INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
6 & 7 SEPTEMBER 2012, ARTESIS UNIVERSITY COLLEGE, ANTWERP, BELGIUM

# CREATING A COMPONENT SELECTION RESOURCE FOR UNDERGRADUATE DESIGN TEACHING

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**ABSTRACT**
Within the industrial setting, it will be quite normal to find company best practices in place, a list of approved suppliers and perhaps CAD models of standard components configured through a PLM (Product Lifecycle Management) or MDAC (Microsoft Data Access Components) system. However, an academic environment may not be so bespoke and rigorous. Undergraduates can sometimes feel overwhelmed by the breadth of information available to them; they do not have the industrial knowledge or experience to disseminate appropriate information. This can be the case when students are asked to specify and integrate 'bought in' components, such as bearings and springs, for design projects of whatever level. Many would rely on on-line search engines like Google or Bing, however this process can lead to confusion and fruitless searches. A design engineer in industry would obtain this information using similar techniques, but in a more controlled and thoughtful manner. This paper describes some of the research conducted and implementations put in place, by the Department of Mechanical Engineering at the University of Bath, to support and address this issue for undergraduate design projects.

*Keywords: Research, component selection, design process*

## 1 INTRODUCTION

This is the age of the internet; information is freely available and on-demand. There are a number of technology shifts from traditional desktop and laptop computers towards mobile devices such as tablet's and smartphones. The searching for information on the internet, as opposed to reading literature is widespread, as the rise of the "digital native" increases [1]. However, undergraduate engineering curriculums are still largely textbook-orientated, in nature, with many students not having to search beyond the realms of a recommended text or lecture notes [2]. This may be the case for experimentation and analytical subjects, but does not hold true for elements of design. Students have to use catalogues and supplier lists to undertake *realistic* design work of which they have no previous experience. An online search engine is often the first port of call, even if supplier manuals are provided to the students. In industry, open searching is unlikely to be the case as designers and engineers would work closely with known, prescribed and previously used suppliers to support the design process. They would be able to view details of approved suppliers, communicate with fellow engineers and access information on demand. Data management systems like PLM allows for better sharing and implementation of 3D CAD models, technical data and 2D drawings.

To help students, a component selection resource is required, which provides information on the types of suppliers they should be looking at, the criteria they need to select the right parts and componentry, and to achieve the best outcome from that process where it be appropriate literature or a CAD model to import into their design. The purpose of this paper is to explain some of the issues surrounding component selection in the digital age, which has been tackled with the implementation of a component selection resource. The paper also describes how component selection information has been filtered for undergraduate use.

## 2 WHERE TO FIND INFORMATION

In industry, engineers and designers can find lists of suppliers though Intranet systems or PLM software solutions. The IHS (Information Handling Services) [3] used to distribute printed Technical Indexes that provided details of suppliers, however they now reside in the digital domain, providing parts, fasteners and supplier catalogues as a service. This information is integrated into a database or PLM system, at a cost. Other sources include literature such as the Handbook of Engineering Design [4], which was to be regarded as a first reference for engineers. The data is still useful, however the references to BS standards and supplier information are largely out-of-date. Also, a problem with most textbooks is that they are rigid resources, frozen in time, unless they are revised regularly they do not keep up with the technological changes and advances of 21st century engineering. In contrast, the internet is organic and always changing, however, it can be hard to find appropriate information. For example, a search for ‘bearings’ on an online search site can yield 116 million results, the first hit being Wikipedia (another first point of call for undergraduates). Engineering search engines, such as Globalspec, are more specific but can still yield up to 558 results for a search for bearings. Mucci’s handbook [4] summarises bearings into 15 pages, describing plain bearings, roller bearings, bearing selection and a list of suppliers. New search technologies, such as Summly [5], aim to summarise content for relevant and productive web browsing; however the technology is still infantile and not appropriate for component searching. Therefore, it is imperative that a support resource is adaptable, freely available and familiar to students-yet contextualized and appropriately filtered with the correct information.

For undergraduate teaching and information sharing, the University of Bath uses Moodle [6][7], an open-source PHP (Hypertext pre-processor) web application for learning. This resource is used frequently by students to get updates on course information, view and download lecture notes and resources as well as uploading submissions. Therefore, it is the most appropriate place to put a support resource as the interface will be integrated and consistent, albeit that it is more configured for course structuring (Figure 1). It can be seen the resource has been designed to include a general selection guide, recommended textbooks and then a limited number of suppliers with good coverage and good web resources. This arguably is similar in the way most PLM packages operate, by linking CAD files, documentation and team communication in one workspace, but with a clear academic dimension. Resources which are relevant to undergraduate projects and teaching have been reviewed and placed on Moodle for students to access.

The resource uses the SEED (Sharing Experience in Engineering Design) Open Educational Resources [8] through DelORES Selections [9]. DelORES (Delivering Educational Resources for Engineering Design) provides students with expert selected resources from a range of collaborating Universities.

The Design Activity Centre within the Department of Mechanical Engineering also provides a physical library of component and part catalogues for students and staff to use. The catalogues have been sorted and categorized to reflect the different needs of each project. The students will be able to browse through four categories, which focus on elements of their design projects (see Figure 2.). The digital Moodle resource and the physical catalogue resource have, as much as possible, been aligned with the same information and suppliers.

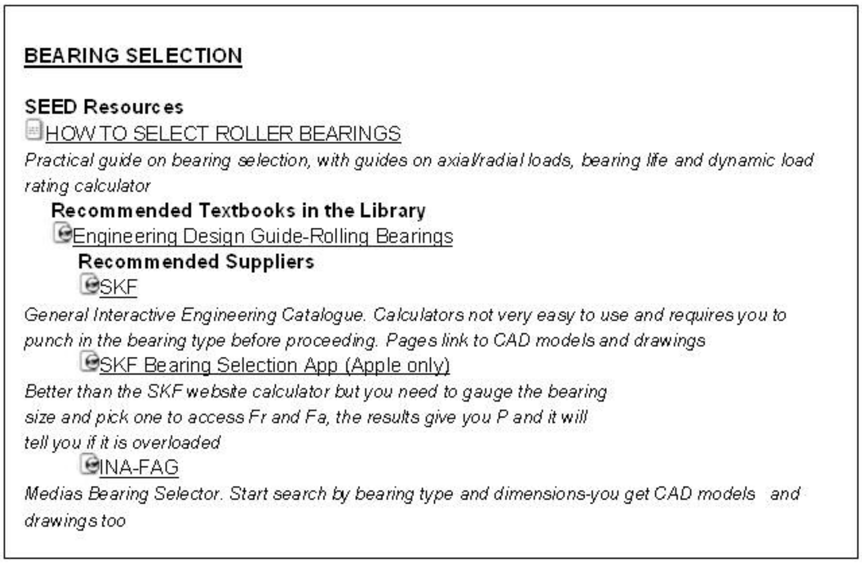


*Figure 1. The ME Design Resource on Moodle*

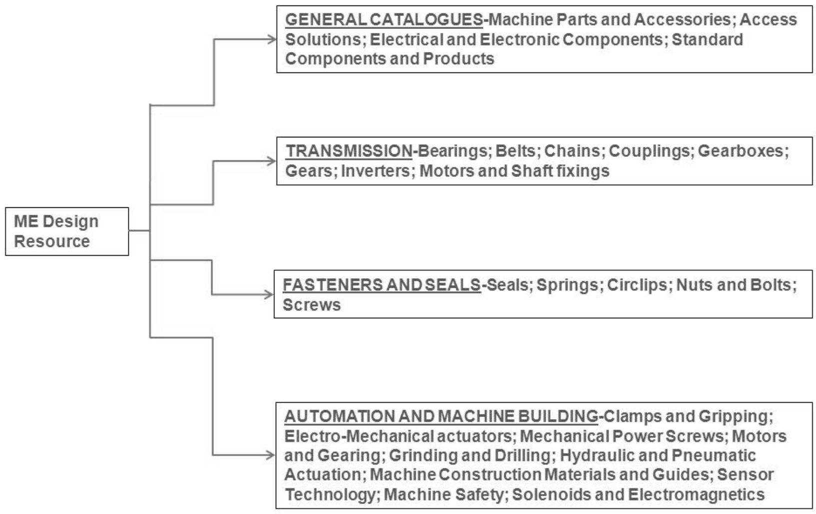


*Figure 2. The categories for different types of parts and components*

## 3 SELECTING A SUPPLIER

The number of potential suppliers available for a particular component or part can be vast and overwhelming. Designers and engineers, working in industry, would select from approved suppliers for a particular component or part. This is often constrained to a selected number of appropriate suppliers for each component category, most likely key parts and components that are bought externally to integrate into a product (Figure 3.). In the case of a drill, the casing would be designed from scratch, but many components would be bought out by external suppliers-these are key to the overall specification, detail design and final design for manufacture. This practice has been mimicked in the support resource, providing students with a small number of suppliers for each component category. This is also reflected in the physical catalogues available to students. For example, with rolling element bearings, students would choose between SKF or FAG as recommended bearing suppliers.


*Figure 3. An example of a cordless drill design*

## 4 UNDERSTANDING REQUIREMENTS

Variables for component selection can vary, those that are rigorous component integrators will have calculated performance requirements based on specification and understand the packaging requirements for a design. However, the outcome of a search for desired componentry could yield a solution that may be too large, too small or too expensive. Equally, a designer trying to find a small component to fit into a product package could realise that the desired solution is overloaded. Both outcomes require a review and possible amendment to the design specification or configuration; such is the iterative nature of the design process. Luckily, many engineers and designers no longer need to flick through pages of websites and catalogues over and over again. Many supplier websites offer online and downloadable selection tools, which allow users to create and save many system configurations (Figure 4.). However, students are not experts in the field, they would need prior understanding to fill in all the variables and design criteria needed for the tools. This is where the SEED resources, available via Delores, play a major part in the selection process. They give *filtered* information on how to select componentry, which is relevant and tailored for undergraduate use.
In addition, most of the textbook references, provided by the SEED resources, are available in the University Library. Relevant textbooks have been linked, via the support resource, to their respective Library web page. This is aimed to encourage students to do further textbook reading and research.

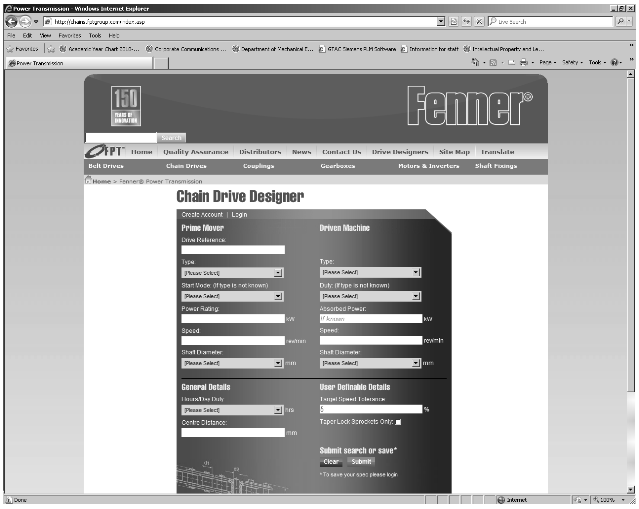


*Figure 4. An example of an online tool used for designing chain drives and selecting components from a supplier catalogue*

## 5 INTEGRATING PARTS AND COMPONENTS

Once a component or system has been selected, there are many options available to a designer or engineer. Many suppliers offer technical data or 2D drawings from literature. The prevalent use of 3D CAD software has meant that many suppliers offer 2D sections or 3D models as free, downloadable material. Integrating a 3D model into an assembly provides a satisfying end to a component selection journey; the flexibility of using online tools and downloading several CAD models allows students (as well as engineers and designers in industry) to play with a number of configurations to make the right selection. The only drawback of this process is that some suppliers offer 3D models in different CAD formats, which may be different to the native CAD software that students use. Many undergraduates lack experience with alternative 3D model formats, for example IGES, STEP and Parasolid. The support resource aims to guide students to what 3D model formats are available from suppliers and what is most appropriate to use for their native CAD software.

## 6 DISCUSSION AND FURTHER WORK

Many suppliers offer online or pdf catalogues, selection tools and calculators; yet despite this they still offer printed literature on request. This is due to the “mixed-use practices” that designers and engineers follow [10]. However, there seems to be a big disconnection between the digital space of the

support resource and the physical space of the catalogue library. This can be said about supplier and component catalogues in general, engineers and designers would terminate their selection process with a product code and perhaps a photocopy or scan of the page they were interested in (arguably most undergraduates these days would take a photograph of a page with a smartphone) and then make an enquiry, or download the relevant CAD data from the supplier website from a PC or laptop computer.
This emergence of smartphone and tablet computing allows students to potentially browse the online support resource quickly and easily, whilst looking at physical catalogue information that they have come across. Furthermore, QR codes are increasingly used in posters, flyers and advertisements for quick access to webpages. Even some component selection tools are finding their way onto smartphone applications (there is even a SKF bearing selection app). Perhaps suppliers would benefit from having direct links to web-selection tools and CAD data to make catalogue browsing more efficient (Figure 5.) A drawback of the current situation that has emerged from this work is that many tablets do not support CAD. Also, many web-based selection tools (that are not specific apps) are more appropriate for viewing on a PC or laptop screen, rather than the small screen of a tablet computer or smartphone. This is similar problem with Moodle, it is difficult to change the standard template and structure of information, which is standardised across the campus. A more adaptable and mobile version of Moodle will be available to use soon. Some of the imagery, textbook references, supplier lists and standards mentioned in the SEED resources (as well as Mucci's handbook) could do with updating. The support resource endeavours to fill that gap.


*Figure 5. QR codes enable users to access digital resources and selection tools quickly*

## 7 CONCLUSION

It is hoped that the component selection resource, provided via Moodle, will be used as a first reference for undergraduate students. This is in fact a further bespoke filtering of the DelORES offering, integrated with the key suppliers and their resources. The participatory nature of Moodle will allow students to comment on the resource, perhaps providing more links to relevant data, but will be constrained and overall controlled by the department. The resource will provide a concise list of selection criteria and information, relevant textbooks and suppliers to support students with their design projects, without them having to meander through online search engines. Capturing tested knowledge (through SEED), applying best practices and knowing the appropriate suppliers in the field is a mature trait that students will apply in industry.

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