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INCREASING THE EFFICIENCY OF DESIGN CATALOGUES BY USING MODERN DATA PROCESSING TECHNOLOGIES

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1. Introduction

An important issue in modern design is its increasing complexity. Therefore, big problems are broken down into smaller and manageable sub-problems. It is clear that there are often lot of sub-functions that are reused in several constructions. Design Catalogues contain collections of known solutions to these design sub-problems. They are a well-known aid for methodical designing containing physical effects, working principles, principle solutions, machine elements etc. [Roth 1972]. Design Catalogues serve various purposes and support technical designers during the whole design process.
Several types of Design Catalogues are available. A large number of them can be found in literature e.g. [Roth 2001], [Franke 1998], [Koller 1976], [Ewald 1974]. Currently, most catalogues are in the printed form. Furthermore, lists of references to some Design Catalogues, e.g. [Pahl/Beitz 1999] or [VDI Guideline 2222], are existing that may be helpful for a first purposeful search.

As a matter of course, a engineer just can start to work with Design Catalogues after obtaining them. But this is the main problem. The limited availability is a crucial obstacle, so that the time-consuming procurement deters many users from working with this aid. At present, there is no accessible central place that collects Design Catalogues providing information for fast, reliable design practices.
This paper describes a computer aided system based on modern data processing technologies that facilitates to access a large number of Design Catalogues via internet.

2. State of the art – current situation

2.1 Use of Design Catalogues

Design Catalogues are collections of generally design related knowledge. They cover physical effects, solution principles, solution concepts, machine elements etc. They provide a problem-oriented access to solutions and are mostly independent of specific disciplines [Pahl/Beitz 1999].

Figure 1 shows the typical basic construction. The classifying criteria determine the catalogue's structure. Typically, the classifying criteria contain a firm number of criteria. The solution column may be presented in form of drawings, sketches, equations, laws, formulae, depending on the intended application. The given solution characteristics are important for the systematic selection of solutions e.g. typical dimensions. Therefore, the user has to consider the requirements list (design specification).
It exists a great number of Design Catalogues (e.g. catalogues of physical effects, types of connections, linear guides, effects to generate power, friction systems etc.) which can be helpful for designers to evaluate solutions.

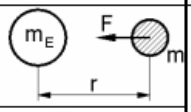
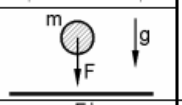
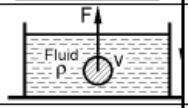
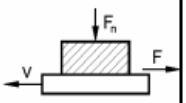
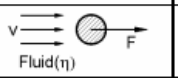
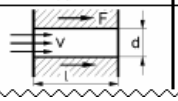
Classifying criteria			Solutions		Solution characteristics		
Force	Physical law	Special effect	Equation	Example	Conditions	Charact. dimension	…
1	2	3	1	2	1	2	…
Force of gravity	Law of gravitation	Gravity	$F = \Gamma \cdot \frac{m_e \cdot m}{r^2}$		two weights	$\sqrt[3]{\frac{m}{\rho}}$	…
		Weight	$F = m \cdot g$				…
		Lifting force	$F = \rho \cdot g \cdot h$		fluid weight	$\sqrt[3]{V}$	…
Frictional force	Coulomb	Sliding friction	$F = sign(v)\mu F_n$		pair of solids	-	…
	Newton	Laminar flow	$F = 6\pi\eta r v$		solid + fluid	r	…
		Turbulent flow	$F = \lambda \frac{l}{d} \frac{\rho}{2} v^2 A$		solid + fluid	1	…

Figure 1. Extract from Design Catalogue of the function „Generate force with other quantities"

2.2 Deficiency of conventional Design Catalogues

Design Catalogues are used insufficiently in practice. There are plenty reasons. One main problem is that products have to be developed more and more in a very short time. Time pressure makes it nearly impossible for engineers to obtain the right catalogue in a passable time.

Another reason for the insufficient use seems to be that Design Catalogues are only available as textbooks so that it is not possible to arrange the information depending on the user's requirement. The static structure of the catalogues is also prejudicial. The classifying criteria determine the structure so that they influence the ease with which catalogues can be handled. On the other hand, solution characteristics exist that are also suitable for restructuring the catalogues in a different way.

In order to overcome these disadvantages a system is needed that offers the possibility to arrange the classifying criteria of a catalogue according to the user's desires. Generally speaking, the ease of use has to be optimised.

All this mentioned functions can not be provided by conventional printed versions. Therefore, the development of a suitable catalogue-system, called "eKat", has been started within the framework of the research project GINA (Holistic Innovation Processes in Enterprise Networks). It is based on the preparatory work of [Derhake 1990], [Speckhahn 1994] and [Franke 1998].

A main goal of this system is to increase the efficiency of Design Catalogues by using modern data processing technologies. The following chapters give a rough view over the functions und applications.

3. Computer aided Design Catalogue

A computer aided system enables to work with Design Catalogues from internet in a very comfortable way. With the help of modern data processing technologies it is possible to make these sources accessible for many technical designers. However, this idea is not new but it still does not exist a system solving adequately this problem. The computer aided catalogues offer substantial advantages compared to textbooks, e.g. easy modification, integrated calculation, links and availability at all hours.

3.1 Functional requirements

The functional requirements of the system are conform with the user's needs. It is extremely important that the system becomes very user-friendly in order to make it attractive for designers. Important requirements are:

- an easy intuitive operability,
- expandability,
- clarity and
- a fast performance.

3.2 Basic functions

With this system it is possible to generate, store and present Design Catalogues with an internet-based access. A user administration tool defines and distributes different rights of access. Basic functions (adding, changing or deleting catalogue data) are only permitted for the administrators who are responsible for contents. The user administration permits the individual storing of the respective catalogue options.
Figure 2 shows the tree structure of the implemented catalogues. Several types are made available, for example catalogues of physical effects including several possibilities to satisfy a given function (see figure 4) or different catalogues of solution principles.

Figure 2. Tree structure of the implemented catalogues

Partially, there are very extensive catalogues so that the limited display is too small for representing the whole data at a glance. Therefore numerous functions were integrated to work with the catalogues very comfortable. It was necessary to realise appropriate display functions. For example, it is possible to advise catalogue sections by mouse click selecting the important columns and lines. The sorting of the data content can also be changed very simple so that users can easily compare different data.
Compared to printed catalogues, the system offers the possibility to extend further information by using hyperlinks to different kinds of information like urls, various computer aided tools or other

documents. You can establish relationships between different catalogues or advanced information in a very simple and comfortable way. Certainly, it is possible to print excerpts or whole catalogues.

3.3 Dynamic function

An essential advantage, compared to printed catalogues, is that users have the possibility to arrange the classifying criteria of a catalogue according to their desires or previous knowledge. After selecting the wanted catalogue, the user can decide how the catalogue is structured. A pull-down menu proposes a list of suitable criteria for sorting and structuring the dataset (see figure 3 and figure 4).

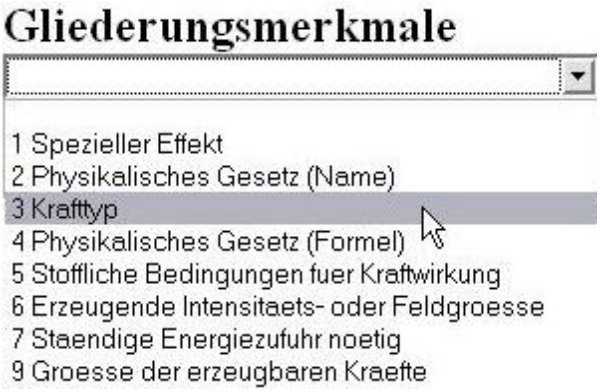


Figure 3. Possibility to select classifying criteria

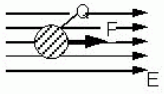
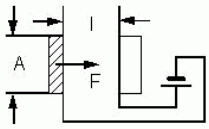
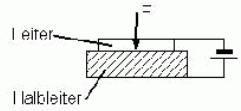
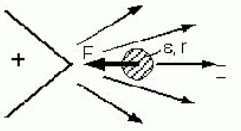
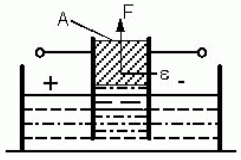
Gliederungsteil	Hauptteil				
Krafttyp	**Gleichung**	**Anordnungsbeispiel**		**Spezieller Effekt**	**Physikalisches Gesetz (Name)**
1	**1**	**2**	**Nr.**	**1**	**2**
Elektrische Kraefte	$F = Q \cdot E$		10	Coulombsche Kraft	Coulombsches Gesetz
Elektrische Kraefte	$F = 0{,}5\varepsilon \cdot \varepsilon_0 (U^2/l^2) \cdot A$		11	Kondensatoreffekt	Coulombsches Gesetz
Elektrische Kraefte	$F = k \cdot U^2 \cdot A$		12	Johnson-Rhabeck-Effekt	Coulombsches Gesetz
Elektrische Kraefte	[illegible]		13	Dielektrikum im inhomog. Feld	Coulombsches Gesetz
Elektrische Kraefte	$F = A (\varepsilon_0 / 2) (\varepsilon - 1) E^2$		14	Dielektrische Fluessigkt.i.Feld	Coulombsches Gesetz

Figure 4. Result of the dynamic structuring

3.4 Program Architecture

The developed system consists of a three-layer architecture. The data management, the technical concept and the user interface are separate. The technical concept contains the functional kernel that controls the interaction between user and system. Modifications at the individual layers have only small effects on the remaining system. Thus, the system can be adapted more simply to new requirements.

The catalogue data sets are stored into a relational data base. The data base language is SQL (Structured Query Language). The communication between data base and technical concept is realised by JDBC (Java Database Connectivity). JDBC offers several interfaces, e.g. a direct access to a Java application for data bases.

The described functions are realised in Java Server Pages (JSP) which enable to generate dynamic websites. The whole system is a web-application. The graphical user interface (GUI) is created with Hypertext Markup Language (HTML) so that the presentation of the contents is platform independent.

4. Conclusions

The key to success when working with Design Catalogues is a funded database of catalogues. Much literature about mechanical knowledge latently exist. A web-based tool called “eKat” was created that close this gap and support engineers within the conceptual design phase. The opportunity to have access to various catalogues at any time makes the system attractive for engineers. Currently, the system contains approx. 30 Design Catalogues and it will be expanded continuously in future.

As a matter of course, Design Catalogues do not solve designing problems, but they are a helpful method to assist designers by reusing existing solutions. The system makes designers able to explore alternatives by an accessible source of information and can be helpful for the embodiment design phase.

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