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A NEW APPROACH FOR PATENT USE IN STUDENT DESIGN ENGINEERING PROJECTS

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ABSTRACT
This paper presents a new philosophy for patent use in student design projects; patents are more valuable when viewed as creative and learning resources rather than as a list of prior art to be considered for infringement. A practical approach to patent searching, clustering and creative use for student product and engineering design projects is summarised. This is timely as there are increasing efforts from the world's IP institutions to improve access to patent databases both in terms coverage and in the way the data is presented to users. There is also a growing research interest in understanding how patent disclosures could be utilised as stimuli and exemplars for creative concept and embodiment design. Such work is making significant progress in understanding how patents may be used creatively by designers, but these functionalities have yet to be made available to designers for general use. Open source systems and tools are increasingly robust and there appears an opportunity to better engage with the patent databases in the spirit of the research base. After describing a search strategy for an example design problem, a prototype morphological patent gallery, trialled within a student workshop, is discussed. Participants found they could quickly understand abbreviated visual and text representations of the patents and were able to synthesise concepts from multiple patent clusters. A new function based format for patent landscaping is also presented. Future work will focus on developing an end to end process and tools interfacing with live patent databases.

Keywords: Patent, functional analysis, cluster, concept design, visual search

1 INTRODUCTION

In final year product and engineering design student projects high level patent reviews are components of market and technology reviews, the Product Design Specification (PDS) and business planning. The drive to include these could be attributed to students' familiarity with longstanding PDS exemplars e.g. Pugh [1] and assessment criteria relating to ethics and commercialisation. Patents are mostly considered in relation to potential infringement issues and the project's own potential for commercialisation.

Realising that the majority of patents in databases are not 'in-force' (abandoned or beyond the maximum period of protection), scope for infringing others within a student project is significantly reduced. The level of confidentiality and funding required to obtain a robust patent are difficult to achieve for students and these are often foregone to freely engage stakeholders in the design process. In light of recent work on leveraging patents for design [2] [3] [4] there appears potential for more direct and real impact on project work by considering patents as sources of creative inspiration. Freely available patent databases and tools have also recently seen significant developments making the introduction of searching and analysis activities more feasible for the novice.

This paper sets out the beginnings of a new approach for search, cluster and use of patents in student design projects. The background section considers patent databases as legitimate design catalogues to support design generation and embodiment phases. Current patent searching platforms are reviewed to highlight trends in visualising patent data to make it more accessible. It is proposed that more work is required to support students/designers in organising and utilising the patent data they may come across. Two student workshops are discussed; one focusing on developing a patent search strategy from a specific design problem, the other presenting students with a set of functionally clustered patents and providing a prototype morphological gallery tool to facilitate synthesis of new ideas from existing patents. The workshops' foci outline 2 stages of a full patent 'search, cluster and utilise'

process. The contribution of the work is a focus on developing explicit guidance and support for searching, organising and using patents and a new visual way of presenting the search scope and results in relation to the design problem.

2 BACKGROUND

2.1 Creative patent searching

Patents are a form of Intellectual Property Right that deals with functionality. They are documents that disclose a "technological" invention. If maintained they provide up to 20 years protection for the assignee and it is this 'protection' aspect that is most often leveraged in competitive business. Extreme strategies such as 'trolling' and 'thicketing' [5] seem to undermine the systems equally important intention of fostering innovation. Patents are published in the public domain (within 18 months) so that others can learn from and develop the described invention. Public databases provide access to up to an overwhelming 90 million disclosures with visual and text based descriptions. A majority of patents are 'not in-force' and therefore serve purely as a repository of useable technical invention; a vast form of 'design catalogue' [6] of rules, past design data, concepts, machine elements, and material selection. The potential for patents to provide stimulating analogical exemplars' and embodying detail is significant, but so is the challenge of efficiently finding the most useful. Patent searching is a highly valued skill in IP industry and a number of standard patent search types have emerged with definitions and guidance for strategies in each [7]. However, there appears to be no defined approach to searching for inspiration, despite some significant interest in doing so.

2.2 Developments in open patent systems and analysis tools

Koch et al. [8] present an iterative and visual search tool, PatViz, which aims to support patent searchers to reduce the complexity of the search. Public patent searching systems have traditionally had limited user interfaces and viewing restrictions, but there is a growing number of platforms aiming to provide enabling access to patents. In 2012 The USPTO made their database available as a 'bulk download' and started development of Patentsview [9]; presenting the database as interactive maps, visualisations and metrics. The US Department of Energy also provide a Visual Patent Search system [10] with a simplified hierarchical interface. In 2016 the Australian IPO released IP Nova [11] under a creative commons licence; a visual and interactive database through dynamic maps of technology trends extracted from patents. There are limitations with any free public service with a broad user base and the WIPO commissioned Manual of Open Source Patent Analysis [12] details further options for the interested novice for obtaining, processing and visualising insights. The Lens.org platform is based on an open source philosophy, linking patents with academic citations and builds some visual analysis features into their platforms results engine. Patentinspiration [13] has specifically targeted creative use of patents providing all of the traditional search features but building in automated text analysis features, implementing TRIZ like principles and identifying functional, manufacturing and materials trends within the patent full-text data. Until significant impact of investment in commercial tools can be demonstrated for designers, it seems necessary to develop an approach for design students that are founded on freely accessible tools.

2.2 Functional organization of patents for design education

There is a perceived lack of training on Intellectual Property in industry [14] and most coverage of patents in engineering education focuses on definitions, infringement examples and linking patents to business strategy. Educational approaches from business and law disciplines may not offer useable models since focus is either on finding very specific prior art, or on statistical trends. There are outlying examples; patent drafting is proposed to have a positive effect on design student understanding and creativity [15]. Studying engineering student participants utilising patent documents for concept generation, Song et al. [3] suggest that patents close to the design problem lead to novelty in generated concepts and far-field patent analogies appear to contribute to concept quality. Fixation is therefore not inextricably linked to patent exemplars, but fixation is a key concern when suggesting the use of any exemplar stimuli in generative design phases [16] [17]. Functional decomposition, a familiar activity for many design students, has been cited as an approach to mitigate fixation [2] [16] and is proposed as a basis for creative patent searching, clustering and use.

3 STRATEGY FOR CREATIVE PATENT SEARCHING

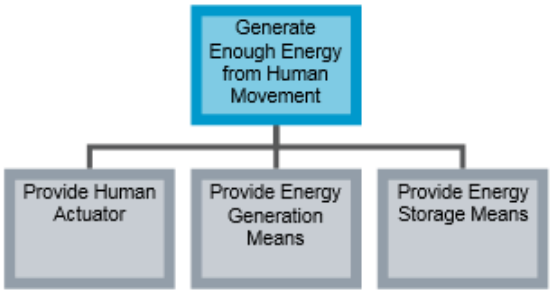
An extracurricular patent searching workshop was held with 13 penultimate year design students. The workshop presented an approach prompting students to:

- State their project brief in concise terms;
- List up to 4 key functional requirements derived from the brief;
- Identify a patent for a relevant existing product and identify classification keys from that;
- Map the classification keys to the function statements (tweaking statements as necessary);
- Start the search using these classification terms and expanding the map through recording and exploring further classification terms that appear on existing documents.

Students were provided with a template for recording their approach. An introductory presentation including examples of patent data use was provided ahead of one-to-one support for each step from a facilitator. Students used their own project briefs and functional decomposition proved to be a time consuming task preventing meaningful focus on search tasks within the workshop. An additional insight is that identifying a single patent relevant to the project is not difficult, but that students need guidance to gain confidence in selecting documents. The full intended search process is described in section 4.

4 AN EXAMPLE DESIGN PROBLEM AND PATENT SEARCH

A separate workshop with postgraduate design management students, looked at patent use rather than searching. To do this a sample design problem was chosen from Fu et al. [3]. This would be the basis of a patent set introduced to the students in the workshop. Where those authors seek functions through text analysis of a large patent set, the approach taken here was to create a functional model of the design problem as stated below and in figure 1.



"Design a device to collect energy from human motion for use in developing and impoverished rural communities in places like India and many African countries."

Figure 1. High level functional decomposition of a design problem

4.1 Function based searching

Murphy et al.'s proposal [18] is that functional modelling should be simple and high level to optimise innovation opportunities. It may be limiting to exclude specific technologies, and we should also be open to the possibility that previously unconsidered functions/technologies might emerge though the patent search.

4.2 Search scope: the database

There are over 95 million patent documents available, from 95 patent offices from around the world in the European Patent Office's (EPO) public database. The documents are manually classified using selections from up to 250,000 technology classifications terms. The Chinese patent office received 2.9 million patent applications in 2015; the patent databases are a prime example of "big data". Patents are necessarily complex documents; they must accurately describe new inventions in a way that captures what is new and inventive. Patent documents can also be drafted in deliberately obscure ways to make them more difficult to find, penetrate and understand when there is a competitive sense in doing so.

4.2.1 Limiting the search

Figure 2 provides a snapshot distribution of patent documents across 8/9 IPC and CPC classification areas. Through filtering results to include 1 document per patent family (family documents describe the same invention) and eliminating any document that did not have image files associated (important for visual searching), the database is reduced from 80 million (Patentinspiration) to 17.7 million records. Fu et. al. [3] proposes that the patent database is an excellent analogy source, as granted patents must be novel and feasible. If only granted patents are used then the search scope drops significantly again. It may be tempting to ignore patent 'applications'; many have been abandoned or refused, however many will be granted within 4 years of application and are valuable documents.

Example search keywords: Harvest, kinetic, human, foot, pedal…

- H02K DYNAMO-ELECTRIC MACHINES (144937)
- H02K7/1807 Rotary generators (CPC Only)
- H02K7/1853 driven by intermittent forces (474) (CPC Only)

- F03G POWER PRODUCING DEVICES OR MECHANISMS (14627)
- F03G7/00 Mechanical-power-producing mechanisms (7639)
- F03G7/08 recovering energy derived from swinging, rolling, pitching or like movements (1369)

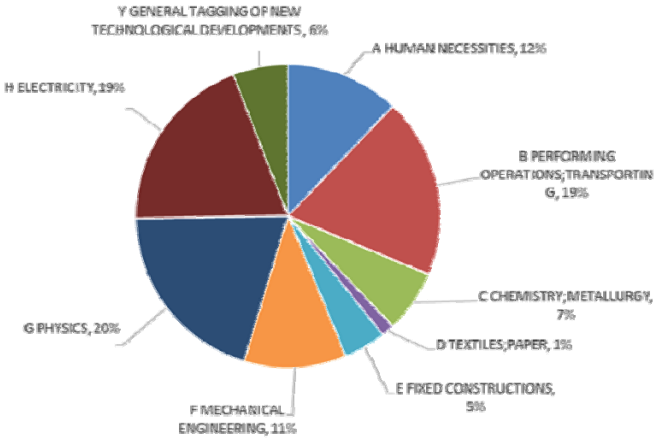


Figure 2. Relative Distribution of 17.7 M Patent families across IPC and CPC indexes (generated from the Patentinspiration platform), keyword search terms and examples of relevant classifications

4.2.2 Developing the search

Finding a relevant patent is an excellent way to start a patent search. Pavegen is the success story of a 2009 UK based design graduate's start-up producing technology to harvest energy from pedestrian footfall. Searching the patent database for "pavegen" as applicant listed 5 patent families titled "Energy Harvesting", "Flooring System" or "Electrical Generator". All are classified with the same main CPC terms which include H02K7/18, H02K7/1853 and F03G7/08 (see figure 2). The search cuts across mechanical and electrical disciplines, and further relevant terms e.g. "footwear with... …generators" are also classified under A: Human Necessity.

4.2.3 Keyword filtering and visual search

Figure 2 shows number of patents (in brackets) approaching a viewable size. Whilst there are too many documents for viewing in parent classes, keyword filters identify a manageable body of relevant work. Most search platforms apply "stemming" to keywords e.g. 'harvest(s)/ing/er…".
Considering 'gallery' or 'thumbnail' views of search platforms such as Patentinspiration [13] and Patentscope and the use of text highlighters, viewing several 100 abstracts together is manageable; the searcher can quickly discard irrelevant patents. Effectively we continue searching whilst viewing results. Visual Search is a significant research area that hasn't had significant attention in patents.

4.2.4 Mapping the search and results

The lens.org platform allows the creation of "collections" of patents as folders which can be used to prioritise and cluster documents. It is also possible to export up to 10,000 patent records, at a time, to spreadsheets. Figure 3 presents a new patent search and cluster landscape which maps patent classifications to key product functions, the relative search areas sizes, and the highest densities of interesting patents found. In this comprehensive but non exhaustive search, around 270 unique patents of interest were identified. 20 of those were selected (highlighted as spots) as the most interesting and representative patents for creative morphological synthesis of new product solutions. The map is clearly linked to the original function tree in figure 1, and it is envisaged in the future that it could be generated in software to automatically reflect the search undertaken.

5 CONCEPT GENERATION STUDENT WORKSHOP

The 20 selected patents were prepared as thumbnail slides including a representative figure and abbreviated abstract. The slides were uploaded into our prototype morphological patent gallery allowing perusal by the designer and side by side comparison with the other functional clusters. The user cycles through each of the carousels looking for creative combinations of excitation, generation and storage.

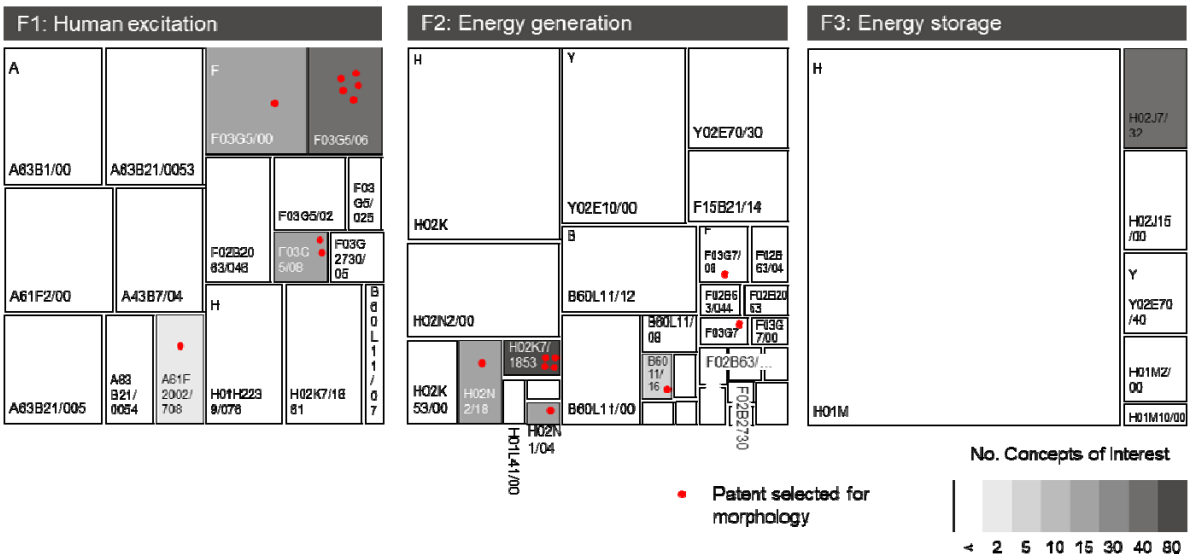


Figure 3. A new patent landscape format

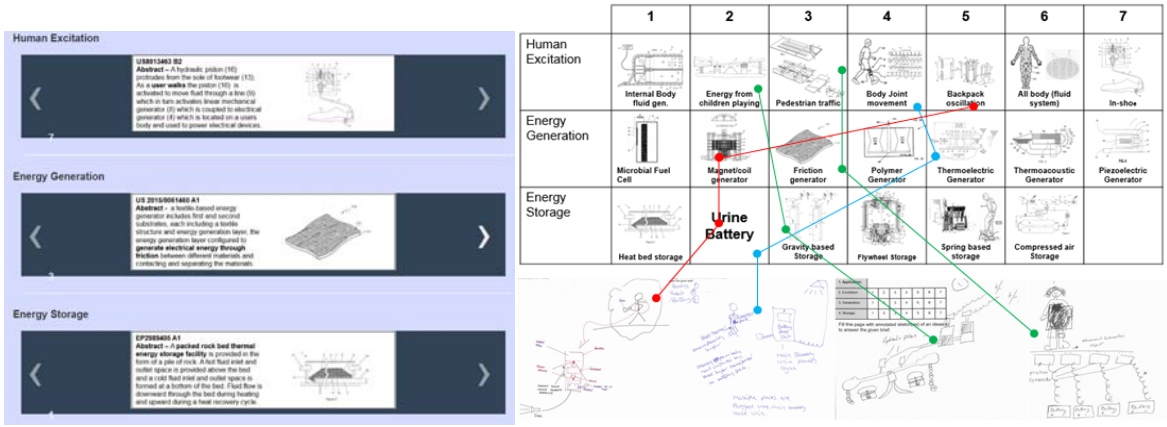


Figure 4. Morphological Patent Gallery and concept development

Three groups of 4 postgraduate participants were asked to trial the system. Each group was introduced to the design brief, function trees, morphological charts and given laptop access to gallery as well as a hard copy morphological chart (figure 4). Groups were then given 30 minutes to generate concepts.

6 DISCUSSION AND FUTURE WORK

Figure 4 shows the limited quantity of creative output from the exercise. One group generated more than one concept, but chose only 2 functions for each. Functional analysis has been proposed as an exemplar fixation mitigation strategy; for some cases only when the designer completes the analysis. Students did not define functions nor does curate patent set likely influencing generation activity. Two groups focussed on the 'urine battery' with some mild amusement. At this stage of the design process storage solutions seemed unlikely starting points for concepts; a urine battery suggests an energy generation means also, and is the closest idea to a standard battery. From observation participants understood the task but required the majority of time for discussion of patents rather than generation. They reported the task as engaging and likely useful.

6.1 Conclusions and future work

The integration of freely available search and analysis tools will be critical to how our approach develops. A prototype pro-forma for visualising the patent data with respect to the design problem and a morphological patent gallery with some early trailing and feedback is presented. There is scope to develop as a software tool in the future. It is considered that there are beginnings of a method and pro-forma for student design projects that will generate new concepts from the patent database. Students are creatively engaged with patent disclosures which might better support transitions from concept to embodiment design. The new function based patent landscaping format (figure 4) developed includes all of the information stated in traditional patent search reports, but more clearly links the search scope and results to the design problem

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