

*COMMENT**COPYRIGHT FOR INNOVATIVE BIOTECHNOLOGICAL RESEARCH: AN ATTRACTIVE ALTERNATIVE TO PATENT OR TRADE SECRET PROTECTION**BY DOREEN M. HOGLE †***table of Contents**

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INTRODUCTION

Scientific research has undergone revolutionary expansion in recent years.¹ Innovative advances, once infrequent, are now commonplace. One area of particular interest and impact is biotechnology. Biotechnology is best described as a hybrid science, combining classic scientific disciplines (such as immunology, microbiology and chemistry) with innovative techniques (such as genetic engineering and molecular biology).² This hybrid science also has hybrid goals. It combines the traditional scientific goal of the pursuit of knowledge for the benefit of mankind with the entrepreneurial goal of the production of useful products and processes.³

Biotechnological products have tremendous commercial potential. Consequently, researchers and their funding agencies are concerned with the protection of their work through intellectual property law.⁴ Some biotechnological products can be termed "inventions" and readily lend themselves to traditional patent coverage.⁵ However, many products fail to meet the stringent statutory requirements for patent protection. These biotechnological "innovations"⁶ are at a transitional stage of development. They are more than mere esoteric results of scientific observation, yet are not quite "useful" products as defined by current patent law.⁷ Nevertheless, these innovations contain extremely valuable scientific information essential for further biotechnological research.⁸ Furthermore, substantial intellectual and creative efforts have already been expended to reach this level of innovation. Recombinant deoxyribonucleic acid (DNA) sequences,⁹ lymphocyte hybridomas producing mono-specific antibodies,¹⁰ and the molecular coordinates representing the three-dimensional structures of proteins and viruses as determined by x-ray diffraction¹¹ or nuclear magnetic resonance (NMR) spectroscopy¹² are typical examples.

Unfortunately, because these innovations are often difficult to categorize within the traditional intellectual property framework, a substantial segment of commercially valuable information is left without legal protection.¹³ In today's intensely competitive world of scientific research, intellectual property protection is essential.¹⁴ What options, other than patent protection,¹⁵ are available to protect these biotechnological innovations while further research is being performed? Two possible modes of protection are trade secrets and copyrights.

Trade secret protection, although certainly viable, erects a substantial barrier to scientific development. A trade secret by definition, requires secrecy.¹⁶ It would compel the scientist to conceal any innovative scientific information until she is ready to surrender control. Not only would this prevent the disclosure of valuable information to the scientific community, but the scientist herself would be deprived of the peer recognition and esteem which are valued rewards for researchers.¹⁷

This comment will demonstrate that copyright protection for biotechnological innovations exists and that a limited form of copyright protection would be an attractive alternative to patent or trade secret protection. Copyright protection is designed to promote progress in the arts and sciences by providing incentive to the author/scientist to produce works which benefit society.¹⁸ Copyright confers upon the author substantial control over who copies, reproduces or makes derivatives from the original work.¹⁹ Given copyright protection, scientists would be encouraged to invest their time and intellectual effort to produce, publish and openly discuss their work, to the benefit of society, because copyright confers upon them the authority to supervise subsequent reproductions.

Section I of this article discusses how innovations, such as molecular coordinates derived from x-ray diffraction or NMR spectroscopy, may be protected under current copyright law. Section II discusses the doctrine of fair use and how it might be applied when a researcher copies the author/scientist's innovation. Section III discusses the possible tensions that could arise if these innovations were granted copyright protection, and whether a balance could be maintained between the traditional scientific principles of dissemination of knowledge for the public good and the scientist's right to control access to her data.

Finally, Section IV recommends modification of current copyright law that could successfully balance the rights of the scientist against the rights of the public. Two possible modifications are proposed: 1) shorten the term of copyright protection for biotechnological innovations or 2) grant compulsory licenses to other researchers who wish to use those innovations as a basis for their own research.

I. BIOTECHNOLOGICAL INNOVATIONS ARE PROTECTED UNDER CURRENT COPYRIGHT LAW

To illustrate the relevance and limitations of copyright protection for biotechnological innovations, this article will employ an example involving two scientists: Dr. A, who has used x-ray diffraction techniques to determine the molecular coordinates of an important viral protein, and Dr. B, who copies the molecular coordinates and uses the information to produce a synthetic vaccine.²⁰

Molecular coordinates are a mathematical description of the three-dimensional structure of a protein molecule, as determined from a crystalline form of the protein.²¹ Proteins may be induced to crystallize under various chemical conditions.²² These crystals, when

placed in a beam of x-rays, will diffract the x-rays in unique patterns.²³ The x-ray diffraction pattern looks somewhat like the concentric rings on a bull's-eye target, composed of millions of tiny, discrete specks. (See Figure 1). This diffraction pattern is then mathematically transformed into an electron density plot.²⁴

The electron density plot consists of interconnected, elongated or circular, contoured shapes. (See Figure 2). These shapes vary in thickness according to the relative density of electrons present in the protein. The patterns of density, combined with other data, such as the amino acid sequence and atomic constraints on geometric placement, are then used to determine the position of each atom in the protein.²⁵ (See Figure 3).

The molecular coordinates are the numerical representation of the location of each atom in the protein. (See Figure 4). These coordinates are typically stored as a database in a tabular format, designating each atom by number and amino acid residue, followed by the numbers determining the x, y, and z points. With the aid of a computer, and a suitable graphics program, these coordinates can be displayed as a three-dimensional model of the protein structure.

Dr. A's coordinates describe a protein located on the surface of a human virus which causes a fatal disease. She has also described which segments (peptides²⁶) of the protein structure are possible antigenic determinants.²⁷ These peptides could be synthesized in the laboratory and used as the basis for producing an effective vaccine against the virus.

As is customary in the scientific community, Dr. A has published a description of the viral protein structure, based on her molecular coordinates, in a leading scientific journal. Prior to publication, the journal requires that the author deposit the database, containing the molecular coordinates of the protein, in a central data bank.²⁸ Dr. A has complied with this requirement.

However, before Dr. A published, she registered a copyright claim for her coordinates in accordance with section 409 of the 1976 Copyright Act.²⁹ She also placed a prominent notice of copyright on her database containing the coordinates, before depositing it in the data bank.³⁰

Dr. B, an expert in the production of synthetic peptides, is employed by a privately-owned biotechnology company. After reading Dr. A's journal article, he recognizes the potential of using the structure in the design of a synthetic peptide vaccine effective against the virus. Dr. B contacts the data bank and obtains a copy of the database containing the molecular coordinates. Using his laboratory computer and Dr. A's molecular coordinates, he displays the three-dimensional model of the protein on his computer screen.

From the three-dimensional model, Dr. B is able to determine which sequences of amino acids comprise the outer surfaces of the protein.³¹ He locates the projecting sequences that hold the most potential for an antigenic response and synthesizes the corresponding peptides. Subsequently, he immunizes laboratory animals with the peptides, observes the immunologic response, and finally prepares a synthetic vaccine effective against the virus.

Upon hearing of Dr. B's vaccine, Dr. A files a copyright infringement action, claiming that Dr. B infringed on her copyright by obtaining the molecular coordinates and reproducing them without her permission.³²

Copyright confers exclusive rights of limited duration upon the copyright holder to reproduce the copyrighted work, to prepare derivative works and to distribute copies to the public.³³ However, the Copyright Act fails to delineate any clear statutory guidelines to determine when infringement occurs.³⁴ A judicial theory of infringement has evolved into a two-part test which requires a court to determine first, whether the allegedly infringing work was copied from the copyrighted work, and second, whether the elements that have been copied are protected by copyright.³⁵

A. Infringement of the Copyright in the Molecular Coordinates

Copying may be proven by the defendant's own admission that he copied or by circumstantial evidence of access to the copyrighted work along with substantial similarity between the two works.³⁶ Even if Dr. B does not admit to copying the coordinates, the absence of any countervailing evidence of independent creation could support a determination of copying.³⁷

Dr. A's coordinates, stored in the central data bank, were easily accessible to Dr. B. Furthermore, Dr. B possessed suitable computer equipment to use the database containing Dr. A's coordinates in his own laboratory. Independent determination of the coordinates through x-ray diffraction experiments by Dr. B is highly improbable. Dr. B possessed neither the expertise nor the resources to accomplish that feat within a short period of time.³⁸

"Reverse engineering" of the coordinates from the published journal article is also highly improbable.³⁹ Although a computer program is available to determine molecular coordinates from photographic images of the three-dimensional model, it lacks the capability to ascertain the coordinates with any degree of accuracy.⁴⁰ Dr. A's journal article and the deposited database comprised the sole source for the molecular coordinates. No other source was available to supply data for Dr. B's model.

Dr. A contends that the situation is analogous to a case involving architectural plans⁴¹ in *Imperial Homes Corp. v. Lamont*.⁴² In *Lamont*, the defendants constructed a home substantially similar to Imperial's model home.⁴³ No evidence was offered that the defendants had ever possessed the full set of copyrighted blueprints. Therefore, proof of actual copying was unavailable.

However, the defendants had visited the model home, made detailed measurements, and obtained a promotional brochure which contained a reproduction of the floor plan.⁴⁴ The *Lamont* court remanded for a determination of copyright infringement, with directions to consider the permissible inference, that the construction of such a substantially similar house could not have been possible without transcribing the floor plans.⁴⁵ Transcription, or imitation, of such plans would therefore constitute an infringement.

Similar factors are present in our hypothetical case. Dr. B's peptide vaccine consists of a segment of the viral protein described by Dr. A's molecular coordinates. Dr. B could not accurately predict which segments of the protein would be immunogenic without resort to the three-dimensional structure.⁴⁶ Nor could Dr. B possibly determine the three-dimensional structure of the protein without Dr. A's coordinates. Dr. B had access to the coordinates as deposited in the central data bank and the suitable computer equipment to display those coordinates as the three-dimensional model of the protein. As in *Lamont*, the court could reasonably find that Dr. B's production of an effective vaccine, containing a copy of a distinctive segment of the protein, could not be possible without copying Dr. A's coordinates.

Dr. B has copied, verbatim, Dr. A's molecular coordinates, thus opening the door to a finding of infringement even in the most constricted scope of copyright protection.⁴⁷ However, once copying is established, the court must determine whether the elements taken from the work are protected by copyright. "The underlying question is whether *protected* elements...were copied."⁴⁸ Copyright protection for the molecular coordinates will hinge on their originality⁴⁹ and whether they are excluded from protection under § 102(b) or the doctrine of merger⁵⁰ and whether they are subject to the defense of fair use.⁵¹

B. The Molecular Coordinates Satisfy the Requirements for Copyright Protection

Section 102(a) grants copyright protection for "original works of authorship fixed in any tangible medium of expression."⁵² Several categories of protected works are listed, including literary works,⁵³ musical works,⁵⁴ dramatic works,⁵⁵ and pictorial, graphic and sculptural works.⁵⁶ These statutory categories clearly encompass novels, plays, paintings and other artistic works. However, Dr. A's molecular coordinates could hardly be categorized as an artistic work. Nevertheless, to merit copyright protection, the molecular coordinates must fit within the scope of statutory subject matter.

1. The Statutory Subject Matter of Copyright

Section 102(a) of the Copyright Act provides: "Works of authorship *include* the following categories...."⁵⁷ The Act further expands the scope of protection by stating that the term "including" is "illustrative and not limitative."⁵⁸ Although the molecular coordinates are not a standard work of authorship, they do fit within either of two statutory categories of protected works: compilations of fact⁵⁹ and pictorial, graphic and sculptural works.⁶⁰

a. Compilations of Fact

Original works of authorship include compilations.⁶¹ "A compilation is a work formed by the collection and assembling of preexisting materials or data that are selected, coordinated or arranged in such a way that the resulting work as a whole constitutes an original work of authorship."⁶² Compilations of facts, such as catalogs,⁶³ financial reports⁶⁴ and mileage charts,⁶⁵ are protectable subject matter under copyright law.⁶⁶

In compilations, the data consists of preexisting, factual material, that is assembled and expressed in an intelligible and useful manner.⁶⁷ For example, in *Eckes v. Card Prices Update*,⁶⁸ a comprehensive listing of valuable baseball cards, with their market value, was protectable as a compilation.⁶⁹

The molecular coordinates are also a compilation. Dr. A has collected the x-ray diffraction data from protein crystals, containing

millions of individual atoms. From this diffraction data, she has determined the spatial relationships between those atoms. These relationships, like the baseball cards in *Eckes*, constitute the preexisting, factual material of the compilation.

Dr. A then selects and arranges those facts, first, into the electron density map and, finally, into the molecular coordinates. The expression of the x-ray diffraction data as molecular coordinates is an intelligible and useful way to present the information to others, as is the analogous guide to baseball cards in *Eckes*. Dr. A is "unquestionably 'assembling, connecting and categorizing disparate facts which in nature occur in isolation...weaving together into a handy, coherent entity thousands of facts....'"⁷⁰ The collection of the diffraction data and the selection, coordination and arrangement of that data into meaningful molecular coordinates fits within the definition of a compilation under section 102.

b. Maps

Pictorial, graphic and sculptural works are specifically listed as copyrightable subject matter.⁷¹ This category of protected works includes maps, globes, models and architectural plans.⁷²

A map is a two-dimensional representation of the geographic relationships between cities, states and countries. It illustrates the actual positions of cities and towns within states and countries. Likewise, Dr. A's molecular coordinates depict the actual positions of individual atoms within the protein structure. The molecular coordinates are essentially a "map" of the protein structure.

However, the scope of copyright protection for pictorial, graphic and sculptural works has been limited to the features that "can be identified separately from, and are capable of existing independently of, the utilitarian aspects of the article."⁷³ Arguably, a map does not contain any features capable of existing independently of its utilitarian aspects.⁷⁴ However, if this were the case, maps would be excluded from copyright protection as useful articles.

A useful article is "an article having an intrinsic utilitarian function that is not merely to portray the appearance of the article or to convey information."⁷⁵ Legislative history indicates that the intent of the "useful article" exclusion was to preclude copyright protection for industrial products such as airplanes and television sets.⁷⁶

The intrinsic function of an airplane is to provide transportation, not to convey information on the aerodynamics of flight. The intrinsic function of a map is to convey information. It portrays the physical layout of the land with geographic locations of cities, states and countries.⁷⁷ Thus, maps are not useful articles to be excluded from copyright protection.⁷⁸

Nor are the molecular coordinates a useful article. The intrinsic function of the coordinates is to convey information about the locations of individual atoms within the protein structure. These coordinates portray the appearance of the protein molecule just as a map portrays the appearance of the land.⁷⁹ Hence, the molecular coordinates fit within the definition of a pictorial, graphic and sculptural work.

Moreover, even if the molecular map coordinates do not fit comfortably within the conventional interpretation of compilations⁸⁰ or maps,⁸¹ the legislative history of the Copyright Act encourages an expansive reading of "works of authorship."⁸² Unless the work is "completely outside the present congressional intent," the form of expression may be considered copyrightable subject matter.⁸³

If sufficient similarity exists between the new form of expression and an enumerated category of 17 U.S.C. § 102(a), the new work should be regarded as within the scope of Congressional intent for copyrightable subject matter.⁸⁴ Molecular coordinates are sufficiently analogous to compilations and maps to be considered appropriate subject matter for copyright.

Nevertheless, compilations, maps and molecular coordinates are based on factual, not fictional elements. These factual works strive to present reality as accurately as possible.⁸⁵ Creativity and aesthetics, the essence of artistic works, are of minimal or insignificant concern in factual works. However, factual works must still meet the standards of originality to warrant copyright protection.

2. The Standards of Originality in Copyright Law

Copyright protection is granted to "original works of authorship."⁸⁶ The standard of originality is minimal; it is a mere "prohibition of actual copying."⁸⁷ The author need only show that the work "originated" with her.

Moreover, the copyright standard of originality is not equivalent to the novelty requirement of patent law.⁸⁸ Under patent law, novelty

requires the work to be new, distinctive and previously unknown to receive protection.⁸⁹ By contrast, copyright protects works that are identical to preceding works as long as the author proves independent creation.⁹⁰

However, the author must contribute some quantum of innovation, uniquely identifiable with the author.⁹¹ A minimum of "ingenuity in selection, combination or expression, no matter how crude, humble or obvious" is required.⁹²

Copyright protection for factual works poses unique problems. Factual works, such as compilations or maps, by their nature, must focus on accuracy, not artistic embellishment.⁹³ Originality and creativity, so evident in artistic works, are minimal or nonexistent in factual works.⁹⁴

Courts have fashioned two distinct theories to circumscribe originality in factual works. One theory finds "[t]he elements of the copyright [in a map] consist in the selection, arrangement and presentation of the component parts."⁹⁵ Therefore, even though a work presents facts from the public domain, the unique selection, synthesis and arrangement of those facts are elements of originality.⁹⁶

The second theory finds originality in the labor expended in collecting the facts. New arrangements of information lack any original elements worthy of copyright protection unless the author obtains some of that information by the "sweat of his own brow."⁹⁷ The work qualifies for copyright protection by virtue of this "industrious collection" of facts and the labor expended in their compilation.⁹⁸

a. The "Selection and Arrangement" Theory

Originality in factual works may be found in the "selection, arrangement, and presentation of the component parts."⁹⁹ The selection and arrangement theory has sustained copyright protection for works such as maps,¹⁰⁰ catalogs of baseball cards¹⁰¹ and restaurant guides.¹⁰²

This originality theory finds support in the statutory definition of a compilation as "a work formed by the collection and assembling of preexisting materials or data that are *selected, coordinated, or arranged* in such a way that the resulting work as a whole constitutes an original work of authorship."¹⁰³ Although trivial elements of selectivity and arrangement are not copyrightable, when a work "displays a significant element of compilation, that element is protectable even though the individual components of the work may not be."¹⁰⁴

The element of originality lies in the presentation of the facts, not in the facts themselves.¹⁰⁵ A subsequent author could select facts from a preexisting work, coordinate the facts and rearrange them into a subsequent, non-infringing work. "If the arrangement...is the single protectable element, there has clearly been no infringement."¹⁰⁶ Some courts have responded to this inequity by finding originality in the labor involved in compiling the data under the "sweat of the brow" or "industrious collection" theory.¹⁰⁷

b. The "Sweat of the Brow" Theory

In factual works, such as directories, courts have found originality in the labor expended in the collection and assembling of the data.¹⁰⁸ "The collection owes its origin to the author as much as does the manner in which the collection is arranged."¹⁰⁹ Thus, the concept of originality shifts from the presentation in the completed work to the industriousness of the act of collection.

However, the sweat of the brow rationale has been strongly criticized as a departure from the intended constraints of originality as evolved in copyright law.¹¹⁰ A minimum of originality is necessary to receive copyright protection.¹¹¹ Arguably, this minimal standard is met, not by the mechanical labor of collection, but the intellectual exercise of judgment and skill.¹¹² Nevertheless, the sweat of the brow theory has often been cited in support of copyright protection for factual works.¹¹³

3. The Molecular Coordinates Meet the Originality Standards

Dr. A's molecular coordinates meet the standards of originality required for copyright protection under either the "selection and arrangement" or the "sweat of the brow" analysis.

Selection, design and synthesis are all elements of originality which merit copyright protection.¹¹⁴ Dr. A has collected and selected out the critical information from the x-ray diffraction patterns. Then, using her skill and judgment, she has twice transformed that data. First, Dr. A has transformed the x-ray diffraction data into the electron density map, and second, she has transformed the density map into the molecular coordinates.

The subjective selection, creativity and judgment exhibited by Dr. A is analogous to the efforts put forth by the compiler, collecting all available information concerning baseball cards, selecting which cards are the most valuable, and arranging the data into a comprehensive guide to market value.¹¹⁵ Although Dr. A's coordinates are not a compendium of data relating to protein crystal structures solved over the years, or a guide to the most important structures solved (like a guide to the best restaurants), she is nevertheless collecting preexisting data, selecting and presenting it in such a way that the resulting work, as a whole, constitutes an original work of authorship.

Likewise, Dr. A's intellectual efforts are analogous to those of the mapmaker who "dug through the records (x-ray diffraction data) and turned the metes and bounds of the...descriptions (electron density map) into a pictorial presentation."¹¹⁶ Dr. A's determination of the molecular coordinates required more than "doing a simple, repetitive task by rote."¹¹⁷ The determination of the structure demanded intellectual skill and subjective judgment at each step of the process.¹¹⁸

Furthermore, the coordinates would also be copyrightable under the "sweat of the brow" theory of originality. Dr. A has demonstrated considerable industriousness in collecting and compiling her data to determine the molecular coordinates. Her industriousness is equal to the effort expended by Dunn & Bradstreet employees in gathering the financial data for its credit reference books.¹¹⁹ In *Dunn & Bradstreet*, the court acknowledged that "compilations [are] more the product of diligent application and less the result of intellectual creativity...."¹²⁰ Nevertheless, the court found that Dunn & Bradstreet's compilations of business data were protected by copyright.¹²¹

Dr. A's determination of the molecular coordinates required a significant amount of "diligent application," far surpassing the threshold in *Dunn & Bradstreet*. Dr. A has spent years of physical and intellectual effort in the collection of the x-ray diffraction data and its transformation into the molecular coordinates.¹²² If a business directory qualifies as copyrightable, based solely on the industrious collection of the facts, surely the molecular coordinates would also qualify for protection.

Under either the "selection and arrangement" or the "sweat of the brow" theory, the molecular coordinates have sufficient originality to procure copyright protection. Nevertheless, establishing that the molecular coordinates meet the standard of originality does not end the analysis.

Copyright protection exists exclusively in original expression. Protection does not extend to facts, ideas or discoveries.¹²³ Furthermore, copyright will be denied for even an original expression, if protection of that expression would confer a monopoly upon the author in the underlying facts themselves. Although the molecular coordinates fall within the subject matter of copyright, it also must be determined whether they are excluded by other provisions of copyright law.

C. The Molecular Coordinates are a Protected Expression, Distinguishable from Pure Fact

Facts, ideas, and discoveries are not protected by copyright.¹²⁴ "No one may claim originality as to facts."¹²⁵ Although facts may be "discovered" by someone, they do not originate with that person.¹²⁶ Moreover, public policy encourages accessibility to facts, ideas and discoveries. They should remain in the public domain, freely accessible to others who wish to elaborate on them.¹²⁷

Furthermore, if the manner in which a fact can be expressed is highly constrained, its expression will not be protected.¹²⁸ When fact and expression merge into an inseparable unit, copyright protection of the expression would essentially extend copyright protection to the facts themselves.¹²⁹

Dr. B contends that Dr. A has merely discovered and reported a fact of nature, the structure of a protein. Therefore, according to Dr. B's argument, the molecular coordinates constitute the discovery of a fact, not the protectable expression of fact.

1. THE MOLECULAR COORDINATES ARE NOT MERE Discoveries of Nature

The discoverer of a scientific fact cannot assert authorship of that fact.¹³⁰ "The discoverer of a fact merely finds and records."¹³¹ Accordingly, Dr. A has "discovered" the x-ray diffraction data. The pattern of x-rays, diffracted by the protein crystal, is "dictated by the laws of nature, not by the creativity of the scientist."¹³² Dr. A merely recorded the diffraction patterns.

However, the facts contained in the x-ray diffraction data are distinguishable from the conclusions presented by the molecular coordinates.¹³³ Conclusions stem from the intellectual creativity and effort expended in transforming discovered facts into usable information.¹³⁴ Drawing conclusions involves skill, discretion and synthesis.¹³⁵

Dr. A's determination of the molecular coordinates involved substantial intellectual effort and creativity to interpret the diffraction data. The x-ray diffraction patterns were meaningless until Dr. A exercised her skill and discretion to transform them into the molecular coordinates.

Moreover, significantly different structures for the same proteins have been reported in the scientific literature.¹³⁶ This emphasizes the skill and discretion involved in transforming the raw diffraction data into molecular coordinates. Proteins may crystallize into any one of sixty-five different crystal lattices.¹³⁷ Even if two researchers obtain the same crystalline form of the protein, different methods used to collect the x-ray diffraction data and different theories used to transform that data into molecular coordinates can lead to significantly different conclusions about the protein's structure.¹³⁸ Two researchers, each possessing a different level of expertise and using different mathematical formulae, could arrive at significantly different crystal structures and hence different coordinates.¹³⁹

Moreover, Dr. A does not claim copyright protection for the raw x-ray diffraction data, nor the theories that she used to transform that data into the molecular coordinates. The raw data and mathematical theories are non-copyrightable discoveries.¹⁴⁰ Dr. A claims copyright protection for the coordinates based on these facts and theories.¹⁴¹ The molecular coordinates are her unique expression of discovered facts (the patterns of x-ray diffraction), just as a mapmaker's map is his unique expression of the discovered geography,¹⁴² or as a compiler's guide to baseball cards is his unique expression of their discovered market value.¹⁴³

Nevertheless, if a fact can only be expressed in a limited number of ways, it is still essentially that fact, not a creative work of authorship. When fact and expression merge, copyright protection of the expression would essentially confer a monopoly of the facts upon the author.¹⁴⁴

2. *The Merger Doctrine*

"[I]f the expression, arrangement and selection of the facts must necessarily, by the nature of the facts, be formulated in given ways then they are not copyrightable."¹⁴⁵ Dr. B contends that the structure of the protein itself dictates the expression of the molecular coordinates. The fact of the protein structure and its expression as molecular coordinates merge into an inseparable entity. Thus, Dr. B claims that copyright protection for the coordinates would effectively grant copyright protection to the protein itself. Other researchers would be precluded from using the protein structure in subsequent research.

However, if the expression of the underlying fact/idea is not highly constrained, the courts will protect its expression.¹⁴⁶ In *Applied Innovations, Inc. v. Regents of the University of Minnesota*¹⁴⁷ the court upheld copyright protection for the Minnesota Multiphasic Personality Schedule (MMPI), which is used to detect particular personality traits in individuals. Although the test statements and scoring tables were based on well-known psychological and mathematical theories, the court found that copyright of the MMPI would not confer a monopoly of those theories upon the MMPI authors.¹⁴⁸ Other psychologists are free to use those theories to formulate their own personality testing strategies.¹⁴⁹

Likewise, copyright protection for the expression of the protein structure as molecular coordinates would not confer a monopoly of the protein structure upon Dr. A. Other scientists are free to describe and then use the protein structure in their own research.

Furthermore, molecular coordinates are not the only manner of presenting a protein structure.¹⁵⁰ Dr. A could have described the protein in a written text, by describing bond lengths and torsion angles, or by determining spectrographic properties.¹⁵¹ Dr. A chose to describe the protein using molecular coordinates merely because it was well-suited to her particular purpose.

Dr. A does not maintain that her molecular coordinates are the essential components of the protein structure. A mapmaker acknowledges that his copyrighted expression of the contours of the land in his map does not grant him a monopoly of the cities and countries he has drawn. Similarly, Dr. A acknowledges that her copyrighted expression in the molecular coordinates does not grant her a monopoly of the protein structure. She claims copyright protection only for her unique expression of the protein structure in her molecular coordinates.

D. Copyright Protection for the Molecular Coordinates Exists

Dr. A's coordinates meet the requirements for copyright set forth in sections 102(a) and 102(b) of the Copyright Act. Using either the selection and arrangement theory or the sweat of the brow theory, the transformation of the x-ray diffraction data into the molecular coordinates constitutes an original work of authorship.

Furthermore, the representation of the raw diffraction data as molecular coordinates is an expression of fact, not a discovery. Nor

would copyright protection of the molecular coordinates prevent other researchers from using the protein structure in their own research, or from determining the structural features of the protein in various other ways. Thus, copyright protection for the molecular coordinates is valid.

The copyright protection granted to Dr. A gives her an exclusive right to reproduce, prepare derivative works and distribute copies of her molecular coordinates.¹⁵² Nevertheless, limitations to her exclusive rights exist. Any individual may reproduce a copyrighted work for a "fair use," even if that reproduction would normally constitute an infringement of the copyright.¹⁵³ Section II discusses whether Dr. B's use of Dr. A's coordinates could be justified as a fair use.¹⁵⁴

II. THE DOCTRINE OF FAIR USE

Fair use is a privilege, extended to others, to use the copyrighted material in a reasonable manner without the author's consent.¹⁵⁵ This limitation on the scope of copyright protection balances the monopoly of the expression given to an author with the ultimate goal of copyright, which is to promote the progress of science and the useful arts.¹⁵⁶ Without a fair use doctrine, subsequent writers and scientists would be forced to negotiate for every piece of prior copyrighted research used in their subsequent works.¹⁵⁷

The 1976 Copyright Act incorporated a list of four factors to be considered in determining fair use.¹⁵⁸ However, Congress did not propose a "bright line" approach to a fair use defense to copyright infringement. Courts have applied an "equitable rule of reason" analysis, based on the circumstances surrounding each case.¹⁵⁹

Equitable analysis is especially troublesome in the area of factual works. Traditionally, the scope of fair use has been interpreted broadly when the work conveys factual material, or material of public interest. An extensive interpretation of fair use has resulted in diminished protection for some copyrighted works.¹⁶⁰ This diminished protection is justified as a constraint on the liberal grant of copyright given to a factual work.¹⁶¹ Consequently, even if copyright protection was bestowed upon a factual work, the doctrine of fair use could be used to insure dissemination of the underlying facts, thus protecting the public interest.¹⁶²

However, the recent Supreme Court decision in *Harper & Row Publishers, Inc. v. Nation Enterprises*¹⁶³ has narrowed the scope of the fair use doctrine. Although the Court concluded that facts were "not copyrightable per se," when the facts became integral and necessary components of the context of the author's expression, the "totality" of work (the noncopyrightable factual elements along with the author's creative expression of those facts) was protected by copyright.¹⁶⁴ In essence, this theory "accords noncopyrightable facts some measure of copyright protection when these facts are somehow combined with copyrightable expression into a protected totality."¹⁶⁵

Nevertheless, the Court in *Nation Enterprises* adhered to the use of the four statutory factors in its analysis.¹⁶⁶ The next section will discuss whether Dr. B's copying of Dr. A's copyrightable coordinates is protected by the fair use doctrine in light of these four factors and the equitable rule of reason as interpreted by the Supreme Court in *Nation Enterprises*.

A. The Application of the Four Factors

Section 107 of the Copyright Act lists four factors to be used in determining a fair use. These factors are:

- (1) the purpose and character of the use, including whether such use is of a commercial nature or is for non-profit educational purposes;
- (2) the nature of the copyrighted work;
- (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and
- (4) the effect of the use upon the potential market for or value of the copyrighted work.¹⁶⁷

Fair use is generally an issue of fact¹⁶⁸ or a "mixed question of law and fact."¹⁶⁹ When a court has analyzed the four statutory factors and has found facts sufficient to make a decision, the court may conclude, as a matter of law, that the use was not fair.¹⁷⁰

1. The Purpose and Character of the Use

A purpose or use that leads to commercial benefit, as opposed to a non-profit application, tends to weigh against a finding of fair

use.¹⁷¹ Dr. B contends that he copied the coordinates for the purpose of furthering medical research, not to develop a vaccine for commercial profit. No one denies the great medical advantages gained from the development of Dr. B's vaccine. The vaccine could be a breakthrough in the treatment of a devastating disease and thousands of lives could be saved.

However, we cannot ignore the fact that Dr. B is employed by a profit-oriented organization. Both Dr. B and the company stand to gain a great deal, both in reputation and financial reward, if they produce an effective vaccine. Indeed, one of the primary reasons for choosing to work on this particular vaccine, rather than another, was most likely the potential commercial success. "[E]very commercial use of copyrighted material is presumptively an unfair exploitation of the monopoly privilege that belongs to the owner of the copyright."¹⁷²

Nevertheless, a "use whose 'character' is commercial may have a 'purpose' that qualifies as fair use."¹⁷³ "Whether an author...has a commercial motive...is irrelevant to a determination of whether a particular use of copyrighted material in a work which offers some benefit to the public constitutes a fair use."¹⁷⁴

However, even if Dr. B's use of Dr. A's molecular map may be characterized as noncommercial, based on the public benefit derived from the vaccine, the unauthorized copying may still be challenged if proof can be offered that the use of the molecular coordinates by Dr. B would adversely affect the potential market for the copyrighted work.¹⁷⁵

"Actual present harm need not be shown,"¹⁷⁶ nor does the copyright holder need to prove the certainty of the harm. However, she must show "some meaningful likelihood" that the future harm exists.¹⁷⁷

Dr. A need only show that harm would result if Dr. B's practice of unauthorized use of a molecular map to produce commercially viable products becomes widespread. Dr. A could demonstrate the effects on her professional reputation (diminished recognition by her peers and the public) and the effects on her research program (fewer sources of government and industrial funding because of diminished recognition). These harmful effects would seriously impair her ability to carry out research in the future.

To argue that Dr. B's motive was not purely commercial, but also of great value to the public, obscures the true issue. "The crux of the profit/nonprofit distinction is not whether the sole motive of the use is monetary gain but whether the user stands to profit from exploitation of the copyrighted material without paying the customary price."¹⁷⁸ The commercial benefits secured by Dr. B as a result of his successful vaccine, weigh against a finding of fair use.

2. The Nature of the Work

The nature, or essence, of the copyrighted work is the second factor in a determination of fair use.¹⁷⁹ The question is whether the nature of the work is informational, such as a treatise or biography, or whether it is creative, such as a fictional novel or drawing.¹⁸⁰ "The extent to which one must permit expressive language to be copied, in order to assure dissemination of the underlying facts, will thus vary from case to case."¹⁸¹

Courts will often widen the scope of fair use when dealing with factual works.¹⁸² The need to disseminate factual information is greater than the need to disseminate fictional works.¹⁸³ However, critics and scholars routinely reproduce portions of copyrighted works, such as novels and biographies, when writing their reviews. Such use is justified.¹⁸⁴ Likewise, researchers routinely copy new scientific protocols to reproduce data from other experiments.¹⁸⁵ When it is reasonable and customary to copy portions of a work after publication, the courts will imply that the author gave his consent.¹⁸⁶ Consequently, courts have often construed fair use expansively in these cases and are reluctant to find infringement.¹⁸⁷

If Dr. B had copied the coordinates to ascertain the accuracy of the protein structure described in the journal article, or to evaluate a statistical method employed by Dr. A, his use would be fair. Similarly, if he had reported the new protein structure to the scientific public in a review article, his use would be fair.

However, Dr. B did not limit his use of the coordinates to review, criticism or scholarly research. He copied the coordinates to further his endeavor to produce a commercially viable vaccine. "The fair use doctrine is not a license for corporate theft, empowering a court to ignore a copyright whenever it determines the underlying work contains material of possible public importance."¹⁸⁸ Dr. B's copying of Dr. A's coordinates, notwithstanding their factual nature, weighs against a finding of fair use.

3. The Amount and Substantiality of the Portion Used

If the portion of the copyrighted work reproduced is substantial, the courts will not find fair use.¹⁸⁹ However, taking only minor portions of the work does not exonerate the copying. Fair use will not be established if what is essentially the "heart" of the work is appropriated.¹⁹⁰

Dr. B copied the entire database containing Dr. A's molecular coordinates. However, he did not use the entirety of Dr. A's coordinates as the basis of his vaccine. He used only a few selected portions.¹⁹¹ Nevertheless, those copied portions could be considered the "heart" of Dr. A's work. They were the key segments comprising the immunogenic regions of the protein.¹⁹² Although the amount copied was insubstantial in quantity, it was qualitatively the essence of the work.

Furthermore, those critical, immunogenic regions could not be ascertained without knowledge of the complete protein structure. Once Dr. A determined the molecular coordinates to describe the structure, Dr. B's task of locating the immunogenic regions of the protein and producing the vaccine was significantly simplified. Dr. B's reproduction and exploitation of the molecular coordinates constituted a substantial usurpation of Dr. A's work and thus further impairs Dr. B's fair use defense.¹⁹³

4. The Effect on the Market

The effect of the copying on the potential market for the original work has been described as the most important of the four factors considered in determining fair use.¹⁹⁴ Economic injury weighs heavily against a finding of fair use.¹⁹⁵ When properly applied, the doctrine of fair use does not permit destruction of the marketability or value of the author's work.¹⁹⁶ "In assessing economic injury, the courts must consider whether the alleged infringement substitutes for the original in a market the original author would typically exploit."¹⁹⁷

The copyright owner does not have to prove actual damage.¹⁹⁸ She need only show a reasonable probability that the marketability of her work is diminished by the unauthorized copying.¹⁹⁹ Moreover, if there is no probability of injury in one particular incident of copying, she need only demonstrate how her market might be injured, if such incidents were to become widespread.²⁰⁰

Dr. B has reported the first synthetic vaccine against the fatal virus. As a result, Dr. A's own research program may suffer irreparable economic injury. Dr. A's collaborators and potential collaborators will be dissuaded from continuing their own development of a competitive vaccine.²⁰¹ Her collaborators may completely sever their ties with her laboratory. Furthermore, funding sources may withdraw support money designated for vaccine development. If Dr. A is deprived of these resources and economic support, her future research progress may be seriously impeded.

The marketability of Dr. A's molecular coordinates has decreased dramatically with the announcement of Dr. B's vaccine. The coordinates are a valuable tool in vaccine and drug design. Dr. A could enter into very profitable licensing agreements for the use of her coordinates. However, the presence of Dr. B's vaccine essentially forecloses any market for a competing vaccine. Moreover, with the availability of a vaccine to prevent the disease, the market for therapeutic drugs has also deteriorated significantly. Potential collaborators will bypass joint ventures with Dr. A and choose other, more profitable projects with other researchers.

Furthermore, even if Dr. A and her collaborators subsequently announce an effective vaccine, its marketability will have been significantly diminished as a result of Dr. B's vaccine.²⁰² Dr. A could have sold or licensed the rights to produce the vaccine to an industrial pharmaceutical company. However, these companies demand a satisfactory return on their investment to generate profit and remain viable. The availability of Dr. B's vaccine forecloses a significant segment of the potential market for Dr. A's vaccine.²⁰³ A subsequent vaccine would have a minimal market share, minimal profitability, and minimal allure to a pharmaceutical firm.

Although academic scientists have traditionally scorned commercial gain for their research efforts, the current scarcity of government-funding and the pace of technological advancements place new emphasis on the economic aspects of scientific achievements.²⁰⁴ If Dr. B's actions are classified as a fair use, Dr. A and her fellow crystallographers may be faced with a difficult decision upon determining subsequent protein structures: to publish their data (and deposit their coordinates as required) or to withhold the data from the scientific community until they can arrange a suitable collaboration or produce a patentable commodity.²⁰⁵

If the practice of copying molecular coordinates from the data banks becomes widespread, the researchers may have no choice but to delay publication of their data. However, delay in releasing the data would deprive the scientific community of valuable information. Furthermore, delay in publication would deprive the researcher of the professional recognition for her work.

Dr. B's unauthorized copying of the coordinates and subsequent announcement of a vaccine derived from them have significantly decreased the marketability of Dr. A's coordinates. If actions like Dr. B's become widespread, researchers will face the difficult

decision of whether to publish or withhold their data to protect their economic interests. The economic injury resulting from Dr. B's copying should weigh heavily against a finding of fair use.

B. Copying of the Molecular Coordinates is not Protected by the Fair Use Doctrine

In light of these four relevant factors, Dr. B's copying of Dr. A's molecular coordinates defeats his assertion of a fair use. Dr. B's vaccine, the result of copying Dr. A's coordinates, significantly undercuts the marketability of the original coordinates. This substantial economic injury to Dr. A may be the most persuasive factor against a finding of fair use.

Dr. B's purpose in copying the molecular coordinates also weighs against fair use. His purpose was commercially motivated. Although courts will usually exonerate copying if the purpose is scholarly comment or criticism, commercial applications are generally deemed infringement.

Consideration of the amount and substantiality of the taking further impairs Dr. B's fair use defense. Dr. B copied the entire database containing the molecular coordinates. The mere fact that only a fraction of the total listing of the coordinates comprised the basis of his vaccine does not sanction their use. These portions comprised the "heart" of Dr. A's data. This taking, although not quantitatively substantial, was qualitatively significant and weighs against fair use.

Furthermore, the factual nature of the molecular coordinates will not validate Dr. B's fair use defense. Although courts have construed fair use expansively when dealing with factual works, this broadened scope is intended to protect the public interest in the dissemination of factual information. However, Dr. B was not copying the coordinates to further public interest in the structure of a virus protein. He copied them to use as a basis for the vaccine. Although the coordinates are factual in nature, and hence more susceptible to the fair use defense, Dr. B's copying could not be contemplated as fair.

Thus Dr. B's fair use defense would be defeated by the combined weight of the four factors: the purpose of the use; the nature of the work; the substantiality of the copying; and the economic injury.

Although a mechanical application of the four statutory factors would invalidate a fair use defense, the ultimate goal of copyright protection is to promote the progress of the arts and sciences.²⁰⁶ Should Dr. B's copying of Dr. A's coordinates be protected as a matter of public policy?

III. PROTECTION OF BIOTECHNOLOGICAL INNOVATION WOULD IMPAIR THE PUBLIC INTEREST

Section I of this article discussed the validity of protecting biotechnological innovations, such as molecular coordinates, under current copyright law. Section II determined that Dr. B's unauthorized copying of these innovations would not be protected under the doctrine of fair use. Although analogies have been drawn between biotechnological innovations and compilations of facts in these sections, fundamental differences do exist between the two classes of works.

Telephone directories, maps, or biographical novels differ qualitatively from biotechnological innovations. These innovations are critical to scientific progress and will have tremendous beneficial effects on our society. In the scientific community, traditional policy dictated that scientists refrain from seeking proprietary rights to their information. Scientific research was dedicated to the pursuit of knowledge for the good of human kind, not for personal gain.

However, current trends in biotechnological research make proprietary protection desirable. Greater emphasis is placed on competition and commercial profit, hence there is a greater need for protection. But can our society afford to protect the proprietary interests of the individual scientist when free access to that research could result in significant benefits to mankind?

Copyright protection must balance the author/scientist's interest in controlling the exploitation of his writings and discoveries with society's interest in benefiting the public good.²⁰⁷ This section will focus on how granting copyright protection to biotechnological innovations may be detrimental to the public interest. First, this section will review the traditional scientific principles of free access to scientific information and the resulting benefits to the public interest. Second, it will examine the current trends in modern science and the desirability of conferring copyright protection in order to promote progress in this area. Finally, this section will discuss whether copyright protection can successfully balance these two interests to benefit the public good.

A. Traditional Scientific Principles

Traditionally, the academic community has eschewed proprietary rights to its scientific data. The erudite scientist, conducting publicly-sponsored research, has sought knowledge, not personal gain.²⁰⁸ Rewards for the traditional scientist have consisted of professional recognition and esteem from the scientific community.²⁰⁹

Originality in one's research and being the "first to publish" have remained of primary importance in earning peer recognition.²¹⁰ However, once the information is published, it becomes accessible to all. Collaborative as well as competing scientists are free to use the published information in their own research without restraint.²¹¹ Secrecy and exclusive rights in scientific research are antithetical to these traditional values.

The copying of research information by a subsequent researcher has been cited as an "obvious example" of fair use.²¹² Researchers and scholars depend on the ability to refer to and quote the work of prior authors. To expect each researcher to reproduce the entire work independently, or else to engage in complicated negotiations to receive permission to use the work, would stifle scientific progress. If "[t]he scholar foregoes the use of a prior work, not only does his own work suffer, but the public is deprived of his contribution to knowledge."²¹³

B. Modern Trends in Biotechnology

"Modern" scientific disciplines, such as biotechnology, pose unique problems for the traditional scientific norms. The advent of biotechnology has altered the direction of modern biological science.²¹⁴ The acknowledged purpose of biotechnological research is to apply basic scientific knowledge to solving current biomedical problems. Biotechnology bridges the gap between the pursuit of knowledge and the application of that knowledge through useful products.²¹⁵ This trend toward "commercialization" has concerned scientists and Congress alike.²¹⁶

However, the academic research environment itself has fostered this commercialization. Federal funding, once the mainstay of university research, has been declining.²¹⁷ As competition for these limited funds has escalated, universities and their researchers have increasingly turned toward funding by private industry to fill the gap.²¹⁸

Furthermore, technologies developed by the universities, such as genetic engineering and peptide synthesis, generate products that are extremely profitable from both medical and economic perspectives.²¹⁹ Thus, mutually beneficial alliances between industry and academia flourish in today's modern scientific community.²²⁰ Private industry now finds it profitable to collaborate with academic researchers.²²¹ Likewise, where private ties to industry do not exist, the universities themselves are beginning to exploit the commercial potential of their research.

As scientific technology has expanded, so has communication technology. The trend to computerize information systems has dramatically increased the "accessibility and utility" of scientific research.²²² Scientific information can be stored in computer databases, which are easily transferred to countless other researchers. Although this ease of transferability may facilitate open access to scientific information, "unlimited access may [also] threaten the scientific process."²²³

These trends of increasing joint-venture research between universities and industry, and widespread access to that research, underscore the need to protect biotechnological innovation.²²⁴ Furthermore, most "modern" scientists also believe that they have a right to control their research and the resulting data. Control is necessary to avert the misinterpretation of premature data and to protect ideas from prepublication theft.²²⁵ These scientists recognize the traditional principles of dissemination of information in order to serve the public interest, but also believe that unlimited access would ultimately threaten their scientific integrity.²²⁶

C. The Public Interest Would Be Harmed by Protection of Biotechnological Innovations Under Current Copyright Law

The immediate effect of our copyright law is to secure a fair return for an "author's" creative labor. But the ultimate aim is, by this incentive, to stimulate artistic creativity for the general public good.²²⁷

Copyright protection for biotechnological innovation would secure a fair return for the scientist's intellectual and creative efforts. Protection would allow the scientist to freely publish and disseminate her information, yet retain a measure of control over subsequent copying that may be detrimental to her professional and economic welfare.

Copyright protection would also stimulate the creation of useful works. It would provide scientists with additional incentives, other

than love of research, to spend the long, tedious hours required to produce these innovations.²²⁸ The scientist's creativity and perseverance would be rewarded by allowing her to see her innovations reach fulfillment.

Furthermore, the denial of copyright protection to factual works, such as biotechnological innovations with significant impact on the public, despite the protection of fictional works such as romance novels, is fundamentally at odds with the scheme of copyright.²²⁹

However, the ultimate goal of copyright law is to promote the progress of the arts and sciences.²³⁰ Copyright protection of biotechnological innovation would accentuate this basic tension between the exclusive rights granted to authors as incentives to produce, and the mandate to promote the arts and sciences, by dissemination of those works.²³¹

Several important reasons exist for denying copyright protection to biotechnological innovations.²³² Scientists routinely rely on prior scientific contributions. To require each scientist to independently reproduce each piece of data needed to conduct his own research would lead to expensive and needless repetition of work.²³³

Moreover, the scientist/copyright owner may not be the best candidate for developing his innovation to its fullest potential. As in any profession, scientists possess varying degrees of knowledge and expertise within a given field. Availability of funding and resources also play a vital role in research and development. Obviously, the scientist with access to the most resources has a competitive edge. It may take the copyright owner years to achieve what another researcher may accomplish in a significantly shorter time period.

For example, Dr. A is a crystallographer. She does not have the expertise, nor the resources, to produce a synthetic vaccine. Valuable time may be lost due to her inexperience in vaccine development or her inability to form successful collaborations. However, restrictions on the availability of the copyrighted innovation would preclude other researchers from working on the problem. Thus, scientific progress would be seriously hindered by granting copyright protection to Dr. A.

If scientific progress is hindered, the ultimate goal of copyright law is also hindered, to the detriment of the public interest. Expansive copyright protection for biotechnological innovation would compromise this underlying policy of copyright law. When there is tension between the copyright holder's proprietary rights and the rights of the public, the public good must prevail.²³⁴

IV. CURRENT COPYRIGHT LAW SHOULD BE MODIFIED TO EASE THIS TENSION

Biotechnological innovations, such as Dr. A's molecular coordinates, are copyrightable expressions of fact. Nevertheless, the public interest in the progress of science would seriously challenge expansive copyright protection for biotechnological innovations. The attempt to balance the policy of encouraging scientific effort, by the grant of exclusive rights, and the public interest in free access to the information results in significant tension.

If excessive tension results from protecting biotechnological innovations under the existing copyright law, the law should be modified. "From its beginning, the law of copyright has developed in response to significant changes in technology."²³⁵ As new developments occur, Congress has fashioned new rules that the technology made necessary.²³⁶

A comprehensive judicial approach to the copyrightability of biotechnological innovation would be difficult to achieve. The doctrinal basis for the copyrightability of factual works has already posed a significant challenge to the courts, as evidenced by the lack of uniform resolution.²³⁷ Furthermore, it is unlikely that the judiciary would initiate such a controversial extension of copyright doctrine.²³⁸

Amending the Copyright Act, rather than awaiting ad-hoc judicial decisions, has obvious benefits. Researchers, universities and industry would know the boundaries of copyright protection before undertaking the costs and risks of research and development. Industry could rely on copyright protection to safeguard its economic investment and reduce expensive and time-consuming litigation to determine its rights in the work.²³⁹ Thus industry would be amenable to support university-based biotechnology research.

Section IV proposes two possible modifications of the current copyright law that could reconcile the ultimate goal of copyright, and thus traditional scientific principles, with the interests of modern biotechnology. One proposed modification would be to shorten the duration of copyright protection for scientific research to five years. Alternatively, a scheme of compulsory licensing for the use of a copyrighted innovation could be initiated.

Both proposed modifications have been enacted previously to accommodate other technological advances.²⁴⁰ Likewise, both modifications would serve the ultimate goals of copyright protection: to encourage scientific research and promote the progress of

science for the general good.

A. Limited Duration of Copyright Protection

Limited duration of copyright protection for new technological advances is not without precedent. In 1984, Congress passed the Semiconductor Chip Protection Act,²⁴¹ which grants copyright protection for the mask works of semiconductor chips²⁴² for a limited period of ten years.²⁴³ Prior to that time, semiconductor chips and mask works were excluded from copyright protection.²⁴⁴ However, Congress recognized the pivotal position of the semiconductor industry in our nation's economy. It also recognized the considerable investment of research hours and millions of dollars that went in to developing these products. Accordingly, Congress addressed the need to encourage and support this industry by modifying the copyright statute.

Limited duration of copyright protection would be comparable to the limited duration of protection under current patent law.²⁴⁵ Patent holders retain title to their invention for only seventeen years, prior to its entry into the public domain. Nevertheless, this relatively short period of exclusivity has benefited many private and commercial developers. Using either the Semiconductor Chip Protection Act or the Patent Act as a model, Congress could enact similar statutory reforms to accommodate biotechnology.

Biotechnological innovation could be protected by a copyright of shorter duration than exists under current copyright law. Copyright duration at present is for the life of the author, plus fifty years.²⁴⁶ Yet biotechnological innovations develop at a rapid pace. The latest research information is quickly surpassed by new information or incorporated into useful products. With the rapid turnover of critical information, only a few years lead time would be necessary for an innovator to capitalize on her work. The duration of copyright protection under existing law is therefore clearly excessive.

Furthermore, even limited copyright protection would persuade the researcher to publish and communicate her information. The researcher could disseminate her data, yet protect her work from unauthorized use. As a result, the individual researcher, the scientific community and the public would benefit.

As a member of the scientific community, the scientist would still desire the professional recognition accompanying significant biotechnological advances.²⁴⁷ This recognition is achieved only by publication or public discussion of her data.²⁴⁸ Copyright protection would facilitate widespread publication and the individual researcher would receive the recognition she seeks.

Moreover, upon publication, the information is disseminated throughout the scientific community. Non-infringing, fair use of the work for scholarly review or criticism would still be permitted by copyright protection. Other researchers could choose to collaborate with the author/scientist. By protecting an author-scientist's rights even upon publication of her proprietary data, copyright protection would encourage communication among the members of the scientific community.

Copyright protection would also protect the public from misinformation. For example, transformation of the x-ray diffraction data into molecular coordinates is a complex process.²⁴⁹ Although an accurate and reliable summary of the data may be publishable, the specific details of the map may need further refinement.²⁵⁰ Copyright protection would permit the researcher to restrict access to the coordinates until their accuracy is ascertained.

Copyright protection would promote increased communication between individual scientists and within the scientific community as a whole. This increased communication would lead to greater scientific achievement. The public would obviously benefit by these advances.

A five-year limit on copyright protection for biotechnological innovation would address these problems. The term would begin on the date of printed publication, public announcement or deposit of the molecular coordinates in a repository. Protection would specifically cover molecular coordinates derived from x-ray crystallographic or NMR data and the recombinant DNA sequence.²⁵¹ Coverage would be limited to the expression of these innovations in mathematical, pictorial or graphic form.

Five years would provide sufficient lead time to allow the researcher to capitalize on the effort expended in obtaining the data.²⁵² If a scientist has not realized the full potential of his research within five years, it is likely someone else already will have found a different route to the same end.²⁵³

Similarly, a shorter term of copyright protection would encourage the author/scientist to develop her research quickly. Research sponsors (whether a university or private industry) would also benefit by realizing a faster return on their investment.

Furthermore, a limited duration of copyright protection would reduce the tension generated by expanding protection to biotechnological innovations. Although exclusive rights would be granted, the term would last for only five years. During those five years, the scientist could pursue avenues to maximize the rewards of her research; after five years, the data would be freely accessible to all.

B. Compulsory Licenses for Biotechnological Innovations

Alternatively, if biotechnological innovations were to be protected by copyright for the life of the author plus fifty years, then compulsory licenses could be granted to other researchers who wish to copy the work.²⁵⁴ Current copyright law provides for compulsory licenses in a number of areas.²⁵⁵ These licenses would permit other researchers to reproduce the copyrighted work without first obtaining permission from the author/scientist. In return, the original author would be paid a royalty in an amount fixed by a Copyright Royalty Tribunal.²⁵⁶

The license requirements could be tailored to accommodate unique biotechnological interests. For example, to prevent misuse of the data, the researcher wishing to copy the information could be required to notify the author/scientist of the intended use. The copier could be required to acknowledge the author/scientist on any scientific publications, perhaps even naming her as a co-author. Because of the commercial aspect of biotechnological innovations, royalties could be based not only on a fee for initial use, but also on a percentage-of-profits basis from any resulting products. These license requirements would confer economic and professional benefits on the author/scientist, even if she were not able to develop the innovation herself.

Compulsory licenses would allow subsequent scientists to use another researcher's scientific data as the basis for their work, thus avoiding the need for repetitive research. Moreover, complex, lengthy negotiations with the original author/scientist to obtain permission to use her data would be avoided. Scientists could concentrate their efforts on problem-solving, not dicker over terms. Yet, the author/scientist would still receive professional recognition and economic rewards for her role in the advancement.

Thus, compulsory licenses would promote the progress of biotechnological research and benefit the public by facilitating the dissemination of scientific information.

CONCLUSION

Copyright protection should be granted to biotechnological innovations. Although they are factual and not artistic works, the substantial skill and creative judgment expended in the selection, arrangement and synthesis of these facts entitle biotechnological innovations to copyright protection as original works of authorship.

However, copyright protection for biotechnological innovations poses a unique challenge to public policy. The underlying policy of copyright protection is to benefit the public good by promoting the progress of science. Copyright protection would certainly benefit the scientist, but it could also impede scientific progress and thus detrimentally effect the public welfare.

Modifications of the current copyright law could accommodate both goals. Shortening the duration of copyright protection or granting compulsory licenses are two proposed modifications. The scientist would be rewarded for his efforts and creative initiative with the protection of his proprietary interests while the public would benefit from access to the newest biotechnological advances and the opportunity to build upon them. These proposed changes in copyright law would protect the rights of the author/scientist without "unduly restricting the free flow of scientific information."²⁵⁷

APPENDIX

Figure 1

The x-ray diffraction pattern of a protein crystal.

Figure 2

The electron density plot of a protein crystal.

Figure 3

The atomic skeleton of the protein crystal (heavy black lines) determined from the electron density plot.

ATOM 2196 OE2 GLU 1296 25.081 28.099 147.874

ATOM 2197 C LYS 1297 25.044 24.333 142.541

ATOM 2198 CA LYS 1297 23.433 25.765 142.398

ATOM 2199 CB LYS 1297 22.786 25.848 141.015

ATOM 2200 CD LYS 1297 20.268 25.481 140.840

ATOM 2201 CE LYS 1297 19.163 24.475 140.508

ATOM 2202 CG LYS 1297 21.658 24.844 140.827

ATOM 2203 N LYS 1297 24.409 26.915 142.590

ATOM 2204 NZ LYS 1297 17.929 24.705 141.268

ATOM 2205 O LYS 1297 25.075 24.073 141.930

ATOM 2206 C GLY 1298 24.196 21.299 142.399

ATOM 2207 CA GLY 1298 23.932 22.200 143.667

ATOM 2208 N GLY 1298 23.415 23.602 143.386

ATOM 2209 O GLY 1298 23.325 21.229 141.544

ATOM 2210 C LEU 1299 24.574 18.823 140.806

ATOM 2211 CA LEU 1299 25.712 19.814 141.262

ATOM 2212 CB LEU 1299 26.907 18.938 141.632

ATOM 2213 CD1 LEU 1299 27.521 18.903 139.158
 ATOM 2214 CD2 LEU 1299 28.827 17.546 140.708
 ATOM 2215 CG LEU 1299 27.424 18.108 140.460
 ATOM 2216 N LEU 1299 25.356 20.732 142.421
 ATOM 2217 O LEU 1299 24.319 18.698 139.630
 ATOM 2218 C THR 1300 21.397 17.724 141.946
 ATOM 2219 CA THR 1300 22.856 17.268 141.548
 ATOM 2220 CB THR 1300 23.044 15.942 142.283
 ATOM 2221 CG2 THR 1300 24.369 15.264 141.966
 ATOM 2222 N THR 1300 24.006 18.242 141.822
 ATOM 2223 O THR 1300 20.617 16.907 142.384
 ATOM 2224 OG1 THR 1300 22.991 16.154 143.685
 ATOM 2225 C THR 1301 19.144 20.195 140.765

Figure 4

A partial list of the location of each atom in a protein, i.e. the molecular coordinates. The first four columns from the left determine the atom and its place in the amino acid sequence. The next three columns determine the x, y, and z coordinates of the atom in the protein.

†1990 Doreen M. Hogle

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1. "The United States stands at the brink of a new scientific revolution that could change the lives and futures of its citizens...." For example, advances in molecular biology now "permit the identification, alteration, and transfer of genetic materials that control fundamental characteristics of organisms." OFFICE OF TECHNOLOGY ASSESSMENT, NEW DEVELOPMENTS IN BIOTECHNOLOGY-BACKGROUND PAPER: PUBLIC PERCEPTIONS OF BIOTECHNOLOGY 9 (1987).

Although this biotechnological revolution has already led to the significant transformation of basic biomedical research, another aspect of this revolution is just now becoming evident, namely the commercial availability of genetically engineered products. To date, relatively few products resulting from these recent advances have progressed to the marketplace. Therefore, the full impact of these revolutionary technologies has yet to be realized by the American public. *Id.*

2. See Comment, *Copyright Protection for the Intellectual Property Rights to Recombinant Deoxyribonucleic Acid: A Proposal*, 19 ST. MARY'S L.J. 1083 (1988) (biotechnology is the application of biological research techniques to industrial processes and products); see also S. BENT, R. SCHWAAB, D. CONLIN & D. JEFFERY, INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY WORLDWIDE 6 (1987) [hereinafter S. BENT] (biotechnology concerns the creation of new plant varieties, animal breeds and microorganisms by the use of traditional or new methods to provide commercial products or processes).

3 Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177, 177-79 (1987); *see also* Schulman, *Changing Relationship Seen in New Corporate-University Ties*, 335 NATURE 106 (1988) (discussing newly evolving relationships between industry and academia).

4. Eisenberg, *supra* note 3, at 178.

5. Patentable subject matter is defined as "[a]ny new and useful process, machine, manufacture or composition of matter, or any new and useful improvement thereof." 35 U.S.C. § 101 (1982). *See, e.g.*, *Diamond v. Chakrabarty*, 447 U.S. 303, 310 (1980) (non-naturally occurring, genetically engineered microorganism is patentable subject matter); *Hybritech Inc. v. Monoclonal Antibodies, Inc.* 802 F.2d 1367, 1381, 1383 (Fed. Cir. 1986) (patent, claiming immunometric assay technique using monoclonal antibodies, was upheld as valid against a 35 U.S.C. § 103 obviousness challenge); *Transgenic Non-Human Mammals*, U.S. PATENT NO. 4,736,866 (issued Apr. 12, 1988).

6. R. MILLER, *LEGAL ASPECTS OF TECHNOLOGY UTILIZATION* 12 (1974). "The term 'innovation' has been taken to mean simply an advance in the state of the art, without regard to patentability." *Id.* In this article, "innovation" refers to a biotechnological advance in the state of the art that does not meet the statutory requirements for patentability.

7. *See, e.g.*, *Parker v. Flook*, 437 U.S. 584, 589 (1978) (product of nature not patentable); *Brenner v. Manson*, 383 U.S. 519, 535 (1966) (products without practical utility are not patentable); *see also* Kayton, *Copyright in Living Genetically Engineered Works*, 50 GEO. WASH. L. REV. 191, 193-94 (1982); Note, *Patent and Trade Secret Protection in University-Industry Research Relationships in Biotechnology*, 24 HARV. J. ON LEGIS. 191, 208-218 (1987); Comment, *supra* note 2, at 1085.

8. For example, the sequence of nucleotides in a deoxyribonucleic acid (DNA) molecule codes for the structure, function, and regulation of all the components and processes which define an organism, whether it is a bacteria, virus or human cell. These sequences can be altered and manipulated in various experiments, resulting in a wealth of new information. *See, e.g.*, Essex & Kanki, *The Origins of the AIDS Virus*, SCIENTIFIC AMERICAN, Oct. 1988, at 64 (discussing the comparison of the nucleotide sequences of Human Immunodeficiency Virus with Simian T-lymphotrophic Virus).

9. *See generally* J. WATSON, J. TOOZE & D. KURTZ, *RECOMBINANT DNA: A SHORT COURSE* 58-69 (1983). Deoxyribonucleic acid (DNA) is a complex polymer, found in most living cells, that carries the organism's genetic code for amino acids (the "building blocks" of proteins). The nucleotides are arranged in a helical configuration. This helix can be broken apart and a new nucleotide can be inserted. This recombinant DNA will then direct the cells to produce new and unique proteins.

10. Kohler & Milstein, *Continuous Cultures of Fused Cells Secreting Antibody of Predefined Specificity*, 256 NATURE 495 (1975). A hybridoma is a cell type formed by the fusion of a B-lymphocyte (an antibody-producing, white blood cell) and a neoplastic myeloma cell (a malignant cell, capable of continuous, in vitro growth). The hybridoma, inheriting the unique characteristics of its parents cells, possesses the ability to secrete a specific antibody (monoclonal) under controlled, laboratory conditions.

11. *See infra* notes 21-25 and accompanying text. *See generally* T. BLUNDELL & L. JOHNSON, *PROTEIN CRYSTALLOGRAPHY* 13 (1976).

12. C. CANTOR & P. SCHIMMEL, *BIOPHYSICAL CHEMISTRY PART II: TECHNIQUES FOR THE STUDY OF BIOLOGICAL STRUCTURE AND FUNCTION* 481 (1980). "NMR techniques monitor the absorption of energy associated with transitions of nuclei between adjacent nuclear magnetic energy levels....[I]ndividual nuclei (e.g. protons) of a given kind within the same molecule... commonly absorb at distinct positions in the spectrum." *Id.* at 481.

The first step in determining a protein structure by NMR consists of assigning each peak in the NMR spectra to a specific proton (hydrogen atom) in the protein molecule (sequence-specific resonance assignments). The next step is to analyze the couplings between the absorption peaks of the protons located in residues close to each other in the amino acid sequence. Using conformational restraints such as interproton distance and torsion angles, information is derived about the secondary structure of the protein (whether the amino acids are linked together in chains, helices or pleated sheets). *See, e.g.*, Wuthrich, *Protein Structure Determination in Solution by Nuclear Magnetic Resonance Spectroscopy*, 243 SCIENCE 45, 46 (1989).

Finally, couplings between absorption peaks far apart in the sequence are analyzed to determine which protons are close together in the protein structure. The constraints derived from the above steps are used to determine the protein's three-dimensional structure using

distance geometry algorithms, in conjunction with molecular dynamic simulation, to convert this information into Cartesian coordinates. These coordinates form the basis of the molecular map of the protein. *Id.* See also Clore & Gronenborn, *Determination of Three-Dimensional Structures of Proteins in Solution by Nuclear Magnetic Resonance Spectroscopy*, 1 PROTEIN ENGINEERING 275, 280-81 (1987); Braun, *Distance Geometry and Related Methods for Protein Structure Determination from NMR Data*, 19 Q. REV. OF BIOPHYS. 115, 116-22 (1987).

13. For example, knowing the three-dimensional structure of a virus is invaluable for a number of reasons. The structure can be used to predict how the protein would react to changes in temperature or chemical modification. It can also be used to predict antibody-antigen interactions, or determine the basis of pathogenicity. See Baltimore, *Perspective: Picornaviruses Are No Longer Black Boxes*, 229 SCIENCE 1366, 1366-67 (1985); Miller, *Redesigning Molecules Nature's Way*, SCIENCE NEWS, Sept. 24, 1985 at 204, 205.

These structures are also extremely important in computer-assisted drug design and vaccine development. Drugs and vaccines can be "designed" on a computer at relatively low cost and with a high degree of accuracy. The most promising candidates can be synthesized and further, costlier investigation initiated. See, e.g., Berzofsky, *Intrinsic and Extrinsic Factors in Protein Antigenic Structure*, 229 SCIENCE 932, 937-38 (1985) (discussing the structural determinants of antibody/antigen recognition in the preparation of synthetic peptide vaccines).

14. See Note, *supra* note 7, at 199-201 (discussing the commercial benefits of protection).

This need for protection encompasses not only the protection of profit, but also the protection of professional scientific reputation. See *infra* notes 224-26 and accompanying text. See also Eisenberg, *supra* note 3, at 226-29 (discussing the dispute between Dr. Robert Gallo at the National Cancer Institute and Dr. Luc Montagnier at the Pasteur Institute concerning the development of an AIDS diagnostic kit and their endeavors to claim scientific recognition in this highly competitive field).

15. All of these innovations could be protected by current patent law if they were used as an intermediate step or process leading to a useful product (machine, manufacture or composition of matter) as defined by current patent law. Ihnen, *Patenting Biotechnology: A Practical Approach*, 11 RUTGERS COMP. & TECH. L.J. 407 (1985).

For example, a recombinant DNA sequence for a specific protein can be inserted into a plasmid (extrachromosomal DNA segments found in most bacteria). These plasmids are "taken up" by bacteria that then express this plasmid DNA as they would their own. Thus, the bacteria produces the specific protein encoded for by the recombinant DNA sequence. Both the protein and the recombinant DNA sequence are appropriate subject matters for patent protection. *Id.* at 422-27.

Another example is a lymphocyte hybridoma that produces a highly specific monoclonal antibody. This monoclonal antibody can be used in a diagnostic assay to detect a specific disease. Both the assay procedure and the monoclonal antibody are patentable. *Id.* at 427-30.

However, it is becoming increasingly difficult to obtain patent protection for new DNA sequences or monoclonal antibodies. As the technology progresses, and more researchers become proficient in these techniques, the statutory requirements of novelty, utility and non-obviousness become more difficult to meet. See also S. BENT, *supra* note 2, at 235-45, 390; Comment, *supra* note 2, at 1108.

This comment will address possible means of intellectual property protection for innovations such as the DNA sequence which, unlike the above, remain at an unpatentable stage of development.

16. The Uniform Trade Secrets Act defines a trade secret as:

information, including a formula, pattern, compilation, program, device, method, technique or process, that:

(i) derives independent economic value, present or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and

(ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.

UNIFORM TRADE SECRETS ACT § 1(4)(i)-(ii), 14 U.L.A. 537-51 (1985 & Supp. 1990).

17. See Note, *supra* note 7, at 205.

18. Henry, *Copyright: Its Adequacy in Technological Societies*, 186 SCIENCE 993, 993 (1974).

[T]he producers of society's knowledge must have economic incentives to produce knowledge. The fundamental thesis of the copyright concept is that the more a knowledge-producer sells of his product, the more he should be compensated. In this fashion, both the individual knowledge-originator and the whole of society will benefit; the producer of information will gain by royalty checks and the society will gain by acquiring new knowledge.

19. 17 U.S.C. § 106 (1988).

20. Typically, the scientific journal article describing the molecular map of a protein deduced from x-ray diffraction or NMR data does not include the three-dimensional coordinates describing the position of every atom in the molecule. The volume of mathematical data is simply too massive. However, these coordinates are easily stored in computer databases. *See, e.g.,* Hogle, Chow & Filman, *The Structure of Poliovirus*, SCIENTIFIC AMERICAN, Mar. 1987, at 42, 45.

These databases can be accessed at any time by anyone who has access to a suitable computer. Using widely available computer graphic software, these coordinates can be displayed as the three-dimensional molecular map on a computer screen. This computerized image of the protein can be twisted, turned and manipulated by the scientist. By inserting or deleting atoms or simulating various conditions, the scientist can conduct "experiments" on his computer screen. *See* Barinaga, *The Missing Crystallographic Data*, 245 SCIENCE 1179, 1180 (1989).

21. *See* T. BLUNDELL & L. JOHNSON, *supra* note 11, at 13. "The X-ray [diffraction] analysis of a protein structure usually proceeds in eight distinct steps: crystallization [of the native protein], preparation of...[a] heavy atom [derivative of the native protein], collection of data, data processing, determination of heavy atom positions [of the derivative], calculation of [phase differences in light scattering between the native protein and the heavy atom derivative], interpretation of the [diffraction data], and refinement [of the diffraction data]." *Id.* at 13.

22. *Id.* Proteins may crystallize into any one of sixty-five different crystal lattices. C. CANTOR & P. SCHIMMEL, *supra* note 12, at 730-36.

23. *Id.* at 112. A large protein molecule or virus particle may require the collection of millions of x-ray reflections. For each reflection, two parameters, the amplitude and the phase, must be measured. The amplitude of each reflection may be deduced from the intensity of each reflection, but the phase cannot be directly measured. *Id.* at 10-11. Data obtained from the heavy atom derivative can be combined with data from the native protein to determine the phases of the reflections. *Id.* at 16. Using the amplitude and phase information, a computer can calculate the electron density map. *Id.* at 134.

24. The diffraction pattern can be mathematically "transformed" into the electron density map through a Fourier transform. *Id.* at 134.

25. From the electron density map, the position of each atom can be modelled and stored numerically in a database as an x,y,z coordinate. The position of these atoms are subjectively analyzed and interpreted in light of constraints on size, angles and distances between atoms to produce the final "fit" of the proposed protein model to the electron density. This model is essentially a "molecular map," that upon interpretation, describes the location and function of various portions of the protein. *Id.* at 399.

26. Proteins are large molecules which are built up from among twenty amino acid "building blocks." These amino acids link together, joined by chemical bonds, to form peptides. The order of amino acids in polypeptide chains is the primary structure of the protein. *Id.* at 25.

27. A substance that can provoke a response by the immune system of an organism is called an antigen or immunogen. The immune response typically includes the production of antibodies specific for a structural feature (antigenic determinant or epitope) of the antigen. *See* S. BENT, *supra* note 2, at 243 n.165.

28. Most leading scientific journals have a policy requiring authors to "make available" their coordinates or biological materials discussed in the paper to other interested investigators. *See* Eisenberg, *supra* note 3, at 198-205. A typical "instruction to authors" reads:

Publication...implies an obligation on the part of the authors to deposit any novel nucleic acid sequence data referred to in their

papers with the..."X" [d]ata [l]ibrary....

It is understood that by publishing a paper...the authors agree to make freely available to colleagues in academic research any of the cells, nucleic acids, antibodies, etc. that were used in the research reported and that are not available from commercial suppliers.

Instruction to Authors, 8 EMBO (EUR. MOLECULAR BIOLOGY ORG.) J. (1989). Journals vary in their enforcement policies, some requiring proof of deposit before publication. See Barinaga, *supra* note 20, at 1180. Others choose not to make formal requirements but rely on voluntary compliance. *Id.*; see also Eisenberg, *supra* note 3, at 201-5.

29. 17 U.S.C. § 409 (1988). When the U.S. adopted the Berne Convention Implementation Act of 1988, Pub. L. No. 100-568, 1988 U.S. CODE CONG. & ADMIN. NEWS (102 Stat.) 2853 (1988) (codified in scattered sections of 17 U.S.C.), significant changes in the formalities of acquiring copyright protection became effective in March of 1989. See Note, *An Overview of Changes in Federal Trademark and Copyright Laws: The Trademark Law Revision Act of 1988 and The Berne Implementation Act of 1988*, SANTA CLARA COMPUTER & HIGH TECH. L.J. 521, 530 (1989).

However, the Berne Convention Implementation Act did not eliminate mandatory copyright registration as a prerequisite to initiating an infringement action for United States authors. 17 U.S.C. § 411(a) (1988). The certificate of registration is considered prima facie evidence of copyrightability and shifts the burden of proof to the alleged infringer. Hatch, *Better Late Than Never: Implementation of the 1886 Berne Convention*, 22 CORNELL INT'L. L.J. 171, 193 (1989). The Act contains a two-tiered registration scheme. Although U.S. authors are required to register before initiating an infringement suit, foreign authors are exempt. Berne Convention Implementation Act, § 9(b)(1), (102 Stat.) at 2858. See also Hatch, *supra* at 194.

30. Under the Berne Convention Implementation Act, formal notice of copyright is no longer required. Berne Convention Implementation Act, § 7(a)(1), (102 Stat.) at 2857. However, voluntary placement of notice will preclude courts from a finding of "innocent infringement," thus preventing any reduction in a damages award. *Id.* § 7(a)(4), (102 Stat.) 2857; see Note, *supra* note 28, at 532.

31. The outer surface of the protein consists of numerous projections comprised of amino acids. These projections are the most likely candidates for use in creating a vaccine. These are the basic steps in producing synthetic vaccines. See Hogle, Chow & Filman, *supra* note 20, at 48-49.

The amino acid sequences that make up these projections can be synthesized in the laboratory as small peptides, linked to larger immunogenic chemicals, and injected into test animals to elicit an antibody response. See Matthews & Bolognesi, *AIDS Vaccines*, SCIENTIFIC AMERICAN, Oct. 1988, at 120, 122.

32. If Dr. B had lawful possession of Dr. A's coordinates, the use of that information to produce the vaccine would not constitute infringement. Infringement occurs only if the copying is unauthorized.

Alternatively, Dr. A may recover from Dr. B on the theory of misappropriation adopted in *Int'l News Serv. v. Associated Press*, 248 U.S. 215 (1918). This doctrine protects an author, who through the fruits of his labor, has created a valuable property asset. The author may recover from another who has taken that property without his permission and used it for commercial gain. *Id.* at 241 (news service liable for reprinting rival service's news stories without permission).

Misappropriation falls under the realm of state common law, not federal statute. It is not preempted by federal copyright, as long as the appropriated material is outside the subject matter of copyright. *Cf. Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 491-92 (1970) (patent law does not preempt state trade secret law). See also Denicola, *Copyright in Collections of Facts: A Theory for the Protection of Nonfiction Literary Works*, 81 COLUM. L. REV. 516, 517 n.7 (1981) for a discussion of possible problems that may arise when seeking protection under the misappropriation doctrine for nonfiction works.

This article will focus solely on the theory of copyright protection. I argue that copyright protection will strike the best balance between protection of the scientist's proprietary interests and traditional scientific interests in order to benefit the public good. The availability of copyright protection has definite advantages in comparison to a suit for misappropriation. The scientist is reassured of some measure of protection before she publishes her information. See *infra* Section III.

33. The Copyright Act authorizes the owner of the copyright: "(1) to reproduce the copyrighted work in copies or phonorecords; (2) to

prepare derivative works based upon the copyrighted work; (3) to distribute copies or phonorecords of the copyrighted work to the public by sale or other transfers of ownership...." 17 U.S.C. § 106 (1988).

34. See Halliday, *Judicial Approach to Copyright Infringement*, 27 IDEA-THE J. OF L. AND TECH. 183, 186 (1987).

35. See *Arnstein v. Porter*, 154 F.2d 464, 468 (2d Cir. 1946). See also Halliday, *supra* note 34, at 186.

36. See *Arnstein*, 154 F.2d at 468.

37. *Roth Greeting Cards v. United Card Co.*, 429 F.2d 1106, 1110 (9th Cir. 1970); see also *Eckes v. Card Prices Update*, 736 F.2d 859, 863 (2d Cir. 1984); 3 M. NIMMER & D. NIMMER, NIMMER ON COPYRIGHT § 13.03[D], at 13-62.1 (1989).

38. See *Eckes v. Card Prices Update*, 736 F.2d 859, 863-64 (2d Cir. 1984). The *Eckes* court focused on the lack of credible evidence of independent creation, the substantial similarities between the plaintiff's baseball card guide and defendant's work, and the short period of time between the publication of the two works, to support its finding of copyright infringement.

39. See *Barinaga*, *supra* note 20, at 1180.

40. *Id.*

41. Architectural plans are not specifically mentioned as copyrightable subject matter in the 1976 Copyright Act. However, under 17 U.S.C. § 101, the phrase "technical drawings, diagrams and models" has usually been interpreted to encompass architectural plans. See 1 M. NIMMER & D. NIMMER, NIMMER ON COPYRIGHT § 2.08[D], at 2-120 (1989). Furthermore, with the adoption of the Berne Convention Implementation Act of 1988, architectural plans have been explicitly included within the scope of copyrightable subject matter. Berne Convention Implementation Act of 1988 § 4(a)(1)(A), (102 Stat.) at 2854-55.

42. 458 F.2d 895 (5th Cir. 1972).

43. *Id.* at 897.

44. *Id.*

45. *Id.* at 899. The court in *Lamont* stated:

We do not hold that the Lamonts were in anywise restricted by the existence of Imperial's copyright from reproducing a substantially identical residential dwelling. All we hold is that if copyrighted architectural drawings of the originator of such plans are imitated or transcribed in whole or in part, infringement occurs.

Id. *Lamont* does not hold that the building of a substantially similar house alone is infringement of copyright. The scope of copyright protection granted to architectural plans only prohibits the unauthorized copying of the plans, and does not extend to a structure based upon those plans. See also 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.08[D], at 2-120.

46. See *Hogle, Chow & Filman*, *supra* note 20, at 48-49.

47. *Narell v. Freeman*, 872 F.2d 907, 910 (9th Cir. 1989).

48. *Id.* (emphasis added).

49. See *infra* Part I Section 2.

50. See *infra* Part I Section 3.

51. See *infra* Part II.

52. The section reads in relevant part: "Copyright protection subsists, in accordance with this title, in original works of authorship fixed in any tangible medium of expression, now known or later developed, from which they can be perceived, reproduced, or otherwise communicated, either directly or with the aid of a machine or device." 17 U.S.C. § 102(a) (1988).

53. 17 U.S.C. § 102(a)(1).

54. 17 U.S.C. § 102(a)(2).

55. 17 U.S.C. § 102(a)(3).

56. 17 U.S.C. § 102(a)(5).

57. 17 U.S.C. § 102(a) (emphasis added).

58. 17 U.S.C. § 101.

59. 17 U.S.C. § 103(a).

60. 17 U.S.C. § 102(a)(5).

61. "The subject matter of copyright as specified by section 102 includes compilations and derivative works, but protection for a work employing preexisting material in which copyright subsists does not extend to any part of the work in which such material has been used unlawfully." 17 U.S.C. § 103(a) (1988).

See also H.R. REP. NO. 1476, 94th Cong., 2d Sess. 57 ("A 'compilation' results from a process of selecting, bringing together, organizing, and arranging previously existing material of all kinds, regardless of whether the individual items in the material have been or ever could have been subject to copyright."), *reprinted in* 1976 U.S. CODE CONG. & ADMIN. NEWS 5659, 5670.

62. 17 U.S.C. § 101 (1988).

63. *See Eckes v. Card Prices Update*, 736 F.2d 859, 862-63 (2d Cir. 1984).

64. *Fin. Information, Inc. v. Moody's Investors Serv.*, 808 F.2d 204, 207 (2d Cir. 1986).

65. *Rand McNally & Co. v. Fleet Management Sys., Inc.*, 591 F. Supp. 726, 730-31 (N.D. Ill. 1983).

66. 17 U.S.C. § 103(a) (1988) (compilations of fact are specifically mentioned as copyrightable subject matter); *see also* *West Publishing Co. v. Mead Data Cent.*, 799 F.2d 1219 (8th Cir. 1986), *cert. denied*, 479 U.S. 1070 (1987) (arrangement of opinions in a case reporter qualifies for copyright protection); 1 P. GOLDSTEIN, COPYRIGHT § 2.14.2, at 180 (1989); Denicola, *supra* note 32, at 527; Gorman, *Copyright Protection for the Collection and Representation of Facts*, 76 HARV. L. REV. 1569, 1571 (1963).

67. *See* Gorman, *supra* note 66, at 1570.

68. 736 F.2d 859 (2d Cir. 1984).

69. *Id.* at 863.

70. *Fin. Information v. Moody's Investor's Serv.* 751 F.2d 501, 506 (2d Cir. 1984).

71. 17 U.S.C. § 102(a)(5) (1988).

72. 17 U.S.C. § 101.

73. *Id.*

74. *See* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.08 at 2-76, n.10.

75. 17 U.S.C. § 101 (1988).

76. *Gay Toys, Inc. v. Buddy L Corp.*, 703 F.2d 970, 973 (6th Cir. 1983); *see also* H.R. REP. NO. 1476, 94th Cong., 2d Sess. 54, *reprinted in* 1976 U.S. CODE CONG. & ADMIN. NEWS 5659, 5668.

77. Likewise architectural plans are not useful articles. 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.08[D], at 2-114. "The intrinsic function of an architectural plan is precisely to 'convey information' as to the manner in which a building may be constructed, and hence it is not a 'useful article' as defined." *Id.*

78. Furthermore, maps have been specifically included within the scope of copyright protection since the first Copyright Act of 1790. ch. 15, § 1, 1 Stat. 124 (1790).

79. Courts have usually focused on works that have utility as their primary purpose when defining useful works, such as chairs and airplanes. 1 P. GOLDSTEIN, *supra* note 66, § 2.5.3 at 103. For example, the Sixth Circuit vacated a lower court holding that a toy airplane possessed utilitarian characteristics, stating: "toys do not even have *an* intrinsic function other than portrayal of the real item." *Gay Toys, Inc. v. Buddy L Corp.*, 703 F.2d 970, 974 (6th Cir. 1983).

80. The conventional definition of a compilation envisions a compiler assembling data from the public domain that has intrinsic value, such as names, addresses or telephone numbers, and arranging them in a useful sequence, such as alphabetical order, into a compilation, such as a telephone directory.

81. Conventional maps are two-dimensional, pictorial representations, using shapes, colors and symbols, rather than mathematical coordinates.

82. H.R. REP. NO. 1476, 94th Cong., 2d Sess. 51, *reprinted in* 1976 U.S. CODE CONG. & ADMIN. NEWS 5659, 5664.

83. *Id.*; *see also* Kayton, *supra* note 7, at 201.

84. *See* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.03[A], at 2-26.1. *See also* Kayton, *supra* note 7, at 201.

85. *See* 1 P. GOLDSTEIN, *supra* note 66, § 2.14, at 173.

86. 17 U.S.C. § 102(a) (1988).

87. *Alfred Bell & Co. v. Catalda Fine Arts*, 191 F.2d 99, 102-03 (2d Cir. 1951). *See also* *Bleistein v. Donaldson Lithographing Co.* 188 U.S. 239, 244 (1903).

88. 35 U.S.C. § 102 (1982); *see, e.g.*, *United States v. Hamilton*, 583 F.2d. 448, 451 (9th Cir. 1978) (originality is not synonymous with novelty; the author need only show that the work originated with him).

89. *See* Note, *supra* note 7, at 213-16.

90. *See* 1 P. GOLDSTEIN, *supra* note 66, § 2.2.1, at 65-66. Furthermore, inventors under patent law are responsible for full knowledge of all preceding works, whether they have actual knowledge or not. *Id.* at 66 n.17.

91. *L. Batlin & Sons, Inc. v. Snyder*, 536 F.2d 486, 490 (2d Cir. 1976), *cert. denied*, 429 U.S. 857 (1976).

A distinction should be drawn between the quantum of originality necessary to obtain copyright protection and the quantum of originality required to avoid infringement. *See, e.g.*, Gorman, *supra* note 66, at 1573. Expressive alteration of preexisting works may be sufficient to procure copyright protection. However, if the preexisting work was copyrighted, the mere addition of some "original"

elements may not be sufficient to avoid copyright infringement. *Id.*

92. *Alfred Bell & Co. v. Catalda Fine Arts*, 191 F.2d 99, 102-03 (2d Cir. 1951); *accord* *West Publishing Co. v. Mead Data Central*, 799 F.2d 1219, 1224 (8th Cir. 1986), *cert. denied*, 479 U.S. 1070 (1987) ("[A]n original arrangement of opinions is copyrightable whenever it is the product of labor, talent, or judgment."); *Hamilton*, 583 F.2d at 452 ("[E]lements of compilation which amount to more than a matter of trivial selection may...support a finding that a map is sufficiently original to merit copyright protection."); *see also* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 1.08[C][1], at 1-48 to -49.

93. 1 P. GOLDSTEIN, *supra* note 66, § 2.14 at 173.

94. *Id.* § 2.14, at 174.

95. *Gen. Drafting Co. v. Andrews*, 37 F.2d 54, 55 (2d Cir. 1930); *accord* *Eckes v. Card Prices Update*, 736 F.2d 859, 862-63 (2d Cir. 1984); *Rockford Map Publishers v. Directory Serv. Co.*, 768 F.2d 145, 148 (7th Cir. 1985).

96. *Hamilton*, 583 F.2d at 452.

97. *Amsterdam v. Triangle Publications*, 93 F. Supp. 79, 82 (E.D. Pa. 1950), *aff'd* 189 F.2d 104 (3rd Cir. 1951). *Accord* *Jeweler's Circular Publishing Co. v. Keystone Publishing Co.*, 281 F. 83, 88 (2d Cir. 1922), *cert. denied*, 259 U.S. 581 (1922); *Rand McNally & Co. v. Fleet Management Sys.*, 591 F. Supp. 726, 731 (N.D. Ill. 1983); *see also* *Denicola*, *supra* note 32, at 516; Note, *Copyright Protection for Compilations of Fact: Does the Originality Standard Allow Protection on the Basis of Industrious Collection?*, 62 NOTRE DAME L. REV. 763, 770 (1987).

98. *Schroeder v. William Morrow & Co.*, 566 F.2d 3, 5 (7th Cir. 1977).

In the infringement context, courts will often use the two theories to further delineate the protectable expression from the unprotected idea/fact. *See* 1 P. GOLDSTEIN, *supra* note 66, § 2.3 at 74. It is axiomatic that copyright protects an author's expression, not the underlying facts or ideas. 17 U.S.C. § 102(a) (1988). *See* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.03[D], at 2-34. Courts will generally weigh the originality of the work when determining the scope of copyright protection. *See* 1 P. GOLDSTEIN, *supra* note 66, § 2.3 at 74. Factual works that reflect more originality are generally given more protection. More originality is often found when the author subjectively selects and arranges the facts than when originality stems from the industrious collection of the facts. *See* *Eckes v. Card Prices Update*, 736 F.2d 859, 863 (2d Cir. 1984); *Fin. Information, Inc. v. Moody's Investors Serv.*, 808 F.2d 204, 207 (2d Cir. 1986).

Courts construe the range of protectable expression very narrowly in factual works, often limiting infringement to situations where verbatim copying is evident. *See, e.g.,* *Landsberg v. Scrabble Crossword Game Players, Inc.*, 736 F.2d 485, 488 (9th Cir. 1984), *cert. denied*, 469 U.S. 1037 (1984). *See also* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.11[B], at 2-159.

99. *Gen. Drafting Co.*, 37 F.2d at 55. *See also* *Hamilton*, 583 F.2d at 452 ("selection, synthesis and design" are all elements of originality).

100. *Hamilton*, 583 F.2d at 452.

101. *Eckes*, 736 F.2d at 863.

102. *Adventures in Good Eating, Inc. v. Best Places to Eat, Inc.*, 131 F.2d 809, 812 (7th Cir. 1942).

103. 17 U.S.C. § 101 (1988) (emphasis added); *see* *Fin. Information Inc. v. Moody's Investors Serv., Inc.*, 808 F.2d 204, 207 (2d Cir. 1986) (Newman, J., concurring).

104. *Hamilton*, 583 F.2d at 451. However, some courts have imposed a higher standard of originality on maps, above the selection and arrangement of the underlying components. *See* *Amsterdam v. Triangle Publications*, 93 F. Supp. 79, 82 (1950); *see also* 1 P. GOLDSTEIN, *supra* note 66, § 2.14, at 177; *Gorman*, *supra* note 66, at 1572. Courts following *Amsterdam* have required that the mapmaker obtain his data through direct observation in the field. "Almost anybody could combine the information from several maps onto one map, but not everybody can go out and get that information originally and then transcribe it into a map." *Amsterdam*, 93 F.

Supp. at 82.

However, the *Amsterdam* case has been severely criticized as overstating the originality requirement. *Amsterdam* implies that factual works will not be protected merely on the basis of their selectivity and arrangement of data, but require sweat from the author's brow to ensure copyright protection. See 1 P. GOLDSTEIN, *supra* note 66, § 2.14.1, at 178; Gorman, *supra* note 66, at 1572. This has led to confusion among the courts. In *West Publishing Co. v. Mead Data Cent.*, the court found that West's pagination system of case reporting would most likely withstand copyright challenge based on the "substantial creative effort consisting of labor, talent and judgment." *West Publishing Co. v. Mead Data Cent.*, 799 F.2d 1219, 1226-27 (8th Cir. 1986), *cert. denied*, 479 U.S. 1070 (1987). The court also noted how unjust it would be to allow competitors access to information that West had spent so much "labor and industry in compiling." *Id.* at 1226. See also *Rockford Map Publishers v. Directory Serv. Co.*, 768 F.2d 145, 149 (7th Cir. 1985); Note, *supra* note 97, at 774.

Hamilton expressly rejected the *Amsterdam* rule. *Hamilton* 583 F.2d at 451. Moreover, the *Amsterdam* rule seems to be in direct conflict with the statutory language of section 103 providing copyright protection for compilation of facts. 17 U.S.C. § 103 (1988). See also 1 P. GOLDSTEIN, *supra* note 66, § 2.14.1, at 178.

105. *Rockford Map Publishers*, 768 F.2d at 148.

106. Denicola, *supra* note 32, at 528.

107. *Id.* at 529.

108. See *Schroeder v. William Morrow & Co.*, 566 F.2d 3, 5 (7th Cir. 1977); *Jeweler's Circular Publishing Co. v. Keystone Publishing Co.*, 281 F. 83, 88 (2d Cir. 1922) (Kay, C.J., concurring), *cert. denied*, 259 U.S. 581 (1922); *Nat'l Business Lists, Inc., v. Dunn & Bradstreet, Inc.*, 552 F. Supp. 89, 94 (N.D. Ill. 1982); see also Denicola, *supra* note 32, at 530.

109. Denicola, *supra* note 32, at 530.

110. See *Fin. Information Inc. v. Moody's Investors Serv.*, 808 F.2d 204, 207 (2d Cir. 1986); *Eckes v. Card Prices Update*, 736 F.2d 859, 862 (2d Cir. 1984); *Miller v. Universal City Studios, Inc.*, 650 F.2d 1365, 1369 (5th Cir. 1981). See also 1 P. GOLDSTEIN, *supra* note 66, § 2.14.2; Note, *supra* note 97, at 776.

111. *L. Batlin & Sons, Inc. v. Snyder*, 536 F.2d 486, 490 (2d Cir. 1976), *cert. denied*, 429 U.S. 857 (1976).

112. See 1 P. GOLDSTEIN, *supra* note 66, § 2.14.2, at 183-86; Note, *supra* note 97, at 776.

113. See, e.g., *Schroeder*, 566 F.2d at 5; *Leon v. Pacific Tel. & Tel. Co.*, 91 F.2d 484, 485-86 (9th Cir. 1937); *Rand McNally & Co. v. Fleet Management Sys.*, 591 F.Supp. 726, 731-33 (1983); *Nat'l Business Lists, Inc.*, 552 F. Supp. at 94; see also Denicola, *supra* note 32, at 530.

114. *United States v. Hamilton*, 583 F.2d. 448, 452 (9th Cir. 1978).

115. *Eckes*, 736 F.2d at 863.

116. *Rockford Map Publishers v. Directory Serv. Co.*, 768 F.2d 145, 149 (7th Cir. 1985) (parentheticals added by author). Although Dr. A's molecular coordinates are not a pictorial representation, they still present a "picture" of the protein structure.

117. *Fin. Information, Inc. v. Moody's Investors Serv.*, 808 F.2d 204, 206 (2d Cir. 1986). In *Financial Information*, the court refused copyright protection for the compilation of daily financial reports on municipal bonds, produced without any selection or subjective judgment.

118. See T. BLUNDELL & L. JOHNSON, *supra* note 11, and accompanying text.

119. *Nat'l Business Lists v. Dunn & Bradstreet, Inc.*, 552 F. Supp. 89, 90 (1982).

120. *Id.* at 95.

121. *Id.* at 97.

122. *See* T. BLUNDELL & L. JOHNSON, *supra* note 11, and accompanying text describing the arduous task of determining the molecular coordinates.

123. 17 U.S.C. § 102(b) (1988).

124. "In no case does copyright protection for an original work extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated or embodied in such work." 17 U.S.C. § 102(b) (1988). For a provocative discussion proposing copyright for ideas see Hopkins, *Ideas, Their Time Has Come: An Argument and a Proposal for Copyrighting Ideas*, 46 ALB. L. REV. 443 (1982).

125. *See* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.11[A], at 2-158.

126. *See* *Miller v. Universal City Studios, Inc.*, 650 F.2d 1365, 1368 (5th Cir. 1981). Authorship requires originality of expression, not merely the discovery of a fact. The discoverer merely finds and records. He may not claim that the facts originate with him although there may be originality and hence authorship in the manner of reporting, i.e. the expression of the facts. Regardless of the effort and labor of the discoverer, the facts are not copyrightable. 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.11[E], at 2-166 to -170.

127. *See, e.g.*, *Hoehling v. Universal City Studios, Inc.*, 618 F.2d 972, 979 (2d Cir. 1980), *cert. denied*, 449 U.S. 841 (1980) (factual information is in the public domain); *Rosemont Enterprises, Inc. v. Random House, Inc.*, 366 F.2d 303, 307 (2d Cir. 1966), *cert. denied*, 385 U.S. 1009 (1967).

128. *See* *Morrissey v. Proctor Gamble Co.*, 379 F.2d 675, 678-79 (1st Cir. 1967) (rules describing sweepstakes play were not protected under copyright); *see also Miller*, 650 F.2d at 1368 ("As was the case with ideas, if the expression, arrangement and selection of the facts must necessarily, by the nature of the facts, be formulated in given ways, then they are not copyrightable.").

129. *See, e.g.*, *Herbert Rosenthal Jewelry Corp. v. Kalpakian*, 446 F.2d 738, 742 (9th Cir. 1971).

130. "If anyone may claim authorship of facts, it must be the Supreme Author of us all." 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.03[E], at 2-34.2.

131. *Miller*, 650 F.2d at 1368 (citing 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.03[E]). *See also* Jones, *Is There a Property Interest in Scientific Research Data?*, 1 HIGH TECH. L.J. 447, 464-65 (1986).

132. Jones, *supra* note 131, at 455.

133. *See id.* at 447, 448-49. Jones proposes that scientific data is not copyrightable. However, he distinguishes noncopyrightable "raw" research data from copyrightable conclusions drawn from the examination and compilation of raw data. "Conclusions involve intellectual effort rather than the mere recitation of data, and summaries involve at least a minimal transformation of the data." *Id.* at 448 n.8.

134. *See* *Applied Innovations, Inc. v. Regents of the Univ. of Minnesota*, 876 F.2d 626, 636 (8th Cir. 1989) (statements contained in psychological test were protected by copyright); *Rubin v. Boston Magazine Co.*, 645 F.2d 80, 83 (1st Cir. 1981) (questionnaire based on plaintiff's theory of love relationships was copyrightable). *See also* Jones, *supra* note 131, at 455-56.

135. *See* Jones, *supra* note 131, at 456.

13636. *See* Branden & Jones, *Between Objectivity and Subjectivity*, 343 NATURE 687 (1990) (discussing the difficulties of x-ray diffraction data interpretation); Wlodawer, *Conserved Folding in Retroviral Proteases: Crystal Structure of a Synthetic HIV-1 Protease*, 245 SCIENCE 616, 620 (1989) (discussing the differences between the author's proposed protein structure and previously published structures); Marx, *NCI Team Remodels Key AIDS Virus Enzyme*, 245 SCIENCE 598 (1989).

13737. *See* C. CANTOR & P. SCHIMMEL, *supra* note 12, at 730-36.

13838. *See* Branden & Jones, *supra* note 136, at 687.

13939. Copyright protection for computer programs is based on such a theory. "Where there are various means of achieving the desired purpose, then the particular means chosen is not necessary to the purpose; hence there is expression, not idea." *Whelan Assoc. v. Jaslow Dental Laboratory*, 797 F.2d 1222, 1236 (3d Cir. 1986), *cert. denied*, 479 U.S. 1031 (1987); *see* Note, *Fact or Fiction: A Survey of the Distinction's Impact on Copyright Infringement Claims*, 18 MEMPHIS ST. U.L. REV. 99, 117-18 (1987).

14040. *See* *Applied Innovations, Inc. v. Regents of the Univ. of Minnesota*, 876 F.2d 626, 636 (8th Cir. 1989); *Rubin v. Boston Magazine Co.*, 645 F.2d 80, 83 (1st Cir. 1981); *see also* 1 M. NIMMER & D. NIMMER, *supra* note 41, § 2.03[E], at 2-34.1; Jones, *supra* note 131, at 456.

14141. *See* *Applied Innovations*, 876 F.2d at 636. "[A]lthough the authors began with certain discovered facts, statistical models and mathematical principles, which cannot be copyrighted, they then made certain adjustments on the basis of their expertise, and clinical experience." *Id.*

14242. *See* *United States v. Hamilton*, 583 F.2d. 448, 451 (9th Cir. 1978).

14343. *See* *Eckes v. Card Prices Update*, 736 F.2d 859, 863 (2d Cir. 1984).

14444. *See, e.g.*, *Herbert Rosenthal Jewelry Corp. v. Kalpakian*, 446 F.2d 738, 742 (9th Cir. 1971); *see also* 1 P. GOLDSTEIN, *supra* note 66, § 2.3.2, at 80; 3 M. NIMMER & D. NIMMER, *supra* note 37, § 13.03[B][3], at 13-57.

14545. *Miller v. Universal City Studios, Inc.*, 650 F.2d 1365, 1368 (5th Cir. 1981); *see also* 1 P. GOLDSTEIN, *supra* note 66, § 2.3.2, at 80; 3 M. NIMMER & D. NIMMER, *supra* note 37, § 13.03[B][3], at 13-57.

14646. *See* *Whelan Assoc. v. Jaslow Dental Laboratory, Inc.*, 797 F.2d 1222, 1240 (3d Cir. 1986), *cert. denied*, 479 U.S. 1031 (1987); *Landsberg v. Scrabble Crossword Game Players, Inc.*, 736 F.2d 485, 489 (9th Cir. 1984); *Herbert Rosenthal Jewelry Corp. v. Kalpakian*, 466 F.2d at 740; *see also* 3 M. NIMMER & D. NIMMER, *supra* note 37, § 13.03[B][3], at 13-57 to -59.

14747. 876 F.2d 626, 636 (8th Cir. 1989).

14848. *Id.*

14949. *Id.*; *see also*, *Rubin v. Boston Magazine Co.*, 645 F.2d 80, 83 (1st Cir. 1981).

15050. *See, e.g.*, C. CANTOR & P. SCHIMMEL, *supra* note 12, at 343-45.

15151. *Id.* at 344-45. Although the molecular coordinates are one of the most accurate methods of describing a protein structure, often this amount of detail is not necessary for further scientific research. For example, fluorescence and NMR techniques have been successfully used to detail smaller, specific areas of the protein. Knowledge of the whole protein structure, as represented by the molecular coordinates, is not necessary to determine, for example, the antigenic portion of a protein.

15252. 17 U.S.C. § 106 (1988).

15353. The Copyright Act provides for fair use as follows:

Notwithstanding the provisions of section 106, the fair use of a copyrighted work, including such use by reproduction in copies or phonorecords or by any other means specified in that section, for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research, is not infringement of copyright. In determining whether the use made of a work in any particular case is a fair use the factors to be considered shall include-

(1) the purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational

purposes;

(2) the nature of the copyrighted work;

(3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and

(4) the effect of the use upon the potential market for or value of the copyrighted work.

17 U.S.C. § 107 (1988).

154. In addition to a fair use defense, Dr. B may also contend that Dr. A is estopped from asserting copyright infringement due to the scientific nature of the work. The doctrine of estoppel can be invoked if four elements are met: 1) the plaintiff must know the facts of defendant's conduct; 2) plaintiff's conduct must be reasonably misleading to the defendant; 3) the defendant must be ignorant of the true facts; and 4) the defendant must detrimentally rely on plaintiff's conduct. *See Hampton v. Paramount Pictures Corp.*, 279 F.2d 100, 104 (9th Cir. 1960), *cert. denied*, 364 U.S. 882 (1960); *Nat'l Business Lists v. Dunn & Bradstreet, Inc.*, 552 F. Supp. 89, 97 (N.D. Ill. 1982).

Dr. A's molecular coordinates are a scientific work that, customarily, once published, are freely available for reproduction. Furthermore, she deposited the database, containing the coordinates, in the data bank with the knowledge of their accessibility to others. Dr. B contends that these actions led him to believe that copying the coordinates was permissible. However, that is precisely why Dr. A chose to copyright her coordinates. If Dr. A wanted to publish her article, she was required to deposit the coordinates. *See supra* note 20 and accompanying text. Yet, she also wanted to protect them from unauthorized copying from the data bank. Consequently, she copyrighted the coordinates and affixed notice of copyright to the database.

Factor 3 states that the defendant must be ignorant of the true facts. To maintain his contention of estoppel, Dr. B must be able to disavow any knowledge of possible copyright protection of Dr. A's coordinates. Dr. B cannot hope to meet this "particularly onerous burden." *See* 2 P. GOLDSTEIN, COPYRIGHT, § 9.5.2, at 176 (1989). The appearance of the copyright notice on Dr. A's coordinates is sufficient to defeat the estoppel claim. *Id.* Dr. B is charged with notice, and is obligated to make reasonable inquiries of the circumstances. *See Hampton*, 279 F.2d at 104.

It is important to note that the scientific community is acutely aware of the problems associated with deposition of coordinates in a central data bank. *See Barinaga, supra* note 20, at 1180. The Commission on Biological Macromolecules of the International Union of Crystallographers is currently formulating a policy that would require deposition of coordinates, but permit the researcher to delay their release for one to four years. *Id.*

15555. *Harper & Row Publishers v. Nation Enters.*, 471 U.S. 539, 549 (1985) (quoting H. BALL, LAW OF COPYRIGHT AND LITERARY PROPERTY 260 (1944)).

15656. *See Denicola, supra* note 32, at 524 "[T]he doctrine of fair use...operates when the objectives of the copyright system would be frustrated rather than furthered by a finding of infringement."); *see also Gorman, supra* note 66, at 1603-05.

15757. *Sony Corp. of Am. v. Universal City Studios, Inc.*, 464 U.S. 417, 477 (1984) (Blackmun, J., dissenting). Fair use has been the subject of many cases and commentaries. *See, e.g., Nation Enters.*, 471 U.S. at 569 (verbatim copying of 300 to 400 words of the copyrighted work is not fair use); *Sony Corp. of Am.*, 464 U.S. at 456 (home video tape recording of copyrighted works for "time-shifting" is fair use).

See also, 3 M. NIMMER & D. NIMMER, *supra* note 37, § 13.05[A] (quoting from McDonald, *Non Infringing Uses*, 9 BULL. COPYRIGHT SOC. 466, 467 (1962), as a succinct expression of the concept of fair use: "Take not from others to such an extent and in such a manner that you would be resentful if they so took from you."); W. PATRY, THE FAIR USE PRIVILEGE IN COPYRIGHT LAW 361-70 (1985).

15858. 17 U.S.C. § 107 (1988).

15959. H.R. REP. NO. 1476, 94th Cong. 2d Sess. 66 (1976) *reprinted in* 1976 U.S. CODE CONG. & ADMIN. NEWS 5659, 5679; *see also Sony Corp. of Am.*, 464 U.S. at 448 (taping of copyrighted movies for in-home use held to be fair use); *Consumers Union, Inc. v. Gen. Signal Corp.*, 724 F.2d 1044, 1049 (2d Cir. 1984), *cert. denied*, 469 U.S. 823 (1984) (vacuum cleaner manufacturer quoting

Consumer Union ratings in its advertisements held to be fair use); *Rosemont Enters. v. Random House*, 366 F.2d 303, 309 (2d Cir. 1966) (verbatim copying of phrases expressing biographical facts regarding Howard Hughes held to be fair use).

16060. *See Gorman, Fact or Fancy? The Implications for Copyright*, 29 J. COPYRIGHT SOC'Y. 560, 561 (1982).

16161. *See, e.g., Francione, Facing The Nation: The Standards for Copyright, Infringement and Fair Use of Factual Works*, 134 U. PA. L. REV. 519, 522 (1986).

16262. *Id.* at 522-23.

16363. 471 U.S. 539, 569 (1985); *see also* Francione, *supra* note 161, at 522.

16464. *Nation Enters.*, 471 U.S. at 548 ("The Nation's appropriation of unoriginal and uncopyrightable elements encroached on the originality embodied in the work as a whole.") (emphasis added).

In *Nation Enters.*, President Gerald Ford contracted with Harper & Row to publish a rendition of his memoirs. As the publication date approached, Harper & Row entered into an exclusive licensing agreement with Time, Inc., permitting Time to print excerpts from the upcoming book. The Nation Magazine acquired a copy of the Ford manuscript and prepared its own article, using "quotes, paraphrases and facts drawn exclusively from the manuscript." *Id.* at 543.

The Federal District Court, recognizing that historical facts were not copyrightable per se, held that the "totality" of facts, memorandum and personal reflections was protected by copyright law. *Nation Enters.*, 557 F. Supp. 1067, 1072-73 (1983).

The Court of Appeals for the Second Circuit reversed. *Nation Enters.*, 723 F.2d 195, 209 (2d Cir. 1983). The majority rejected the theory of a copyrightable "totality" of fact and expression. At most, 300 words from the original manuscript were protected by copyright. *Id.* at 206. The appellate court therefore held that the Nation's use of these words and phrases constituted a "fair use" under the 1976 Copyright Act. *Id.* at 208.

The Supreme Court focused on the fair use doctrine, and all but ignored the controversy between the two lower courts. The Court held that The Nation's use of the Ford material was not a fair use. *Nation Enters.*, 471 U.S. at 569. However, the reasoning of the Court incorporated some of the district court's totality theory. "Some of the briefer quotes...are arguably necessary adequately to convey the facts;...[s]uch use, focusing on the most expressive elements of the work, exceeds that necessary to disseminate the facts." *Id.* at 563-64.

See also, Francione, *supra* note 161, at 567-75.

16565. *See* Francione, *supra* note 161, at 522.

16666. *Nation Enters.*, 471 U.S. at 560-69.

16767. 17 U.S.C. § 107 (1988).

16868. *See* 3 M. NIMMER & D. NIMMER, *supra* note 37, § 13.05, at 13-63 to -64.

16969. *Pac. and S. Co. v. Duncan*, 744 F.2d 1490, 1495 n.8 (9th Cir. 1984).

17070. *Id.* at 1495.

17171. *Sony Corp. of Am. v. Universal City Studios, Inc.*, 464 U.S. 417, 451 (1984); *see also* W. PATRY, *supra* note 157, at 365; Francione, *supra* note 161, at 549 n.164.

17272. *Sony Corp. of Am.*, 464 U.S. at 451.

17373. *See* W. PATRY, *supra* note 157, at 367-68.

17474. *Rosemont Enters. v. Random House*, 366 F.2d 303, 307 (2d Cir. 1966); *see also* Francione, *supra* note 161, at 543-51.

175. *Sony Corp. of Am.*, 464 U.S. at 451.

176. *Id.*

177. *Id.*

17878. *Harper & Row Publishers v. Nation Enters.*, 471 U.S. 539, 562 (1985).

17979. 17 U.S.C. § 107 (1988).

18080. *See* Abramson, *How Much Copying Under Copyright? Contradictions, Paradoxes, Inconsistencies*, 61 *TEMPLE L. REV.* 133, 156 (1988); *see also* Gorman, *supra* note 66, at 1603.

18181. Gorman, *supra* note 160, at 563.

18282. "[F]air use of a copyrighted work, [includes reproduction] for purposes such as criticism, comment, news reporting, teaching, ... scholarship, or research." *Harper & Row Publishers v. Nation Enters.*, 471 U.S. 539, 563 (1985). *See also* 17 U.S.C. § 107 (1988); Abramson, *supra* note 180, at 156; Gorman, *supra* note 66, at 1603.

18383. *See Nation Enters.*, 471 U.S. at 563. *See also* Gorman, *supra* note 160, at 561-63.

18484. *Contra Nation Enters.*, 471 U.S. at 550 ("[A] reviewer may fairly cite largely from the original work, if his design be really and truly to use the passages for the purposes of fair and reasonable criticism. On the other hand, it is clear, that if he thus cites the most important parts of the work, with a view, not to criticize, but to supersede the use of the original work, and substitute the review for it, such a use will be deemed in law a piracy.") (*quoting* Story, J. in *Folsom v. Marsh*, 9 F. Cas. 342 (No. 4901) (CC Mass. 1841)).

18585. In addition, subsequent researchers use published experimental protocols on their own samples and materials. For example, a new procedure for determining the concentration of a drug in human subjects may be used by other researchers throughout the country to produce their own data. They do not copy the published data from the journal article. *See* Jones, *supra* note 131, at 448.

18686. *Nation Enters.*, 471 U.S. at 549-50. *See* Abramson, *supra* note 180, at 156. Professor Abramson decries this "implied consent" rationale as "unsupportable." *Id.* An author who claims infringement has clearly not consented to a use of his work. "[T]o claim that an author should reasonably have consented...can only be determined by a rigorous, complete fair use analysis." *Id.*

18787. *See, e.g., Time, Inc. v. Bernard Geis Assoc.*, 293 F. Supp. 130, 146 (1968) (the court permitted the appropriation of "still" photographs from plaintiff's film on the assassination of President Kennedy, stating that the public had an "interest in having the fullest information available on the murder...").

However, the Supreme Court in *Nation Enters.* stated that "[t]he fact that a work is unpublished is a critical element of its 'nature.'" 471 U.S. at 564; *see also* *Salinger v. Random House, Inc.* 811 F.2d 90, 97 (2d Cir. 1987), *cert. denied*, 484 U.S. 890 (1987) ("Narrower 'scope' seems to refer to the diminished likelihood that copying will be fair use when the copyrighted material is unpublished.").

Dr. A's molecular coordinates were not "published" in the statutory sense. "Publication is the distribution of copies...of a work to the public by sale or other transfer of ownership, or by rental, lease or lending....A public performance or display of a work does not of itself constitute publication." 17 U.S.C. § 101 (1988). Dr. A merely deposited her coordinates in the data bank, as required by the scientific journal.

This is analogous to the situation in *Salinger v. Random House*, where the court found that liberal quotes taken from unpublished, copyrighted letters written by author J. D. Salinger and subsequently published in a biography without his permission was not fair use, notwithstanding the fact that these letters were available for examination at various university libraries. "Salinger's letters are unpublished, and they have not lost that attribute by their placement in libraries where access has been explicitly made subject to observance of at least the protections of copyright law." 811 F.2d at 97. *See also* Comment, *Guardian of the Public Interest: An*

18888. *Iowa State Univ. Research Found. v. Am. Broadcasting Cos.* 621 F.2d 57, 61 (2d Cir. 1980) (ABC's copying and broadcast of approximately three minutes of plaintiff's copyrighted film biography of an Olympic wrestler was not fair use).

18989. *See Nation Enters.*, 471 U.S. 539, 565 "[T]he fact that a substantial portion of the infringing work was copied verbatim is evidence of the qualitative value of the copied material, both to the originator and to the plagiarist who seeks to profit from marketing someone else's copyrighted expression.").

19090. *Nation Enters.*, 471 U.S. at 564-65; *accord Meeropol v. Nizer*, 560 F.2d 1061, 1070-71 (2d Cir. 1977), *cert. denied*, 434 U.S. 1013 (1978) (although copyrighted material constituted only a small percentage of the infringing work, it played an essential role in the story).

19191. *See supra* note 31 and accompanying text.

19292. *See Matthews & Bolognesi, supra* note 31, at 120. The entire virus or bacteria need not be present to trigger the immune response. Only key, characteristic areas of the organism's proteins, the antigenic or immunogenic portion, need be exposed to the body's antibody-producing cells. Once the body has been exposed to a foreign organism, the immune system is "imprinted" with the structure of the antigen in its memory. Upon subsequent exposure to that antigen, the immune response intensifies. This is the basis of vaccination as a means of preventing disease. *Id.*

However, vaccination with the organism, either live or killed, can lead to some harmful side-effects. For example, the diphtheria-pertussis-tetanus vaccine (DPT) is associated with convulsions in 1 out of every 1750 doses and permanent brain damage in 1 out of every 310,000 doses. Steinmen, Weiss, Adelman, Lim, Zunigan, Oehlert, Hewlett, Falkon & Zamril, *Molecular Analysis of Pertussis Encephalopathy*, in VACCINES '86: NEW APPROACHES TO IMMUNIZATIONS 187 (1986); *see also* Grey, Sette & Buus, *How T Cells See Antigen*, SCIENTIFIC AMERICAN, Nov. 1989, at 56.

Whole-organism or whole-protein vaccines can also induce immune responses that cross-react with other vital proteins, and thus lack the specificity to be effective. *See* Stevens, *A Synthetic Peptide Vaccine Against Human Chorionic Gonadotrophin*, in VACCINES '86: NEW APPROACHES TO IMMUNIZATIONS 39 (1986).

Problems such as these have led researchers to synthesize small portions of the organisms and proteins to use as the basis of vaccines. The use of a molecular map to determine which segments of the protein would be most effective in eliciting an immune response has been used in a number of situations. *See, e.g.*, Wilson, Bergmann & Stura, *Structural Analysis of Antipeptide Antibodies Against Influenza Virus Hemagglutinin*, in VACCINES '86: NEW APPROACHES TO IMMUNIZATIONS 33 (1986).

19393. *Compare* *Hoehling v. Universal City Studios* 618 F.2d 972, 974 (2d Cir. 1980), *cert. denied*, 449 U.S. 841 (1980) ("[A]bsent wholesale usurpation of another's expression, claims of copyright infringement where works of history are at issue are rarely successful.") *with* *Meeropol v. Nizer*, 560 F.2d 1061, 1071 (2d Cir. 1977) (use of copyrighted letters of Julius and Ethel Rosenberg, comprising less than one percent of the entire work, deemed a substantial taking).

In *Nation Enterprises*, the Supreme Court discussed quantitative versus qualitative substantiality. *Nation Enters.*, 471 U.S. at 564-66. "In absolute terms, the words actually quoted were an insubstantial portion." *Id.* at 564. Nonetheless, the Court found that the copied words took "essentially the heart of the book." *Id.* at 565.

19494. *Id.* at 566. *See, e.g.*, Abramson, *supra* note 180, at 165.

19595. "The major consideration in evaluating economic injury is market substitution, that is, whether the use tends to displace the original in the marketplace, by cutting into its sales or marketability." Abramson, *supra* note 180, at 159.

19696. *See* 3 M. NIMMER & D. NIMMER, *supra* note 37, § 13.05[A][4] at 13-80 to -82. This factor has often been cited as the most important fair use factor because it gets to the heart of copyright law: the balance between protecting the author's economic interests and the public benefit in obtaining the information. *See infra* Section III.

19797. Abramson, *supra* note 180, at 165.

19898. "Proof of actual harm, or even probable harm, may be impossible in an area where the effect of a new technology is speculative...." *Sony Corp. of Am. v. Universal City Studios*, 464 U.S. 417, 482 (1984) (Blackmun, J., dissenting). However, some market impairment must be likely. *See Salinger v. Random House, Inc.* 811 F.2d 90, 99 (2d Cir. 1987), *cert. denied*, 484 U.S. 890 (1987).

19999. *See Sony Corp. of Am.*, 464 U.S. at 450-51. *See also* Abramson, *supra* note 180, at 160-61. A test for economic harm to the author, rather than a commercial purpose test for the infringing work, is preferable. "'Commerciality' focuses on benefit gained by the alleged infringer; 'economic injury' focuses on detriment to the original author. The incentive scheme of copyright mandates that the detriment must be taken into account. Profits of another author are, by themselves, no disincentive to creation." *Id.* at 160.

Furthermore, some commercial uses do not compromise the economic potential of the copyrighted work. For example, a parody of a work does not necessarily diminish the market for the original. The parody is aimed at a different market than the original work. *Id.* at 171-76.

20000. *See Sony Corp. of Am.*, 464 U.S. at 451.

20101. Dr. A's laboratory resources are geared to determining crystallographic structures, not producing, testing and marketing vaccines. She would typically rely on outside collaboration for further development.

20202. This is especially true if Dr. B's vaccine meets the statutory criteria for patentability. A patented vaccine could effectively exclude any subsequent vaccine from the market.

20303. Diminished market share means diminished profit-return to these companies. Profitability is a key factor in deciding which collaborations to establish. *See* OFFICE OF TECHNOLOGY ASSESSMENT, PATENT-TERM EXTENSION AND THE PHARMACEUTICAL INDUSTRY, OFFICE OF TECHNOLOGY ASSESSMENT REPORT 16-19 (1988).

These companies rely heavily on the proprietary rights of their products to ensure adequate returns. Patent protection has been the traditional choice. *Id.* at 11-12. However, the statutory requirements of patentability set forth in 35 U.S.C. §§ 101-103 (1982) (usefulness, novelty and non-obviousness) would be difficult to satisfy for Dr. A's potential vaccine if Dr. B announces an effective vaccine. *See* Ihnen, *supra* note 15, at 410-14.

A detailed discussion of patentability of a virus vaccine is outside the scope of this article. Mr. Ihnen's article offers an excellent summary of the pertinent points.

20404. The role of traditional scientific norms in modern, biotechnological research will be discussed in detail in Section III.

20505. If "suitable" collaboration is with a pharmaceutical company, release of her data may be suppressed until a patentable product is developed. Alternatively, the company may suppress the information as a trade secret. *See* Barinaga, *supra* note 20, at 1180. Copyright would protect the information, yet permit the dissemination of the data throughout the scientific community.

20606. *See Sony Corp. of Am. v. Universal City Studios*, 464 U.S. 417, 432 (1984).

20707. *See, e.g.,* Abramson, *supra* note 180, at 152.

20808. *See* Eisenberg, *supra* note 3, at 181.

20909. *Id.* at 183.

21010. We are all familiar with the "publish or perish" mandate to secure faculty tenure. A commentator suggests that the altruistic ideals of academic science "may never have the force that the community would like them to have." *Id.* at 205. Even in the purely academic setting, competition is evident. *Id.* at 182 n.17 (discussing the competition between two teams of scientists racing to determine the structure of DNA); *see also* Note, *supra* note 7, at 205.

21111. *See* Eisenberg, *supra* note 3, at 197. The traditional scientific community acknowledges some reluctance to aid the competition. However, the first person to publish reaps rewards which tend to offset this reluctance and encourage early disclosure.

21212. *See* Sony Corp. of Am. v. Universal City Studios, 464 U.S. 417, 477 (1984) (Blackmun, J., dissenting). *See also* 17 U.S.C. § 107 (1988).

21313. *Sony Corp. of Am.*, 464 U.S. at 477-78 (Blackmun, J., dissenting).

21414. *See* Note, *supra* note 7, at 195 (discussing the concerns of the "commercialization of academic biomedical research").

21515. *Cf.* Nelkin, *Intellectual Property: The Control of Scientific Information*, 216 SCIENCE 704, 704 (1982). Nelkin discusses the control of scientific information in light of the evolving relationships of science to government and industry. "[Q]uestions [concerning the control of scientific data] have long been controversial because of the application of science to practical problems and its role in public affairs. They have become more urgent, however, as the gap between the production of knowledge and its application has narrowed." *Id.* Although Professor Nelkin does not limit her discussion to any single field of science, her characterization is especially applicable to biotechnology.

21616. *See, e.g.*, Note, *supra* note 7, at 195-99. "Biotechnology is regarded as more of an academic science which should not be commercially influenced." *Id.* at 195.

21717 *See* Eisenberg, *supra* note 3, at 178 n.2 (providing an excellent overview of the changing trends in research funding in the 1980s); *see also* Note, *supra* note 7, at 192.

21818. Shulman, *Changing Relationships Seen in New Corporate-University Ties*, 335 NATURE 106, 106 (1988) (industrial funding for research has risen 20% annually at Massachusetts Institute of Technology, now totalling about 15% of all money spent on research at the school).

21919. *See* Note, *supra* note 7, at 199-201.

22020. *Id.* at 193.

22121. *Id.* at 192 (in 1981, Massachusetts General Hospital and Hoechst, A.G. entered into a formal agreement to create a new department of molecular biology to undertake new research projects).

22222. *See* Henry, *supra* note 18, at 993.

22323. Nelkin, *supra* note 215, at 707. Researchers would be faced with the situation Dr. A was presented with, either publishing her data or maintaining secrecy until a patentable product is produced. If every scientist opted for secrecy, progress could be significantly hindered.

22424. Industry's primary motive for these joint-ventures is profit. *See* Note, *supra* note 7, at 199. Industry's need to protect its investment requires protection of the research information from unauthorized exploitation. *Id.* at 193. In the past, industry has relied heavily on trade secret protection. *Id.* at 218. However, trade secret protection requires strict maintenance of secrecy, which conflicts with traditional, scientific values. *Id.* at 219, 221.

Patent protection, based on full disclosure of the invention, encourages the dissemination of the scientific information. *See* Eisenberg, *supra* note 3, at 206. However, the patentability of biotechnological innovation in many areas remains questionable. *See supra* note 15 and accompanying text.

22525. *See* Nelkin, *supra* note 215, at 708.

22626. *Id.*

22727. *Twentieth Century Music Corp. v. Aiken*, 422 U.S. 151, 156 (1975).

22828. *See* Sony Corp. of Am. v. Universal City Studios, 464 U.S. 417, 429 (1984). The purpose of copyright law is to "promote the

Progress of Science and the Useful Arts." U.S. CONST. art. I, § 8, cl. 8; *see also* Mazer v. Stein, 347 U.S. 201, 219 (1954) ("[E]ncouragement of individual effort by personal gain is the best way to advance public welfare through the talents of authors and inventors.").

22929. *See* Sobel, *Copyright and the First Amendment: A Gathering Storm?*, 19 COPYRIGHT L. SYMP. (ASCAP) 43, 62, 76 (1971). "If every volume that was in the public interest could be pirated away by a competing publisher,...the public [soon] would have nothing worth reading." *Id.* at 78.

This statement does not imply that fictional works are of less importance to society than factual works. It merely reflects the current judicial reluctance to expand copyright protection of factual works. *See, e.g.,* Miller v. Universal Studios, 650 F.2d 1365, 1372 (5th Cir. 1981). "The valuable distinction in copyright law between facts and the expression of facts cannot be maintained if research is held to be copyrightable." *Id.* at 1372. However, "[c]opyright does not offer a monopoly over facts; it merely requires later authors to return to the public domain sources of [or receive permission to use] those facts rather than copy directly from the copyrighted work." Denicola, *supra* note 32, at 541. "One unresolved question is whether defendant's work serves the public interest or if it is primarily entertainment." Some courts have protected the social value of pure entertainment. Gordon, *Fair Use as Market Failure: A Structural and Economic Analysis of the Betamax Case and its Predecessors*, 82 COLUM. L. REV. 1600, 1638 (1982). However, some courts have required a showing of some additional claim of public interest. Cases discussing the eligibility of parody for fair use protection highlight this debate. *Id.* at 1638-39 nn.208-12.

23030. U.S. CONST. art. I, § 8, cl. 8.

23131. *See, e.g.,* Denicola, *supra* note 32, at 519.

23232. *See* Jones, *supra* note 131, at 469.

23333. *Id.* at 470.

23434. *See* Sony Corp. of Am. v. Universal City Studios, 464 U.S. 417, 431-32 (1984); Twentieth Century Music Corp. v. Aiken, 422 U.S. 151, 156 (1975).

23535. *Sony Corp. of Am.*, 464 U.S. at 430. Congress has amended the Copyright Act to accommodate the technology of cable television (17 U.S.C. § 111 (1988)), phonorecordings (17 U.S.C. § 115 (1988)) and semiconductor computer chips (17 U.S.C. §§ 901-914 (1988)).

Congress has also amended the Patent Act to allow universities and other nonprofit organizations to patent work funded by federal agencies. 35 U.S.C. § 200 (1982). "It is the policy and objective of Congress to use the patent system to promote...collaboration between commercial concerns and nonprofit organizations, including universities;...to promote the commercialization and public availability of inventions made in the United States...." *Id.*

In 1970, Congress also amended the Plant Patent Act of 1930 to accommodate new and distinct varieties of plants. Plant Variety Protection Act of 1970, 7 U.S.C. § 2321 (1988).

23636. *Sony Corp. of Am.*, 464 U.S. at 430-31. "Congress can safely move forward if the cost to the public...is deemed to be less than the value to the public of the total benefits caused by the law." Kastenmeier & Remington, *The Semiconductor Chip Protection Act of 1984: A Swamp or Firm Ground?*, 70 MINN. L. REV. 417, 442 (1985) (discussing the merits of a sui generis approach versus amending the Copyright Act for the protection of mask works). "[T]he [Semiconductor Chip] Act has precedential value for other new technologies....Recent strides in the fields of...molecular and genetic engineering...also provide fertile ground for future congressional scrutiny and oversight." *Id.* at 468-69. "Indeed, it points to the need to rethink and broaden our concepts of protectable intellectual property." *Id.* at 469 n.215 (quoting the President's Commission on Industrial Competitiveness). "New concepts of what intellectual property is and how it should be protected...may well be needed, as may sweeping changes in intellectual property laws, and how they are administered." *Id.*

23737. *See* Francione, *supra* note 161, at 597.

23838. *Sony Corp. of Am.*, 464 U.S. at 431. "The judiciary's reluctance to expand the protections afforded by copyright without explicit legislative guidelines is a recurring theme. Sound policy, as well as history, support our consistent deference to Congress when

major technological innovations alter the market for copyrighted materials." *Id.* (citations omitted).

See Francione, supra note 161, at 597. For example, the Supreme Court avoided this controversial area when it "declined to discuss the merits of the totality approach" to copyrightability of factual works in *Harper & Row, Publishers v. Nation Enters.*, 471 U.S. 539 (1985). Instead the court focused on the fair use defense. *Id.*

23939. *See Note, supra* note 7, at 234.

24040. The Semiconductor Chip Protection Act of 1984, 17 U.S.C. §§ 901-914 (1988); Compulsory License for Secondary Transmissions by Cable Systems, 17 U.S.C. § 111(d) (1988).

24141. 17 U.S.C. §§ 901-914 (1988).

24242. The Semiconductor Chip Protection Act defines a mask work as:

a series of related images, however fixed or encoded-

(A) having or representing the predetermined, three-dimensional pattern of metallic, insulating, or semiconductor chip product; and

(B) in which series the relation of the images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product.

17 U.S.C. § 901(a)(2) (1988).

24343. The Senate Commission did not believe that the full term of copyright protection was needed in the case of semiconductor chips. "A ten-year term appears sufficient to provide incentives and security of investment to encourage a desired level of innovation and research and development. This term is also consistent with that generally afforded industrial property." SENATE COMM. ON THE SEMICONDUCTOR CHIP PROTECTION ACT OF 1984, S.REP. NO. 425, 98th Cong., 2d Sess. 22, *reprinted in* BAUMGARTEN, THE SEMICONDUCTOR CHIP PROTECTION ACT OF 1984 236 (1984).

24444. *See Kastenmeier & Remington, supra* note 236, at 444.

24545. 35 U.S.C. § 154 (1982) (term of patent protection is seventeen years).

24646. 17 U.S.C. § 302 (1988).

24747. *See supra* notes 210-11 and accompanying text.

24848. In the case of the molecular map, the molecular coordinates derived from the x-ray or NMR data must also be deposited in a database, allowing other scientists to access the structure of the protein after publication. *See supra* notes 20, 28 and accompanying text.

An argument may be made that a shortened term of copyright may actually encourage scientists to protect their innovations as trade secrets. Although an in-depth discussion of the reasonable precautions needed to maintain a trade secret is beyond the scope of this paper, such precautions would be extremely difficult to maintain in the typical university research laboratory. *See, e.g., Note, supra* note 7, at 219-23.

24949. *See supra* notes 21-25 and accompanying text.

25050. *See Barinaga, supra* note 20, at 1180. Ambiguous portions of the molecular map may require several more cycles of mathematical contouring to determine the precise position of atoms in a particular region of the protein. Unfortunately, even a slight error in the placement of a few atoms can cause serious damage to other developments in the scientific community. *See also Marx, supra* note 136, at 598.

Furthermore, misinterpretation of the data by another researcher may damage the professional reputation of the original author/scientist. Other researchers may believe the error lies with the original author. The scientist is then forced to defend himself by disparaging the other scientist. Situations such as these seriously impede the progress of science and harm the integrity of the scientific community. These situations could be avoided if the original scientist were permitted control over the accessibility to the coordinates.

25151. *See* Kayton, *supra* note 7, at 192-94 for an excellent discussion on the copyrightability of recombinant DNA. *See also* Comment, *supra* note 2, at 1096-1107.

Monoclonal antibodies and genetically-engineered viruses and microorganisms may also be suitable for copyright protection. As the scope of the prior art widens in these areas of biotechnology, satisfying the non-obviousness requirement for patentability of these innovations will become more difficult. *Id.* at 1108.

Furthermore, these innovations often lack the requisite utility for patentability. *See, e.g.*, *Brenner v. Manson*, 383 U.S. 519, 528-29 (1966) (patentable product itself must be useful, not simply the basis of further research).

25252. One need only remember that it has been merely six years (since 1984) since AIDS was conclusively shown to be caused by the human immunodeficiency virus to realize how quickly innovative research can progress. *See* Yarchoan, Mitsuya & Broder, *AIDS Therapies*, SCIENTIFIC AMERICAN, Oct. 1988, at 110.

25353. *See* Denicola, *supra* note 32, at 541. Copyright protection extends only to that particular expression of the underlying facts. Another scientist could still use those facts, as they exist in the public domain, and independently reproduce the same innovation.

25454. "Compulsory licenses are a likely compromise when new rights are granted." Gordon, *supra* note 229, at 1614 n.84.

25555. 17 U.S.C. § 111 deals with compulsory licenses for secondary transmissions by cable television systems; § 115 provides for compulsory licenses for making and distributing phonorecords; § 116 concerns compulsory licenses for jukebox performances; § 118 provides for compulsory licenses for noncommercial educational broadcast stations permitting them to perform published musical compositions. 17 U.S.C. §§ 111, 115, 116, 118 (1988).

25656. *See, e.g.*, 17 U.S.C. § 115 (1988).

25757. Jones, *supra* note 131, at 482.