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Patent Information Use in Engineering Technology Design: An Analysis of Student Work

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Abstract

How might engineering technology students make use of patent information in the engineering design process? Librarians analyzed team project reports and personal reflections created by students in an undergraduate mechanical engineering technology design course, revealing that the students used patents to consider the patentability of their ideas, to explore the state of the art in given areas of technology, and to inspire creative problem solving. These results have implications for future patent-related instruction and for conducting information literacy outreach to engineering and engineering technology departments.

Introduction

Patents are valuable sources of information for engineering design. The World Intellectual Property Organization estimates that two-thirds of the technical content in patents is not published in other sources (WIPO 2017). Neglecting patent literature in the design process can lead to significant knowledge gaps and suboptimal results. To help fill this void, engineering librarians regularly incorporate patent literature into undergraduate information literacy curricula (Roberts and Bhatt 2007; Morrow 2010; Strife et al. 2012). Students learn about patents and patent searching, but how do they use patent information in their design processes? The authors explored this question through their work with a course in the Mechanical Engineering Technology (MET) program at Purdue University, West Lafayette.

Literature Review

Information literacy is a cluster of information-related skills, including the abilities to find, analyze, synthesize, and present information. As a means for putting the concept of information literacy into practice in higher education, the ACRL Framework for Information Literacy articulates a series of core threshold concepts that contribute to information literacy in the modern academic context. Among those concepts are the ideas that searching is strategic, that information has value, and that the creation of information is a process (ACRL 2016).

Engineering design, the range of techniques employed by engineers to develop solutions to technical problems, is a foundational piece of any engineering or engineering technology curriculum. Information literacy is an integral part of this process, through the gathering and analysis of information (Bursic and Alman 1997). Parallels can be drawn between models of information literacy and models of the engineering design process (Fosmire 2012), and engineering design courses are an ideal platform in higher education in which to integrate information literacy content (Fosmire and Radcliffe 2013).

Patents are limited-term grants of rights to inventions, issued to inventors in exchange for detailed specifications of the invention. Patents are awarded based on the novelty, usefulness, and non-obviousness of the described invention (USPTO 2015). In the United States, the patent system is administered by the United States Patent & Trademark Office in order to comply with the Constitution's requirement to "promote the progress of science and the useful arts" (U.S. Const. Art. 1, Sec. 8, Cl. 8). Patents are public documents and are freely available through a variety of online tools. These can be supplemented with more difficult-to-access resources that provide additional content and/or searching options, such as fee-based licensed resources like Derwent Innovations Index and secure, restricted resources like USPTO's PubEAST (Meier 2015).

While patent information in its raw form is freely available, patent documents are often written in a legal-technical argot that can seem archaic and obfuscatory to the layperson. Searching for patents using simple keyword queries can be ineffective as a result. The patent searching method recommended by the USPTO for use in patentability searching, and the method most frequently discussed in library and information science literature, involves mixing keyword searches with searches of a patent classification system and requires an understanding of the way patent information is structured (Morehead 1977; Roth 1985; Wherry 1995; Wohrley and Mitchell 1997; Seeber 2007; White 2014).

Patent information is a natural fit for discussion in an engineering technology course, given that patents are rich sources of technical and engineering design information. In order to receive a patent, an inventor needs to disclose the invention's specifications. This will often include precise parameters and drawings. Each patent represents a unique and detailed technological solution to a given problem, in effect making the patent literature a collection of novel case studies (Whittemore 1981). Further, it should be noted that patents are potent commercial tools. In the context of an engineering technology course, patents work well as a starting point for discussions of intellectual property (Fishman 2010) and competitive intelligence (Shih et al. 2010).

Course Background

MET 302, CAD (Computer Aided Design) in the Enterprise, is an elective, project-based design course in the Purdue University, West Lafayette MET curriculum. Students typically take this course during the spring term of their junior or senior year. Section

sizes are small, with enrollment capped at 20-25 students. The course consists of two projects. The first is an individual project focused on exposing students to a variety of CAD software packages. The second is an open-ended team project, where students work in groups of four to five to design and prototype a solution to an engineering problem.

In Spring 2016, the authors were embedded in this course. They co-instructed a 75-minute patent information literacy lesson, consulted with student teams after the in-class session, and participated in two student design reviews. The instruction session consisted of required pre-work, where students completed a worksheet focused on exploring the key parts of a patent prior to class, a brief (10-15 minute) introduction to patent information and patent classification, and an active learning exercise where students worked in their teams to identify relevant patent classifications and patents for their designs using Lens and Espacenet.

Methods

Participants

The participant group consisted of 22 undergraduate students enrolled in MET 302 in the Spring 2016 term. Of the 22 students, 20 were male and two were female. All were seniors majoring in MET. The university's Institutional Review Board reviewed and approved this study (IRB #1604017610) as exempt research.

Data Collection and Analysis

The authors analyzed two sets of completed student assignments using a general inductive approach (Thomas 2006). The first assignment was a one-page individual reflection where students were instructed to reflect on what they learned from the overall course experience (n=22). No specific areas of focus were given for this prompt. The second assignment was a team report for the open-ended design project (n=6). Appendix A contains the details of this assignment. As part of being the embedded liaison librarian in this course and others in the MET program, one of the authors had access to the course management site. The completed assignments were downloaded, anonymized, and stored on a shared drive in a folder accessible only to the researchers.

NVivo software was used for this analysis. The completed assignments were uploaded into NVivo and read multiple times by both authors. Using the software, the authors independently highlighted and labeled sections of the assignments that discussed patents to identify initial categories and themes related to the research question (how do undergraduate engineering technology students make use of patent information in their design processes?). They compared their work, re-read the assignments several more times, and made adjustments to the categories and themes as needed to develop a coding framework. They reviewed the assignments and labels in NVivo several more times to ensure the coding framework was consistently applied to all of the data.

Results

Based on the analysis of student work, the authors identified three themes: the use of patents to assess patentability, the use of patents to explore the state of the art, and the use of patents to inspire creativity.

Patentability

Predictably, students used patents to assess their idea's patentability (n=12; 8 personal reflections and four team reports), specifically through the frame of whether or not their idea was novel. This was done for two distinct but related reasons: to avoid infringing on someone else's intellectual property and to verify the uniqueness (or novelty) of their solution. On the infringement side, several students expressed this directly and indirectly.

> "[We need to] constantly search to make sure we were not infringing on anything" -- personal reflection

> "We needed to learn about the patent process so that we did not copy past products" -- team report

On the uniqueness side, one student discussed the trial and error process involved.

> "The next step was using the patents we found to come up with our own unique design... [our initial idea] was not easily patentable" -- personal reflection

State of the Art

In addition to patentability, some students used patents to explore the current state of the art related to their project (n=12; seven personal reflections and five team reports). This took the form of both investigating existing products on the market that could inform their design choices and more generally using patents to understand how a particular piece of technology works. While students were told that the existence of a patent does not mean the product is commercially available, they saw patents as windows into the markets they were investigating.

> "A few patents were research[ed] to understand the products that are currently available pertaining to [our project]" -- team report

> "[We need] to gather existing information on products like [our project]" -- personal reflection

In terms of understanding technologies, students saw patents as both guides to issues and challenges they would want to address in their own work and as tools for digging deeper into the subject matter.

> "The inspiration for a majority of design came from the patent that demonstrated all things to consider in a build like this" -- team report

> "It is important to understand this material so that we may understand other... related patents" -- team report

Creativity

On the creative side of the design process, some students used patents to verify the feasibility of their ideas and to inspire creative solutions to their problems (n=9; six personal reflections and three team reports). Several students saw the patent literature as a repository of positive and negative responses to technological problems and used them to determine whether or not they were on the right track in designing their own solutions.

> "These two patents helped us verify that our [inventions] were valid concepts" -- team report

> "It really was helpful to see past successes and failures in this design in order to avoid those same pitfalls" -- personal reflection

Additionally, some students simply looked to patents for inspiration, using existing inventions to spur their imaginations. The emphasis on novelty in the patent literature, as seen in the previous discussion of patentability, also related to this aspect of creativity.

> "Once the categories are determined, then inspiration can be found by overserving [sic] current patents" -- personal reflection

One student who felt their team didn't use patents in a particularly creative way expressed regret at the missed opportunity:

> "I still feel as though we looked at the patent for [our project] and thought about how we can make it different enough to not be normal, whereas I think it would've been more interesting to use [these] patents to be inspired to make something different and more creative" -- personal reflection

Discussion and Conclusion

In the library science literature, patents appear primarily as tools for patentability searching. This makes a degree of sense, as many of the patent-related tools and resources available to the public are expressly designed for this purpose. However, our data shows while students readily find the obvious first-order use case for patents, they also find additional use cases. They are able to see the value in the range of available information, including but not limited to the commercial, and apply it in creative ways. This points to the possibility of alternate approaches in how librarians discuss patent information with students, beyond patentability concerns.

The students' use of patents to explore the state of the art for their design projects parallels pedagogical approaches to "information gathering" or "background research" commonly seen in the engineering design process literature. Patents are typically one type of resource (including books, journals, product/trade literature, etc.) instructors and librarians encourage students to search and use to determine how others have approached similar problems in the past. Some student teams in MET 302 took this a step further and expressed value in using patents not only to identify different approaches, but as key documents to help them understand the technologies of other solutions. Additionally, the creative theme in the data, where students indicated patents motivated their conceptual design processes or helped them feel as if they could validate concepts they generated, is not a use case commonly seen in engineering design literature, but an aspect the authors feel is significant.

The variety of ways the students reported using patents is informative for librarians in making information literacy outreach to engineering and engineering technology faculty, and in creating meaningful patent instruction experiences. Librarians can use the themes identified as talking points with faculty to show the value of deep, focused patent information literacy.

Future Work

The authors plan to use the insight gained from this analysis to make improvements to patent instruction for future offerings of MET 302, and other courses in the Purdue University, West Lafayette engineering technology and engineering curricula. MET senior

design reports will be examined to determine how extensively patents are being used for capstone projects. Additionally, the authors plan to create a model for patent information literacy instruction through the lens of the ACRL Framework, notably the frames Searching as Strategic Exploration, Information has Value, and Information Creation as a Process. They also plan to investigate using patents and other forms of gray literature (e.g., technical standards) as tools in conducting information literacy outreach to faculty in engineering and engineering technology programs.

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Appendix A

MET 302 Team Project Reports:

For the design project you are to develop a written report that includes the following:

1. Project Description: State the problem, limitations, expectations, etc.
2. Sketches/ preliminary designs: Provide information related to research completed for this project, highlighting any patents that were useful in the design phase. Provide all team member sketches that were completed during the brainstorming phase.
3. Plan for project completion: Develop a Gantt chart that displays your plan for project completion in the time allotted.
4. Plan for build and test: Develop a plan of attack as it relates to how you will build and test the item you have designed.
5. Design analysis: You are to conduct some sort of analysis of your design whether it is through FEA or hand calculations. Discuss why this analysis is critical to the functionality of your design.
6. Mechanical drawings: you are to provide a set of fully annotated mechanical drawings for your machine.
7. Documentation of the build: Please provide images and captions that show your team in the prototyping and construction phases.

8. Conclusion/Recommendations: Explain what it is that you learned throughout this design process and recommendations for what you would change or investigate moving forward.