function, behaviour and structure. A fundamental model of whole activities of the design process has been outlined which defines the relationship between the activity of design and its management. This forms the basis to determine the behaviour through performance measurement and analysis, and potentially re-design, in order to meet the processes' functional requirements. The paper concludes with a summary of how the work is being applied within industry, some of the advantages gained and the need for continuous improvement.

Doctor **Bill Hollins** realizes that theoretical models of design management have now moved from being too shallow to being too complex. As a result, they are not being used.

Furthermore, they do not include an appreciation that people who are experienced, or even expert, in a particular field do not need to pass through every stage of the process. Consequently, there needs to be a new approach that is flexible enough to capture particular experiential knowledge but also work when used by the less experienced. In his paper, entitled ***Using Experience in Design. A Practical Attempt to Simplify the Design Process,*** he compares theoretical design management techniques to those stages undertaken in a real design situation. He also describes elements of a modified system that were found to work.

A group of papers is based on conclusions from industrial practice and experience. A good representative is the paper ***Product improvements through a Cooperative Design Approach Between Industry and Academia,*** by Professors **A. J. Medland** and **G. Mullineux.**

Professor Medland leads the research group at the University of Bath, which has been working closely with its industrial collaborators for many years. Some companies were first involved in a research programme into the 'Redesign of Packaging Machines' in which a redesign methodology was created. Two of these companies continued their association by a further set of Teaching Company Schemes. In the consequence of this cooperation a programme of machine optimisation has been undertaken in parallel to the creation of the prototype for a new range of machines. This has allowed the company design team to develop the basic concepts and structural form, whilst the research team is working alongside on the analysis and refinement of the core mechanical elements.

Doctor **Tony Robotham,** who is Director of the Innovative Product Development Centre at The University of Wolverhampton, describes his experience in ***Supporting Small to Medium Sized Enterprises in Product Development.*** In particular, his paper demonstrates the continued need to develop the use of computer aided design in SMEs and the importance that rapid prototyping has made to their innovation process. The paper is based on two new ERDF supported programmes that put emphasis on employing experienced people who can provide advice and support to the assisted companies. He reports how the continued use of "best practice" product development tools and techniques by the consultants during these "assists" will ensure that the SMEs are taken through a more effective product development process, which will address both short and medium term needs.

Mrs. **Regine W. Vroom** from Delft University of Technology describes ***Research into the Practice of Design Engineering Working Methods within Automotive Companies.*** Her paper describes a research project in which the development processes of three automotive suppliers have been analyzed and documented in three representations, formatted according to a generic scheme. Based on these representations a so-called induced model of product and process development has been created. The format of the representations is explained, the working method laid down and the resulting induced model is presented as well as research problems that came up during the research.

A considerable group of papers is devoted to specific methods of design. A good example is the paper on ***Design Optimization Practice on Product Development*** by Professor **Panos Y. Papalambros.** Use of design optimisation is now fairly routine in several industries, including the chemical, aerospace, automotive, and electronics industries, where a significant investment in the development of CAE models has taken place over the past twenty years. Current efforts are directed primarily into complex products and new technologies. Design optimisation combines mathematical optimisation algorithms with computer-aided engineering (CAE) models to generate designs with improved performance. In product development this approach is useful for complex products involving a large number of interdependent design decisions or for new products where significant experience has not been accumulated and fast design exploration is highly desirable. The author outlines requirements for successful application of design optimisation and provides example applications primarily from the automotive sector.

Professor **Asko Riitahuhta** addresses the importance of a proper structuring data for co-ordination of the product development process in a networking environment. He proposes the ***Enhancement of Collaborative Product Data Management*** by describing a product as different hierarchical systems on three abstraction levels, process, organ and part structure, as the Theory of Technical Systems recommends. The intention is to coordinate the total development area, particularly for companies producing multi-technical products. The efficient utilization of modular structures and definition of network identity makes it possible to precipitate the product realization process.

The two-fold paper on ***Ontology-Based Modeling of Product Functionality and Use,*** by **Y. Kitamura and R. Mizoguchi** and **Van Der Vegte et al.** also presents systematic functional description for application in a production company. Although importance of knowledge sharing among designers has been widely recognized, the knowledge about functionality in the conceptual design phase is often scattered across technical domains and it lacks consistency. They have developed a framework for consistent and systematic description of functionality based on the functional ontology, which provide fundamental concepts for capturing the target world and a common vocabulary for description of functional knowledge applicable to other domains. A successful deployment of this framework in a production company is discussed. The second paper presents a collaborative research with Delft University of Technology elaborating on use and unintended behavior.

The problem of design methods selection is among the crucial ones in designer's practice. Every user has specific requirements which coincide with the description of methods. Thus, optimising the description of design methods and the access to them is a precondition for the effective use of methods. The paper on ***Describing Design Methods According to the Specific Needs of Users,*** by **T. Sauer, B. Berger,** and **H. Birkhofer** presents a *Process oriented Method Model* (PoMM), which offers a standardised description of design methods and the individual access to them. The PoMM is suitable as a checklist for describing design methods and as a guideline for teaching and applying them. It can be used by the practising designers who wish to solve a problem or by a teacher at the university who wants to impart knowledge about methods to the students.

A similar concern share Dr **McMahon** and **Chris Draper** in their ***Patterns of Design and Development for Adaptive design: How do We Match Design Method to Design Circumstance.***

It is their observation that in many design domains engineering effort is concentrated on designs that are conceptually static at a macro level. Technical progress is constrained by demands placed on the design by the customer and by limitations which arise from the environment in which the design exists. The evolution of designs in a given domain can be by improved understanding of the demands

and constraints, by overcoming constraints through new technology, or by the incremental or revolutionary adoption of new design approaches. The presentation describes and categorises ways in which a guidepost design may be developed. In particular, it will be suggested that there is an optimum line describing the correct amount of embedded procedure for different stages of knowledge.

After all, the quality and reliability of compterized design methods is fundamental for the practice. This is the subject of the paper ***A Strategy for Quality Assurance of Computer Based Design Methods,*** by **E. Z. Opiyo et al.** This paper presents a novel strategy for reducing faults by assuring quality of the in-process implementations, dubbed *abstract prototyping*. It extends the current practices by defining the steps of the design phase of the processes of development of engineering design software tools. Under this procedure, reviews are performed to remove faults before theories, methods, algorithms, or pilot prototypes are passed to the subsequent stage rather than exclusively reviewing the requirements or designs. Prototypes provide the feel and the look of these in-process implementations and specially designed metrics help the developers estimate the extent to which they fulfill their respective requirements. Case studies show that the levels of fulfillment of requirements can adequately be estimated and faults detected early on.

Much room I devoted to contributions of our guests from abroad means by no means that I have underestimated papers of Polish authors. Professor **M. Szafarczyk** presents very interesting paper on ***Knowledge and Subconscious Activity at the Conceptual Stage of Design***. Professor **J. Wróbel** and Professor **J. Sempruch** address important issue of ***Internet-Based Management Systems.*** Professor **J. Pokojski** describes an ***industrial application of integrated computer support system.*** Several excellent papers raise very important subject of production planning and management: these are papers of Professor **Z. A. Banaszak**, Professor W. **Przybylski**, Professor **B. Skolud**, and Professor **Z. Weiss.** Still other papers describe application of more or less generic design methods and tools to specific, real life design problems, e.g. Professor's **T. Koch and A. Owczarek** paper on application of FAST, QFD, and other methods to designing of an inventive modular machine tool with parallel kinematics. Professor **E. Lisowski** presented his analysis and application of ***CAD 3D Systems to the Hydraulic Gear Pump Design***. And yet I did not mention all. There are a number of contributions written by our younger colleagues, that give a hope for worthy continuation of design theory and practice.

Finally, I wish to thank all participants for their contributions, and first of all the invited lecturers for presentation of excellent papers and running stimulating discussions. All participants have contributed much to the success of the Seminar but the major part must be attributed to our special guests from abroad.

Zielona Góra, October 2002 ***Ryszard Rohatynski***