ISSN 1392 - 1207. MECHANIKA. 2006. Nr.6(62)

Computer supported application engineering and design of hydrostatic systems

D.G. Feldmann
Technical University Hamburg-Harburg, Denickestraße 17, D-21073 Hamburg, Germany,
E-mail: feldmann@tu-harburg.de

1. Introduction

Increased global competition forces enterprises to intensify and structure the information flow between the departments and contractors to be successful on the market with its grown technological and economical challenges in product development. Time to market decreases; introducing innovative communication and information tools, which enable the project teams to work on the basis of a common development platform, can substantially shorten development time. Particularly the early phases of product development offer a large potential for development time reduction and for product quality improvement; because of the lack of tools for a suitable data processing this potential is not exhausted yet. The variety of possible design solutions in the early stages, in connection with a poor information quality, i.e. incomplete and unstructured data, leads to delays in the development process and has negative impact on the product quality.

The improved mechanisms for data transfer and data protection in recent years were a basic condition for the acceptance of the Internet as a medium for information exchange; however there are still weak points in the safety mechanisms, whereby a hundred percent security of data in the Internet cannot be guaranteed.

On basis of the Internet/Intranet technology which is widely hardware independent, the Arbeitsbereich Konstruktionstechnik der Technical University Hamburg-Harburg is developing a web-based application engineering tool for hydrostatic systems. The client-server-architecture allows distributed project teams to develop several new products at the same time. Thereby the designers always have access to a current base of product data. The design and experience which is structured in a central database can be used systematically to develop new products.

Fig. 1 shows the procedure of product development which represents the basis of the conventional engineering design process of hydrostatic systems. The stages shown will be explained later in this paper.

The steps in the conventional engineering process are supported by use of several closed and platform dependent tools as shown in Fig. 1. The variety of program specific and thus usually not compatible data formats represents a weak point; there is no central data management implemented, whereby redundancies and inconsistencies in the data pool accrue, which typically leads to design faults, to delays in product development and product quality losses. Considerable delays in the later stages are the result, that often causes unnecessary iteration cycles with additional costs and prolonged time to market.

With the following concept of a WEB-based application engineering tool for hydrostatic systems a constant computer support of all planning and design phases becomes possible. The engineering tool supports the systematic solution search by supplying design experience and design notes. A product model particularly defined for hydrostatic systems contains the design knowledge and saves the product specific information. The product independent data are stored in a "static" area of the data base. For circuit diagram generation and simulation of the solution concepts, a commercial simulation tool is connected to the IT-tool (information technology tool). A specific kind of value analysis tool is used to select the best concept.

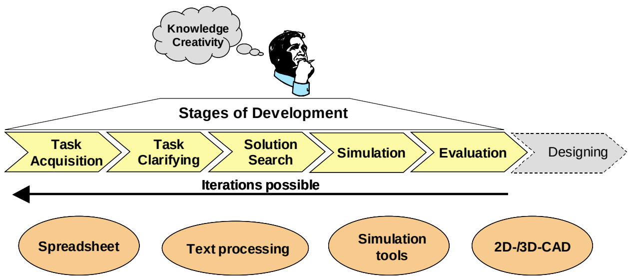

Fig. 1 The first stages of product development

2. The structure of the application engineering tool hyplan

Fig. 2 shows the structure of the application engineering tool. Four interlaced modules for information input, information storage, information extraction and visualization are tied together. With consideration of the heterogeneous information of the planning and design phases, separate modules have been developed, which support data processing and storage in the respective projecting step. The product model, which is specific for each product, enables the structuring and central storage of the information. The product model contains the entire information for a product. During the development process quantity and quality (accuracy and completeness) of information in the product model increase. When a project is in its final stage, i.e. an optimal solution concept has been identified, the project manager finishes the development process. Thereupon the system modifies automatically the access rights for the current product model. From this point in time, the product model is fixed and represents new design experience, and is available for following projects and development stages. Only the project manager or one of the assigned coworkers can make subsequent modification of "fixed" product models, which may be necessary to correct faults or optimize the design as a result of application experience. In such a case they have to use the design tool.

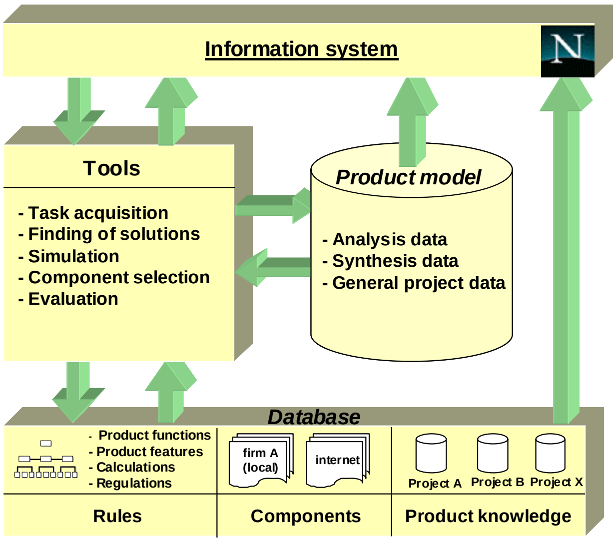

Fig. 2 Structure of the Application Engineering Tool

All static and not product specific information such as rules, component libraries, experience data and also the product model are administrated by use of JAVA routines and a data base. The information system represents the interface to the user. For the entire development process a uniform user interface was implemented. Web-browsers are used to visualize the in- and output forms; theses browsers are available in each modern enterprise for standard. The concept of a client-server-architecture allows a distributed and parallel use in the company wide Intranet and guaranties, that inconsistencies and redundancies in the data base are avoided. The parallel operation of multiple users in one project requires, that there are password-protected areas. So it is not possible that more than one coworker is able to change the same data at the same time; however parallel reading of data is possible.

For user acceptance data security is important. The compliance of security requirements at the enterprise-internal Intranet can be ensured by password controlled access rights. This however presupposes that no connection to the Internet exist. If there is a demand to access across the enterprise boundaries beyond Internet, far more complex safety mechanisms are necessary. At present these, usually server-lateral mechanisms, offer still no total protection from abuse by unauthorized persons. These concerns by those involved in e-business are the reasons why developers of web- browsers and servers are doing much to improve data security. The present application engineering tool prototype utilizes currently available safety mechanisms of browsers and servers.

3. The computer-supported process of product development

To explain the functionality of the application engineering tool in the following some planning and design phases are exemplarily skipped. The projecting process of a hydrostatic system starts with the computer supported entry of the task followed by the solution concept identification, continues with the circuit diagram creation, simulation and concept evaluation and ends with the selection of components and a first geometric layout.

DEFINITION OF THE DESIGN TASK. The identification of a new product idea is normally the first step in the development process, which is put down either by a contractor or by a department of the company. The first requirements on the new product are typically incomplete and unstructured and they are documented in form of discussion logs, simple CAD documents or also handwritten tables, sketches and diagrams.

In this early step the support of the application engineering tool starts; all documents are stored via “scanning” in a database, i.e. in a new product model. For an initial structuring, the collected information is divided into request classes. The classes include *technical requests*, *economic requests* and *organizational requests* and are predefined. Company specific modification and expansion of the classes is possible.

The class *technical requests* contain information for description of product performance (this includes the kinetics of the output of the hydrostatic system). For example, maximum torque and speed are usually specified. These technical requests may include a space envelope the hydrostatic system must fit in and maintenance requirements.

The class *economic requests* contain the finance plan, the estimated manufacturing costs and other economic information. This engineering tool is not intended to replace project cost calculation programs currently used in many companies but to provide project team members access to financial and economic data to promote cost considerations during product development. This often leads to a reduction of development costs.

The *organizational requests* are summarized in the third class. The project schedule complete with mileposts and project goals will be included as well as project team members and their educational and professional experience. This feature of the web based engineering tool enables each project team member to have access to all task documents via the enterprise Intranet to view and commentate directly from their workstation. The coworkers of a project group are informed about task modifications automatically by e-mail and they are obligated to acknowledge their notice of the modifications in the system. All team members have the same knowledge status. So communication problems by inconsistencies of the task can be avoided at an early point in time.

THE COMPUTER SUPPORTED CLARIFICATION OF THE TASK DEFINITION. The task definition and the clarification of it is coupled. Both phases will be reviewed in an iterative process until a sufficiently structured and complete task definition is formulated. The task definition is released by the project manager. Using product functions shortens this process and ensures a structured formulation of the task. The advantage of representing the technical requirements by product functions is, that it does not limit the set of solutions in advance by the determination of components. The review of the task definition concerning completeness is made easier by the functional description of requirements and can be to a high extend carried out automatically by the application engineering tool.

The simplified presentation of the *Functional Product Structure (FPS)* shown in Fig. 3 captures the product functions necessary for the representation of the product requirements. The functions are structured by dividing them into the groups such as output, control, input, fluid conditions, maintenance and others. These groups contain in a hierarchical structure all product functions that have been defined within the framework of previous projects. These groups are predefined for the first application of the tool and will be adapted and extended according to the needs of the company along with the number of completed projects.

In order to clarify the task definition, the project team assigns the requirements defined within the framework of the problem description to the product functions necessary for the performance. If, for example a linear output is requested as a part of a new hydrostatic system, the project designer first calls up the class of output in the FPS and limits the possible number of product functions by selecting the required main function (*supply transnational motion).*

The designer is now provided with the next set of functions in the functional hierarchy. Five steps are needed as a rule to reach the level of basic functions to describe the requirements completely. Each function is described by a set of product independent attributes. Foremost the definition of the product specific specifications of each attribute describes the requirement.

So the representation of the product-related requirements from the task is effected by a quantification of the features, see Fig. 4. Should it not be possible to indicate values for all specifications provided by the system, it is an indication towards an incomplete task formulation. The corresponding function is marked accordingly by the tool. All product functions that are not completely cleared are automatically summed up in a report and can then be discussed with the contractor or the concerned departments. The task definition can only be released, when all product functions are finally cleared or the yet unknown features are marked as "to be cleared" upon authorization of the project manager. If none of the systems existing product functions are suitable to describe the task, the tool offers an editor to define new functions with their attributes and specifications.

THE SYSTEMATIC GENERATION OF A CONCEPT. The use of the application engineering tool supports the systematic access to the experiences from previous projects. The design experience stored in the product models of previous projects can be extracted through search patterns considering the requirement specificationsof the contractor. So correspondences and similarities be

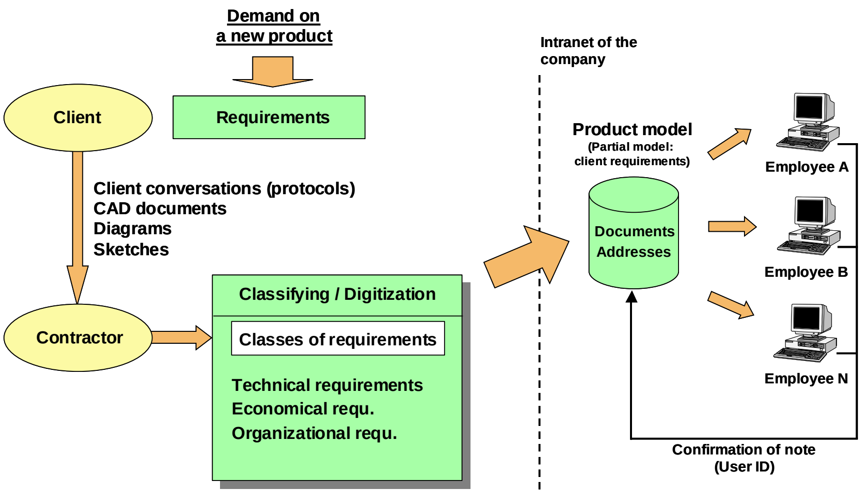

Fig. 3 Acquisition of the task for a new hydrostatic product

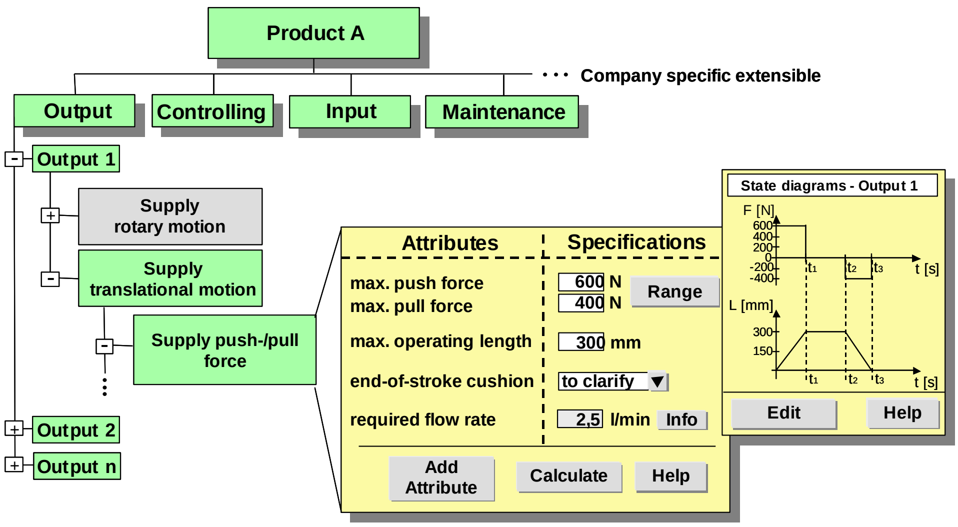

Fig. 4 Functional Product Structure (FPS)

tween the new product models and stored product models of previous projects can be identified. As a result of the search, the project designer is supplied with a catalogue of preceding projects with similar requirements which can be used as a basis for the new concepts. The search results are arranged according to the priorities of the requirements of the task definition by weighing the search parameters in the search patterns of the different requirement groups.

The basis for the step from concept to realization of the product is the *Function- / Functioncarrier - Matrix*. This matrix represents the connection between the *Functional Product Structure* and the *Functioncarriers*, defined as a mathematical and geometric description of real hydrostatic components. Functioncarriers can be single components such as a cylinder as well as complex components like a speed control unit. In addition to this functional description, they are assigned to symbols for circuit diagram generation as well as to simulation parameters. A Functioncarrier can perform more than one function of the FPS. Conversely the same function can be performed by different Functioncarriers. After the step of the task clarification, the application engineering tool provides the project group with a requirement specific Function-/ Function Carrier Matrix for the solution search. Every required product function is assigned to all known suitable function carriers. Every new project enlarges the scope of the Function- / Functioncarrier - Matrix. By choice of different Functioncarriers, which are all suitable to fulfill the FPS, various solutions are generated.

By choice of different Functioncarriers, which are all suitable to fulfill the FPS, various solutions are generated (see Fig. 5). To support the decision of selection, the tool offers a detailed online-help, for example to explain the functionality of the concept creation, the typical range of applications as well as the pros and cons of the Functioncarriers. Each project designer has to justify his choice of a Functioncarriers by a comment. Not all of the Functioncarriers fitting to the product function in principle are applicable or reasonable considering all specifications. The system locks these Functioncarriers automatically. A release can only be accomplished by a change of the task definition and thereby an adjustment of the Functional Product Structure. Depending on the extent, it may need the agreement of the customer.

The application engineering tool must not hinder creativity by the offer of only design experience from previous product models and so known concepts. The demand for a high product quality requires a constant optimization of the products, therefore the project designers have to develop and compare various concepts. As in the existing product development process, the creativity of the project designer has a great importance. The application engineering tool encourages creativity, because it offers all Functioncarriers known to the company for every required product function together with an explanation of their pros and cons. This methodical procedure and the requirement related access to design experience in preceding projects makes a optimization of the existing development process possible.

THE SIMULATION, CHOICE OF COMPONENTS AND EVALUATION. The examination of the behavior of the developed concepts is validated with a commercial program that is used to support the creation of the circuit diagrams as well as the simulation of the static and dynamic performance. This program is an integrated part of the application engineering tool, so that the concept specific component libraries are displayed on the graphical-user-interface of the simulation program. These libraries contain all Functioncarriers and their hydrostatic symbols, needed to describe the concept developed within the framework of projecting. The symbols are pooled in groups analogous to the FPS. So a clear allocation of the symbols to the circuit diagram becomes possible. For circuit diagram creation and simulation of the system's performance the internal functions of the simulation program are used. A detailed description of the software is beyond the scope of this paper.

In the course of the first simulation the capability concept is checked in principle. The concept is defined as capable when the kinematics of the output is within the defined limits of the task definition's requirements. In the next design step, the real components are allocated to the hydrostatic circuit design. The parameters of the simulation are adjusted to the parameters of the components actually available in the company. These adjusted parameters are plugged into the program for examination of the designed system's performance. The standardized functions in the simulation program are used to optimize the control parameters. The allocations of the device data to the Functioncarrier deduced from the task definition is carried out automatically on the basis of the product-independent Function-/ Functioncarrier Matrix. Apart from the local device data, there is the possibility in principle to use electronic component libraries in the internet, although this would presuppose a standardized and company-independent language of description that has not yet been defined for the fluid technology.

The assessment of the system concept concerning the fulfillment of the problem definition is the last step in the frame-work of the design. The weighted criterions from the guideline [1, 2], in a computer-aided method, came into use as a method of assessment. This method stands out due to its easy of use and clarity. As a result of the assessment, a priority of possible product concepts is provided and the optimal product concept can be chosen.

4. The realisation of the IT-tool

The most important stages for the realization of the design tool are:

1. concept design;
2. definition of Entity-Relationship-Models (ER-Models);
3. data base structure development (MS ACCESS);
4. programming the object structure (JAVA);
5. preparing the web-based user-interface and the necessary data base inquiries (HTML, CFML, XML, SQL, JAVA);
6. filling the data base with examples.

Not every phase will be explained in detail in the following, but there will be a general survey of the construction in principle of the IT-tool.

After the data structure and the flow of information had been deduced in the form of ER-models from the

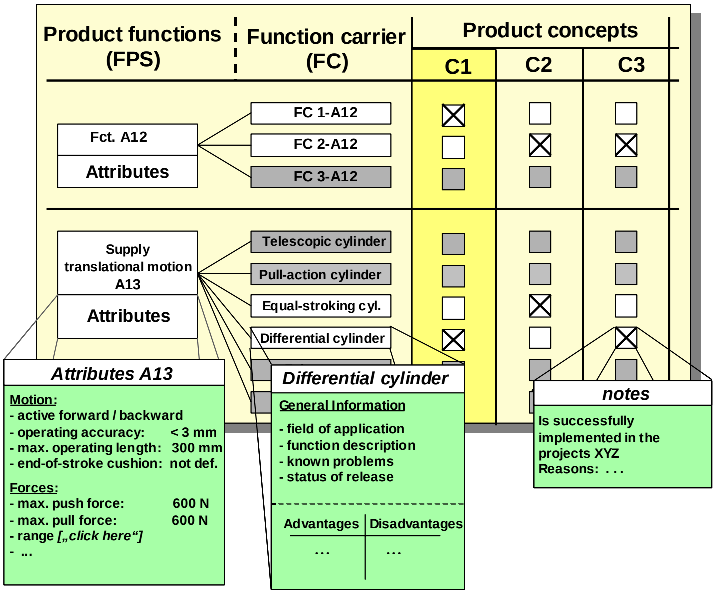

Fig. 5 Systematically creation of product concepts

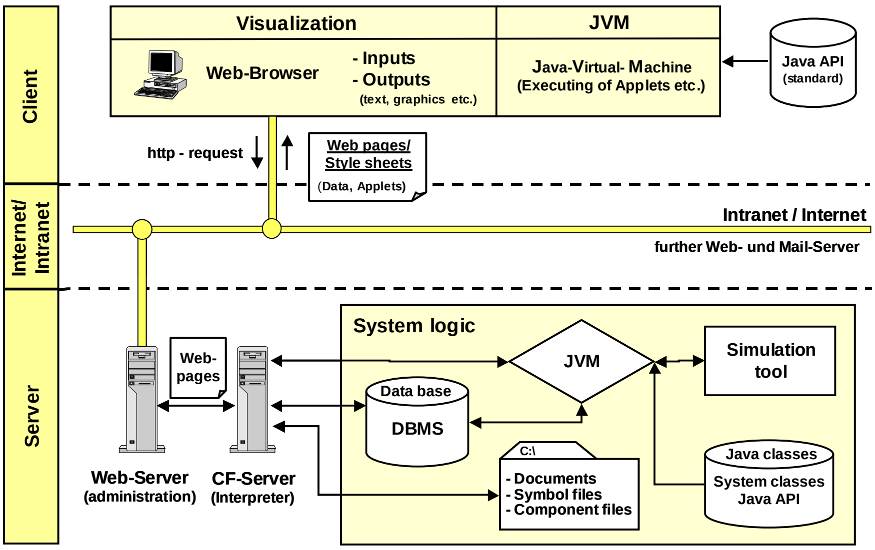

Fig. 6 Data transfer with integrated CF-Server

concept of the engineering tool, the main emphasis of the project work was the predefinition of the actual data bank structure, i.e. the definition of the relations, their entries and keys. The relational data base used can be divided into a product-independent static part and in a product-specific dynamic part. The product model that clearly describes every product concept is member of the dynamic part of the data base. Through data bank inquiries, views on the internal sections of the product model are opened. This enable the project designers to be informed via internet/intranet about the state of the project.

Fig. 6 illustrates the internal data transfer of the client-server-architecture of the tool. The interface between user and engineering tool are the web-browsers which are installed at every operating place in the company. The project designers "communicate" through the internet/ intranet with the system via interactive html-forms. A commercially available interpreter (CF-server) was installed between the web-server and the data base since a common web-server is not able to interpret a html-source coding with integrated data base inquiries. This CF-server was able to reduce the programming expenditure and increase the functionality of the html- and cfml-pages substantially. The investigations for the development of an internet-based information system by Stritzke [3] confirm the advantages of such software. Html-forms are used to acquire the initial data of a new project. Apart from forms with input fields, tools such as charts, graphics and trees will be used to visualize and acquire information. Tools for the generation of state-diagrams or for the visualization of 3D-CAD models have to be taken into consideration as well.

5. Introduction to Manifold Design

Valves are the components of hydrostatic systems to control pressure and flow. In many applications, conventional spool type valves have been replaced by 2-position / 2-port built-in valves (cartridge valves) as pilot operated main stages, controlled by small spool type or seat type pilot valves. These cartridge valves are mounted in a manifold. The manifold typically is a metal block which provides cavities for the cartridge valves as well as mounting faces on the block surface for the pilot valves. Bores within the manifold connect the orts of the cartridge valves. Using today's standard solid modeling 3D-CAD systems to design a hydraulic manifold, the designer handles cubes, cylinders and cones as functionally meaningless geometric elements. The system provides no specific support. The designer himself must ensure that the geometric arrangement fulfils the hydraulic function and the mechanical and manufacturing needs. The program does not provide all the information needed. Manual calculations are needed to insure the design meets the goals. One example is the calculation of flow losses.

To create a higher efficiency, a CAD tool must be extended for this special task, so that some of the calculations and checking of the constraints can be done internally by the program and are immediately available. To create such an application, the system must be able to handle geometric and non geometric data.

6. Object oriented product models for hydraulic components

Four main-classes derived from classes of the ACIS modeler have been created.

- HYDROELEMENT is the main class for all hydraulic components that have a certain function in the hydraulic system (valves, pumps, etc.). In the circuit diagram they are represented by symbols. For every component type, a new class is derived from HYDROELEMENT that contains the specific data and functions of the component. Fig. 7 shows the basic model structure.
- BOHRZUG. An object of this class defines a number (one or more) of linked bores that connects two ports of HYDROELEMENT objects. In the circuit diagram, the connecting lines between the symbols represent the connecting bores. When a BOHRZUG class object is initialized, a structure of subobjects of following classes is created as shown in Fig. 8.

First the BOHRPUNKT class is representing and administrating the connection between two bores in the chain. Every BOHRPUNKT class object refers to a subobject of the class BOHRUNG that contains the model for a specific bore. Objects of both classes cannot be accessed directly by the user, they can only be modified via the higher BOHRZUG class object. In Fig. 8, a BOHRZUG object is shown (in grey background) that creates a connection between the ports of two HYDROELEMENT objects. The bottom of Fig. 8 shows the relation between the objects. The objects of the HYDROPUNKT class contain the coordinates of the position in the model space and the relation between the HYDROELEMENT and the BOHRPUNKT. Fig. 8 also shows (in white) how the object structure is changed when a new bore is added to the BOHRZUG.

- The hydraulic manifold is created by the class HYDROBLOCK. It mainly marks surfaces to place HYDROLEMENT and BOHRUNG objects and ensures that the relation is kept during modifications of the manifold's geometry.
- The FLUID class is a nongeometric class that represents the characteristics of the fluid used in the hydraulic circuit for calculation purposes. In one design session more than one object of the FLUID class can be created if the manifold with different fluids should be used.

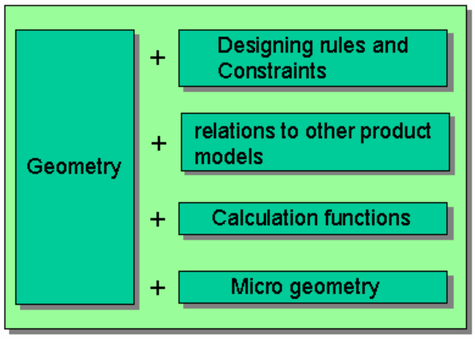

Fig. 7 Product model for hydrostatic components

How the geometry is extended in the product models is demonstrated in Fig. 9. It shows the cavity for a cartridge valve with the additional features. The class describing the valve is derived from the HYDROELEMENT class. On the left side of Fig. 9, functions and data are listed that are related to the whole valve. The features on the right side are related only to parts of the valve, e. g. the definition of ports extended functionality of a CAD tool for hydraulic manifold design based on the product model data. Based on the data and functions of the product models, the following functionality for the design of hydraulic manifolds is realized.

CREATION AND ADMINISTRATION OF PRODUCT MODELS. For every component to be used in a hydraulic manifold, a product model based on the HYDROELEMENT class is created and stored in a database. To create a new product model, a 3D geometry is designed with an CAD system that is able to create files in the ACIS format "SAT". In the authors' Institute, the program SolidEdge from Intergraph is used. The SAT file is imported into a program where all additional information for the product model can be added. When the input is completed, the model is stored in the database. At the moment, the database contains about 250 product models. One example is the cartridge valve shown in Fig. 9.

LOADING OF THE HYDRAULIC CIRCUIT DIAGRAM INTO THE CAD SYSTEM. In the circuit diagram (not shown in the paper) of a hydraulic system all components and their connections are defined. The CAD system has an interface to choose a product model from the database equivalent to a component in the diagram. After loading the models, the user defines the connections between the ports of the product models. For calculation purposes the maximum flow and pressure at the ports can be added. These are normally not notified in the circuit diagram.

After loading all components into the system, an initialization is done. During this process, BOHRZUG-objects are created that realize the connections between components ports.

PLACEMENT FUNCTIONS. In the first design step, a solid block must be created with an initial size. To set the adequate dimensions of an hydraulic manifold re-

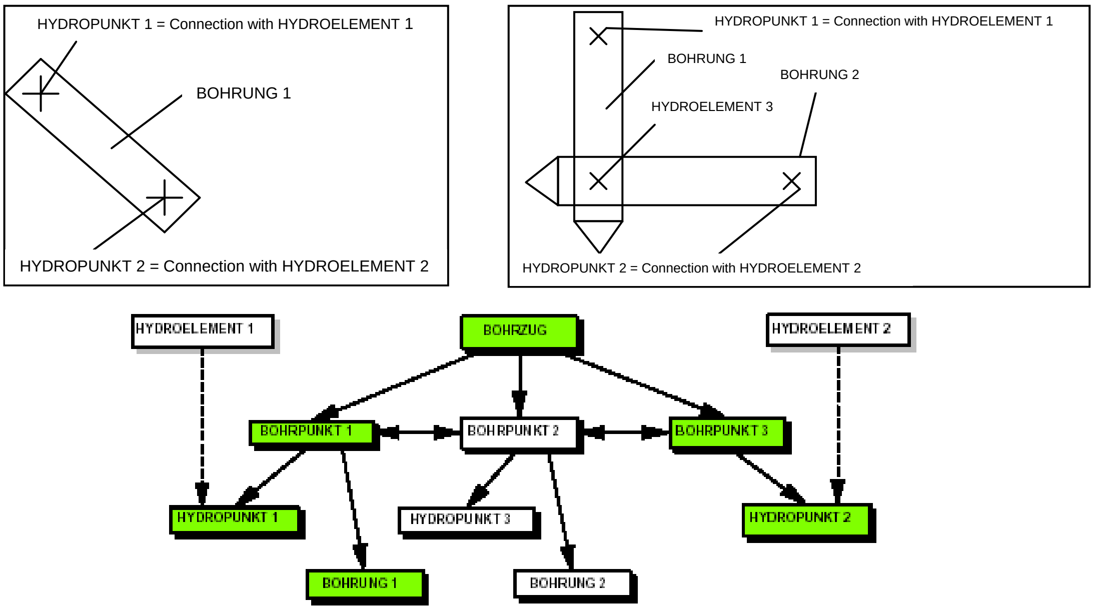

Fig. 8 Modified structure of product models after inserting a bore into the chain

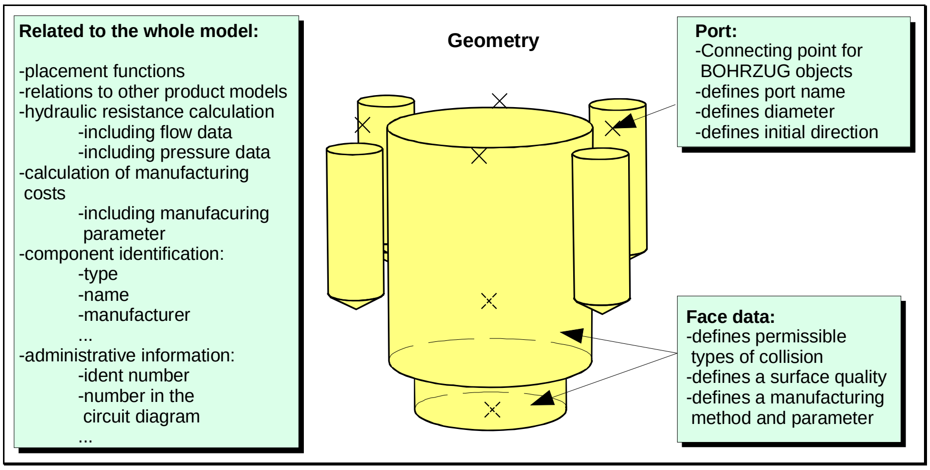

Fig. 9 Product model for a cartridge valve realized as an ACIS-class

quires some experience of the designer! Now the user can select one of the components from a list and can locate to position on a manifold surface. The functions of the product model ensure that the model is transformed in a defined relation to the chosen position. Example a Cartridge-Valve (Fig. 9) is placed with its main axis rectangular to the manifold surface at the chosen point and with its front side on the manifold surface. Now the product model is connected to the surface and when the surface is moved, the model will be moved with the surface.

GENERATION AND MANIPULATION OF CHAINS OF BORES. When a new component is placed in the manifold, the CAD-tool checks if, due to the circuit diagram, port connections can be made with components already located in or on the manifold. In this case, the BOHRZUG-objects create a chain of bores between ports to be connected. The necessary diameters are stored in the product models. At first the chain consists of three bores, Fig. 10 left.

With the ports of the product models, an initial direction and length for the bore starting at the port is stored to avoid bores intersecting. So two bores are created directly at the ports of the cartridge and a third that connects the two other (Fig. 10). Once a chain of bores is created, it can only be modified by the functions of the BOHRZUG-object. This ensures that the chain cannot be cracked by error.

- The BOHRPUNKT-objects define the bore endings. When a new point is put into the chain, an existing bore is replaced by two new ones, that include the new position. It is shown Fig. 8, right, how a bore is split into a vertical and horizontal bore by adding a new point to the chain. When a BOHRPUNKT is moved or deleted, the chain will remain linked. A point can not be deleted when it is the starting- or the endpoint of the chain and linked to a port.
- Similar functions exist for the creation, manipulation and deleting of bores.
- To make the bores suitable for manufacturing an automatic function replaces an angled bore by a number of bores that are rectangular to the manifold sur-

faces.

MODIFICATION OF THE BORE GEOMETRY. Before the final position of a bore is found, it consists only of a cylinder between the related BOHRPUNKT-objects. Finally the designer calls functions of the BOHRUNG-objects to create automatically either an tapered ending or an extension to a manifold surface. In the second case, the system automatically creates a suitable sealing plug. The three bores of the chain in Fig. 10, right, are perpendicular to the manifold surfaces and completed with suitable threads for plugs.

ADVANCED COLLISION CHECKING AND MINIMUM DISTANCE CALCULATION. When the bore intersection check of a standard CAD system is used to investigate the correct design of a hydraulic manifold, it marks every intersection, including those which are necessary, to fulfill the function of the manifold listed below:

- bores, that are connected according to the circuit diagram;
- HYDROELEMENT-objects (e. g. cartridge-valves), which front sides are placed on a manifold face;
- bores, that penetrates the geometry of a component because the connected port is placed on or in the component.

Because in the CAD-tool for hydraulic manifold design, every geometry belongs to a product model, it has a "meaning". Based on this data a more intelligent bore intersection check tool has been created. This tool identifies all bore intersections in the manifold, identifies which ones are necessary and displays only those not required to the user. In addition, it determines the minimum distance between bores that are close but do not intersect. These distances may be small enough that the wall may in service and cause leakage. The tool determines maximum port pressure, material properties and performs a calculation to determine if the design is adequate (no material failure between ports). This function is based on algorithms that have been developed within the project.

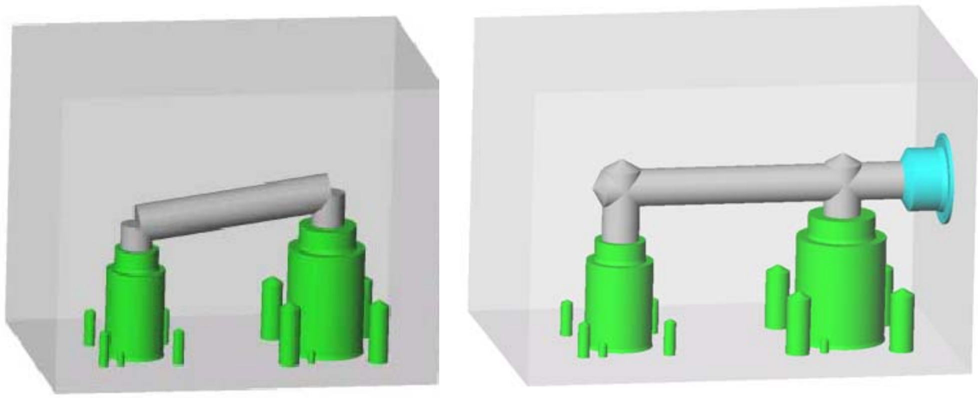

Fig. 10 Complete chain of bores between two ports

7. Integration into existing IT-environments

Because every company has a unique IT-environment, a special software like the design system for hydraulic manifolds can only be integrated successfully when it can be easily adapted to the environment and needs only a small amount of support service.

The design system for hydraulic manifolds offers two possibilities to reach that target.

- The design of the hydraulic manifold is done completely in a stand alone version of the design system. In the next step the geometry is saved into a SAT file which is imported into the companies CAD system which is able to read such files. With the CAD program, all following steps can be done, technical drawings, NC-programs, etc. When the SAT file is converted to another file format (e. g. STEP; [4-7]) the number of possible CAD and additional software tools is growing.

If an ACIS-based CAD system is already used, the design system for hydraulic manifolds can be integrated. Such an integration can only be done from the CAD company and is only promising if the number of possible users is large enough.

8. Conclusion

With the afore described web-based information tool for hydrostatic system design, it becomes possible to archive all information that is handled or produced within the early product development process. The IT-tool supports, in contrast to Hoffmann [8], the early stages of product development since these stages have the greatest potential for an improvement of the design process and the product. Next to the preliminary task definition of the customer and its changes, the FPS, the product concepts, the results of simulations, the circuit diagrams and lists of parts as well as all decisions and comments of the concerned project group are documented. With increased use of the IT-tool, more product data is accumulated for use in new product designs. The IT-tool guides the project designers through the development process of the hydrostatic system and enables thereby a systematically and structured approach. The web-based client-server-architecture enables cooperative work as it is possible to share the design decisions with other project designers and allows the tracking of the reasoning process by the recording of all development steps. Furthermore this system architecture ensures a consistent data pool with a minimum of redundancies.

Further development of the application engineering software will provide tools for the geometric design of the hydrostatic systems specified in the product concept. The aim is to make statements about possible collisions between devices or dimensioning errors in the project design stage of the product when using a 3D geometrical model. With the help of a so-called assembly model, the project designers can arrange early remedial measures, like selecting different devices, in the case of inconsistencies on a new or modified construction. The hydrostatic devices are assigned simplified geometric models in order to keep the amount of geometric data low for the assembly research. The assembly model of the hydrostatic system consisting of these "configuration models" of components is composed of simple geometries like cuboids and cylinders. Only the functional surfaces and volumes which are of significance for the assembly and the dimension process are completely worked out on these simplified geometries. For example the master gauge for holes, casing surfaces or the fastening threads important for assembly.

With the described CAD tool for manifold design, that is based on an object oriented solid modeler, it is demonstrated that product models can be established and implemented in a CAD system. These product models contain not only geometric data but also nongeometric data and functions that represent features of the real product. Based on these product models, the CAD tool provides an improved functionality so that the design of hydraulic manifolds can be done better and more efficient.

References

1. VDI-Richtlinie 2221: "Methodik zum Entwickeln und Konstruieren technischer Systeme und Produkte", Düsseldorf, VDI-Verlag, 1986.
2. VDI-Richtlinie 2225: "Konstruktionsmethodik, Technisch-wirtschaftliche Bewertung", Blatt 3, Düsseldorf, VDI-Verlag, 1990.
3. **Stritzke, H.** Internetgestütztes Informations- und Kommunikationssystem für verteilte Projektteams am Beispiel der Produktentstehung. Dissertation. Fortschrittsberichte VDI Reihe 10 No 569. Düsseldorf, VDI-Verlag, 1999.
4. N. N.: ACIS 5.0 - Getting Started Guide, Spatial Technology Inc, U.S.A, 1999.
5. N. N.: ACIS Open Solutions Catalog, Spatial Technology Inc, U.S.A, 1998.
6. **Pott, B.** Steigerung der Konstruktionsleistung durch ein Produktmodellbasiertes CAD-System für Hydraulische Steuerblöcke. VDI-Fortschritt-Berichte Reihe 20, No 348, 2002.
7. **Schmidt, J.; Feldmann, D.G.** "A WEB based tool for the holistic projecting of hydrostatic systems", 3. Int. Fluidtechnisches Kolloquium, Vol. 1, S.373 - 382 Aachen, 05.-06. März, 2002.
8. ISO 10303 - 1: Industrial Automation Systems and Integration - Product Data and Representation and Exchange - Part 1.

D.G. Feldmann

HIDROSTATINIŲ SISTEMŲ KOMPIUTERIZUOTAS PROJEKTAVIMAS IR TAIKOMOJI INŽINERIJA

R e z i u m ė

Hamburgo-Harburgo technikos universiteto Gamybos plėtros ir konstravimo katedra plėtoja hidrostatinių sistemų projektavimą bazinių elementų pagrindu. Reikia, kad visi projektavimo padalinio darbuotojai galėtų kompiuterių tinkle naudotis duomenimis apie gaminį ir jo projektavimą. Pagrindinis projektuojamos sistemos komponentas yra hidrostatinėms sistemoms adaptuotas gaminio modelis, kuriame yra specifiniai produkto analizės ir sintezės duomenys. Hidrostatinės sistemos projektavimas yra gaminio modelio informacinis užpildymas IT įrankiais per keletą projektavimo etapų pagal VDI 2221 nurodymus.

Hidrostatinių sistemų valdymo posistemiai ir hidrauliniai vamzdynai pradiniame etape projektuojami rankiniu būdu. CAD naudojamas tik įrankiu rankiniu būdu daromiems sprendimams patikrinti, brėžiniams paruošti. CAD įrankių efektyvumui padidinti jų galimybės praplėstos taip, kad pati programa atliktų kai kuriuos patikrinamuosius skaičiavimus.

Gamybos plėtros ir konstravimo katedroje pradėta kurti projektavimo sistema, pritaikyta 3D-CAD modeliams. Projektuojant galima sukurti modelį, kuriame būtų ne tik geometriniai, bet ir techniniai bei valdymo duomenys, būtini skaičiavimams bei kontrolei. Šių technologijų pagrindu sukurti hidrostatinių sistemų komponentų modeliai naudojami naujose projektavimo sistemose.

D.G. Feldmann

COMPUTER SUPPORTED APPLICATION ENGINEERING AND DESIGN OF HYDROSTATIC SYSTEMS

S u m m a r y

The Institute for Mechanical Engineering Design of the Technical University Hamburg-Harburg is developing a product model based tool for application engineering of hydrostatic systems, which supports the early stages of product design. To guarantee that all employees of the company have access to product data and design knowledge via Intranet the tool is WEB-based. Increased data processing support especially in the early stages of product development requires computer supported acquisition of the task, which is offered by the tool. Additionally different modules support the solution identification process by supplying design experience and giving access to realized solutions. Circuit diagram creation, selection of components, system simulation, error estimation and 3D layout of the hydrostatic system are also supported by the tool. The central component of the application engineering tool is a product model, defined especially for hydrostatic systems, in which all product specific analysis and synthesis data are stored. The design of the hydrostatic system, thus the filling of the current product model with information, takes place with help of IT tools, which support the several stages of product design, following the VDI guideline

2221.

Design of Hydrostatic Systems, namely control-systems and especially hydraulic manifolds is “the up to date” subject of „by hand“ designers; CAD support can be found as a tool to reproduce a handmade layout for interference checking, presentation and make of production drawings. To create a higher efficiency a CAD tool must be extended for this special task, so that some of the calculations and checking of the constraints can be done internally by the program and are immediately available.

Due to this situation the „Arbeitsbereich Konstruktionstechnik I“ started to build a design system based on an object-oriented 3D-CAD-modeller. With the objectoriented programming it is possible to create product models that contain not only geometric data but also technical and administrative data that are necessary for calculations and constraint checking. Based on this technology product models for hydrostatic components are evaluated and used in the new design system.

Д.Г. Фельдманн

КОМПЬЮТЕРНОЕ ПРОЕКТИРОВАНИЕ И ПРИКЛАДНАЯ ИНЖЕНЕРИЯ ГИДРОСТАТИЧЕСКИХ СИСТЕМ

Р е з ю м е

Кафедра Конструирования и модернизации производства Технического университета Гамбурга совершенствует проектирование гидростатических систем с помощью базовых элементов. Это возможно при условии, что все сотрудники могут с помощью интернета пользоваться данными об изделии и его проектировании. Основным компонентом проектируемой системы является модель изделия, адаптированная к гидростатическим системам, в которой содержатся данные анализа и синтеза изделия. Проектированием гидростатической системы является информационное заполнение модели изделия по указаниям VDI 2221.

Проектирование гидростатических систем управления и гидравлических трубопроводов в начальной стадии производиться вручную. CAD может использоваться, как вспомогательный инструмент для проверки расчетов и изготовления чертежей. Для увеличения эффективности инструментов CAD, необходимо расширить их возможности, чтобы проверочные расчеты можно было бы проводить внутри программы.

На кафедре Конструирования и модернизации производства начато создание системы проектирования, приспособленной к моделям 3D-CAD. Можно создать модель, имеющую в себе как геометрические, так и технические данные, а также данные об управлении, необходимые при расчетах. Модели компонентов гидростатических систем, созданные на базе этих технологий, используются в новых системах проектирования.

Received November 17, 2005