

DESYS Research Group: Development of Tools and Methods to Improve the Output of Product Creation Processes

Willem G. Knoop, Ernest van Breemen, Joris Vergeest, Tjamme Wiegers
Delft University of Technology
Faculty of Industrial Design Engineering

1. ABSTRACT

This paper discusses the research that is carried out in the DESYS research project. DESYS is part of a larger research structure, the TPI-programme, that is performed in the department of Engineering Design in the faculty of Industrial Design Engineering. The relation with the greater research structure is explained. DESYS itself was initiated due to the lack of efficiency of current IT-systems that promise to support and optimize the product creation process. The research objectives and strategy are discussed. The objectives are focused on the information handling in the design process as a mean to determine requirements for tools and methods to support it. It is justified why this kind of research is of major importance for the industry. An overview is presented of the work that was done so far and the directions for the future are indicated as well. The sections on staffing and publications complete this article.

2. INTRODUCTION

The faculty of Industrial Design Engineering has a long tradition in education and research in the field of computer support systems in the product creation process. This was built up due to the enthusiasm of professor Schierbeek, one of the founders of our faculty. Over the years a lot of CAD/CAM tools have become available in industry. Most of them support a specialized part of the design process, for instance optimization tasks through finite element analysis. However, the need to assist the total process grew, and it was seen that a single tool was not available that supported all the different tasks in the design process. Along with this need there was still little support given in the early design phases. These circumstances were the initiators that defined the DESYS research project.

Initially DESYS, an abbreviation for Design Environment SYStem, aimed at the development of a software shell around existing programs. It was thought that this approach could lead to a better understandable information environment for the designer at work. Making current programs transparent through an umbrella tool would protect the designer from all the specialized operations of the different tools. However the integrated functionality would support the design process more than the separated pieces together. This should lead to an improvement of the process itself in terms of throughput time and design quality, including the very early stages. During the early stages of the project it became more clear that the research had to focus on the information aspects first before defining any requirements for a tool. After all if one wants to study the impact of an information system, one has to start with the basic entity, that is the information processed in the design process by designers. A literature survey showed a lot of research already undertaken in the field of design. The drawback however was that this research was carried out on a high-level of abstraction, not showing the detailed information needs in the design process. These needs will become clear when research is done on the micro-level. DESYS will therefore investigate the information handling on the micro-level in the design process including the early phases of design.

The DESYS project is part of a larger research structure in the Engineering Design department in our faculty. The Technical Product Information (TPI) programme, which is presented in Figure 1, covers a span of research activities in the fields of:

- Fast Shape Prototyping
- Product Information Management
- Product Model Definition and Applications

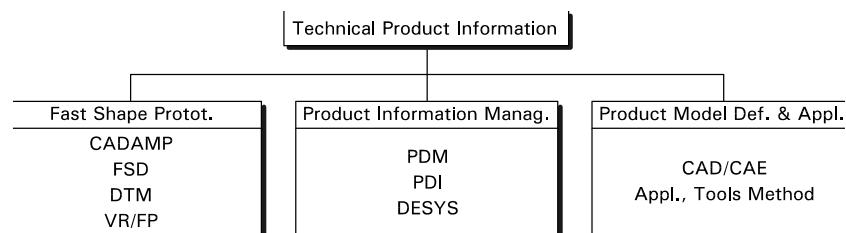


Figure 1: The position of DESYS within the TPI project.

The different abbreviations indicate the individual research projects and have the following meaning:

CADAMP	Computer Aided Design And Model Production
FSD	Fast Shape Designer
DTM	Desk Top Manufacturing
VR/FP	Virtual Reality/Fast Prototyping
PDM	Product Data Management
PDI	Product Data Interchange
DESYS	Design Environment SYStem
CAD/CAE	Computer Aided Design and -Engineering

The TPI-programme is carried out by 23 staff members. On a yearly base they produce on average 15 scientific and 25 other publications as well as one PhD thesis. There are worldwide contacts with leading research institutes in the field of CAD/CAM and there is a close work relation with the Product Centre TNO in the Netherlands.

Within the TPI-programme DESYS can be seen as a pivot project. Integrating the results from other, specialized projects into one environment.

3. RESEARCH OBJECTIVES AND STRATEGY

In principle the research objectives of DESYS are driven from the fact that only limited achievements were reached in industry in the product development process, in spite of the major investments in information technology systems. The literature described this phenomena often as the productivity or Solow paradox. A greater understanding of the role of information in product design will give a better insight into the process and lead to recommendations about tools and organization around it. The management of information is the central element. From this perspective a three step problem definition was defined as follows:

PB1: When using information technology, how can the product development process be supported to obtain a product definition which leads to a future product with required characteristics?

The product definition is the information as it comes out of the product development process. The optimal product characteristics are achieved when the mix of price, time-to-market and performance fits the market demands.

PB2: How is the product definition characterized, or what is the meaning and impact of the information elements in this?

PB3: What does the use and need of information of a product designer or design team look like, and how does it relate to the product definition?

These general problem descriptions were translated into a research strategy. It is expected that insight in the role of information on a micro-level (PB3) leads to the identification of bottlenecks in the design process. The next most challenging topic is to verify that the removal of bottlenecks can be actually measured. A resolution of the bottlenecks will be translated to the second problem level (PB2). Hereafter recommendations can be formulated that contribute to the overall problem definition (PB1). Recommendations will be in the field of tools or organizational options. These recommendations can be tested later on in laboratory and/or field experiments. In the area of tools this research distinguished itself in the way that requirements are set from the inside out. The design process drives the design of tools and not the other way around as often seen in commercial vendor environments. Summarized we formulated the research strategy:

- 1 Gain insight into the “information landscape” of the product design process. This activity takes place on the level of one designer or a design team, so the micro level of designing.
- 2 Discover and indicate the bottlenecks that come out of the analysis of the data gathered in the first stage.
- 3 Develop recommendations for methods to remove the bottlenecks.
- 4 Verify the recommendations by laboratory and field testing.
- 5 Formulate models and theories which make the acquired knowledge more generally applicable in multiple domains.

Based on this strategy the DESYS team formulated detailed research questions. The first task of the team was then to develop a research method which explicitly shows the role of information in the process. An overview of the research work until now is given in section 5.

4. RELEVANCE OF RESEARCH

This research has some important relevance in several fields. Besides the educational relevance we distinguish two further major fields of relevance: scientific and industrial.

4.1 Scientific relevance

From a large number of conferences it has been seen that scientific research towards an optimized product creation process is performed by numerous institutions around the world. Our research is supplementary to that. Furthermore, the research will lead to a better insight into the complex structures of information used in the (conceptual) design process. The results will be relevant also for the field of cognition and methodology. A literature survey showed that detailed research into the information structure in design has hardly been done. There has been done

much information analysis of design processes on a high-level of abstraction (SADT, IDEF, etc.) but the main question of how to solve designer bottlenecks has not been answered.

4.2 Industrial relevance

Companies that are able to create new and innovative products are very important for the health of an economy. They are at the start of the value chain and can not rely on the innovativeness of their suppliers. Therefore it is necessary that the product development process, which forms the first prime activity in the chain, is controlled and managed in the optimum way. The importance is confirmed by Seitz in his book on the German industry where he declares to improve the product development processes to keep in pace with the increasing level of global competitiveness.

A lot of companies invested enormous amounts of money in IT-systems. The opportunities which are incorporated in these systems are however only partly used. In-depth insight into the design process as an information driven process, the aim of this research, will result into a more effective and more efficient application of these IT-systems. This will lead to an industry which is constantly on the frontiers of new markets and keeps distinguishing itself in the rapidly changing world of today.

5. STATUS OF DESYS RESEARCH

In the following paragraphs the separate research activities that are carried out or planned to be carried out are listed. The actual start of the activities was in 1993.

5.1 Finished work

- Exploratory research of a real-life industrial design process (Do-experiment). This research was performed to gain insight in the information structures that might occur during the design process. The retrospective research leads to a set of recommendations on the experiments that were planned in a later stage in the DESYS project.
- Literature survey of the state-of-the-art in design research. Supplementary to the Do-experiment, this survey listed the commonly used methods in design research. Special attention was given on the study of information aspects in previous research.

- Recruitment of a pool of testees. To supply the experiments with enough qualified subjects a recruitment procedure was carried out. This leads to a pool of over 60 available persons for our experiments. The subjects are upper level faculty students.
- Development of an observation and data structuring method. This method serves the experiments that had to be carried out. It makes it possible to visualize the design process as a set of activities with their information elements attached to it. As a result a design process can be visualized in an “infogram”. The infogram shows the design activities, information input and output items and information links.
- The set-up of a design experiment that reflects the complexity of an industrial design assignment but was as compact to be performed in multiple experimental sessions.
- Observations of the design processes of 10 designers. This D1-experiment was accomplished to become experienced with the previously described method to present the information structure in the design process.

5.2 Current work

- Analysis of the D1-experiment. Focusing on the defined information links and detecting bottlenecks in certain activities that were observed. The analysis will eventually lead to a conclusive overview of the D1-experiment, helping to provide guidance in future experiments.
- Description of the research method. Due to the experiences in D1 the proposed method will be fine-tuned and described in detail to provide a non-ambiguous procedure to process design observations.
- Definition of follow-on experiments to prove that bottlenecks can be removed.

5.3 Future work

- Experiment sets to study the detectability and removability of bottlenecks.
- List of constraints for design environment definition.

6. STAFFING

The research project is carried out under the responsibility of prof.ir. P. de Ruwe. He is in charge of the department of Engineering Design. Prof. de Ruwe holds a master degree in Mechanical Engineering and was involved in many automation projects especially in the electronics industry. His practical knowledge is a major driving force in the project. The project itself is staffed by two coordinators and three researchers. On average the researchers are available for 75% of their time to support the project. Their background and experience can be summarized as follows:

6.1 Coordination

Ir. Aad P. Bremer, associate professor. Holds a master degree in Aeronautical Engineering and worked for over 20 years as a university staff member. He is the overall project coordinator of the TPI-project and as such managing the position of DESYS in relation with the other projects that are carried out.

Dr. Joris Vergeest, assistant professor. Holds a PhD in physics, worked as a university staff member at several universities in the Netherlands. He has a broad experience in the setup and management of scientific research projects, and serves as the scientific gatekeeper in the DESYS project.

6.2 Research

Ir. Ernest J.J. van Breemen, assistant professor. Holds a master degree in Industrial Design Engineering and worked for 3 years in an industrial design agency.

Ir. Willem G. Knoop RB, assistant professor. Holds a masters degree in Mechanical Engineering and a MBA degree. He worked for 10 years as a CAD/CAM Consultant in several fields of the industry.

Ing. Tjamme Wieggers, assistant. Holds a bachelor degree in electrical engineering. He worked for many years in a variety of software development companies, programming complex industrial systems.

Besides the permanent staff students carry out scientific training programs or graduation projects.

7. REFERENCES

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