Web platform for functional design

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Abstract. Today’s global competitive trends, especially those related to industries, determine a much higher degree of pressure and demands for substantial innovation driven improvements, flexible and time sensitive solutions. Improving and optimizing the design activity by shortening its timeline and maintaining a high quality level for its output have become the main success factors. The evolution of design activity is strongly related to the evolution of education and research made in the design field. Thus, the development of web tools which can contain knowledge about mechanical products functionality and structure may be an important achievement for the education and industry. This paper presents a web platform which contains functional-constructive knowledge in the area of mechanical design field and was developed to support design activity. The proposed web tool can provide any user, even one without background in design theory, information about the functionality of products and the way it is related to the product structure.

1. Introduction
The demand for reducing the time-to-market for a new product and, at the same time, to provide it with a very good functional level, has become a main requirement in today’s business environment. To support this requirement, the researchers have developed methods and tools which can help the designers to accomplish faster their design task. Most of these tools have as background design knowledge stored in databases. However, most of these databases contain only CAD data and no knowledge about products functionality [1].

It has been recognized that knowledge sharing in product design area influences both the development time and the product cost in a positive way [2]. Today, due to the evolution of the internet, easy access to design knowledge and design collaboration can be possible, and this makes the web-based design tools flexible and cost-effective.

If we look from the educational perspective, it is proven that today’s students no longer spend their time writing by hand or collecting information from books in a library room. The functionality of these learning components has changed and computer and web-based applications made the knowledge more accessible and transportable. Web-based knowledge sharing is the start of new developments in education and especially in higher education area.

A web-tool which provides information about functionality and its applications is “production inspiration” [3]. Here, various solutions can be found for 37 primary functions linked to one of the states: solid, liquid, gas or field [3, 4]. This tool can be used as source of inspiration for products and
manufacturing development, but the information regarding the solutions presented here is at minimum level and the designer work cannot be improved considerably by its use.

The most important achievement in the domain of sharing functional knowledge is the development of the web-based repository made by the University of Missouri–Rolla in collaboration with the University of Texas at Austin, Pennsylvania State University, Bucknell University, Virginia Polytechnic Institute and State University [5, 6]. However, using this tool implies a certain level of knowledge regarding Functional Basis functions and flows considered for products [7].

To improve the educational process in the design field, it is imperative to provide and share design knowledge based on products functionality. For this reason, it has been considered that the design of a web-platform with a simple and easy interface which contains functional-constructive knowledge which can be easy understood by any user with a technical background can provide a good basis for improving this process.

2. Objective
The objective of this research is to develop a web-platform to support students, teachers and engineers in the design activity by providing information about the functionality of products and the way it is related to their structure.

The main elements defining the research program have been: creating a design knowledge database with information about products functionality and its relationship to the constructive structure, documentation on the state of art regarding web tools available for supporting design activity, defining the platform structure, creating the platform interface and establishing its relationships to the knowledge database, testing the platform functionality.

3. Web platform design
The web platform was created having as a background a knowledge database developed for functional design [1]. One of its purposes is to be used as an interface between the potential users – teachers, engineers, and students – and the functional-constructive knowledge present in the database, for supporting users in design activities (table 1).

Using this web-tool, the information will be accessed easily because the user does not need to be connected at a device which has a fix location and can have the information at hand only if it has a device which allows him to have internet connection. The only problem which can appear is the use of CAD data, because this involves to have installed on his computer CAD software.

Table 1. Schematic extract of the functional-constructive knowledge [1].

| Functional class | Specific functions | Sub-functions | Constructive units |
|------------------|-------------------|---------------|--------------------|
| Code             | Name              | Code          | Name              |
| FC1              | Motion            | 1SF1          | Create            |
| 1SF2             | Transfer          | 12F1          | Rotary motion     |
| FC2              | Connect           | 2SF1          | Assembly          |
| 21F1             | Removable         |               | 211CU1            | Fasteners          |
| 21F2             | Permanent         |               | 212CU1            | Welding            |
|                  |                   |               | 110CU1            | Combustion engines |
|                  |                   |               | 121CU1            | Rotary shafts     |
|                  |                   |               | 121CU2            | Bearings           |
|                  |                   |               | 122CU1            | Linear shafts     |
|                  |                   |               | ...               |                    |
|                  |                   | 12F2          | Linear Motion     |
|                  |                   |               | ...               |                    |
|                  |                   |               | ...               |                    |

...
For the design of the web-platform, the Hyper Text Mark-up Language, HTML, [8], and the Cascading Style Sheets, CSS, style [9] were used, as presented in table 2.

### Table 2. Platform code and style examples.

| Code                                                                 | Style                      |
|----------------------------------------------------------------------|----------------------------|
| `<html xmlns="http://www.w3.org/1999/xhtml">`                      | `#container`               |
| `<head>`                                                             | `{                         |
| `<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />` | `margin: 0 auto;`          |
| `<title>Web - Platform for functional design</title>`               | `width: 1400px;`           |
| `<link href="styles1.css" rel="stylesheet" type="text/css" />`   | `background-color: #fff;` |

This work also incurs the need for a hardware environment. For the web-platform implementation, a data server will be necessary to contain the information from the database and an internet server on which the web application will be installed and from which the connection with the internet will be made. As an alternative, for reducing the costs with the hardware equipment, internet hosting can be bought from a specialised provider. The network relations of the web-platform, when hardware acquisition is considered, are briefly described in figure 1.

![Relations between users and database content](image)

**Figure 1.** Relations between users and database content.

### 4. Web platform user interface

In general, the user interface design has as its main objective making the users interaction with the web-tool easy, efficient and enjoyable.

The web platform that has been created, Web Platform for Functional Design, denotes a simple and user friendly interface (figure 2). The main page contains a set of functional classes considered for the mechanical products – motion, connect, control, support and convert – represented by buttons which will guide the user to the specific functions, sub-functions, their definitions and the associated constructive-functional units assigned. For each constructive-functional unit, the user can retrieve...
information about its features and can download a CAD model which can be used as the component to be developed.

The platform includes also other sections which present general information related to its purpose, such as:
- *About* – general presentation of the web-tool and the reason for which it has been created;
- *News* – here news about research made in the design area will be listed;
- *Contact* – contact detail of the platform administrator;
and specific data and tools related with the design process, such as:
- *Design tools* – here tools for supporting design activity, as the tool for creating functional-constructive matrices, FCM will be found;
- *CAD library* – here the CAD models for most of the considered design functions will be stored. These models will be accessible as .step format files or Autodesk Inventor format files. The CAD library will contain also a section on which students can exchange CAD data and also functional knowledge. The information inserted here will not influence or modify the functional-constructive knowledge presented in the main database, but the platform administrator can decide if the contents uploaded by users will be included there or not.
- *Materials library* – here information regarding material characteristics will be stored.

![WEB - PLATFORM FOR FUNCTIONAL DESIGN](image)

**Figure 2.** Web-platform main page.

Every functional class, specific function and sub-function name is linked to a web page which contains information related to that subject, and where, under their name or definition a button, *Constructive-functional units* is displayed, which guides the user to the different levels of constructive-functional solutions. By selecting one of the constructive-functional units displayed for a certain function, a page with the constructive characteristics of that specific unit is opened. If until this moment the user obtains only functional information, from this page the user can complete the design information with its constructive characteristics and download a CAD model with the desired dimensions by selecting them from the table present on this page. To obtain complete information related with the desired material from the list of possible options, the user should click on the material name and its characteristics will be displayed. A preview of what is described above is presented in figure 3. The path followed to access the presented platform pages is: *FC1 - Motion* (page content not shown) → *1SF2 - Transfer* → *12F1 - Rotary motion / Constructive-functional units* → *Rotary shafts.*
Figure 3. Preview of the web-platform interface.
5. Conclusions
This paper presents the design and the interface of a web-platform developed for supporting and sharing knowledge in the design process field.

The simple interface of this web-tool can provide, to any user which has a device which can allow internet connection, even without background on the design theory, the ability to consult and retrieve information about the functionality of products and the way this is related with their structure. Besides the functional-constructive knowledge, the platform also includes other sections presenting general information related to its purpose, such as news about research made in design area, specific data and tools related to the design process, a CAD library and a material library.

The implementation of this web-tool can shorten a lot the time necessary for design because for the elements retrieved from here the design is almost complete, the only missing information being the part/product drawings. But, to achieve the implementation of the proposed web-platform further work is needed in order to develop all the connections between the knowledge content, filling in complete information regarding geometrical and material characteristics for the considered constructive solutions, introduction of cost elements and tools, choosing the hardware support for making it accessible to the users and in order to introduce it in the design educational process.

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References
[1] Dijmarescu M D, Parvu C and Gheorghe M 2015 Knowledge Database for Functional Design of Mechanical Products Applied Mechanics and Materials 760 pp 15-20
[2] Chai K H, Wang Q ,Song M, Halman J and Brombacher A 2012 Understanding competencies in platform-based product development: antecedents and outcomes J. of Product Innovation Management 29-3 pp 452-472
[3] Information on http://www.productioninspiration.com, accessed: 10.08.2014.
[4] Chulvi V and Vidal R 2009 TRIZ on Design-oriented Knowledge-based Systems The TRIZ Journal available at http://www.triz-journal.com/triz-on-design-oriented-knowledge-based-systems
[5] Bohm M, Stone R and Szykman S 2005 Enhancing Virtual Product Representations for Advanced Design Repository Systems J. Comput. Inf, Sci. Eng. 5-4 pp 360-372
[6] Bohm M and Stone R 2004 Representing Functionality to Support Reuse: Conceptual and Supporting Functions Proceedings of ASME DETC & CIE Conferences Utah pp 411-419
[7] Hirtz J M, Stone R, McAdams D, Szykman S and Wood K 2002 A Functional Basis for Engineering Design: Reconciling and Evolving Previous Efforts Research in Engineering Design 13-2 pp 65-82
[8] Information on http://en.wikipedia.org/wiki/HTML, accessed: 10.02.2015
[9] Information on http://en.wikipedia.org/wiki/Cascading_Style_Sheets, accessed: 10.02.2015