Teaching Patents And Design Novelty to Engineering Students A Narrative Case Study Based Approach

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Award winning Designer, Inventor, Entrepreneur & Professor, in the Segal Design Institute – Northwestern University. Dan Brown is a champion of establishing a design-leadership based culture in our economy & society. "Design is how humans create value, I believe in the power of design as a discipline of creative based problem solving through enlightened strategic practice." Dan's vision is to educate and empower the future design leaders to serve society. "Sustainable design based thinking, beyond the past environmental focus has unlimited potential in solving social, ethical and economic problems in society." Dan is currently earning his PhD at Coventry University in the UK, through his research of his thesis entitled "Differentiation by Design®.

A native of Chicago, Dan attended St. Xavier University, earning a Bachelors Degree in Biology, with a minor in Chemistry. Upon graduating, Dan embarked on a career in the chemical and plastics industry where he applied his science education, and natural ability in engineering and leadership to a fast track business career. While serving in roles of increasing responsibility in the rapidly globalizing marketplace of the 1980's, Dan quickly discovered the necessity of creating competitive product advantages to sustain a business model. These early marketplace experiences and highly competitive interactions inspired Dan to identify and create several new technologies for his employers leading to the application for his first three patents for these products before the age of 30.

After 12 years of progressive responsibilities in managing several businesses as an employee, Dan launched his own Product Design consultancy: Consul-Tech Concepts. Dan describes his design methodology as Differentiation by Design®, a product design process that discovers the unseen activity based user needs and product requirements, seeking to reveal differentiated-inventive design solutions across all aspects of the user-product experience. As a consultant using this strategy, Dan has worked with large and small companies to create and commercialize many differentiated products and processes for their customers, often creatively redefining these spaces, while at the same time receiving an additional twenty patents for his unique and novel new product solutions.

In 2001, Dan challenged himself to create a case study project for his design philosophy, to validate the methodologies of his design strategies, and to provide a sales and marketing tool for his design services. Seeking to create a new and innovative product while emulating the Differentiation by Design process, this vision resulted in the creation of the Bionic Wrench®. Launched at the National Hardware show in May 2005 from a newly founded entrepreneurial startup, LoggerHead Tools LLC, the patented Bionic Wrench has received over 10 international Design and Innovation Awards, while at the same time undertaking a very challenging path in today's consumer market of manufacturing the Bionic Wrench in the USA. Today the Bionic Wrench is approaching 2 million units sold.

As an advocate of leveraging design leadership to create and support sustainable markets, Dan has participated in numerous interviews, conferences and educational activities. One of Dan's life goals has been to teach; he earned a Masters Degree in Product Development (MPD) from Northwestern University where he is currently a Clinical Associate Professor at Northwestern teaching in both the Graduate and Undergraduate programs in the Segal Design Institute, McCormick School of Engineering. Collectively Dan's expertises in Design, Technology, Intellectual Property and Business have provided him numerous experiences to share and advance his perspectives on his vision of design thinking, value creation and their ability to create and transform competitive markets. "I believe that the path for domestic global economic competitiveness is user-centered - inventive driven - competition based innovation, in the execution of differentiated value-creating user solutions. This vision must include environmental, economic, and social sustainable competitive advantages, competing accountably in a free and fair marketplace"

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Abstract

Teaching Design to Engineering students is challenging, especially inventive Design where the novelty requirements of the patent process of new, useful and nonobvious contributions over the prior art are a statutory requirement for receiving a patent. Complicating this process is that while most students have had an exposure to the fundamentals of scientific theory and method in laboratory practice, they have not been exposed to the rigors of a research-based, designerly form of problem framing and solving in creative practice. Inventive problem solving relies heavily on the interplay of designerly methods of inquiry arising from the foundational disciplines and methods of technology, with the additional requirements of discovery and novelty. This paper proposes a teaching methodology for introducing students to this designerly practice of design and invention through the use of case study presentation and studio experiences. The combined lecture and studio experience around a well-known case example, allows participants to learn the lessons of the patent regimen in an immersive experience. The studio experience builds on the narrative of the inventive history of Barbed Wire, and participants are challenged as teams to strategically address the design challenge in a novel and inventive new knowledge space, what I have referred to in my teaching and practice, as the technical "white space".

Introduction:

Globalization, competition, and the rapid evolution of technology has challenged today's engineering educational paradigm to produce students who can enter the workplace with the skills to creatively contribute to their organizations. However, in the pursuit of novel engineering creativity in practice, students are seldom exposed beyond the basic patent protocols for invention in school. This paper seeks to explore the practical challenges of teaching patents, inventive-design and the creative role of patents in today's engineering and design education. As the philosopher of science, Thomas Kuhn, once stated, *"Traditional engineering curriculum creates people who are efficient researchers and highly productive, but this approach does not encourage creativity or innovation"* [1] Teaching novel problem solving is challenging, especially with students who lack real world experience in engineering practices, or creative design. Focusing on design in engineering education is an opportunity to encourage creativity and technical innovation arising from an engineering discipline.

While Kuhn's comment is still relevant some 20 years later, this educational philosophy has evolved. Contemporary engineering education is addressing this challenge by integrating new classroom methods with traditional pedagogical teaching practices, to better prepare future engineers to meet the demand for design creativity in practice. In my own institution, Northwestern University, for the past 20 years, the education of all engineers begins in two quarter sequence of Design Thinking & Communication (DTC) [2]. This curriculum augments the traditional engineering educational pedagogy with the early introduction of designerly forms of inquiry, and design practice experiences as a foundational aspect of what Northwestern Engineering has coined "Whole Brained Engineering" education. Having entered academia 10 years ago, after 30 years of industry practice, I observed that although students were often seeking innovative and inventive solutions, they lacked the technical research foundations necessary for bringing focus to their creative engineering design challenges.

Seeking to bridge this "what is inventive design" gap in the classroom, I have found my own personal experiences of invention practices useful in communicating the creative-inventive design heuristics for my students. As Garris has observed "*While American engineering students are generally well-grounded in the fundamentals, design courses rarely provide an historical perspective on how designs have advanced in the particular discipline of interest. As a result, engineering students tend to design in a vacuum, basing their concepts on their own limited personal experience.*" [3] In this paper, I will present a patent workshop for students, beyond basic protocol, built on the patent research process. This workshop uses patent case study along with the invention narrative history of Barbed Wire, as a basis to equip and enlighten engineering design students to the challenge and process of inventive design.

While case-based instruction has existed for years, and has proven to be a rigorous teaching method in other disciplines such as business, law, medicine, and education, it has not been so in engineering design education. Hoover reports, "*Case studies should offer a useful technique for teaching design, but, although instructive cases abound, most are not well enough documented to be readily useful to teachers.*" [4] Case studies arising from researching the invention journey of successful product cases, in both the patent documents and the other market research associated with the product, can combine to form a rich creative instructional and multi-dimensional context for students to learn from. Many successful cases are readily identifiable in the marketplace, and the development process is researchable, along with the historical documents of the patents.

Fortunately the well-documented patent databases contain a vast array of potential practice based lessons that await exploration. Many of these patents communicate foundational novelty and insights of the inventive design journey. The ability to research this data provides insights for the designer into both the technology and invention's prior art, as well as the developmental journey, as the research is made explicit through narrative case based examples. Carroll and Rosson commenting on the authentic classroom learning situations write,

> *One thrust of contemporary educational reforms is to anchor classroom learning in authentic situations and issues, that is, situations and issues that evoke, describe, or comprise real-life experiences. Case studies are descriptions of a specific activity, event, or problem, drawn from the real world of professional practice. They provide narrative models of real life to students and other novice practitioners. Cases incorporate vivid background information and personal perspectives to elicit empathy and commitment, and present contingencies, complexities, and often dilemmas intended to evoke integrative analysis and critical thinking. Cases engage the student in the drama of a real situation* [5]

Inventor and invention stories arising out of competitive practice in the marketplace have a unique journey that go beyond the patent; they include the competitive historical market data as well as the artifacts themselves as resources available for analysis of the design-invention experience. Beyond gaining insights into the problem space, once students learn the proper patent research skills they can become aware of both the active and expired prior art technical solutions.

Currently, there exists a full text database of US patents going back more than a century, along with various levels of similar coverage for foreign patents. This database is the collective repository of patents; many inventions acting as the foundations for commercial success stories. Ozkul has concluded, *"Studying patents give the idea of "know-why" which leads to understanding of intricate industry needs that leads to the particular invention. Every patent has a section on "background" which explains the need for the invention. Studying and understanding these needs is the first step in finding the solution."* [6] Literature searching of patents early in the design process provides a wealth of insight into the problem domain, and past solutions.

One particular database and user interface for research is Thomson Innovation, which has a very effective search engine that allows for Boolean word searching of the worldwide patent database in a very efficient manner. The evolution of patent research software to quickly search these databases has fundamentally changed the technical research ability for professionals as well as students. In contrast to earlier times, when research was a long and arduous process, the enlightened researcher today is very efficient and productive in researching the technical domain when trained to use this technology.

Patent research, when combined with other forms of designerly research provides insights into the past designers' efforts to creatively solve challenging problems, and often reveals the engineering design process of the inventor, as well as the novelty of the invention. Garris notes, *"…an essential resource for pedagogy and engineering practice, one that has been at the heart of American capitalism from the founding of our nation, has not been widely recognized in this reform movement. This is the United States patent system."* [3] Cases from real world examples of commercially successful invention can provide practice based examples of design for students that can facilitate learning in the traditional engineering classrooms.

In practice, creative and inventive design must focus on challenges that require novel solutions evolving from existing best domain practices, or in patent terms, the prior art. In addition, to qualify for a patent, the inventor's application must not only be judged as new, but also useful, non-obvious and a novel advancement over the prior art. Inventive solutions must arise out of practice in the pursuit of novelty. Ozkul correctly observes, "*Studying patents encourage alternatives ways of design. To avoid possible infringement on existing patents, inventors need to find alternative solutions to the problem. This process enlarges the scope of vision of students and encourages them to find alternatives."* [6] A common paradox confronting students in engineering design is one where they often find themselves reinventing the wheel during their design journey, working hard in existing knowledge spaces. I have observed the frustration of students as they seek to find novelty in their design work, often working in the blind as they have little or no knowledge of what constitutes the prior art. They are often shooting before they aim, instead of aiming before they shoot.

In my experience what is often lacking, especially in creative-inventive design pursuits, is the omission of patent research as the basis for guiding student design strategy and focus in the quest for a novel solution. Exposing students to patents and patent research skills, as a precursor for inventive engineering design as early in the education of engineers as possible, is an essential skill for the creative engineering pedagogy. Patent research allows the existing patent knowledge

database to become an asset for understanding the prior art, thus providing focus and strategic pathways for quickly and efficiently identifying potential novel, or what I refer to as "white space", new knowledge pathways.

Beyond defining the knowledge space, existing patents and their stories of creation, provide a wealth of insights into competitive product design practice for engineering students. *"Studies have shown that up to 80 percent of the information contained in patents is not published" [G.C. Andrews, and J. Oppenheim and C. Oppenheim as cited in Michael White* [7]*]* The patent literature represents not only a qualitative narrative of the technical challenge of the patent (the problem), but often new information, both qualitative and quantitative in nature, for the designer that is not often available from other sources. Logically, embarking on a novel problem solving quest must be informed by the prior art of the domain, and patent research is the best practice way of accomplishing this.

Student outcomes from teaching patent research include understanding the patent system rules, the history of intellectual property, the anatomy of a patent, the story of the competitive design challenge encountered by the inventor, and the strategic value of learning the prior art prior to embarking on a new design journey. Again Ozkul observes, *"Studying patents refines the design process. By studying case studies from patent databases, one can learn innovative approaches to problems solving."* [6] In my efforts to teach patent research and analysis, I have sought a prominent product case example to easily demonstrate the insights that can be gained from patent research. What is needed is an understandable invention case with a rich contextual inventive history, an obvious problem and market, combined with an inventive studio based student design challenge and lesson so the participants could immerse themselves into the experience.

One such case that I have found to be effective is the history of Barbed Wire. I chose this case because of its unique role in society, business, and technology. In addition, the innovation of the early barbed designs has prevailed more than a century. Allowing a student's first exposure to patents claims, the technology is simply twisted wires with barbs with a functionally that is very easy to understand and comprehend. This allows for the lesson development of the case without burdening the student with an overly complex technical knowledge foundation. Once the basic patent rules, protocol, and analysis techniques are learned, students can then explore these early patents which are structurally less complex for facilitating introductory understanding.

This is not the first effort to incorporate patents or to use case based studies in engineering education. Typically, the use of patents has been for learning patent protocol rules. In my own department, we have been teaching a class titled Innovation and Invention for over 10 years, as an upper level Intellectual Property course for engineering students. I have taught this class for the last 6 years, inheriting a very well developed syllabus from the previous faculty. This class uses patents from various disciplines as resources, and challenges student teams to research their stories and discoveries as a basis for teaching design, invention, protection, and litigation along with the patent protocols. The learning experience that arises from this narrative case approach exposes students to patent research skills, and inventive discovery, while simultaneously learning the patent rules, and facilitating the student's future creative design and engineering practices.

The Innovation and Invention course includes the other forms of Intellectual Property and is taught over an academic quarter, which allows sufficient time to build the IP lessons over thirty class hours. In order to build off this successful class structure, I wanted to create a workshop to introduce students to the design power of the patent research process in support of the creative action of discovery and invention. The compressed time frame has required a unique patent case that can be leveraged for these lessons. The case presented in this paper is that of the invention and commercial evolution of Barbed Wire. Nearly 650 patents were granted for fencing materials during the period to 1790 – 1873, more than half of which occurred in 1866, 1867 & 1868 alone.[1] (Fig. 1) This period of only three years saw an intense competition of design and invention in practice in the Barbed Wire industry, arising from market awareness and demand driving entrepreneurial opportunities. Barbed Wire's, market competition, and intense legal battles, provide a rich historical context based opportunity for studying the inventive design process in the context of how novel design arising from the technology creates value and competitive advantage in the marketplaces.

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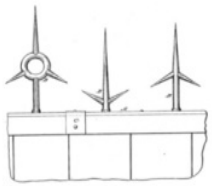
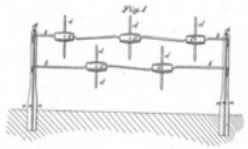
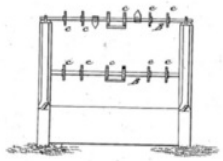
[1] As stated in McCallum, *The Wire That Fenced The West p. 27* " Statement to the Farmers of the Northwest from Washburn & Moen Company, On Some Aspects of the Barb Fence Question, and Results of the Patent System in the Northwest," June 30, 1881, AS&W Records, loc. Cit.



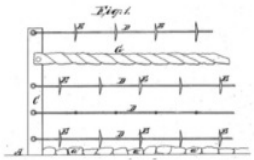
Picketed strip to be installed on top of an existing fence to prevent intruders from crossing over



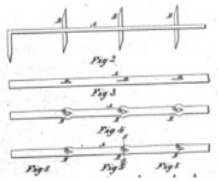
Free to rotate spikes mounted on wire rails / fence. Free rotation to prevent serious injury



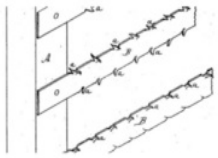
Spur wheels with sharp edges to deter animals, but free to rotate to prevent serious injury upon impact



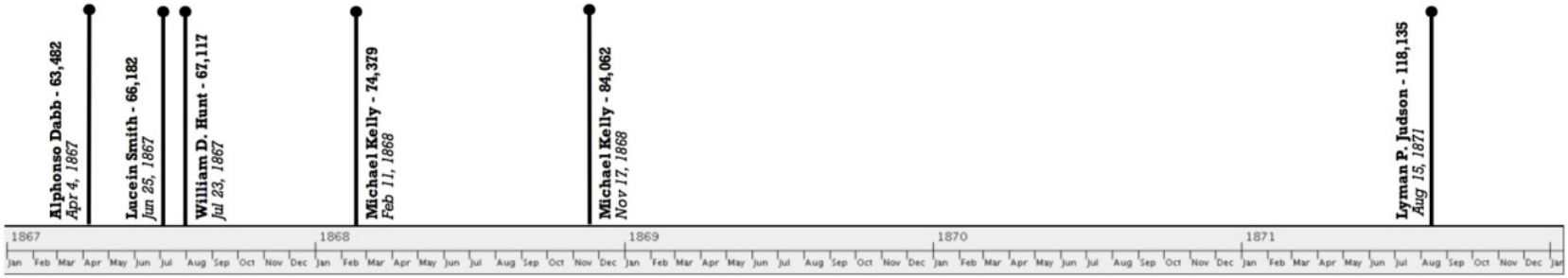
Sharpened sheet metal inserts with holes to pass through wire. Inserts held together on fence



Improvement over US 74,379 as pins need not be passed along, rather simply inserted into slots in wire



Flat iron strip with cuts on either edges, bent in opposite directions to act as "barbs". No wires or rods.



1866 – 1868: 350+ patents related to fencing materials [out of about 650 from 1790 – 1873] Ref. MacCullum

A Discussion of Method and Methodology

The predominant methodology of this paper is based on Reflective Practice (*The Reflective Practitioner*, Donald Schön), both in my approach to prototyping the workshop, and the actual participant's experiences of learning through experience and reflection. I am an inventor with over 30 US Utility patents, and have been teaching the use of patent database searching, as an integral component of design research for 8 years. Research is an early stage design heuristic and an essential part of the functional-technical process of inquiry for creative projects, especially those seeking inventive solutions. This paper is my reflection on seeking to create an introductory workshop that could evolve into a program for other faculty interested in teaching the introductory lessons of patent protocol, rules, and research as a foundational design strategy for invention.

The premise behind this teaching method is based on the logic that one cannot efficiently design solutions into a new knowledge space, without first researching and developing a deep appreciation of the existing technology, economic, or emotional drivers of the existing spaces. This patent based narrative inquiry is both qualitative in its similarity to literature review, and quantitative in its mapping of the past novelty, defining the prior art provides a reference to move forward in a focused strategy for synthesis of the potential new invention. "*Patents are an attractive choice for analyzing technological change because they are: generalizable, objective, quantitative and qualitative.*" [8] Patent research is but one of the many areas that an engineer must explore when designing in the pursuit of inventive solutions in new product development practice.

The expansion of this qualitative case-based research methodology into the traditionally quantitative engineering lesson space, augmented by the patent database research of technical knowledge, is a logical extension of the currently accepted non-patent research practice methodologies being practiced within all disciplines.[2] In my experience, this technical research, combined with the unique invention narrative, is a natural gateway for introducing even first year students to the opportunities for creating novel solutions through design. A front end designerly research process, arising from the combined best practices of both quantitative and qualitative forms of inquiry, provides a natural gateway for introducing lessons arising from designerly inquiry building on novel technical problems and project challenges.

In an effort to teach research skills to engineers, as a heuristic of seeking new technical white spaces, it is necessary to build on the research skills for the existing knowledge space, beyond peer reviewed literature, and into the patent literature when working with technology. In addition, the integration of patent research into the traditional quantitative engineering

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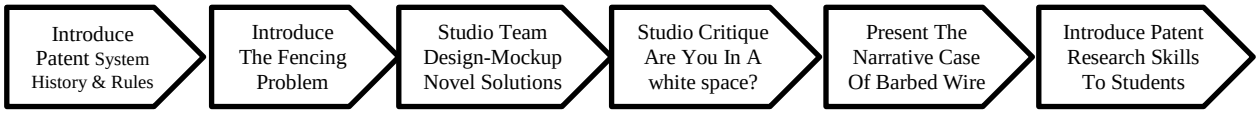
[2] In their paper "Emerging Methodologies in Engineering Education Research", Case & Light noted upon reflection a possible bias for quantitative research over qualitative research. "… *engineering educators at a recent conference lamented the lack of qualitative studies in the engineering education literature …*" they also noted that "*engineering educators who have been trained primarily within the quantitative tradition may not be familiar with some of the norms of qualitative research*" [Borrego et al. as cited in Case and Light, 2011] [13]

curriculum will require educating the educators about patent law and patent research. As stated by Garris, "*Clearly, if faculty are to utilize the patent system in design courses, they must familiarize themselves with the philosophical foundation of patents, the language and structure of patents, the resources available for searching, and the legal fundamentals.*" [3] I foresee the development of select patent cases as mixed methods modules, where the learning by the faculty, who have not been exposed to these methods, as well as the students, will co-evolve in the engineering design classroom.

Using The Case Based Research Patent Research in a Workshop Setting

Although similar patent systems exist all over the world, the focus for this Barbed Wire case centers on the United States (US) patent system. While most International patent rules are similar, one key element is the fact that engineers, designers and other creators of new knowledge must understand the intellectual property system and its rules in order to avoid infringement, while also securing protection for their own works. Beyond the patent technology itself, Ozkul has observed, *"Studying patents leads to understand of ethics, conflicts and infringements. By studying these concepts, students learn how to avoid litigations and learn about what is novel."* [6] Using patent cases as examples of practice for teaching builds off the history of invention as a fundamental research strategy for engineering design.

Half Day Invention Workshop Flowchart



Stage 1 - Introduction to the US Patent System History & Rules

Stage 2 - Introduction to the problem of fencing for farmers during 1870s

Stage 3 - Studio exercise to design and mockup novel fencing alternatives

Stage 4 - Studio critique of designs – How do you know you are in a white space?

Stage 5 – Presentation of the narrative case study of Barbed Wire

Stage 6 – Introduction to patent research skills as a designerly research strategy

Upon completion of the workshop, students are asked to reflect on the lessons, specifically the inventive-design challenges and ambiguity associated with finding a white space. Specifically the workshop seeks to reinforce the value of how early patent research serves to inform the aspiring inventor of the existing knowledge space, providing a strategic foundation and focus for pathways to new knowledge spaces essential for inventive design lessons.

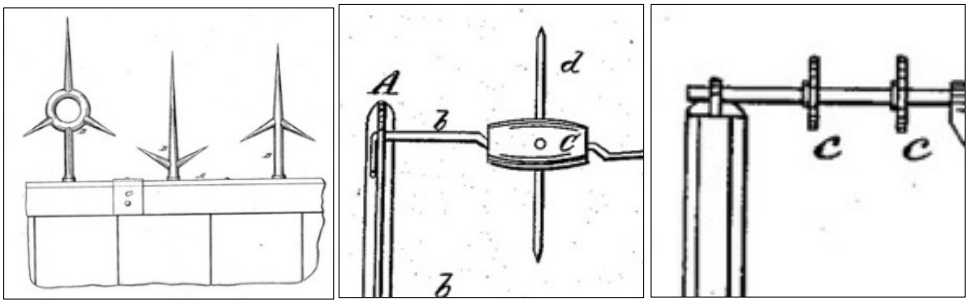
Stage 1 - Introduction to the US Patent System Overview

A Broad Summary of the Introduction to Patents Section Is Provided Below

Patent Topic	Lessons From The Narrative Patent Case Research
Definition of Intellectual Property	Introduce intellectual property, which is an umbrella term that includes patents, trademarks, copyrights, and trade secrets. In the most general terms, IP is any product of the human mind, which in the US the Constitution protects the originator against unauthorized use by others.
Importance of Intellectual Property	• Fend off aggression from competitors • Competitive evolution of higher value products • Negotiation leverage with suppliers & customers • Strategic leverage for acquisitions or spinouts • Stronger market position, with a pathway to branding • Access to capital for investment • Prestige for company and its employees
Necessity for patent research in the design process	• Avoid infringement of other companies' active patents when designing one's new products and services • Understand state of prior art in field of the invention, allowing the designer to analyze the past active and expired prior art • Allows for a strategic focus for creative design away from the active patents • Allows for a strategic focus for creative design based on advancing the expired public domain of prior art • Make informed licensing, joint development, and other corporate transactional decisions based on a higher level of certainty
Criteria for patentability	• What is new • What is useful • What is obvious • What is obviousness • What is novelty
Structure (anatomy) of a patent	• Title • Abstract • Background of the invention • Brief Summary of the invention • Description of Drawings • Detailed Specifications of the invention • Claims

Stage 2 - Introduce the Problem of Fencing for Farmers During 1870s

The scenario centers on the 1870's farmers, and their expanding need for inexpensive and functional fencing for their farms and grazing lands. Students are then challenged to design their own "improved and novel" fencing using simple pipe cleaners to simulate the creative challenge of solving the "fencing" problem. Using such simple and readily available materials allows this exercise to be carried out in any classroom environment. This is a team exercise, and it challenges the students to work together and think about the design needs, problems and opportunity, along with improving over the "prior art", (which has yet to be formally researched in the workshop), thus the participants are challenged to seek potential novel solutions for similar fencing solutions in a technical white space, without prior art knowledge.

Patent Topic	**Lessons From The narrative Patent Case Research**
Need for invention	Purpose of Fencing – To contain cattle and animals; define the landowner's boundary, farmers were seeking a low cost and effective solution.
Introduce early fence prior art solutions	• Rock walls • Wooden fences • Trees and Hedges • Natural boundaries
Introduce Early Prior Art patented Solutions	 Figure 1: (a) Picket Fence, A. Dabb (1867) US Pat. 63482, (b) Wire Fence, L.B. Smith (1867) US Pat. 66182, and (c) Fence, W.D. Hunt (1867) US Pat. 67,117 [9]

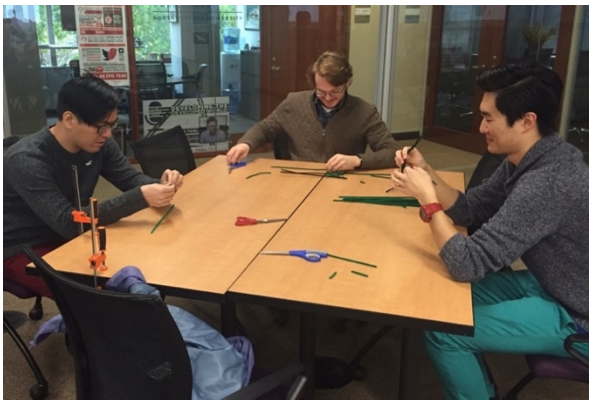
Stage 3 - Studio Exercise to Design and Mockup Creative-Novel Fencing Alternatives

This exercise allows the students, through simulated practice, to appreciate the creative ambiguity of not knowing the extent to which what prior art exists. The studio exercise was limited to simple pipe cleaners and scissors. Pipe cleaners provide a good amount of dexterity because of their flexible nature; while limiting the number of items needed to conduct a simple design exercise in a studio environment. Optionally as seen in the photographs below, simple clamps were provided to simulate fence posts for the exercise.

Protocol - Attendees are divided into groups of 2-3, and asked to design a novel and improved (white space) barbed fencing system that would not infringe on existing patents and that could be patented beyond the prior art.

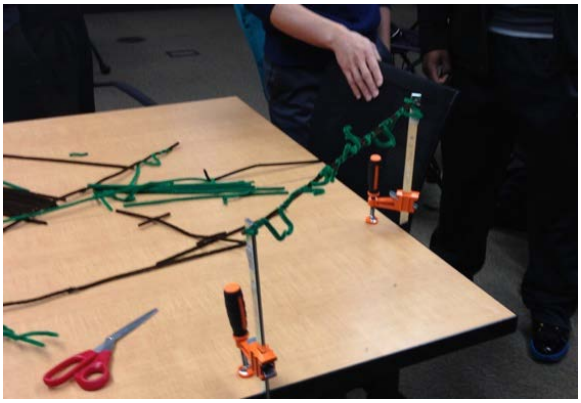
A simple demonstration of cutting and twisting the pipe cleaners was demonstrated.

Students are given 20 minutes to design and mock up fencing alternatives.



Bar clamps (optional) are used to attach to the desktops to provide the “fence posts” for the mockups to be installed for discussion. These clamps are readily available from a home improvement store.

Students are asked to display their best of designs based on the knowledge shared about the problem to date. A group reflection is conducted to discuss the challenges of designing into a white space.



Teams were able to come up with a number of designs, often utilizing a design method similar to that of existing prior art solutions. Also, lesser consideration was paid to manufacturability or material saving, although these constraints can be easily incorporated into the design challenge. The exercise highlighted the following:

- Designing without knowledge of the prior art, creates awareness of the importance of researching in order to know what past solutions already exists. This is not only to prevent potential infringement of active patents, but also provide insights into existing solutions which could lead to novel improvements that may be patent protected.

- The importance of patent research in learning the invention evolutionary process, highlighting what invention claims took precedent and how their relevancy changed in the development process. For example, in the barbed wire case, more attention was paid to inflicting injury / having sharp barbs in the initial phases of invention. Thereafter, the design focus moved towards material saving, manufacturability, and other similar factors as the product grew.

Stage 4 - Studio Critique of Designs – How Do You Know You Are in A white space?

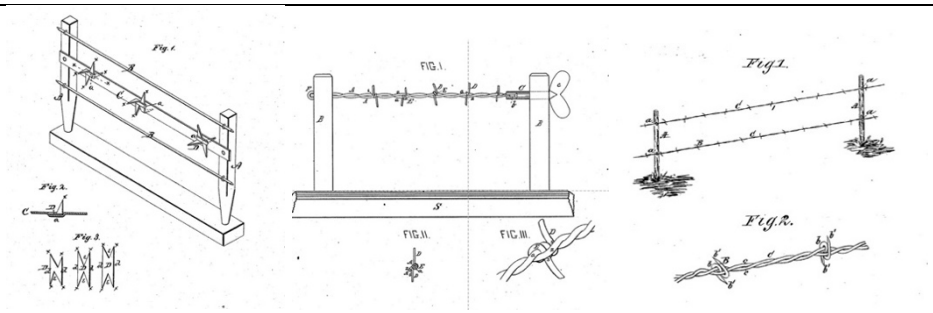
At this point the question is then posed by the instructor to the students, “are any of your solutions novel?” A group reflection on this experience ensues highlighting the challenge of strategically seeking a novel white space. This is a critical insight for inventive design as by definition an invention must be new, useful, and non-obvious.

The students are then introduced to the example board of prior art Barbed Wire with 70 - 75 of the existing Barbed Wire patented designs. It is also explained that currently there are over 300 past Barbed Wire prior art artifacts. I have found that this explicit example of the amount and quality of past work is a sobering reality into itself for both experienced and aspiring inventors. The goal of the studio simulation is not to measure the teams’ ability to create a novel Barbed Wire, as this is a well-worn path, but to demonstrate and personally experience the frustration of a design challenge that does not include the prerequisite research as a focus for potential white space solutions.

Students, when asked if their mockups were novel, especially in light of the preponderance of actual Barbed Wire artifacts, experience firsthand the uncertainty of designing without first researching the domains prior art. This “lack of knowledge” induces creative anxiety for the team, and reinforces the value of research at the beginning of a new Design challenge. Creating this knowledge gap tension-experience within the student/team simulation, leads to the introduction of the history of Barbed Wire Case, followed by basic patent research training as a method of researching and mapping the prior patented art.

Stage 5 - Students Were Then Presented the Following Narrative Case of Barbed Wire

The Narrative Case History of Barbed Wire Patents [10], [11]

Leading Inventors for Barbed Wire	• **Jacob Haish** • **Joseph Glidden** • **Isaac Ellwood**
Early patents From These Inventors	 Figure 2: Respective inventions Ellwood, (b) Glidden "The Winner", (c) Haish "S-Barb" [9]

Patent Topic	**Lessons From The Narrative Patent Case Research**
Securing rights	Assignments to barbed wire designs and machines by Washburn and Moen Co.
Growth of Barbed Wire	10,000 lbs. to ~12,000,000 lbs. in three years during 1874 – 1877 (3 years) To 480,000,000 lbs. by 1950
Court battles Glidden – Ellwood – Washburn & Moen vs Haish	• Interference Papers by Jacob Haish • Growth of Moonshiners (Infringers / Illegal Manufacturers) • Legal battles over novelty and obviousness, that have the same relevance in patent litigation today
Trial – Verdict of 1880	Jacob Haish's "famous S-barb" decreed as an infringement on foundation patents – Hunt, Kelly, and Glidden. Haish was made liable for damages already accrued.

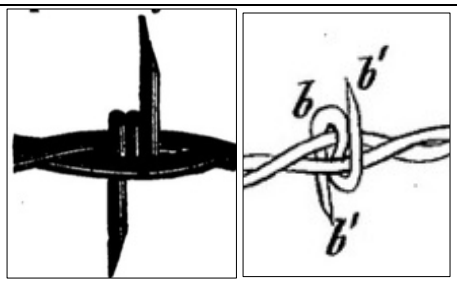


Figure 3: Comparison of inventions
Glidden (b) Haish [9]

"…this is the most important mercantile decision that has ever been made in this country" [Industrial World, Dec 23, 1880]

Supreme Court Judgement of 1882

Glidden design's novelty in question. Eventually ruled in favor of Glidden with important precedents.

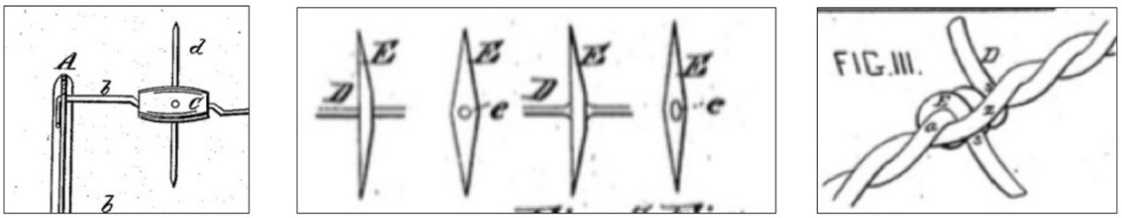
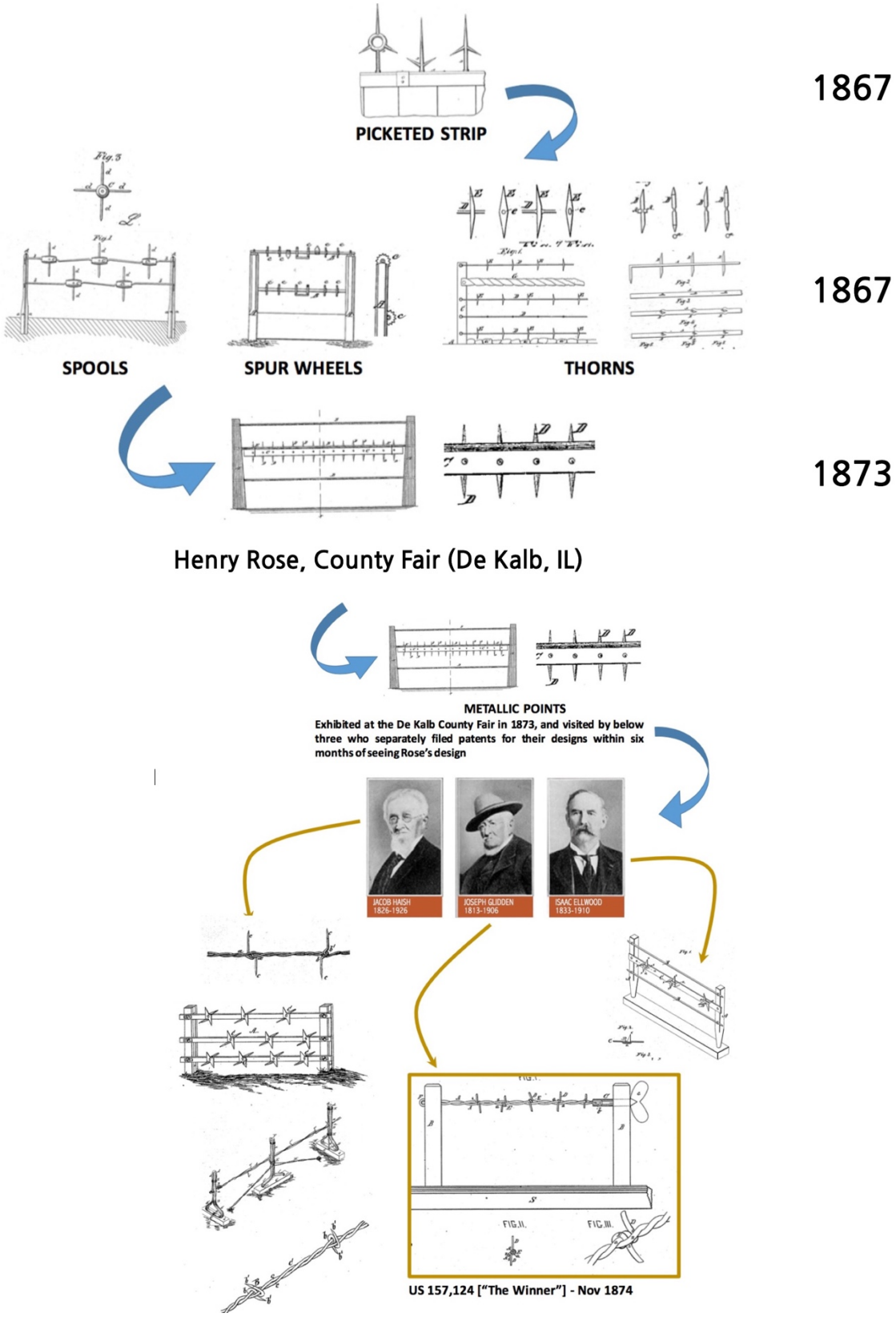


Figure 4: Comparison of inventions by
Smith (b) Kelly (c) Glidden [9]

Excerpt from Supreme Court opinion

"It is true that the affixing of barbs to a fence wire does not apparently give a wide scope to the ingenuity of the inventor, but from the crude device of Hunt to the perfected wire of Glidden, each patent has marked a step in the progress in the art. The difference between the Kelly fence and the Glidden fence is not a radical one, but, slight as it may seem to be, it was apparently this which made the barbed wire fence a practical and commercial success. Under such circumstances, courts have not been reluctant to sustain a patent to the man who has taken the final step which has turned a failure into a success. In the law of patents, it is the last step that wins. It may be strange that, considering the important results obtained by Kelly in his patent, it did not occur to him to substitute a coiled wire in place of the diamond-shaped prong...and to the man to whom it did ought not to be denied the quality of inventor." [12]

Figure 5: Product Evolution [9], [10]



Stage 6 – Introduce Students to Patent Research

The studio exercise and History of Barbed Wire Case is followed by teaching the process of patent research through leading software, Thomson Innovation. The analysis and mapping through research allows the designers to analyze the past efforts and focus their work on ideas and concept spaces that are potentially novel white spaces. Using this studio challenge followed by the case based immersion provides a simulated experience for inducing this dialectic design challenge of research, analysis and synthesis. The purpose of this simulation is to bring focus to the designerly creative challenge of creating new knowledge driving home the value of patent research arising through a designerly research analysis and synthesis of novelty beyond the existing technology practice.

There are rules that all patent applicants must follow when filing a patent. One of these obligations is that the inventor should identify the relevant prior art when submitting their patent application to the Patent Office. The cited prior art patents would be the pre-existing patents that were identified by the inventor as the past inventions in the area of the art directly relating to the application. In addition the patent examiner runs a complimentary search and includes any new references into the patent application. These references are a rich source of identifying the relevant prior art when designers today undertake their patent research. As new invention is often an evolutionary process, researching positions the new invention application in context of disclosing the improvements over the prior art, while importantly seeking to avoid infringing active patents in the design process.

In addition, a new patent, once issued, becomes patented prior art, and may itself be cited subsequent patents as the technology evolves. Thus, a researcher utilizing this software, has the ability to identify a patent or patents in the prior art area they are working in, and once identified can network the past and future prior art citations of the network of relevant patents. This strategy allows the researcher to augment the search by building on the previous references where they may apply to the new design challenge. Thus Designer's exploiting the research power of the software and data bases of full text patents, can build on past searches of inventors and examiners as a patent search strategy.

One advantage of the Thomson Innovation software over other patent search engines, I that Thomson easily returns searches with all front page images included in a quick summary form. This ability to quickly produce search reports with images facilitates the review of the prior art, which can often be hundreds if not thousands of patents, when compared to text only search reports of the past years. It has been my experience that this image based summary output of the relevant searches has been very helpful in reviewing the prior art, especially in mechanical patents. Building on the patent research skills, and the information discovered through research, students can experience the enlightening and transformative potential of strategically focusing new design efforts, on the pathway to potentially new, useful and non-obvious solutions.

Reflections, Lessons, Student Assessment, Improvements - Future Work and Next Steps

Assessment of Learning Objectives: Survey Reflections from Workshop Participants

1. “It was informative and interesting. I liked the idea of building a narrative before presenting the story behind a patent.”

2. “Upon reflection, I think a portion of the workshop could be an exercise of creating a provisional patent. Perhaps a sample provisional could be derived from the design exercise of the workshop.”

3. “Provide explanation of provisional, patentability search, and non-provisional components and general sequence of process in clearer more concise preface.”

4. “I think the explanation of patent breadth needs to be elaborated and show the narrowing from provisional to non-provisional to examined/ critiqued and how the narrowing is part of the game and art (I think the art of patent-hood could be communicated more)”

5. “Perhaps a story about the process of creativity in the context of solving a problem that one was facing and how one takes an idea into a concept or methodology of breadth”

6. “Thank you for the didactic event. I have raved about how great this event was and I am very thankful I attended. Please take all my feedback as words from someone who believes better is possible forever. You taught me a lot and I am very appreciative of the tools- peace”

7. “I enjoyed the barbed wire exercise. I think it really helped to show how tough it is to come up with a novel design that actually improves on its predecessors.”

8. “The workshop was a great learning experience, especially the design activity which was a demonstration of how similar things can be developed at the same time. Barbed wire narration was fantastic pick to showcase the patent industry. I would suggest including an activity of filing a patent, which gives an experience of how to file the patent after designing something (considered novel) and what could be the possible hurdles in order to do so. Overall, it was a good experience and I would love to attend more sessions like this. Thanks."

Patent Workshop Summary

What worked	• Introduction to the USPTO and the history of patents in the US. • An overview of IP – Patents, Trademarks, Copyright, Trade Secrets, a separation of the different IP regimens based on their role in IP protection, with a focus on patents. • The Barbed Wire Case study resonated with the students, exhibiting a rich competitive product narrative, without the burden of technical complexity. • Narrative nature of the presentation - the barbed wire narrative facilitated the students understanding of invention, patents and market competition. • Studio exercise to let attendees experience the design process as they created their own fence solution, along with the frustration of the knowledge gap created by seeking a novel solution without foundational knowledge of the prior art. • Patent search process by the demo of Thomson Innovation as a group exercise demonstrated the use of citation analysis to bring a focus to the prior art in a quick and easy to understand methodology.
Improvements	• Run more workshops and capture more data based evidence on the effectiveness of the inventive design exploration aspect of the process. • Create an extended tracking of those students who attended the workshop in an effort to gauge the long term effects. • Extend the workshop to include more in depth strategies of prior art research and include patent claim analysis. • Include the strategy and process of applying for Provisional patents. • Possibly, extend the studio exercise beyond the current level - it may be worthwhile to see how the students design after they have searched the prior art also.
Potential next steps	• Create an advanced level one day workshop that would probe deeper into the analysis of the researched patent data, and develop a roadmap for evolving the search and creative design into a Provisional Patent. • Create a workshop Syllabus and support site to assist educators in integrating these lessons into their engineering programs. • Create an online workshop. • Develop the workshop into a class focusing specifically on inventive engineering design. • Build more case studies that could supplement the lessons of the Barbed Wire narrative cases.

Conclusion:

The objective of this paper is to explore the development of an enhanced workshop for teaching the US Patent System protocol for students beyond the traditional patent rules of the road approach. It has been the author's experience that simply understanding the patent system rules is not sufficient for students to understand what actually qualifies as novelty for inventive design. Beyond the basic rules, this workshop is an effort to convey to students that patent research is a skill that is an essential component in the quest for invention. The rational of this proposal is built on the legal concept of patent novelty, the USPTO standard of new, useful, and non-obvious contribution to the subject matters prior art. This workshop is an attempt to create a simple immersive lesson for students to experience inventive design challenges, early in their education, without the commitment to a full Intellectual Property class which is typically available only to upperclassman, if at all. Early exposure to the inventive design challenge and the role of qualitative based designerly research and inquiry can inform engineering design projects, and influence the student's subsequent projects as they advance in their coursework.

The narrative case of the history of Barbed Wire is a particularly interesting case study. The marketplace for barbed wire exploded in the late 1870's, primarily driven by the need of farmers expanding into the American West, who were in search of a low cost and effective fencing solution for their needs. The case has all the elements of a good story as the players competed in the marketplace and the court system, fighting for control of the inventive property rights. The encompassing design, engineering, invention, competition, and legal battles serve as an opportune narrative to teach the broader lessons of patent invention and protection.

The workshop also integrates a basic studio design challenge. This challenge is purposely basic; sufficient to demonstrate that designing into an inventive white space is a particularly frustrating challenge when you do not have sufficient knowledge of the domain's prior art. Without background knowledge of the designs, designers experience creative frustration when seeking a novel white space inventive solution. Critical for the students understanding of how novel design creates competitive advantage, is the discovery and understanding of the competitive benchmarks through research. The workshop concludes with a demonstration of a best practice patent researching tool, in a dynamic online patent search, conducted by the instructor and directed by the student's inquiry. The search skills and tools are demonstrated for the students so that they can begin to immediately integrate the patent research process into their coursework.

While there is more development work to be completed for this case study based workshop, this paper has explored the value of introducing the US Patent System protocol and patent research in an immersive design workshop format. An important premise is that this research methodology is essential for inventive design, and fundamental for technology research. The workshop relies on a combination of methods: Lecture, Case Study, Studio Challenge, and Literature Review to facilitate the students' strategic design strategy for inventive problem solving. Further work is necessary to bring this workshop beyond my personal teaching, and it is a goal of this paper to solicit the interest and input of other engineering design faculty regarding the effectiveness of the effort, as well as the appropriateness for integrating this research focus into first year curricula.

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