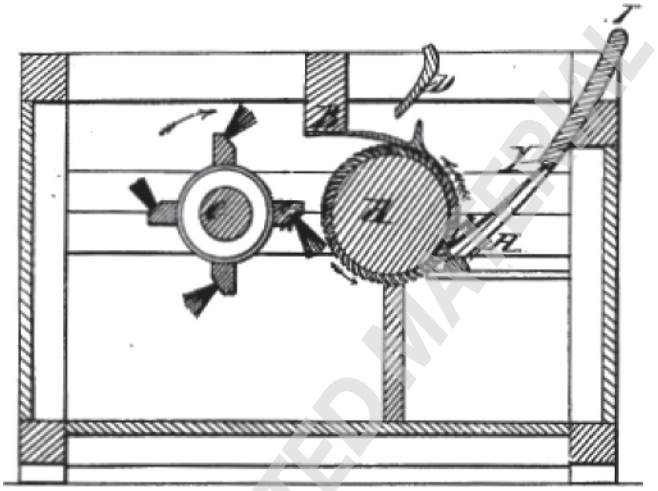
◆ INVENTORS AND INVENTIONS ◆

Eli Whitney

THE COTTON GIN



The first patent of major importance to be issued by the U.S. government after it was formed was Eli Whitney's patent for the cotton gin ("gin" is short for "engine"), which was issued on March 14, 1794. The patent description is in longhand, for reasons I cannot explain.

Upon graduating Yale as an engineer in 1792, Whitney, like many college graduates of today, found himself in debt and in need of a job. He left his home in Massachusetts and took a job as a teacher in South Carolina. That job fell through, and Katherine Greene, the war widow of General Nathanial Greene, invited Whitney to stay at her Georgia cotton plantation in early 1793. He noticed that long-staple cotton, which was readily separated from its seed, could only be grown along the coast. The inland-grown variety of cotton had sticky green seeds that were difficult to cull from the fluffy white cotton bolls, and thus was less profitable to grow and harvest. It took 10 hours of hand labor to sift out a single point of cotton lint from its seeds.

Whitney, after observing the manual process being used for separating the sticky seeds from the cotton bolls, built his first machine, which did not work. The bulk cotton was pushed against a wire mesh screen, which held back the seeds while wooden

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teeth extending from a rotating drum pulled the cotton fibers through the mesh screen. However, this machine jammed. His next version incorporated thin wire hooks to replace the wooden teeth, and the collected fibers were cleared away by a moving brush. This second machine was successful.

According to some accounts, a question remains to this day whether Whitney or his employer, Mrs. Greene, was the "inventor" of the key element of the successful cotton gin—the wire hooks. Some say the plantation foreman suggested to Greene that the wooden teeth be replaced by wires, and that Greene then told Whitney. Whitney's supporters, on the other hand, cite a letter to the editor of *Southern Agriculturist* magazine, admittedly based on shaky sources, that Whitney specifically asked Mrs. Greene for a pin to use at the start of his experimentation. A factor tending to swing the pendulum toward Whitney was that, before he left Massachusetts, he was the new country's only hatpin manufacturer.

In 1794, Whitney filed a patent application for his (or Greene's) cotton gin. He also gave a demonstration of his model to a few friends, producing in 1 hour a full day's output of several workers. The witnesses to this demonstration immediately had whole fields planted in green seed cotton. Word spread, and the farmers grew excited and impatient. Whitney's shop was broken into, and examinations made of his new cotton gin. Then, more fields were planted with cotton.

Before Whitney had a chance to prepare a patent model of his invention (required in those days), or to secure patent protection, the cotton crops were ready for harvest, and the planters did not have time to work within ethical or legal parameters. Whitney's cotton gin was simply pirated. Whitney and his partner, Phineas Miller, decided to build cotton gins and lease, not sell, them to the planters in exchange for 1 pound of every 3 pounds of cotton put through their machines. The planters revolted at this arrangement, as a virtual flood of white cotton was erupting from the Southern soil.

The partners, heavily in debt, were forced to approach the Southern courts to enforce their patent rights, which resulted in disaster. In 1801, they opted for grants from several Southern states, and, in return, the cotton gin would become public property. One state, South Carolina, accepted, offered $50,000, made a down payment of $20,000, and never paid the remainder. Eventually, Whitney and Miller received about $90,000 from the states, which was used up immediately to pay legal costs and other expenses. In 1803, the states repudiated their agreements, and sued Whitney for the return of the money paid previously. In 1804, Whitney petitioned the U.S. Congress for relief, and by one vote avoided financial ruin. At that point, he felt the past 10 years were wasted. Whitney became discouraged with cotton, and left the South forever.

Upon returning to New Haven, Connecticut, he started manufacturing goods and developing mass production techniques and factories. In time, his manufacturing process developments changed the industrial capabilities of the North, just as his cotton gin had changed the face of the South.

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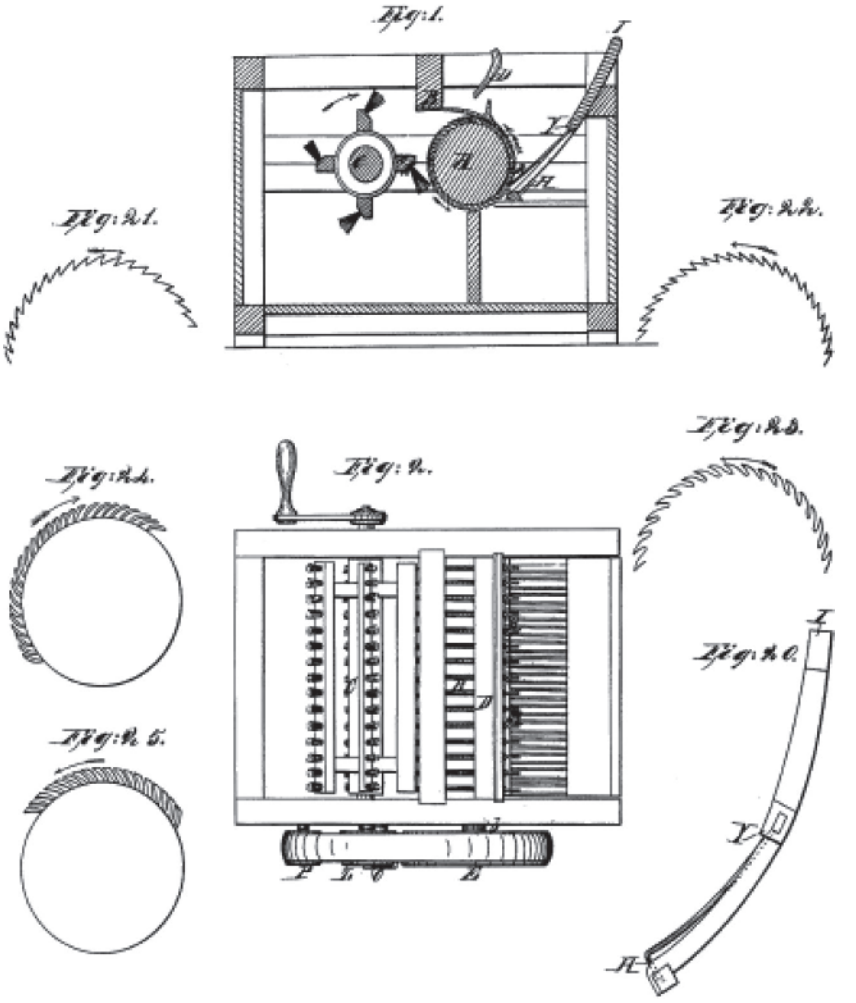
E. Whitney,

Cotton Gin.

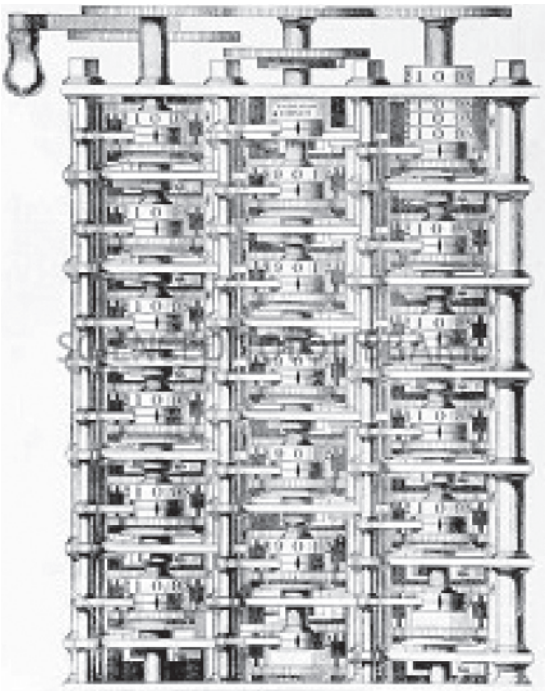
Patented Mar. 14, 1794.



◆ INVENTORS AND INVENTIONS ◆

Charles Babbage

THE DIFFERENCE ENGINE



Charles Babbage was a man of many talents. However, completing projects he started was not one of them. This essay will skip over many of the accomplishments of Mr. Babbage in his lifetime, and go straight to the point where he became known as a computing pioneer. Babbage, an Englishman, is credited with developing the first mechanical computers. However, his models were never completed, largely because of economic problems, and possibly clashes of personality, particularly with the Astronomer Royal of England.

Babbage directed the construction of early steam-powered calculating machines that achieved modest success, but those machines also suggested that the calculations could be mechanized. He received British government funding for his calculation

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mechanism project for over 10 years, but eventually the treasury in England lost faith in him, and stopped funding his project. The machines that Babbage did manage to prototype were mechanical, and their basic architecture was similar to a modern computer. For example, the program memory and the data memory were separated, operation was based on instructions, the control unit could make conditional jumps, and his devices had a separate input/output unit.

In Babbage's time, printed mathematical tables were calculated by humans. As you might expect, errors were constantly known to occur in the transcription of such calculations. Babbage at one time prepared his own account of how he began thinking about mechanical mathematical computations to replace those that were made by hand. In his own words, he stated that, in 1812, he was in his room in the Analytical Society, reviewing a table of logarithms, which he concluded was full of mistakes. He then had the thought of computing all tabular functions by machinery. He knew that the French government had previously produced several tables by a new method, where several French mathematicians decided how to compute the tables, six more divided the operations into simple stages, and the work itself, which was merely addition and subtraction, was performed by 80 human "computers" who knew only those two arithmetical processes. Babbage considered that this was mass production applied to arithmetic, and became enthralled by the concept that the labors of unskilled human computers could be taken over completely by faster and more reliable machinery.

In about 1819, Babbage's interests were turning to astronomical instruments, and his ideas became more precise. He conceived of a plan to construct tables using the method of differences by mechanical means. He began to construct a small prototype "difference engine" in 1819, which he completed by 1822. He described his invention in a paper published on June 14, 1822, by the Royal Astronomical Society of England, titled "Note on the Application of Machinery to the Computation of Astronomical and Mathematical Tables." At the time the paper was written, Babbage had also thought about a machine that could print the results of the difference engine, but this printer was not completed at the time his paper was written. An assistant of Babbage's was required to write down the results obtained by the difference engine by calculating successive terms of the sequence $n^2 + n + 41$. Babbage urged that a larger difference engine could do the work undertaken by many people, saving costs and being totally accurate. However, such a larger machine was never built during his lifetime.

Babbage's difference engine was designed to compute values of polynomial functions. The calculations were supposed to be done automatically by using the method of finite differences, which made it possible to avoid the need for multiplication and division. In his 1822 paper, he described a machine using the decimal number system that was powered by cranking a handle. Babbage worked with Joseph Clement on the prototype of his design for a difference engine in 1823. In 1831, the collaboration between Babbage and Clement ended over arguments involving money. The prototype that Babbage and Clement did construct evolved into the first difference engine, but remained unfinished. This prototype was approximately one-seventh of the calculating section of the difference engine that Babbage initially envisioned. Even though Babbage's design was feasible, the metalworking techniques of the early 1800s could not economically produce the needed parts in the quantity and to the precision required. The design of the first difference engine would have included, had it been completed, around 25,000 parts, weighed 15 tons, and would have been 8 feet tall.

Babbage received ample initial government funding for the project; however, the device was never completed.

A *difference engine* can be defined as an automatic mechanical calculator designed to tabulate polynomial functions. The name derives from the method of divided differences, a way to interpolate or tabulate functions by using a small set of polynomial coefficients. Most mathematical functions commonly used by engineers, including logarithmic and trigonometric functions, can be approximated by polynomials, allowing a difference engine to compute several useful tables of numbers. The difficulty in producing an error-free table by teams of mathematicians or human computers was the driving force behind Charles Babbage's desire to build a mechanical device to automate the calculating process.

In 1827, the costs of constructing Difference Engine No. 1 were becoming astronomical, and work stopped on the project in 1834. Up to that time, the British government had invested £17,000 into the project, and Babbage had invested £6,000 of his own funds. From 1834 to 1842, the British government did not make a decision on whether to continue to support Babbage in his projects, but the decision not to proceed was taken in 1842 by Robert Peel's government.

Between 1847 and 1849, Babbage produced detailed drawings for an improved version, which he called Difference Engine No. 2, but he failed to receive funding for this project from the British government.

After failing at his efforts to complete Difference Engine No. 1, Babbage worked on a design for a more complex machine, which he called the "Analytical Engine." He and C. G. Jarvis, who had previously worked for Clement, worked on the analytical engine, which was a transition from mechanized arithmetic to full-fledged general-purpose computation. It is largely on his development work on the analytical engine that Babbage's reputation as a computer pioneer was established, although the analytical engine was never completed in Babbage's lifetime.

The analytical engine was to be programmed with punch cards that would control a mechanical calculator, which would use the results of preceding computations as input. The device was also intended to employ several features subsequently used in modern computers, including sequential control, and looping and branching. It would have been the first mechanical device to be considered a complete computer. The analytical engine was not a single physical machine, but rather a succession of designs that Babbage continued working on until he died in 1871.

By 1834, Babbage had completed the first drawings of the analytical engine, which is now considered by some as the forerunner of the modern electronic computer. The analytic engine never progressed beyond detailed drawings; however, it is quite similar in logic components to present-day computers. Babbage's writings described five logic components of his computer: the store, the mill, the control, the input, and the output. The store contains all the variables to be operated upon, as well as all quantities that had arisen from the results of other operations. The mill, which is similar to the CPU in a modern computer, is a locale into which the quantities about to be operated upon are always brought. The control was carried out by a Jacquard loom–type device, operated by punch cards. The punch cards comprised a program for the particular task, where every set of cards made for any formula would at any future time recalculate the formula with whatever constants would be required. Thus, Babbage envisioned that his analytical engine would possess a library of its own—with every set of cards, having once been made, reproducing at any time the calculations for

which it was first configured. Babbage designed the analytic engine to effectively have infinite storage by outputting data to punch cards, which could be read into the system again at a later stage when necessary. As the difference engine, the analytical engine was never completed by Babbage.

Babbage visited Luigi Federico Menabrea in Turin, Italy, in 1840. During this visit, Menabrea collected all the material needed to describe Babbage's analytical engine, which Menabrea published in October 1842. Ada Lovelace, also known as Lady Byron, the daughter of Lord Byron, translated Menabrea's article into English, adding considerably more extensive notes than the original memoir. Lovelace's work was published in 1843.

Ada Lovelace described seeing Babbage's working prototype in 1833: "We both went to see the thinking machine (or so it seems) last Monday. It raised several numbers to the 2nd and 3rd powers and extracted the root of a quadratic equation."

Ada Lovelace was credited with developing an algorithm that would enable the analytical engine to calculate a sequence of Bernoulli numbers. Therefore, Ada Lovelace is often considered the first computer programmer, although no programming language had yet been invented during her time.

When Babbage turned his attention to developing the analytical engine, he further undermined the British government's support of his difference engine, and this was one reason government financial support was withdrawn. By improving the concept as an analytical engine, Babbage had obsoleted his earlier difference engine.

Believe it or not, Babbage's design was finally constructed between 1989 and 1991 using his plans and nineteenth-century manufacturing tolerances. Lo and behold, this machine performed its first calculation in the Science Museum in London, returning results to 31 digits. During the 1980s, Allan G. Bromley, assistant professor at the University of Sydney, Australia, looked at Babbage's original drawings for both the difference engine and the analytical engine that were located at the Science Museum Library in London. Ultimately, the Science Museum was persuaded to construct a working Difference Engine No. 2, which was built between 1980 and 1991 to tolerances achievable with nineteenth-century technology. In 2000, the printer that Babbage had originally designed for the difference engine was also completed. Construction revealed some minor errors in Babbage's design, which some commentators surmise had been purposefully introduced as protection in case his designs were stolen. These errors were corrected, and once completed both the difference engine and his printer worked flawlessly, and still work to the present day. This resolved the long-standing debate as to whether Babbage's design would have actually worked.

Babbage's printer's primary purpose was to produce stereotype plates for use in printing presses, by pressing type into soft plaster to create a flong. Babbage's plans show that the engine's results would be conveyed directly to mass printing, having recognized that many errors in previous tables were not the result of human calculating mistakes, but resulted from errors in the manual typesetting process. Therefore, the printer's paper output is a means of checking the difference engine's performance.

There are many articles and books written about Babbage's work and how his difference engine operates. Those of you who are interested in delving into this subject matter further are encouraged to review the literature and gain more information about the earliest computer ever made from these sources, several of which are named in the Bibliography section of this text.

1 Overview of Intellectual Property Law

1.1 DEFINING "INTELLECTUAL PROPERTY"

First, we need to define the core term of our subject: *intellectual property*. The term "intellectual property" generically describes those "intangible" property rights—those you usually cannot see or touch—which are initially created by one's intellectual creative efforts. The results of those intellectual efforts, in most cases, are then anointed with these intangible property rights that give their creator or owner the "exclusive" ability to control, and profit from, the results of this creativity. "Intellectual Property Law" is that field of law which defines those intellectual creations that are entitled to protection as intellectual property, how to obtain (or lose) those intellectual property rights, how to properly use and benefit from those rights, and how to obtain enforcement and compensation when those intellectual property rights are infringed upon by a competitor or other evil person. Intellectual Property Law also provides guidance to a competitor who desires to produce a new product or use a new process, by designing around, and thus avoiding, the proprietary territory defined by your intellectual property rights.

Winning or losing out in business and financial opportunities many times heavily depends upon whether your creative output, inventions, products and business ideas and services are protected by patents, trademarks, copyrights, trade secret rights, mask work rights, and others. Commercially new and useful ideas, inventions, products, and business services are the foundation of practically every highly successful business. As a result, successful business owners and entrepreneurs typically place a high value on the exclusive rights granted to intellectual property developed by their employees.

Businesses have succeeded or failed because of their owner's efforts to protect their intellectual property, or their failure to do so. The value of many publicly traded companies has taken huge swings based principally upon whether the company has been successful in obtaining and enforcing its patent rights, for example. There are many common myths and misunderstandings surrounding the need for and the difficulty in obtaining patent, trademark or copyright protection. Understanding the protection rules and processes and appreciating the valuable rights which can be acquired ensures that your intellectual property is protected, as well as that of your employer.

"Tangible" property includes things such as land, houses, jewelry, communication system terminals and networks, and even animals—things you can see and feel and physically possess. Intellectual property rights, on the other hand, are "intangible"

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rights which cannot be seen or touched, but they still exist, or can exist, if the rules laid down by centuries of Intellectual Property Law are understood and followed. Intangible property, to be protectable, must ultimately be described or depicted in some tangible form, such as a description in a patent grant, or a work of art or manuscript of a book covered by a copyright certificate. In each of these two examples, the law describes the intangible exclusive rights possessed by the owner and/or creator of a patentable or copyrightable work.

The building blocks of intellectual property law are patents, copyrights, trademarks and service marks, as well as anti-cybersquatting laws, unfair competition laws, trade secret protection laws, and mask work protection laws. These are all concepts that were created by legal systems in most of the countries of the world, and, although they are merely legal devices, they provide powerful instruments of protection for your intellectual creations. These systems of rights were developed to document the existence of intellectual property rights and how they can be protected, and to give the creators the right to exclusively use, own, transfer ownership, or license their exclusive intellectual property rights.

In general terms, each Intellectual Property Law system throughout the world is devised to document enforceable protection for specific types of creative and innovative output, and to allow people and business entities to own and transfer ownership in the exclusive rights in their intellectual property. For example, patents cover novel, useful, and non-obvious machines; articles of manufacture; compositions of matter; ornamental designs; plants; manufacturing, electrical, and chemical processes; and other methods, including software algorithms and methods of doing business. Patents also cover any improvement made to an article or process falling in any of the preceding categories. Copyrights cover the creative works of authors, composers, software developers, artists and the like. Trademark and service mark registration laws, as well as the common law, which I shall explain, protect the source identity of a product or service, such as the name and/or logo, and sometimes product configuration, under which goods or services are advertised and marketed to the trade or public, and that differentiates such goods and services from those of others. Trade secret protection laws prevent a competitor or another from misappropriation of valuable and confidential information that is not generally known or available to a competitor or to the public, such as a secret chemical formula or a secret process. Mask work protection is a recent intellectual property structural block that provides exclusive rights in creative mask works used in the manufacture of semiconductors. In all, the specific nature and content of the results of your creative endeavors determines which vehicle or vehicles of the various intellectual property laws are best suited to protect the ultimate output of your efforts.

1.2 SPECIFIC INTELLECTUAL PROPERTY VEHICLES

1.2.1 Patents

A U.S. patent grant covering your invention can only be obtained from the U.S. government, namely, the United States Patent and Trademark Office (USPTO), currently located across the river from Washington, D.C. in Alexandria, Virginia. Most of the business of the USPTO is conducted electronically, and patent and trademark

applications can be filed, examined, and prosecuted online. In foreign nations too, patents are granted only by the nation's government. Each country's patents are enforceable only in the issuing country and its territories. There are also a few regional patent systems—such as the one controlled by the European Patent Office (EPO), which issues patents enforceable in each country of the European Union. In the United States, the Patent Law is found at Title 35 of the United States Code, a body of laws periodically enacted and amended from 1790 to the present by the U.S. Congress, as mandated by Article 1, Section 8, of the U.S. Constitution. These U.S. laws define what can and cannot be patented, the conditions and requirements for obtaining a patent grant on patentable subject matter, the rights granted by a patent, the ability of a patent owner to enforce the exclusive rights embedded in the patent grant, and the ability of a patent owner to license or transfer ownership of the intangible rights embedded in the invention and patent grant for monetary consideration.

As mentioned briefly in the preceding text, patents are granted on "new and useful processes, machines, manufactures or compositions of matter, or any new and useful improvement thereof" (35 U.S.C. §101). Designs of utilitarian articles of manufacture may also be protected by a Design Patent. Recent court decisions have held that anything "new" made by man or woman falling within the definition of 35 U.S.C. §101, quoted earlier, can be the subject of a patent. This includes new forms of animal life, for example, the Harvard Mouse, which is particularly susceptible to cancer and therefore valuable in research, and the modified *E. coli* bacterium, which produces insulin. Also, more recently, novel and unobvious methods of conducting business have also been pronounced to be the subject of patents, as well as software under certain circumstances, as discussed in detail later in this text. By way of comparison, any material that appears naturally in nature cannot be the subject of a patent, since it was not "invented" by the alleged inventor. Also, pure abstract ideas and concepts that have no "physical" embodiment are not protectable under the patent laws. However, as discussed later, a novel concept embodied in a new and useful device or procedure may come close to being fully protected by effective and creative patent application and claim drafting.

An issued patent grant describes and illustrates the covered invention, and its advantages over the "prior art," and also includes specifically worded "claims" that define the metes and bounds of the protection afforded by the patent grant. If a competing device or process falls within the definition set forth in a patent's claim or claims, or comprises equivalent structure, the competing device infringes the patent. However, I am getting ahead of myself—the topic of patent infringement will be covered later.

1.2.2 Trademarks and Service Marks

Trademarks, services marks, collective membership marks, trade dress or product configuration, trade names and the like are indicia of origin of one's products or services. These indicia are directed toward the protection of the reputation and goodwill of the manufacturer of a product or a provider of services, who uses a mark or symbol distinguishing the source of origin of its products or services from those of another manufacturer or service provider. These marks may comprise a name, logo, symbol, product shape, container shape, or other distinctive and non-functional feature

of a product or service which indicates that a certain supplier or group is the sole source for that particular brand of product or service, and the supplier or group stands behind the quality and reputation of the particular product or service. Rights in the exclusive use of the mark are protected to avoid the likelihood of consumer confusion in the marketplace as to the source of the goods or services they purchase, thereby protecting the public against fraud by the second user of a confusingly similar mark.

A trademark or service mark registration application must be submitted to the government (the USPTO in the United States) to obtain federal registration, and sets forth both the identifying mark and those goods or services with which the mark is, or is intended to be, used. A trademark never stands alone. A trademark or service mark is always considered as an adjective, modifying the goods or services to which it pertains. Thus, "Scotch tape" is proper usage, as long as the "Scotch" is followed by the identifying word "tape." When used, a trademark or service mark should always be followed by the descriptive term of the associated goods or services.

Trademarks and service marks may also be protected in the United States and certain other common law countries without registration, if long usage and advertising of the mark has advised the public that the name or symbol has been adopted as a distinctive mark by its owner. As discussed later, each state of the United States has a trademark/service mark registration system directed to marks for goods and services that do not travel across state lines, such as a dental office, for example.

1.2.3 Copyrights

A copyright is a form of intellectual property that protects the expression of authorship or artistic rendition of the author or creator, but does not protect the idea or concept upon which the expression is based. A concept for doing something cannot be protected by copyright, but the fixation, or expression of that concept, can be protected. For example, the concept of writing a book about tornado hunters is not protectable. However, a book or film about tornado hunters is a "fixation" of the author's expression, and the expression, but not the concept, is protectable under the copyright statutes.

Copyright protection is normally easier and less expensive to obtain than either patent or trademark protection. Under existing law, the creator of a copyrightable work obtains an intangible copyright in the work immediately upon the fixation of the work in a tangible medium of expression. To obtain a U.S. registration of that copyright, which provides tangible evidence of the existence of the copyright, an application setting forth, among other things, the author's name, the identity of the work to be protected, and its date of creation are submitted on an appropriate form to the Register of Copyrights, along with a deposit sample of the work. The Register of Copyrights works under the aegis of the U.S. Library of Congress. The application is subjected to an examination procedure, which is much quicker than the examination of patent or trademark applications, because there is no examination for novelty or likelihood of confusion as compared to existing copyrighted works. The copyright application must indicate which portions of the work are original and which are not. This permits the public to ascertain which portions are protected and which remain in the public domain. Copyrights are used to protect books, films, videos, works of art, sculptures, and, more recently, choreography and software.

It is possible to overlap protection between the copyright and patent laws. For example, a novel, useful and non-obvious computer program may be protectable under

both patent laws and the copyright laws. The expression of an algorithm or formula can be protected as a literary work under the copyright law. In addition, a novel method for controlling a machine by use of an algorithm may qualify for patent protection.

1.2.4 Trade Secrets

As discussed later in this text, patents and copyrights expire after a term of years, while trade secret protection does not. As long as the information covered by a trade secret umbrella remains secret, that information is protected from improper discovery or use by others, unless the secret is independently discovered, as by reverse engineering, or otherwise lawfully made public by someone else. Where the secret is very difficult to discover and the owner is willing to maintain security to ensure its secrecy, trade secret protection is a valuable option and has no endpoint.

However, once the trade secret becomes known, there is no way to restore secret status. If the secret is discoverable upon reviewing the articles in which the secret is used, trade secret protection is useless. In such cases, patent or copyright protection should be considered instead. Unlike patents and copyrights and trademarks, until recently, there was no federal law regulating trade secret protection in the United States. However, in 2016, the U.S. Congress enacted a federal law to protect trade secrets, which is discussed in Chapter 27 of this text. Each state has its own trade secret protection law, and if it is determined that the best way to protect your intellectual property is through the trade secret law, an attorney familiar with this area of your state law should be consulted in the state or states in which you are operating. In the State of Illinois, where I practice, the state legislature has enacted the Illinois Trade Secrets Act, which is currently in effect. This Act sets forth what types of subject matter are considered as trade secrets, such as secret processes, formulas, customer lists, confidential future business plans, etc., and how they are protected. Even if a particular state has not enacted a statute granting trade secret protection, the common law may be available in that state to enforce trade secret rights against misappropriation once the secret is created.

1.2.5 Mask Works for Semiconductors

In 1984, the U.S. Congress enacted a law to protect mask works used in creating semiconductor microprocessor chips. This law became part of the Federal Copyright Statute. Chapter 26 of this text describes in detail how mask work protection can be obtained for semiconductor chips.

1.3 WHICH FORM OF INTELLECTUAL PROPERTY PROTECTION TO USE?

Depending on the nature of the technological project you are engaged in, one or several of the vehicles of intellectual property may be advisable to use. In some situations, you may not have any choice. If the subject matter of protection is a book or manuscript, patent or trademark protection cannot be obtained. For example, book titles other than periodical titles cannot be the subject of trademark registration, since each book title is descriptive of the precise book sold under that title. In some

situations, multiple forms of protection will be available. In the case of a novel form of packaging, both article and design patent protection may be available, covering a novel construction embedded in the packaging, as well as the aesthetic outward design of the package. Also, the name of the product on the packaging would be susceptible to trademark protection, while the graphics used on the packaging label could be protected under copyright laws.

Which protection to be used is a business decision that must be arrived at by the owner of the invention or originator of the creative work. This decision should be made with the assistance of an attorney with experience in the intellectual property law field, and after the creator or owner has a full understanding as to the best vehicle or vehicles to be used for protection.