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Incorporating Intellectual Property into Engineering Education

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Abstract

Engineering education is not addressing one of the most important areas of the engineering professional: Intellectual Property. Intellectual Property (IP) encompasses the intangible "stuff" which is what engineering is all about – original thought, invention, and progress. The three traditional areas of IP are copyrights, trademarks, and patents. An engineer cannot protect his or her interest, whether it be an invention, expression of idea, or some other non-tangible property, without understanding these three IP areas. Engineering educators should understand that IP has not been incorporated into the discipline. Educators should also note that by the lack of IP instruction, engineering graduates are ignorant as to the protection of their creations. This impacts their futures as they will be entering the creative field of engineering without IP knowledge and may not protect their rights. Of course, this does not help the student or the progression of engineering. This paper, written by a patent agent and patent attorney, both holding doctorate degrees in computer science and electrical engineering, respectively, will introduce the basic concepts of intellectual property and show ways to introduce IP into an engineering curriculum.

Introduction

Intellectual Property (IP) is rarely, if ever, included in engineering education. This is unpropitious as basic IP knowledge by engineers is important to help protect IP rights. Furthermore, IP searches provide an accurate picture of the growth of the engineering fields. Intellectual Property includes three traditional areas: copyrights, trademarks, and patents. Two of these areas, copyrights and patents, are incorporated in the U.S. Constitution to advance science and the arts. As will be discussed, IP is also important to further the advancement of engineering. Please note that the laws, rules and cases associated with IP are constantly changing and some information presented may be outdated prior to publication. Furthermore, this article covers only IP basics; therefore, the authors advise contacting an IP professional in order to properly protect IP rights.

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IP Knowledge Important for Engineering Students

Engineers often delve into uncharted territory and sometimes create intellectual property. The interesting aspect of creation is that the methods of creation, and the underlying concepts of the creation, are not tangible. For example, an engineer may create a novel method for storing data. This novel method can be written on pieces of paper and bound into a book. The book itself is tangible; the ideas in the book are intangible. There are laws to protect the physical property of the book; if the book is stolen, a police officer can physically retrieve the book from the thief. But how are the rights of the intangible creation protected? This protection encompasses the importance of intellectual property. Basic IP knowledge will help an engineer make more informed decisions in protecting his or her creative work.

Intellectual Property - 101

As stated above, the three traditional areas of Intellectual Property (IP) are copyrights, trademarks, and patents. All three protect intangible property. The type of intangible property and the rights of protection are different for all three, but the rules for all three areas can be found in the Code of Federal Regulations (CFR) Title 37, Patents, Trademarks and Copyrights.

Right to Own IP

The right to patents and copyrights is guaranteed by the U.S. Constitution. The Constitution of the United States of America, Article I, Section 8, states, "The Congress shall have Power … To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."

The trademark right is not guaranteed by the Constitution, but instead is covered under statutory law and case law. The first trademark laws were enacted by Congress in 1870 and 1876 but were deemed unconstitutional as the laws referred to state matters. In 1881 and 1905, Congress began passing statutes addressing the interstate use of trademarks.

Infringement

An IP owner has the right to seek civil recourse against anyone infringing his or her property. Infringement is the invasion of the rights secured by patents, copyrights, and trademarks. Each type of IP has its own aspects of infringement. Copyrights can be infringed by the unauthorized use of the copyrighted material. Patents can be infringed by anyone, other than the owner, making, using, or selling the patented invention. Trademarks can be infringed by the unauthorized use or colorable imitation of the trademark.

Copyrights

Copyright is the most common form of intellectual property. Almost everyone is familiar with the symbol © that designates copyrights. Copyrights are administered by the Copyright Office, a department of the Library of Congress. A copyright is a right of literary property as recognized and sanctioned by positive law.

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Copyright protection extends to an original expression of an idea, but not the idea itself. For example, the idea of a love story about two people from feuding families is not copyright material, but the expression of the idea, such as the works Romeo & Juliet and West Side Story are copyrightable material.

Copyright is an intangible, incorporeal right granted to the author or originator of certain literary or artistic productions, whereby the author or originator is vested, for a specified period, with the sole and exclusive privilege of multiplying copies of the same and publishing and selling them. Copyright infringement is the unauthorized use of copyrighted material. For example, suppose a portrait is hanging in a museum and a person photographs the portrait. This unscrupulous person then makes photocopies of the photograph and sells the copies. This person has infringed the creator's copyright. Note that there are some exemptions to infringement such as “fair use,” most often applied to academia. Copyrights have a length of term of the life of the author plus fifty years for a personal copyright, and seventy-five years from first publication, or one hundred years from creation, whichever expires first, for a corporate copyright. To obtain copyright protection, put the symbol ©, or the word "Copyright" with the date and author's name on the work. The Copyright Office officially registers the work when the work is properly submitted to the Copyright Office.

Trademarks

Trademarks are also a familiar form of IP. Again, almost everyone has seen the symbols ™ or ®, which both represent trademarks. Trademarks are handled by the U.S. Patent and Trademark Office (USPTO). The Trademark Manual of Examining Procedure, published by the USPTO, describes the procedures for obtaining a registered trademark. According to Black (1990), a trademark is a "distinctive mark of authenticity, through which the products of particular manufacturers or the vendible commodities of particular merchants may be distinguished from those of others." It is a proprietary word, letter, symbol, or device pointing distinctly to the product of one producer. For example, most Americans will identify the NBC peacock or the Nike "swoosh," both trademarks of the given companies. Trademark infringement is the unauthorized use, or colorable imitation of the trademark already appropriated by another, on goods of a similar class. Therefore, it may be infringement if another television network used a peacock to identify itself or if another running shoe company used a similar "swoosh."

A trademark is used to identity and distinguish a product brand from other brands. Yet, if a trademark becomes part of the vernacular, it loses its status and becomes a description of the product itself, vice a method to distinguish one producer from another. A trademark can lose its distinctive meaning, which companies do not want to happen! For example, the term “aspirin” was a trademark of the Bayer Co., yet Bayer lost its trademark for “aspirin” in Bayer Co. v. United Drug Co. (1921); the trademark had lost its distinctive meaning and became synonymous with the product itself. Band-Aid™, on the other hand, keeps its trademark by enforcing it. Every commercial or material that uses the term Band-Aid™ always states "Band-Aid Brand" which keeps its trademark active.

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The length of term of a trademark is indefinite as long as it is properly renewed or used in commerce. To officially register a trademark, one should use it with the symbol ™ and register the trademark with the USPTO.

Patents

An interesting statement was issued by the U.S. Patent Office in 1899, "Everything that can be invented already has been." Where would our world be today if everyone agreed with the U.S. Patent Office in 1899? We wouldn't have to worry about engineering, that's for sure.

A patent is a grant of a privilege, property, or authority, made by the government or sovereign of a country to one or more individuals. The United States Code Title 35 (35 U.S.C.) specifies this right; 35 U.S.C. 101 states, "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." Specifically, a patent is a grant or right to exclude others from making, using or selling one's invention and includes the right to license others to make, use or sell the invention. The USPTO has the authority to grant patents, along with trademarks, as mentioned above.

There are three types of patents: utility, plant, and design. All three types must contain a specification and at least one claim. A specification is a written description of the invention. A claim points out and distinctly claims the subject matter which the inventor regards as the invention or discovery. Engineers may be interested in all three types of patents.

A utility patent is a patent that is novel, useful, and non-obvious. An invention such as the light bulb would be an example of a novel, useful, and non-obvious invention and covered under utility patents. The right to a utility patent stems from 35 U.S.C. 101. A utility patent has a patent number consisting of all digits.

The right to a design patent stems from 35 U.S.C. 171: "Whoever invents any new, original and ornamental design for an article of manufacture may obtain a patent therefor, subject to the conditions and requirements of this title. The provisions of this title relating to patents for inventions shall apply to patents for design, except as otherwise provided." U.S. Commerce (2001) states, "In general, a 'utility patent' protects the way an article is used and works (35 U.S.C. 101), while a 'design patent' protects the way an article looks (35 U.S.C. 171)." An example of a design patent is the Coca-Cola® bottle. A design patent has a patent number consisting of a "D" followed by digits.

The right to a plant patent comes from 35 U.S.C 161: "Whoever invents or discovers and asexually reproduces any distinct and new variety of plant, including cultivated sports, mutants, hybrids, and newly found seedlings, other than a tuber propagated plant or a plant found in an uncultivated state, may obtain a patent therefor, subject to the conditions and requirements of this title. The provisions of this title relating to patents for inventions shall apply to patents for plants, except as otherwise provided." Information about plant patents can be found in U.S. Department of Commerce (2001), Chapter 1600. A plant patent has a patent number consisting of a "P" followed by digits.

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Patent protection extends to any useful, non-obvious, novel, application of an idea. Patent infringement is the unauthorized making, using, or selling for practical use, or for profit, of an invention covered by a valid claim of a patent during the life of the patent. The length of term for a utility patent is 20 years from application date. To obtain patent protection, an application must be sent to the USPTO.

Table 1. Copyrights, Trademarks, and Patents in a Nutshell

Copyright:		
	Denoted:	©
	Infringement:	Unauthorized Use
	Obtaining:	Put ©, date, and author's name on work Officially: register with Copyright Office
	Term:	Life of the author + 50 years (personal copyright) 75 years from first publication, or 100 years from creation, whichever expires first (corporate copyright)
Trademark:		
	Denoted:	™ or ®
	Infringement:	Unauthorized use or colorable imitation
	Obtaining:	Use with ™ and register with USPTO (with ®)
	Term:	Indefinite as long as it is properly renewed or used in commerce
Patent:		
	Denoted:	Patent Number (preceded with a "D" for a design patent, a "P" for a plant patent)
	Infringement:	Unauthorized using, making, or selling
	Obtaining:	Apply to the USPTO
	Term:	20 years from application date for a utility patent

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Representation of IP Owners

Obviously, one must be a lawyer to litigate in court. Yet, for IP issues, specifically patents and trademarks, the process may begin in the USPTO, depending on the type of action. One must be a patent agent or patent attorney (or the patent owner) to prosecute or prepare patents in the USPTO. Note that any lawyer may litigate copyright and trademark infringement cases, but normally a patent attorney represents a patent owner in patent litigation.

Table 2. IP Specifications

IP Type	*Guaranteed by U.S. Constitution*	*Patent Attorney/Agent Needed*	*Administered by USPTO*
Copyrights	✓		
Patents	✓	✓	✓
Trademarks			✓

IP Indicates Growth of Engineering

An IP search shows an increase in engineering research and progress. Of the three traditional areas of IP, copyright is the most difficult to quantify as anyone can copyright his or her original work themselves. Searching using the Google™ search engine on "engineering" yielded 27 million hits! Even if most, perhaps 75%, are duplicated sites, that still would be 6.75 million unique sites, which is a vast amount of possible copyrighted information. Unfortunately, this does not give an indication as to the growth, only the current status. Copyrights do give an indication as to the positive trend of the field; since the amount of copyrighted material is large, the interest in engineering is huge!

A trademark search, on the other hand, yields viable growth information for a given field. A search of the USPTO web-site for trademarks with "engineering" yielded 32,919 trademarks. The first trademark using the term engineering in its description was submitted to the USPTO by Albert & J.M. Anderson Manufacturing Company, with a filing date of February 19, 1906. This is valuable information that shows that "engineering" has been used in business since the turn of the twentieth century, and gives viable information regarding the development of the field. Note that the most recent trademark indicated on the USPTO web-site had a filing date of June 14, 2002. Further searching on "engineering" yields more information. Viewing trademarks in twenty-year periods, an exponential growth can be seen for all trademarks with the word "engineering" in their texts: From 1906 to 1926, approximately 24 trademarks were filed; From 1926 to 1946, 105 trademarks; From 1946 to 1966, 1,390; From 1966 to 1986, 5,400; From 1986 until the present time, 26,000 trademarks were filed. Obviously, the greatest boom to engineering within trademarks has been the last twenty years. This information can be seen in figure 1 below.

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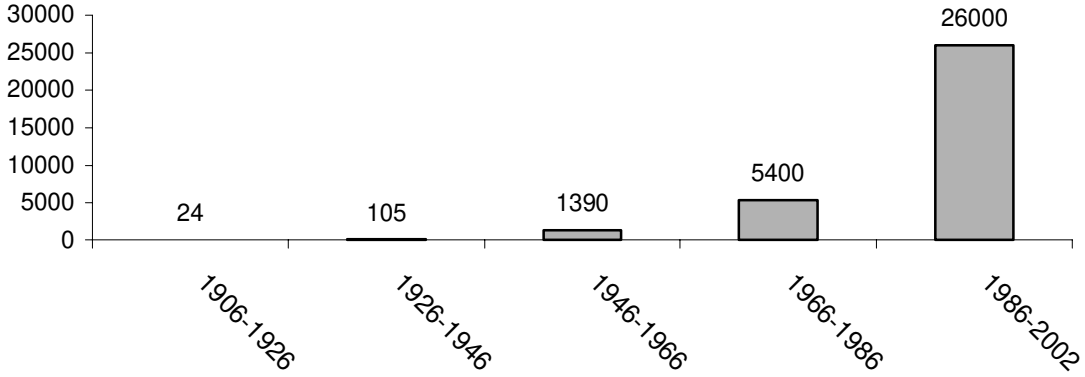


Figure 1. Numbers of Trademarks with "engineering" in Text

Breaking this last twenty-year period into three-year periods yields: From 1986 to 1989, 2,000; From 1989 to 1992, 3,000; From 1992 to 1995, 4,100; From 1995 to 1998, 4,400; From 1998 to 2001, 7,500; From 2001 to 2002, 5,000. (Note that this last period is not three years yet!) This information can be seen in figure 2.

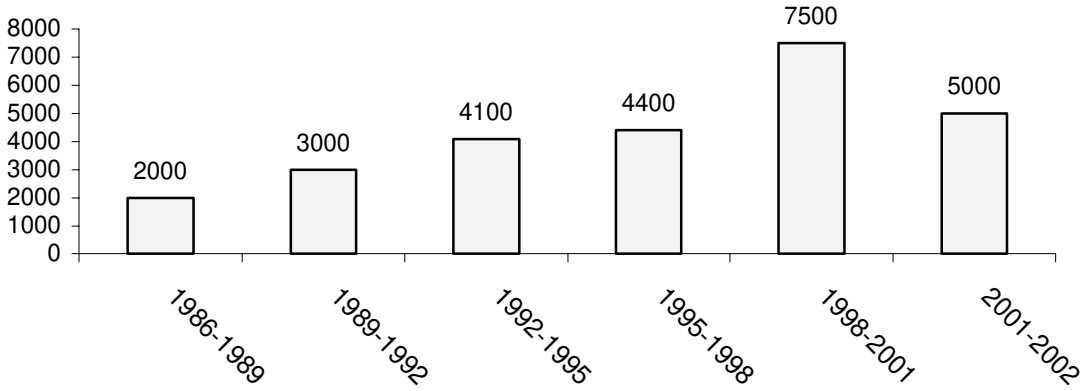


Figure 2. Numbers of Trademarks with "engineering" in Text in Three-Year Periods, from 1986 to Present

A patent search gives a better indication as to the growth of the engineering field. Current research trends in a given field can be determined by the number of patents granted over time and the number of patent applications in the USPTO. As shown in figure 3 below, there has been an explosion of advancements in engineering.

Searching the USPTO web-site on "engineering" shows that from 1996 to 2002, there have been 75,138 patents granted. Searching patent applications (patents not yet granted) shows 15,769 patents outstanding. From 1991 to 1995, there were 29,020 patents granted; From 1986 to 1990, 20,052; From 1981 to 1985, 14,008; From 1976 to 1980, 11,556 patents granted. Patents from 1790 through 1975 are searchable only by Patent Number and Current US Classification, and therefore were not researched for this paper. These trends can be seen in the graph below.

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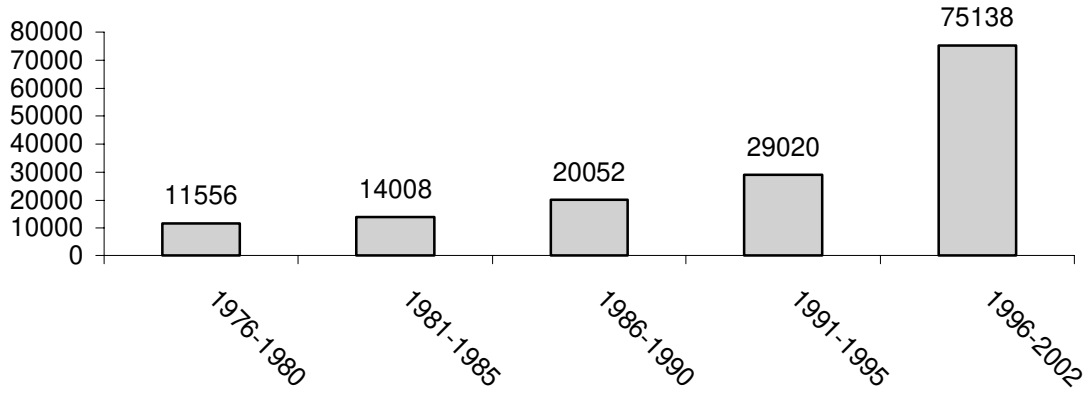


Figure 3. Engineering Patents

Obviously, there is a sharp rise in engineering patents. This is a clear indication of the increase in the engineering field, thereby showing the increase in opportunities for future engineers.

Engineering can be applied to many different fields, but to get an idea of the actual progress of a specific discipline, patent searches can be applied to a given aspect of engineering. For example, searching on "asynchronous circuits" shows a marked increase since 1976. From 1970 to 1975, there were no patents granted with the term "asynchronous circuits." From 1976 to 1980, there were 6 patents. From 1981 to 1985, there were 3. From 1986 to 1990, there were 15, from 1991 to 1995, 37, and from 1996 to 2002, there were 137 patents granted. There are currently 14 patent applications outstanding. The number of patents granted with the term "asynchronous circuits" can be seen in figure 4. Figure 4 shows an exponential growth in the discipline of asynchronous circuits, and thus indicates a growing research field.

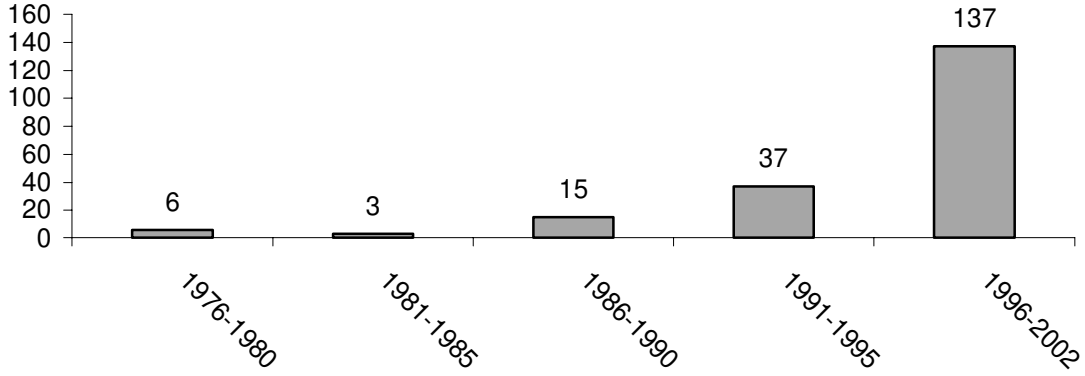


Figure 4. "Asynchronous Circuits" Patents

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Advancement of Engineering Through IP

Patents and copyrights are guaranteed by the U.S. Constitution. These rights were created to "promote the Progress of Science and useful Arts." But, how does IP advance science? Suppose for a moment that there was no way to protect one's inventions. In that case, Thomas Edison may have kept the light bulb a secret and used it in a business venture for an advantage over others; his employees could work effectively at night and double production. This would not promote the progress of science, only Edison's own interest. The drafters of the U.S. Constitution knew that in allowing inventors to secure rights to their inventions, two benefits would occur: (1) the inventor could reap monetary compensation for his or her invention by exclusively selling his or her invention or selling the invention rights and (2) the specific field benefits from the invention disclosure. The disclosure, part of a patent, provides the scientific details of the invention and is a stepping stone to build society's storehouse of knowledge. Without the patent disclosures, many scientific breakthroughs and advancements may have remained unknown, thereby reducing the overall scientific storehouse and limiting further scientific advancements.

Introducing IP into an Engineering Curriculum

Engineering professors are known to give projects, but not many incorporate IP into their project requirements. References are sometimes required, specifically references to copyrighted material, but rarely are patent or trademark searches required for projects. This is a disservice to engineering students.

Of all the academic disciplines, engineering may encompass most of the patentable technological breakthroughs, yet some engineering students are never exposed to IP education. If taught early, starting in the freshman year, and often, throughout the undergraduate education, IP education will be ingrained into the student's creative thought process. It will also give the undergraduate engineering student other options upon graduation, perhaps to study patent law or technology transfer.

Incorporating IP into an undergraduate engineering curriculum need not replace any ABET (Accreditation Board for Engineering and Technology, Inc.) or any other accreditation board criteria. In fact, it would reinforce the goals of accreditation. In fact, of the eleven criteria required under ABET Criterion 3, stating the requirements for engineering graduates, IP knowledge would be included in seven, including "an ability to design," "a knowledge of contemporary issues," and "an understanding of professional and ethical responsibility." IP encompasses design and identifies the latest contemporary issues associated with engineering. More importantly, it is an engineer's professional and ethical responsibility to research claims prior to publication or use. Performing copyright searches are standard practice, but performing other IP searches should be standard as well.

In an undergraduate engineering curriculum, every project assigned should require a copyright, patent, and trademark search. In order to do this, two things must be established: introduction to IP through at least one lecture, and familiarity with the USPTO website.

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First, at least one lecture is required. The information given in this paper is enough to get started, for those not familiar with IP. Another reference is one of the authors' websites: http://www.imappl.org/~kaplan/IPKaplan.htm. This is a lecture that the author gives her students.

Second, a student must be familiar with the USPTO website. As an assignment, the authors give their students search criteria and have the students access the USPTO website. For example, if a project involves asynchronous circuits, as given above, an assignment will be for the student to access http://www.uspto.gov and search "asynchronous circuits." These types of assignments were used in the authors' Introduction to Engineering course given to all freshmen. For example, the students were given a design project involving reducing the interior temperature of a parked automobile; an IP assignment prior to starting the design project involved a patent search on a particular patent that claimed to solve this problem. Performing this a priori search helped the students understand the design problem better, gave a patented solution, and introduced patents and patent searches. Obviously, patent searches are relevant to every design project; trademark searches can be incorporated where needed. The authors have used patent and/or trademark searches in all of their classes, including engineering ethics. In last semester's Ethical and Social Impact of Computing course, one of the authors gave patent dispute cases as a final project, where two companies were involved in infringing patents. The students were responsible for reviewing the patent in dispute and to provide patent reviews, along with research on the infringement. A past final project involved researching controversial trademarks and the ethical responsibility of companies and the USPTO with respect to these trademarks.

The more an engineering student is exposed to IP, the better prepared the graduating engineer will be to utilize this information and understand IP options to protect his or her creations.

Results

One of the authors has included IP into most of the courses she has taught at Howard University. Through her courses, the engineering students have been introduced to an overview of IP and have been required to perform IP searches within their assignments. All of the students have reported that they enjoyed the information and will use the material in the future. Some of the students have applied to the United States Patent and Trademark Office as patent examiners. A few are applying to law schools to become IP lawyers. Without the introduction given in their undergraduate curriculum, many of these students would not have made the connection between IP and their future.

The best result came well after the completion of a course. Ms. W. returned to thank the professor; apparently she impressed an interviewer with her knowledge of IP and received an engineering position because of it!

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Conclusion

IP knowledge is important for engineers: engineers should try to understand IP basics to protect their creations. Also, IP searches can indicate the growth of different engineering fields. Furthermore, the proper use of IP promotes the progress of a field. Engineers should become familiar with the basics of the three traditional IP areas: copyrights, trademarks, and patents. Engineers should know which IP rights are needed to protect their creations. IP rights are guaranteed either by the U.S. Constitution, as in copyrights and patents, or statutory laws, such as trademarks. In the case of copyrights and patents, the two were included in the U.S. Constitution to promote the advancement of science, such as engineering. It has been shown that by using IP searches, researchers and businesses can get a sense of research trends. This paper has given a basic introduction of the three IP areas as well as patent and trademark searching. We have shown the importance of introducing this knowledge to engineering students and suggestions of how to incorporate IP into engineering courses. In a nutshell, for protection, analysis, and progression of the creations and field of engineering, basic IP knowledge should be incorporated into engineering discussions.

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