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The New Prometheus: Will Scientific Inquiry Be Bound by the Chains of Government Regulation

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"Eppur si muove"
—Galileo Galilei[1]

I. Introduction

The Prometheus of ancient lore stole fire from the gods, delivering it to mankind to allow men to protect themselves from Zeus.[2] Today, science, like the mythical Titan, is discovering the secrets of the universe and delivering them to mankind for its betterment. For Prometheus' efforts in helping an unworthy mankind, Zeus had him chained to a crag in Scythia at the ends of the earth. Will the government of today demand an equivalent price of science? In return for the benefits of fire, Zeus extracted a heavy price from mankind: he sent them Pandora's box filled with evil, disease, and hardship. Will the price that present society pays for the benefits of science be equally high?

Until recently there has been very little desire expressed to control science. Society has been indifferent to the activities of scientists in their labs and has generally accepted the benefits of science. Nevertheless, it is recognized that the process as well as the product of science can present society with potential risks of harm.

Consider for a moment some of the various areas with which science is grappling: the deciphering of the genetic code of the DNA molecule,[3] the creation of human life outside the womb,[4] research on fetal

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1. "And yet it does move." Legend has it that Galileo muttered this defiantly in response to the demand of the Inquisition that he repudiate the Copernican Heliocentric Theory of the Universe. This phase marked but the first round in the continuing confrontation between the truth-seeking enterprise of scientific inquiry and the government. *See* W. Durant & A. Durant, The Age of Reason Begins 600-12 (1961).

2. *See* E. Tripp, Handbook of Classical Mythology 499-501 (1970).

3. *See* notes 220-27 and accompaning text *infra.*

4. *See* note 165 and accompanying text *infra* for a discussion on external human fertilization.

development,[5] and determining the biochemistry of the brain.[6] Each of these activities has created new risks of harm which could arise out of the new knowledge itself (or its misapplication),[7] or from the carrying out of an experiment. As a result of the original research on recombinant DNA, there arose an awareness of these new risks which impose the possibility of physical injury to the public at large. This awareness gave rise to the government's first real attempt to control scientific experimentation.[8]

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5. *See* notes 200-13 and accompanying text *infra*.

6. Science is just beginning to understand the biological system known as the human mind. The interaction of billions of neuron cells as well as innumerable hormones is the most complex entity man has considered. *See generally* R. RESTACK, THE BRAIN, THE LAST FRONTIER (1979); P. RUSSELL, THE BRAIN BOOK (1979). Legal issues are beginning to arise because, as knowledge increases, so does the ability to manipulate the mind. As an alternative to our present penal system, one sociologist proposes to make use of advances in knowledge of the human mind:

> It might be possible to trace priority structures in the brain and selectively erase or replace inappropriate priorities in much the same manner that one edits a computer program by erasing unneeded subprograms and routines. Although one effect would be some memory loss, a totally different feeling and priority structure and concomitant personality change could be achieved. It also could be possible to edit memory structures selectively and arrange either short- or long-term memory loss without disabling consequences.
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> Techniques of brain editing are potentially the most effective means of incapacitating known offenders from committing future crimes.

Lehtinen, *Controlling the Minds and Bodies of Prisoners—Without Prisons*, BARRISTER, Fall, 1979, at 13.

7. Some states made the judgment that the study of Darwin's theory of evolution was dangerous to the school children of the state and passed laws to preclude the teaching of this concept. In Tennessee, this resulted in the infamous Scopes Monkey Trial. *See* Scopes v. State, 154 Tenn. 105, 289 S.W. 363 (1927). The United States Supreme Court overturned similar legislation in Arkansas. Epperson v. Arkansas, 393 U.S. 97 (1968).

8. On September 21, 1973, *Science* published a letter signed by Maxine Singer and Dieter Soll addressed to the presidents of the National Academy of Sciences and the Academy's Institute of Medicine. The letter read in part as follows:

> We are writing to you, on behalf of a number of scientists, to communicate a matter of deep concern. Several of the scientific reports presented at this year's Gordon Research Conference on Nucleic Acids . . . indicated that we have the technical ability to join together . . . DNA molecules from diverse sources . . . .
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> . . . .
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> Certain such hybrid molecules may prove hazardous to laboratory workers and to the public. Although no hazard has yet been established, prudence suggests that the potential hazard be seriously considered.

Singer & Soll, *Guidelines for DNA Hybrid Molecules*, 181 SCIENCE 1114 (1973).

In 1974, scientists engaged in recombinant DNA research called for a voluntary moratorium on certain experiments, and outlined guidelines to control such research. Letter from Berg, et al., 185 SCIENCE 303 (1974). After further debate and meetings, the National Institute of Health (NIH) released a set of guidelines in June, 1976. National Institutes of Health, Recombinant DNA Research, 41 Fed. Reg. 27,902, 27,911 (1976). For proposed revised guidelines, see 43 Fed. Reg. 33,042 (1978).

Counterbalancing this new desire to control science, are several equally important societal interests. Society has a long-standing interest in the acquisition of scientific knowledge and the free flow of such information,[9] as well as the preservation of the maximum number of choices for an individual.[10] Finally, the development of new technology is dependent upon unrestrained scientific inquiry, and without continuing technological growth, development within the areas of health care, employment, business, and defense will stagnate. These above policies, considered within the framework of our constitutional system, support a strong argument for a constitutional right of scientific inquiry.

During the past decade there have been several instances in which the government has imposed restraints upon scientific inquiry[11] without giving full consideration to the existence of such a right. The existence of a right would place substantial limitations upon governmental activity, and must be considered before any meaningful scheme of regulation can be adopted. It is the purpose of this article to lay the foundation by proposing that there exists a constitutional right of scientific inquiry. It will be shown that such an activity can be protected as speech or a necessary incident to speech under the first amendment, or as an unique freedom entitled to protection as a fundamental right similar to the right of privacy or the right to travel.

Before undertaking the constitutional analysis, this article will set forth a legal definition of the term scientific inquiry.[12] Such a definition is necessary in order to predict which activities fall within the scope of the protected right.[13] In formulating this definition, the nature of science and the complexity of the scientific process will first be examined. From this analysis the essential elements of the process will be gleaned and used to derive a suitable legal definition.

Having established the legal definition of science and the scope of the right of scientific inquiry, this article will discuss the judicial standards for review. It is at this stage that the crucial balance be-

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9. *See* notes 71-79 and accompanying text *infra*.

10. As one author has noted, this freedom is particularly important to the scientist:

> The freedom to choose his own problem is the scientist's most precious possession. At the cutting edge of science, on the frontiers of knowledge, nature confronts the scientist with a tangled obscurity which he can hope to penetrate only occasionally and with the most intense and dedicated effort. This kind of effort comes of devotion born of free choice, and scientists have therefore resisted external restraints and blandishments.

B. Commoner, Science and Survival 49 (1966).

11. Examples would include recombinant DNA research, fetal research, and human experimentation.

12. Prior commentators in this area have failed to articulate such a definition. *See, e.g.*, note 49 *infra*.

13. This is not to say that other human activities such as inventing or economics might not also be entitled to constitutional protection.

tween the competing societal interests must be struck. Such difficult problems as national defense,[14] human experimentation,[15] fetal research,[16] and recombinant DNA research[17] will be considered as examples.

II. THE NATURE OF SCIENCE

The following is a primer for the non-scientist, an introduction to the process by which science develops new ideas and concepts. This discussion is important to sensitize the reader to the complexity and the fundamental nature of the scientific process. Before a legal definition of scientific inquiry or a discussion of the related constitutional right can be meaningful, some grasp of the process from the scientist's viewpoint is essential.

A. *The Scientist's Definition*

While it is possible to give short definitions of science, it is difficult for the non-scientist to gain significant insight into the process of scientific inquiry from them. Nevertheless, such definitions will provide a useful starting point for discussion.

Dr. Joshua Lederberg, a Nobel laureate, has suggested the following definition:

> The profession of science is the search for truths about the natural world; more precisely, it seeks verifiable generalizations that simplify human comprehension and prediction of natural phenomena. Still more must be said: the truths must be novel and significant—which is to suggest that they are measured according to their impact on the minds of other scientists, a statement which labels science firmly as a human and social enterprise.[18]

It should be noted that when Dr. Lederberg uses the word "truth" it does not denote a good or bad quality but a scientific "truth"; *i.e.*, that which is subject to empirical verification.

In his book, *The New Priesthood*, Ralph E. Lapp describes science slightly differently:

> The goals of science focus upon the exploration of the unknown and the enlargement of knowledge. Very often the greatest discoveries come when a man sees relationships between things which no one recognized before—or sees these in a new light. But usually science expands into

14. *See* notes 149-57 and accompanying text *infra*.
15. *See* notes 187-93 and accompanying text *infra*.
16. *See* notes 200-13 and accompanying text *infra*.
17. *See* notes 220-29 and accompanying text *infra*.
18. Lederberg, *The Freedoms and the Control of Science*, 45 S. CAL. L. REV. 596, 599 (1972). Dr. Lederberg received the Nobel Prize for Medicine in 1958.

> the unknown like a hugh amoeba, moving first this way and then that, seeking the virgin and the fertile. Its goals are determined by opportunity and chance, and sometimes design.[19]

Finally, J. Bronowski, arguing that science at its highest level is an extremely creative human process, has offered the following definition:

> All science is the search for unity in hidden likenesses . . . .
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> The scientist looks for order in the appearances of nature by exploring such likenesses . . . .
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> . . . .
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> The progress of science is the discovery at each step of a new order which gives unity to what had long seemed unlike. Faraday did this when he closed the link between electricity and magnetism. Clark Maxwell did it when he linked both with light. Einstein linked time with space, mass with energy, and the path of light past the sun with the flight of a bullet. . . .[20]

As can be seen in the above definitions, science is the search for knowledge of how and why the universe around us functions.[21] The process by which this knowledge is acquired is as complex as, and indeed might be considered parallel to, the development of the human mind. At times the process involves merely mechanical data gathering or tedious computation, but, like art, it is also a creative process in which the scientist, like the artist, seeks to provide some new insight or a different, broader, perspective of nature.[22]

In addition, science is a social activity.[23] The growth of scientific knowledge is heavily dependent upon the interchange of ideas among scientists, both contemporaries and predecessors. The scientist who makes a "breakthrough" not only "stands on the shoulders of giants, and hence can see a little farther," but he perceives reality subject to all of the strengths and weaknesses of this colleagues.[24]

B. *The Parallel Between Human Development and Scientific Growth*

In many ways, the process by which scientific knowledge has advanced over the centuries is similar to the process by which each in-

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19. R. LAPP, THE NEW PRIESTHOOD 1-2 (1965) [hereinafter cited as LAPP].

20. J. BRONOWSKI, SCIENCE AND HUMAN VALUES 13-15 (1965) [hereinafter cited as HUMAN VALUES].

21. *See* J. BRONOWSKI, THE ORIGINS OF KNOWLEDGE AND IMAGINATION (1978) [hereinafter cited as ORIGINS OF KNOWLEDGE]; T. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTION (1969) [hereinafter cited as KUHN].

22. HUMAN VALUES, *supra* note 20, at 3-20.

23. Zimar, *What is Science?* in PHILOSOPHICAL PROBLEMS OF SCIENCE AND TECHNOLOGY 11-12 (A. Michalos ed. 1974).

24. It has been suggested that while Robinson Crusoe might have engaged in religious and technological activities, he could not have engaged in scientific and/or legal activities without fellow humans available to take part. *Id.* at 12; *see also* ORIGINS OF KNOWLEDGE, *supra* note 21, at 122-38.

dividual human being assimilates information to produce a working model of the world around him. It is a process that begins at birth and continues until death.[25]

Consider the newborn infant. While his state of self-awareness is non-existent, the pain of hunger is real and it is only eliminated with the consumption of a liquid provided from a source that will soon be labeled "mommy." The infant knows nothing about the milk itself, but does enjoy the social contact of the feeding and prefers a stomach full rather than empty. At this stage, the infant's knowledge approximates the level of science that existed prior to the formation of civilizations or societies. It receives sensory data and instinctively does that which is necessary for survival, but does not know, and is incapable of asking, why things are the way they are.

Within a few months, the child begins to eat a diversity of foods. This increase in sensory data results in different classifications or categories of food. Even though these first distinctions may not be verbalized, anyone who has observed a young child recognizes the functioning of the categories in the acceptance and rejection of different foods or the same foods under different conditions. Foods may be sweet, sour, salty, spicy, hot, or cold. Additionally, they can be categorized by physical state—liquid, solid, or lumpy. The child will accept food in one state, but not another. Still, the child does not understand the real source or function of food. As with science, classification of observable data into various categories is the first step in the process of knowledge.[26] As a child develops, visual data provides a new perspective of foods. The child observes that the parent is not the source of food. Rather the refrigerator, the cabinet, or even the supermarket is believed to be the source. Food is thus seen in a broader context.

Within a year or two the child begins to develop a powerful tool that will aid in his understanding of food: the tool of communication.

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25. Since the mind of the scientist is the ultimate source of scientific knowledge, a study of the development of science as a human endeavor is inextricably intertwined with the capabilities of the human mind. Thus, to understand the capabilities and maturation of the individual is to understand the process of science.

26. Aristotle's physics started not from theory or definitions, but from observations of the distinctions between products of nature and products of art. F. WOODBRIDGE, ARISTOTLE'S VISION OF NATURE 65 (1965) [hereinafter cited as WOODBRIDGE]. *See generally* W. DURANT, THE LIFE OF GREECE 134-41, 526-31 (1939). For example, Aristotle believed that the different kinds of matter could be distinguished by their different observable physical properties. All things were composed of four basic elements or combinations thereof: earth possessed the properties of cold plus dryness, water combined cold with dampness, air possessed heat plus dampness, and fire combined heat with dryness. R. STEARNS, SCIENCE IN THE BRITISH COLONIES OF AMERICA 9 (1970) [hereinafter cited as STEARNS].

This is the first and foremost tool of science or any other human institution and, indeed, the beginning of an organized society can be traced to the increasing ability of its individuals to communicate.[27] Communication allows the individual, child or scientist, to learn what others have observed, multiplying many times the raw data from which knowledge will grow. It must be understood that all knowledge is limited by the availability of data. The farmer's child has observed the seeds and plants that produce vegetables, whereas the urban child does not have that opportunity, and cannot possess this data unless it is obtained by communication with parents, through books, or via television. Having acquired this new knowledge, the child's understanding of the source of his food also changes. He no longer perceives as the source his parents or the refrigerator, but learns that food comes plants and animals.[28]

The next step that the child may take is of particular importance in the analogy to science. As described above in Bronowski's definition, it is the finding of likeness in that which was previously believed dissimilar. The urban/suburban child in America has two sets of observations which, at least initially, are not tied together. An example of the first is the awareness of beef being part of his family's normal diet. The second is an awareness of a cow as a farm animal, that she has big brown eyes and says "moo." These observations may co-exist within the child's mind for a period of time, but at some point the child will realize that the same cows that he or she admired in pleasant pastoral settings are killed and consumed by humans.[29] Those facts which had co-existed separately were found to be related. The same process is very important to the growth of science. It took an Einstein to see the common denominator between energy and mass, both of which were

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27. *See* R. LEAKEY & R. LEWIS, ORIGINS 178-206 (1978) [hereinafter cited as ORIGINS].

28. History suggests that early scientific data gathering was similarly limited. Early fact gathering was usually a random process that resulted in a pool of facts containing data from (1) casual observation, (2) wide experiments, and (3) established crafts such as medicine or metallurgy. For example, Bacon's writings are typical of this early approach in that they contain observations which are inconsistent or lacking sufficient detail. *See* KUHN, *supra* note 21, at 15-16.

Science in Colonial America operated at about the same level as the typical child. During this time scientists pursued three broad objectives: the collection of data, classification of data, and nomenclature. Few if any experiments as we know them today were carried out. STEARNS, *supra* note 26, at 6-8.

29. Santa Claus is another classic example of a child's realization or analysis of conflicting coexistent facts. This is slightly different from the cow example because of the strong cultural position that promoted belief in Santa Claus. Nevertheless, at some point in time the facts overcome the myth.

well known to scientists prior to Einstein's realization of the interrelationship.[30]

As the child develops further, those categories by which food had previously been classified are no longer sufficient to satisfy the child's intellectual curiosity. For while these classifications describe the physical characteristics of food, they do not help to explain what food does in the body or to determine why some foods might be more beneficial for consumption than others. The questions why and how now become important. Through information gathered from parents, contemporaries, or teachers, the child learns of the components of food: calories, proteins, carbohydrates, vitamins, and minerals.

By adding this new method of food classification to his working information, the child is capable of making more knowledgeable decisions as to what foods his body needs. Likewise, science often finds existing systems of classification inadequate when faced with new information. The new information does not discredit the previous classification, rather it demands that an additional system be created to take the new knowledge into account. When scientists first dealt with air pollution from a smoke stack, they determined the degree of pollution by opacity. As knowledge of pollutants became more sophisticated, it became apparent that other emissions could not be categorized by opacity and additional criteria had to be developed.[31]

At this point in the child's development he must move beyond his day-to-day experiences to acquire more knowledge about food and its relationship to human existence. He must actively seek detailed knowledge about this particular topic. This level of understanding represents what must be the vast majority of human effort in the scientific process: the refining of existing ideas, the seeking of better and more data while working within existing scientific theories and paradigms.[32] The student will learn that a calorie represents energy potential which is stored in the fat cells of the human body. He will

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30. This relationship as finally articulated by Einstein is expressed by the equation $E = mc^2$. *See* RELATIVITY THEORY: ITS ORIGINS AND IMPACT ON MODERN THOUGHT 85 (L. Williams ed. 1968).

31. The residue of the old approach can be found in most state air pollution laws or regulations. For example, the Michigan Air Pollution Control Commission prohibits any emission of a density darker than No. 1.0 of the Ringelmann chart or not more than 20% opacity. This rule is very seldom used because of the difficulty of proving a violation. Today industrial smoke emissions are considered under the general categories of particulate matter, sulfur oxides, carbon monoxide, ozones, hydrocarbons, nitrogen dioxide, and lead, and are measured by concentration in the air not opacity. 40 C.F.R. §§ 50.1-.12 (1980).

32. Paradigms are accepted models or examples of actual scientific practice. They include law, theory, application, and instrumentation. "Copernican astronomy," "Newtonian mechanics," or "wave optics" are examples of paradigms. KUHN, *supra* note 21, at 10-11, 187-91.

discover that proteins are constructed from building blocks called amino acids, and that amino acids are built in accordance with the specifications of DNA molecules found in the genes of different life forms.

The student's ability to gain this knowledge is a function of communication with those who have spent a lifetime seeking information and of the growth of the underlying technological support that allows better and more sophisticated data to be gathered. The various scientific fields interrelate; for example, the ability of the biologist was limited by the development of knowledge in the field of optics. Thus, until physicists advanced the understanding of light and optics, the equipment available to the biologist was limited.[33]

The final step that our student will take is not to acquire a more detailed knowledge of food, but to set it in a broader perspective: to see how food relates to other human and natural activities. It is impossible to predict which individuals will be able to go on to this next step in the process. It does not appear to be a function of intelligence but of creativity.[34] While it is relatively easy to understand and observe the connection between lack of food and malnutrition, it is more difficult to perceive the relationship between a bushel of wheat and a barrel of oil. Few understand food in the context of human economics and the power of the free market to allocate more in terms of money and less in terms of need. Fewer still see food as a resource allocation of land and energy which is done consciously by government planning or unconsciously through the free market economy.[35]

Consider for a moment the vast change in the state of knowledge that our example child has realized over a twenty-five to thirty year period. Thirty years ago some of these concepts would not have been realized by even the most perceptive of individuals. Thirty years from now much of what is presently in the forefront of knowledge will be proven correct or merely the starting point for future insight. For if the process of science is anything, it is change: seeking out the new, discarding the outmoded, constantly looking for an ultimate, complete view of the universe which may never be attained.

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33. The Dutch appear to have been the first to combine the convex and concave lenses in the late part of the 16th Century. Soon thereafter the instruments were developed to resolve 1.4 microns at 270 magnification. In modern times the versatility of the microscope has been greatly expanded by using electron beams (at a resolution of 100A° a magnification of 50,000 is routine), x-rays, and ultrasound. T. ROCHOW & E. ROCHOW, AN INTRODUCTION TO MICROSCOPY BY MEANS OF LIGHT, ELECTRONS, X-RAYS OR ULTRASOUND (1978).

34. *See generally* M. POLONYI, THE TACIT DIMENSION 55-92 (1966); Greenberg, *Einstein: The Gourmet of Creativity*, 115 SCI. NEWS 216 (1979).

35. For a discussion of this topic, see L. BROWN, THE TWENTY NINTH DAY 128-60 (1978).

Take, for example, the fundamental issue of what are the elemental building blocks of the physical world. The first clear articulation of an atomic theory, before that term was created, was by Aristotle. While reflecting many of the ideas of the Egyptians and Indians, he stated that the physical world was composed of a mixture of four basic elements: air, fire, earth, and water. Additionally, these elements could be found in four states of being: hot, wet, dry, and cold.[36] This theory represented an attempt by some of the most gifted intellects of Greece to explain the basic structure of the physical universe. Artistotle's theory was arrived at with little, if any, scientific experimentation as we know it. As with the first steps of the child in the prior example, he merely observed the world around him with his five senses, and then tried to provide some rational explanation and categorization for the phenomena which he observed.[37]

Aristotle's conception of the basic elements passed on through the centuries by the alchemists and pharmacists of medieval times. This complete paradigm remained largely unchallenged until the latter half of the 1700's. During this period a few researchers, using more sophisticted apparatus, were experimenting with air and various gases. There developed quickly a realization that air was not the same everywhere: bottles of gases derived from different sources had different properties (sustain the breathing of a canary, support a flame, have different weights, etc.). This provided the first crack in the Aristotle paradigm.[38]

This step is analogous to the child gathering new information that makes old series of categories seem inappropriate. The men of the 1700's were able to do this because the developments in primitive technology allowed a great increase in the type of data gathered by the human senses.[39] Note also that these men were among the first to develop a scientific method for gathering data,[40] and, thus, set the intellectual stage for Lavoisier to make his scientific breakthrough which would destroy the Artistotelian paradigm of matter.

36. Read, *Chemistry*, in WHAT IS SCIENCE? 154-55 (J. Newman ed. 1955) [hereinafter cited as Read].

37. *See* WOODBRIDGE, *supra* note 26, at 65.

38. Read, *supra* note 36, at 157-65.

39. As Read states, modern chemistry owes its birth to the use of the balance and other instruments of precision that allowed the chemist to observe chemical changes quantitatively. *Id.* at 164. For a discussion of how the development of technology is a critical part of the advance of science, see Asimov, *Pure and Impure: The Interplay of Science and Technology*, SAT. REV., June 9, 1979, at 23.

40. For a full enumeration of the elements of scientific method, see text accompanying notes 56-57 *infra*.

> Now, as so often in the history of science, a point had been reached at which the known facts enabled a tremedous step forward to be taken. The only remaining obstacle was a mental one; for one of the most difficult of all mental processes is to reassemble a series of familiar facts and relationships and to regard them from a new viewpoint.
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> In this ability lay the great genius of Lavoisier, who, without making a single discovery of any new body, or property, or natural phenomenon, demolished in the 1780s the barrier that had hitherto blocked progress in chemistry.[41]

In his mind he rejected the previous paradigm and found that there were elements more fundamental than air, water, and solid; that, in fact, these new fundamental elements could be forced to go from one physical state to another[42] (*i.e.*, oxygen may be a pure gas, or combined with hydrogen to form water or with other chemicals such as iron to form solids). Thus, there arose a new paradigm around the concept of atomic theory. According to this theory, atoms were the building blocks of the universe. The atom was pictured as a "hard, impenetrable, movable particle . . . so very hard as never to wear or break in pieces. . . ."[43] This picture corresponded with the best information available at that time. However, science never stops inquiring and, with more observation and better equipment, new ideas again come to the forefront.

In 1898, J.J. Thomson discovered the particle known as the electron and thus destroyed the picture of the impenetrable atom. Subsequently, the atom was found to consist of three different particles: the electron, proton, and neutron.[44] Since the development of this model of the atom there have been additional discoveries of particles but the search has moved out of the realm of chemistry and into the world of high energy physics. These developments in turn produced continued evolution and refinements of the concepts contained within the atomic theory. If science were not open ended and uncontrolled, the new ideas that spurred further development would have been stifled.[45]

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41. Read, *supra* note 36, at 165.
42. *Id.* at 166-68.
43. This was the view of Newton. *Id.* at 167.
44. *Id.* at 170-75.
45. A prime example of how outside control of science can stifle its growth is found in the Lysenko affair in the Soviet Union. Lysenko, a self-educated agronomist who produced several ideas that helped the collective farms of the Soviet Union, had gained the political support of Stalin around 1935. With this support came an attack by Lysenko on Soviet geneticists. He believed that all characteristics were acquired by inheritance, and that genes played no part in the development process. Lysenko believed that the heredity characteristics of a living organism were determined by the external environmental condi-

The preceeding has been a non-scientist's introduction, not so much to the substance of science, as the process of science. The process of doing science is the focal point for the remainder of this article. It is the process of science and scientific inquiry, as well as the substance of science, with which society through the legal system must deal.

C. *Science and the Law—Definition of Science*

Before any meaningful legal analysis of the basis for a constitutional right of scientific inquiry can be pursued, a workable legal definition of scientific inquiry must be formulated. This definition would allow some measure of predictability in the selection of activities to receive constitutional protection—without the constant use of litigation to classify each activity case by case.[46]

While almost everyone may have a general sense of what science is, such vague definition is not very helpful. Similarly, the previous definitions suggested by scientists and philosophers of science cannot be used since they are imprecise in their attempts to distinguish between protected and unprotected activities.[47] For example, which of the following activities are scientific inquiry: A group of college physics students attempting to build an atomic bomb, the basement biologist trying to

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tions of many generations and that each alteration of conditions led to a change in heredity. The culmination of the genetics controversy came in 1948 when Stalin banned research and teaching in standard genetics and permitted Lysenko to mandate changes in school curriculum and research programs.

Many reasons for the suppression have been given. For example, the genetics theorists of his time were generally from the bourgeois families, and had been educated abroad. Thus, it took only a little effort for the communist party to convert the geneticists' disinterest in agriculture into a purposeful wrecking of the new economy, or their interest in eugenics into sympathy with facist theories of racism. Others have stated that Stalin's support for Lysenko arose from his desire to build a new Soviet man. It was theorized that if the characteristics acquired in a man's lifetime can be inherited, then a unique Soviet individual would emerge all the more quickly.

After 1948, in spite of constant attacks by modern geneticists, Lysenko maintained his power through personal friendship with Stalin and, later, Khrushchev. With each attack, Lysenko proposed other grandiose agricultural projects in order to boost his political stock. It was not until 1964 with the fall of Khrushchev that Lysenko was finally discredited and modern genetics was reborn in the Soviet Union. L. GRAHAM, SCIENCE AND PHILOSOPHY IN THE SOVIET UNION 195-256 (1972); D. JORAVSKY, THE LYSENKO AFFAIR (1970); Z. MEDVEDEV, THE RISE AND FALL OF T.D. LYSENKO (1969).

46. A failure to classify the conduct as protected could lead to hopeless confusion. A classic example of this problem has occurred in obscenity cases. Without an adequate definition of obscenity or pornography, the Supreme Court has been faced with an endless procession of cases in which it has attempted to classify activities as protected or unprotected under the first amendment on a piecemeal basis. *See* L. TRIBE, CONSTITUTIONAL LAW 656-70 (1978) [hereinafter cited as TRIBE].

47. *See* text accompanying notes 18-20 *supra*.

create life by randomly combining organic chemicals, the engineer who must design an engine component for the NASA space shuttle, the professor trying to determine the chemical reaction which takes place during photosynthesis, the corporate scientist who works to understand the fundamental process by which sunlight can be directly converted to electrical energy, or the professor of sociology taking a random on-the-street survey of views on marriage and divorce?

There are a number of possible approaches to legally defining a term. One could break down the process of scientific inquiry into its component parts; *e.g.*, thinking, analyzing, observing, experimenting, communicating, writing reports, publishing, receiving information, advocating positions, disseminating information, and collecting data. Each component is analyzed independently[48] to determine whether it deserves constitutaional protection. If the activity is made up solely of traditional first amendment components, then *a fortiori* it is protected. If traditional first amendment analysis shows the activity is composed of both protected and unprotected parts, then the activity is entitled to protection if a preponderance of the components are protected.[49]

The advantage of this approach is that the definition is framed in terms of familiar concepts; *e.g.*, thought, communication, etc. Additionally, its application in individual cases is relatively simple and straightforward. There is a significant disadvantage, however, in breaking scientific inquiry into component parts, because what results

48. This procedure has been adopted in formulating a legal definition of death. Life can be broken down into many of its component activities; *e.g.*, breathing, talking, thinking, heartbeat, etc. Death is then defined in terms of the absence of one or more activities; for example, unresponsiveness to normally painful stimuli, absense of spontaneous breathing, a flat EKG; *i.e.*, absence of heart spontaneous brain functions. *See* Commonwealth v. Golston, 373 Mass. 883, 336 N.E. 2d 744 (1977), *cert. denied*, 434 U.S. 1039 (1978)

49. Delgado and Millen employ this approach in their article which proposes a right of scientific inquiry:

> The precise components of a given scientific investigation will vary depending on the discipline, the problem under study, and the researcher's choice of methodology. In general, however, the process will include many of the following elements: thinking, consulting with colleagues, experimentation, publishing results, and teaching. The process is a continuous cycle; it can be interrupted by interference with any of the component activities. New ideas and theories are often sparked by experimentation or by discussion of the research results of colleagues. The testing of one hypothesis may unexpectedly produce evidence suggesting a completely different theory or casting doubt on an established principle. Because of this interconnectedness, each stage of the process must be protected if the entire enterprise is to be protected. Conversely, if each step in the process is protected, the whole must be protected as well.

Delgado & Millen, *God, Galileo, and Government: Toward Constitutional Protection For Scientific Inquiry*, 53 WASH. L. REV. 349, 371 (1978) [hereinafter cited as Delgado & Millen] (footnotes omitted).

is a list of activities thay may encompass more than the "scientific inquiry" that was originally intended to be protected. For example, the components thinking, analyzing, observing, etc., would also encompass the activities of lawyers, economists, and historians.[50]

This approach does not take cognizance of the uniqueness of scientific inquiry or the complex problems associated with its regulation.[51] Frequently the focal point of governmental concern will be the experimental components of scientific inquiry. It is this step in the process which is most difficult to incorporate into traditional categories of analysis, but may nevertheless receive protection if a preponderence of other components are protected. The ultimate effect of this approach is to de-emphasize that component which should be the focus of the analysis.

A better approach allows for the recognition of scientific inquiry as a unique process and a spectrum spanning from purely theoretical work to scientific experimentation. Because of the complex variety of such situations, the development of a precise definition to help draw the lines of distinction is difficult.[52] Nevertheless, the following test should be sufficiently succinct to enable one to distinguish scientific inquiry from other activities. For an activity to fall within the definition of "scientific inquiry" it must (1) have as its primary but not sole motivation, the acquisition of knowledge which will lead to additional understanding of the natural universe, allow new explanations of natural phenomena, and result in the ability to make predictions concerning the organic laws of the natural universe; and, (2) be carried out in accordance with the accepted scientific method appropriate to the nature of the activity.

The inquiry will be considered to be primarily motivated toward the goal of the acquisition of knowledge if it is

50. This is not to suggest, however, that these activities should not be protected under the first amendment; merely that they do not qualify as scientific inquiry.

51. Based on this approach, all the factual examples discussed in the text could be classified as protected. All of those activities include thinking, analyzing, collecting data, and observing. In addition, the college professor, the industrial researcher, and the NASA engineer will, to a greater or lesser degree, engage in experimenting, communicating, writing reports, and publishing and, therefore, would be protected under the component approach.

52. Two prior articles that address the issue of the constitutional right of scientific inquiry did not develop a workable definition. In passing, Robertson states that "research is taken generally to encompass all activities and procedures designed to generate new knowledge . . . ." Robertson, *The Scientist's Right to Research: A Constitutional Analysis*, 51 S. CAL. L. REV. 1203, 1204 (1977) [hereinafter cited as Robertson]. Delgado and Millen suggest that "'Basic research' has been defined as 'original investigations for the advancement of scientific knowledge . . . which do not have specific [practical] objectives or ends in view.'" Delgado & Millen, *supra* note 49, at 352 n.21 (quoting NATIONAL SCIENCE BOARD, SCIENCE INDICATORS 53 (1975)).

(a) theoretical in nature, and involves the use of one's intellect and communicative ability to develop existing theories, law, or paradigms, or to formulate new theories, laws, or paradigms concerning the natural universe;
(b) experimentation which seeks data to verify existing theories, laws, or paradigms concerning the natural universe; or
(c) experimentation which seeks data from which new theories, laws, or paradigms can be formulated concerning the natural universe.

The term experimentation in the above definition is used in its broadest sense. It is intended to include the passive observation of naturally occurring phenomena as well as the collection of data obtained under controlled conditions produced by human instigation.

The definition of scientific inquiry requires that the inquiry be focused on the operation of the natural universe. Clearly included within the scope of this term is the subject matter of the basic disciplines chemistry, physics, biology, and astronomy,[53] since they are governed by laws which cannot be created by human intervention. These "organic" laws exist independently of human discovery and postulization, and are in theory the ultimate goal of scientific inquiry. One the other hand, pursuits such as law, economics, and political science would not be included in scientific inquiry since they concern themselves with man's relationship with man rather than man's relationship with the natural universe. These disciplines are governed by laws which can be created and changed by human intervention. Finally, those disciplines referred to as the social sciences would be included to the extent that they are concerned with organic rather than human law.

It should be noted that not all experimentation is to be included within the definition of scientific inquiry. Quite often experiments are undertaken for purposes other than to verify existing theories, laws, or paradigms; for example, educational experiments which seek to demonstrate rather than verify, would not be included.[54] Additionally,

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53. Astronomy is the observation and accumulation of data concerning the history and physical laws of the large bodies of the universe. Another major area of science is physics which "concerns itself with matter and energy in all their general manifestations." E. Condon, *Physics*, in WHAT IS SCIENCE 102 (J. Newman ed. 1955). Chemistry is concerned with the properties of matter such as its structure, composition, and susceptibility to change. Finally, there is the broad category of biology which may be considered as the study, classification, and interaction of living organisms. *See generally* WHAT IS SCIENCE (J. Newman ed. 1955).

54. The classic example is the dissecting of frogs in biology class. Killing frogs does not result in any additional understanding of the natural universe. While a particular student may gain personal knowledge, society has gained no additional information. This activity therefore cannot be protected as scientific inquiry.

testing procedures, although sometimes referred to as experiments, would not be included. The purpose of testing is to acquire data which can be used as a basis for decisions concerning the environment, health, economics, or other areas of human interest. For example, a series of chemical and biological tests on a particular stream to determine if the standards in the Federal Clean Water Act[55] are being met would not constitute scientific experiment—even though the tests were carried out using scientific methodology.

Although an activity qualifies under the first part of the test, it may still fall short of being classified as scientific inquiry unless it is carried out in accordance with accepted scientific method.[56] An activity will be considered to employ the scientific method if it

> (1) uses a suitable method for describing its subject matter; *e.g.*, mathematics, words, diagrams, or symbols;
> (2) uses an existing method systematizing or classifying the material to be described, or creates a new method for doing so; *e.g.*, classifying plants into species on the basis of particular features, or naming and classifying sub-atomic particles;
> (3) uses hypotheses for the purpose of predicting or accounting for the occurrence of natural phenomena;
> (4) uses experimentaton, as previously defined, to test hypotheses. Experimentation should include (a) planning objectives and procedures, (b) potential for recognizing error and minimizing it by proper design, (c) gathering data and insuring its uniformity, (d) analyzing the data, and interpreting the data and drawing conclusions based on the data.[57]

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55. Pub. L. No. 95-217, 91 Stat. 1567 (1977) (codified in scattered sections of 33 U.S.C.).

56. It is important to understand the fundamental purpose of using the scientific methodology. One author has suggested the following:

> The real purpose of scientific method is to make sure Nature hasn't misled you into thinking you know something you don't actually know. There's not a mechanic or scientist or technician alive who hasn't suffered from that one so much that he's not instinctively on guard. That's the main reason why so much scientific and mechanical information sounds so dull and so cautious. If you get careless or go romanticizing scientific information, giving it a flourish here and there, Nature will soon make a complete fool out of you. It does it often enough anyway even when you don't give it opportunities. One must be extremely careful and rigidly logical when dealing with Nature: one logical slip and an entire scientific edifice comes tumbling down. One false deduction about the machine and you can get hung up indefinitely.

R. PIRSIG, ZEN AND THE ART OF MOTORCYCLE MAINTENANCE 101 (1974) [hereinafter cited as PIRSIG].

57. *See* W. FOWLER, THE DEVELOPMENT OF SCIENTIFIC METHOD (1962); E. NAGEL, THE STRUCTURE OF SCIENCE 1-13 (1961); 5 MCGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY 156 (1977); 12 MCGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY 102 (1977). The classic college science experiment has the student go through the following steps: "(1) statement of the problem, (2) hypotheses as to the cause of the problem, (3) experiments designed to test each hypothesis, (4) predicted results of the experiments,

It should be recognized that the elements discussed need not co-exist before an activity will be considered to employ the scientific method. Theoretical work need only meet the first three requirements. Experimental work must satisfy the fourth as well.

Based upon the above two-part test for scientific inquiry, only the chemistry professor and the corporate scientist would be engaged in scientific inquiry. The college students attempting to build an atomic bomb do not engage in scientific inquiry because their motivation is not to gain an additional explanation, understanding, or prediction of the natural universe. At the very best they are seeking to increase their personal knowledge. Their work could not be considered an attempt to verify an existing theory or law, since it is merely an effort to reproduce present technology.

While the basement biologist seeking to create life by randomly combining organic chemicals may have the goal of gaining an additional understanding of the natural universe, he is not carrying out his work according to the scientific method. In particular, he has no hypothesis on which to base his work. Furthermore, if his experimentation is unplanned or carried out using techniques which would not insure uniformity and repeatability, it would not be considered to be using the scientific method. This is not to say that all efforts of amateur scientists are not scientific inquiry. It means only that their work must meet the full test.

The space engineer who seeks to develop a new engine component for the NASA space shuttle does not engage in scientific inquiry because his primary goal is not to gain an additional understanding of the natural universe, but to develop a technology which will meet a particular design criteria. Although his work may in fact add to our understanding of the natural universe, it would be insufficient to qualify it for scientific inquiry.

The professor who works at his university laboratory to determine the chemical reaction of photosynthesis does engage in scientific inquiry because his primary goal is to gain an understanding of a basic process underlying the conversion of sunlight to plant energy. This conclusion assumes that the professor employs the scientific method in the conduct of his work.

The scientist who is employed by a private corporation to study the fundamental process by which sunlight can be directly converted into electrical energy would be engaging in scientific inquiry. This conclusion presumes that the primary goal of the corporation in supporting this work is to gain an additional understanding of the laws governing

(5) observed results of the experiments and (6) conclusions from the results of the experiment." PIRSIG, *supra* note 56, at 100.

the process of direct energy conversion in certain materials. The fact that any useful knowledge developed from this work could lead to the development of a profitable product or technology would not disqualify the work from classification as scientific inquiry.[58] The overriding purpose of any business entity is to create a profit for its investors. A business entity, however, could sponsor some work so fundamental that it cannot be said to relate directly to any product. The ultimate test remains the same: if the primary goal is to gain knowledge which will lead to an additional understanding of the universe, it is scientific inquiry; if the prime motivation of the particular project is economic gain, then it does not qualify as scientific inquiry.

Finally, the professor of sociology who conducts a survey on attitudes about marriage and divorce, perhaps to determine the cause of the increase in divorce rates, would not be engaging in scientific inquiry. His study seeks to gain an understanding of the changing relationships between man-made laws and human conduct.

The purpose of the foregoing discussion has been to give as precisely as possible, a legal definition of scientific inquiry. Using this definition, one can differentiate those activities which may claim constitutional protection as scientific inquiry.

III. Constitutional Right of Scientific Inquiry

If scientific inquiry is to be recognized as a constitutionally protected right, the government's ability to impose restrictions and regulations will be severely limited. Faced with a constitutionally protected activity, the government has the burden of justifying any interference.[59] Instead of requiring the scientist to overcome the presumption that laws and regulations are valid, the government must justify its intrusion under the appropriate constitutional test.

A constitutional right of scientific inquiry may be developed under

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58. This fact is well accepted within the scientific society. As reflective of this attitude, scientists at Bell Telephone Laboratories have received seven Nobel Prizes for research.

> Clinton Davisson shared the Nobel Prize in 1937 for demonstrating the wave nature of matter. In 1956, John Bardeen, Walter Brattain and William Shockley were honored for their invention of the transistor. Philip Anderson's theoretical work on amorphous materials (such as glass) and on magnetism led to a Nobel Prize in 1977. And in 1978, Arno Penzias and Robert Wilson received the Prize for detecting the faint radiation from the "big bang" explosion that gave birth to the universe some 18 billion years ago.

Scientific Am., June 1979, at 5 (Bell Labs advertisement).

59. For example, if a regulation attempts to abridge speech directly, it will be found unconstitutional unless the government shows that the message being suppressed poses a "clear and present danger," constitutes a defamatory falsehood, or is otherwise unprotected. Tribe, *supra* note 46, at 582.

either of two different approaches. The first finds its basis in the first amendment right to free speech.[60] Under this approach a number of possible lines of analysis can be pursued. Scientific inquiry can be viewed as a single expressive activity; *i.e.*, speech, and thus entitled to constitutional protection.[61] Alternatively, one can recognize that certain activities carried out by the scientist are not communicative, but nevertheless must be protected as a necessary incident to the full exercise of the communicative aspects of science. Finally, scientific inquiry could be categorized as "speech plus."

The second approach for the development of a right of scientific inquiry offers a broader basis for establishment of constitutional protection. Under this approach scientific inquiry, like the right of privacy or travel, would be recognized as a fundamental right found either within the structure of the Constitution or standing alone.[62]

A. *Scientific Inquiry as Speech or as a Necessary Incident of Speech*

1. Science as Pure Speech

It has been suggested that scientific research is protected as pure speech under the first amendment.[63] Scientific research is presumed to be predominantly expressive and, therefore, entitled to be protected in its entirety as speech. Many of the steps in the process make use of written or verbal expression; *e.g.*, consulting with colleagues, publishing reports, teaching others in lectures, and interviewing the subject of an experiment. Since a majority of the individual components of scientific inquiry are communicative, it is argued, the process in its entirety must be protected.

Other aspects of science are not directly involved with written or verbal communication. For example, an experiment in high-energy physics will involve months or even years of data gathering, computer programming, and analyzing results. The actual communication of the results of the work will occur over a short period of time and would normally involve publishing a paper or giving an oral presentation. Thus, while it is true that the normal communicative activities may numerically outweigh these other activities, in fact, a much larger proportion of a scientist's time is spent on activities other than speaking or writing. Since these activities are not expressive in the normal

60. "Congress shall make no law . . . abridging the freedom of speech, or of the press . . . ." U.S. CONST., amend. I.

61. A hybrid of the above analysis has been suggested by Delgado. *See* Delgado and Millen, *supra* note 49, at 371.

62. *See* notes 237-350 and accompanying text *infra*.

63. Davidson, *First Amendment Protection for Biomedical Research*, 14 ARIZ. L. REV. 893, 896-907 (1977).

sense of the word, if they are to be protected, they would have to be classified as symbolic speech.

In *Spence v. Washington*[64] the Supreme Court suggested that two important elements were necessary for symbolic speech. First, the speaker must have an intention to convey a particular message and, second, in the environment of the activity in question, the message would be understood by those who were viewing it.[65]

The weakness of considering scientific inquiry as pure speech becomes apparent when the test of symbolic speech is applied to experimentation. If a subjective standard is employed, it is unlikely that any communicative intent will be found. When the scientist conducts an experiment, he intends to acquire data—unlike a demonstrator who burns a draft card or displays a flag to communicate a concept or idea.[66] Additionally, the requirement of an intent to communicate will not be satisfied when a particular researcher, by his own initiative or by government regulation, decides to keep his research secret. In practice, a requirement of intent to communicate depending upon the experimenter's state of mind would result in some work being protected and others not. Such a distinction would be entirely artificial and unworkable in practice. Such a requirement could produce denial of constitutional protection because a scientist about to carry out an experiment is unlikely to perceive it as a communicative activity. On the other hand, the requirement could be formally met by a simple one-sentence declaration that all work was intended to be communicative.

It might be argued that an objective standard be used to determine the communicative intent of the experimenter. In such a case, the surrounding circumstances would be used to infer an intent to communicate. When burning a draft card or displaying a flag is carried out before an audience, it is inferred that the person intends to communicate a message by his acts. However, experiments are rarely carried out before an audience; moreover, from the scientists's viewpoint, it would highly undesirable to do so, because of the need to control the surrounding circumstances. Even assuming that the experimenter's intent would be to communicate a message, it is highly unlikely that anyone would receive his ideas or concepts from observing the activity.[67]

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64. 418 U.S. 405 (1974) (per curiam). In *Spence* the Court was called upon to determine the validity of a conviction based on a statute which made it a crime to publicly display an American flag to which a peace symbol had been attached. The Court reversed the conviction concluding that the petitioner's conduct was protected as symbolic speech under the first amendment. *Id.* at 415.

65. *Id.* at 410-11.

66. In *Spence*, displaying a flag with a peace symbol attached was alleged to be symbolic speech. *Id.* at 405. In United States v. O'Brien, 391 U.S. 367 (1968), the petitioner claimed that burning his draft card was symbolic speech. *Id.* at 376.

67. Pirsig, *supra* note 56, at 103.

The test developed in *Spence* was designed to deal with a single event of relatively short duration which was intended to be expressive. When this test is employed to evaluate experimentation, its applicability becomes questionable. The process of experimentation rarely involves a single event: much research is carried out over periods of months or even years. Considering experimentation as symbolic speech is like trying to place a triangular shape into a rectangular hole. Depending on the size used it may occasionally be forced in, but in no event is the result particularly satisfactory.

The pure speech approach requires that some aspects of scientific inquiry such as experimentation be classified as symbolic speech. While a logical argument can be made in support of such a position, it requires extending present concepts well beyond the current boundaries established by the Court. It is unlikely that the Court would be willing to so distort the symbolic speech concept.

Even if the problems of fitting experimentation within the confines of symbolic speech are ignored, it is still very awkward and misleading to classify the entity of scientific inquiry as pure speech. The primary purpose of scientific inquiry is to advance the body of scientific knowledge.[68] Although communication of ideas and data is important to this goal and to the long term development of science, it is improper to characterize the scientific process as basically expressive. Communication, either oral or written, is an important step in achieving the ends of science, but it is only one step. Observation, data gathering, experimentation, analysis, and conclusions are equally important means for achieving the ends of science—and such acts are not expressive as normally defined.

2. Necessary Incident of Speech

Under a second line of analysis, those components of scientific inquiry which are not clearly speech may be protected, nevertheless, as necessary incidents of speech. On a number of occasions the Supreme Court has found it necessary to protect certain non-communicative activities in order to insure the most effective exercise of the right of free speech,[69] thereby fully implementing the strong policies underly-

68. *See* text accompanying notes 18-21 *supra*.

69. The following is a summary of the "incident" cases as gathered by Professor Tribe:

> Buckley v. Valeo, 424 U.S. 1 (1976) (contributing money); Spence v. Washington, 418 U.S. 405 (1974) (displaying flag with peace symbol attached); Cohen v. California, 403 U.S. 15 (1971) (wearing sign on back of jacket); Schacht v. United States, 398 U.S. 58 (1970) (wearing uniform); Tinker v. Des Moines School Dist., 393 U.S. 503 (1969) (wearing black armbands); Edwards v. South Carolina, 372 U.S. 229 (1963) (demonstration); NAACP v. Button, 371 U.S. 415 (1963) (litigation); West Virginia

ing the first amendment.[70] In order to determine if a specific activity is to be protected as a necessary incident, the Court must decide whether the activity is essential to the meaningful exercise of the right of free speech in light of the underlying policies. To ascertain whether the non-communicative aspects of scientific inquiry are necessary incidents, the policies underlying the first amendment will be examined. Then specific activities will be evaluated to determine their importance to the meaningful exercise of the communicative aspects of scientific inquiry.

The policies and purposes of the first amendment have been variously described as promoting individual self-fulfillment, societal interests, and combinations thereof.[71] The policy of self-fulfillment was first suggested more than fifty years ago in *Whitney v. California*,[72] when Justice Brandeis stated, "Those who won our independence believed that the final end of the State was to make men free to develop their faculties . . . ."[73] The roots of this right of individual self-fulfillment go

State Bd. of Educ. v. Barnette, 319 U.S. 624 (1943) (compulsory flag salute); Thornhill v. Alabama, 310 U.S. 88 (1940) (picketing); Stromberg v. California, 283 U.S. 359 (1931) (displaying red flag).

TRIBE, *supra* note 46, at 599 n.11.

70. Concerning these policies the Court in Griswold v. Connecticut, 381 U.S. 479 (1965), stated:

> [T]he State may not, consistently with the spirit of the First Amendment, contract the spectrum of available knowledge. The right of freedom of speech and press includes not only the right to utter or to print, but the right to distribute, the right to receive, the right to read (*Martin v. Struther*, 319 U.S. 141, 143) and freedom of inquiry, freedom of thought, and freedom to teach (see *Wieman v. Updegraff*, 344 U.S. 183, 195) indeed the freedom of the entire university community. *Sweezy v. New Hampshire*, 354 U.S. 234, 249-50, 261-63; *Barenblatt v. United States*, 360 U.S. 109, 112; *Baggett v. Bullitt*, 377 U.S. 360, 369. Without those peripheral rights the specific rights would be less secure.

Id. at 482-83.

71. Professor Emerson has suggested that:

> The values sought by society in protecting the right to freedom of expression may be grouped into four broad categories. Maintenance of a system of free expression is necessary (1) as a method of assuring individual self-fulfillment, (2) as a means of attaining the truth, (3) as a method of securing participation by the members of the society in social, including political, decision-making, and (4) as a means of maintaining the balance between stability and change in the society.

T. EMERSON, TOWARD A GENERAL THEORY OF THE FIRST AMENDMENT 1-5 (1963) [hereinafter cited as TOWARD A GENERAL THEORY]; *see also* T. EMERSON, THE SYSTEM OF FREEDOM OF EXPRESSION 17-18 (1970); A. MEIKLEJOHN, FREE SPEECH AND ITS RELATION TO SELF GOVERNMENT (1948) [hereinafter cited as FREE SPEECH]; A. MEIKLEJOHN, POLITICAL FREEDOM (1960) [hereinafter cited as POLITICAL FREEDOM]; TRIBE, *supra* note 46, at 576-79; Rehnquist, *The First Amendment: Freedom, Philosophy, and the Law*, 12 GONZ. L. REV. 1 (1976) [hereinafter cited as Rehnquist].

72. 274 U.S. 357 (1927).

73. *Id.* at 375. This concept of individual self-fulfillment was recently referred to by the Supreme Court in Police Dep't v. Mosley, 408 U.S. 92 (1972): "To permit the continued

much deeper than the first amendment. They are based on two widely accepted premises of Western thought: (1) that the proper end of man is the fulfillment of his character and potential as a human being, and (2) that an individual, as a member of society, is entitled to fair and equal treatment from the state.[74]

What standard is to be used to measure the development of man's character and potential? It is man's extraordinary intellectual capacity which differentiates him from the rest of the animal kingdom.[75] This intellectual capacity consists of a unique ability to observe and understand the functioning of the environment and man's relationship to it. Thus, in order for each individual to achieve fulfillment of his character and potential as a human being, it is necessary to fully exercise and develop these intellectual abilities. The process of developing these abilities requires the acquisition of information from diverse sources and the formulation of ideas and actions based on this information.

This concept of self-fulfillment has been recognized in the United States from the very beginning. In the Declaration of Independence it is recognized that all men have certain inalienable rights including "life, liberty and the pursuit of happiness," rights which represent the process by which one may obtain self-fulfillment.[76] Further, the first amendment was to be the guarantee that this pursuit of self-fulfillment would not be interfered with by governmental action. If the first amendment is perceived as the vehicle for carrying individuals to their goal of self-fulfillment, then information and ideas are the fuel for the vehicle. Without the right to acquire information or to formulate ideas, the right to speak would be meaningless.

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building of our politics and culture, and to assure self-fulfillment for each individual, our people are guaranteed the right to express any thought, free from government censorship." *Id.* at 95-96.

74. *See* TOWARD A GENERAL THEORY, *supra* note 71, at 4-5.

75. *See* ORIGINS, *supra* note 27, at 179-205; C. SAGAN, THE DRAGONS OF EDEN 22-79 (1977).

76. To Thomas Jefferson self-fulfillment was one of the basic drives of man. Gary Wills observed:

> Within its original rich context, the pursuit of happiness is a phenomenon both obvious and paradoxical. It supplies us with the ground of human right and the goal of human virtue. It is the basic drive of the self, and the only means given for transcending the self. As Hutchenson put it: "The several rights of mankind are therefore first made known by the natural feelings of their hearts, and their natural desires pursuing such things as tend to the good of each individual or those dependent on him; and recommending to all certain virtuous offices." Men in the eighteenth century felt they could become conscious of their freedom only by discovering how they were bound: When they found what they *must* pursue, they knew they had a *right* to pursue it.

G. WILLS, INVENTING AMERICA 247 (1979) [hereinafter cited as WILLS].

Another aspect of self-fulfillment focuses on the relationship between an individual and his government. The right of an individual to receive fair treatment from the state can likewise be assured only if he can communicate his needs to the government and can participate in the decisions made by the state. An individual must be free to voice dissatisfaction with acts of the state, to petition for benefits, or to give one's point of view to those who govern.

The second basic interest promoted by the first amendment focuses on the benefits of free expression to society.[77] This approach, labeled "utilitarian,"[78] has sometimes been narrowly viewed as extending only to the discussion of public or political issues which are essential to intelligent self-government in a democratic system.[79] More recently it has been argued that societal interests are broader and that the first amendment was meant to promote discussions of philosophical, social, artistic, economic, or ethical matters.[80]

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77. Justice Frankfurter, in his concurring opinion in Sweezy v. New Hampshire, 354 U.S. 234 (1957), stated:

> For society's good—if understanding be an essential need of society—inquiries into these problems, speculations about them, stimulations in others of reflections upon them must be left as unfettered as possible. Political power must abstain from intrusion into this activity of freedom, pursued in the interest of wise government and the people's well-being, except for reasons that are exigent and obviously compelling.
>
> . . . .
>
> "Freedom to reason and freedom for disputation on the basis of observation and experiment are the necessary conditions for the advancement of scientific knowledge."

Id. at 263 (Frankfurter, J., concurring) (quoting THE OPEN UNIVERSITIES IN SOUTH AFRICA 10-12). In *Sweezy* a teacher's refusal to answer questions about his lectures at the University of New Hampshire and his knowledge of the Progressive Party led to his conviction under the state's Subversive Activities Act. The Supreme Court overturned the conviction. *Id.* at 255.

78. Justice Rehnquist describes the utilitarian approach as follows:

> The . . . "utilitarian" justification, sees this right of the citizen as a means to the end of achieving certain social purposes. Whether cast in terms of the need for an informed electorate, or the desirability of a free flow of ideas for non-political reasons as well, the citizen's right to speak out exists not so much because it benefits *him* but because it benefits *society*. . . .
>
> [This view], treats as the highest end of society the maintenance of an informed electorate. . . . As Alexander Meiklejohn, the primary exponent of this viewpoint in modern times, has said: "Self-government can exist only insofar as the voters acquire the intelligence, integrity, sensitivity, and generous devotion to the general welfare that, in theory, casting a ballot is assumed to express."

Rehnquist, *supra* note 71, at 3-4 (quoting Meiklejohn, *The First Amendment is an Absolute*, 1961 SUP. CT. REV. 245, 255 (emphasis in original). *See also* FREE SPEECH, note 71 *supra*; POLITICAL FREEDOM, note 71 *supra*.

79. TRIBE, *supra* note 46, at 577.

80. Abood v. Detroit Bd. of Educ., 431 U.S. 209, 231 (1977). *See* TRIBE, *supra* note 46, at 577.

As is the case with individual self-fulfillment, society's interests in an informed citizenry[81] cannot be adequately protected unless the rights incident to speech are also recognized. While it is true that the first amendment expressly refers to speech, it is also apparent that certain non-communicative activities are of equal importance in carrying out first amendment policies. The Supreme Court has recognized this fact on numerous occasions and has given protection to these corollary activities.[82]

Underlying both the interest of the individual and the interest of society is a fundamental premise that individuals and government will make the best decisions only when they have the most reliable information available. The first amendment acts as the mechanism for fulfillment of individual and societal interests, since it assures a process to determine the truth of a particular matter.[83] It has long been recognized that the best way to insure that individuals and societies arrive at the truth is through the free exchange of ideas in the marketplace.[84] Even before the first amendment was drafted, the need for a free exchange of ideas was understood. More than 300 years ago,

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81. This broad social interest was recognized in Roth v. United States, 354 U.S. 476 (1957), in which the Court stated, "The protection given speech and press was fashioned to assure unfettered interchange of ideas for the bringing about the political and social changes desired by the people." *Id.* at 484.

In Virginia State Bd. of Pharmacy v. Virginia Citizens Consumer Council, 425 U.S. 748 (1976), a statute that held a pharmacist guilty of unprofessional conduct if he engaged in price advertising was attacked as a violation of the first and fourteenth amendments. The Court recognized that a consumer's interest in the free flow of commercial information could be keener than his interest in the day's most urgent political debate. *Id.* at 763-64. "Generalizing, society also may have a strong interest in the free flow of commercial information." *Id.* at 764.

The Supreme Court in striking down a Massachusetts law that prohibited corporations from spending funds to influence referenda elections, recognized the public's right to receive information from corporations. The Court noted that "the people in our democracy are entrusted with the responsibility for judging and evaluating the relative merits of conflicting arguments." First Nat'l Bank of Boston v. Bellotti, 435 U.S. 765, 791 (1978).

82. *See* note 69 *supra*.

83. As Justice Brandeis stated in Whitney v. California, 274 U.S. 357 (1927), "They [the founding fathers] believed liberty to be the secret of happiness and courage to be the secret of liberty. They believed that freedom to think as you will and to speak as you think are means indispensable to the discovery and spread of political truth . . . ." *Id.* at 375.

84. Professor Emerson suggests that:

> It is essential to note that the theory [of free speech] contemplates more than a process for arriving at an individual judgment. It asserts that the process is also the best method for reaching a general or social judgment. Through the acquisition of new knowledge, the toleration of new ideas, the testing of opinion in open competition, the discipline of rethinking its assumptions, a society will be better able to reach common decisions that will meet the needs and aspirations of its members.

TOWARD A GENERAL THEORY, *supra* note 71, at 8.

the English Parliament enacted a statute which provided that no books could be printed or sold without first obtaining a license. John Milton, in attacking the statute stated, "Truth and understanding are not such wares as to be monopolized and traded in by tickets and statutes and standards."[85]

Justice Holmes, in one of his famous dissents, laid the groundwork for incorporating a marketplace of ideas into the first amendment:

> Persecution for the expression of opinions seems to me perfectly logical. If you have no doubt of your premises or your power and want a certain result with all your heart you naturally express your wishes in law and sweep away all opposition. . . . But when men have realized that time has upset many fighting faiths, they may come to believe even more than they believe the very foundations of their own conduct that the ultimate good desired is better reached by free trade in ideas—that the best test of truth is the power of the thought to get itself accepted in the competition of the market, and that truth is the only ground upon which their wishes safely can be carried out. That at any rate is the theory of our Constitution.[86]

This concept of the marketplace of ideas subsequently has been accepted by the majority of the Supreme Court in several opinions.[87] From these cases there can be gleaned three activities which are necessary for the effective functioning of the marketplace: (1) the acquisition of information; (2) the development of ideas or concepts; and (3) the communication of ideas.[88]

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85. Milton, *Areopagitica*, in POLITICAL AND CIVIL RIGHTS IN THE UNITED STATES 1 (N. Dorsen, P. Bender & B. Neuborn ed. 1976).

86. Abrams v. United States, 250 U.S. 616, 630 (1919) (Holmes, J., joined by Brandeis, J., dissenting).

87. For example in Red Lion Broadcasting Co. v. FCC, 395 U.S. 367 (1969), the Court stated:

> It is the purpose of the First Amendment to preserve an uninhibited marketplace of ideas in which truth will ultimately prevail. . . . It is the right of the public to receive suitable access to social, political, esthetic, moral, and other ideas and experiences which is crucial here. That right may not constitutionally be abridged either by Congress or by the FCC.

Id. at 390.

In a case dealing with a state law requiring the signing of loyalty oaths by college professors, the Court stated, "The classroom is peculiarly the 'marketplace of ideas.' The Nation's future depends upon leaders trained through wide exposure to that robust exchange of ideas which discovers truth 'out of a multitude of tongues, [rather] than through any kind of authoritative selection.' " Keyishian v. Board of Regents, 385 U.S. 589, 603 (1967) (quoting United States v. Associated Press, 52 F. Supp. 362, 372 (1943)). *See also* Sweezy v. New Hampshire, 354 U.S. at 250.

88. It could be argued that science was the first institution to make use of the concept of the marketplace and that the framers of the Constitution were well aware of its value as a truth-seeking mechanism. In fact, during the 18th Century this concept was adopted by the developing social and political institutions of the time. *See* text accompany-

In a variety of fact situations, the Supreme Court has recognized a right to acquire information. The Court has upheld such a right in connection with the door-to-door distribution of religious material,[89] the receipt of sexually explicit material,[90] the receipt of political propaganda from abroad,[91] and receipt by consumers of information about prescription prices[92] and availability of real property.[93] In all of these decisions, the Court analyzed the policy underlying the first amendment and concluded that these activities must be protected as necessary incidents to speech.

The second necessary element of the marketplace is the development of ideas or concepts. In the United States most people take the right to think for granted. History is replete with tales of attempts to control what men believe and think,[94] however, and even the United States, long considered a free country, is not without examples of in-

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ing notes 254-63 *infra*. *See also* ORIGINS OF KNOWLEDGE, *supra* note 21, at 121-37; WILLS, *supra* note 76, at 93-164.

89. In Martin v. City of Struthers, 319 U.S. 141 (1943), the Court struck down an ordinance which banned door-to-door distribution of literature as applied to a Jehovah's Witness who sought to advertise a religious meeting. The Court held that the ordinance infringed on the rights of individual householders to decide whether or not to receive information as well as the right of the distributor to disseminate such information. The "right to receive" was "necessarily" protected by the first amendment since its purpose was to promote enlightenment over ignorance. *Id.* at 143.

90. In reversing a criminal conviction for knowingly having possession of obscene matter, the Court in Stanley v. Georgia, 394 U.S. 557 (1969), focused on the issue of obtaining the material in question. "It is now well established that the Constitution protects the right to receive information and ideas. 'This freedom [of speech and Press] . . . necessarily protects the right to receive. . . .' *Martin v. City of Struthers*, 319 U.S. 141, 143. . . . This right to receive information and ideas, regardless of their social worth, see *Winters v. New York*, 333 U.S. 507, 510 (1948), is fundamental to our free society." *Id.* at 564.

91. In Lamont v. Postmaster Gen., 381 U.S. 301 (1965), the Court held that a post office regulation which required that addressees of Communist political propaganda from abroad affirmatively request its delivery violated the first amendment. In a concurring opinion Justice Brennan stated: "I think the right to receive publications is . . . a fundamental right. The dissemination of ideas can accomplish nothing if otherwise willing addressees are not free to receive and consider them. It would be a barren marketplace of ideas that had only sellers and no buyers." *Id.* at 308 (Brennan, J., concurring).

92. Virginia State Bd. of Pharmacy v. Virginia Citizens Consumers Council, 425 U.S. 748 (1976).

93. In Linmark Assocs. v. Township of Willingboro, 431 U.S. 85 (1977), the Supreme Court struck down a township ordinance that prohibited the posting of for sale or sold signs on real estate. The Court's holding was based at least in part on the recognition of the right of the would be purchasers to receive information concerning the availability of real property. *Id.* at 92.

94. Galileo encountered similar difficulties with his beliefs. *See* note 1 *supra*. Lysenko with the aid of Stalin attempted such control in Russia. *See* note 45 *supra*.

tolerance for the beliefs and thoughts of others.[95] While it appears encroachment by the government upon one's thoughts or beliefs is a remote possibility, the potential for such action nevertheless exists.

Over fifty years before the drafting of the first amendment the necessity of free thought was acknowledged by Mrs. Silence Dogood, also known as Benjamin Franklin:

> Without freedom of thought, there can be no such thing as wisdom, and no such thing as publick [*sic*] liberty, without freedom of speech; which is the right of every man, as far as by it, he does not hurt or controul [*sic*] the right of another; and this is the only check it aught to suffer, and the only bounds it aught to know.[96]

Franklin's beliefs are at the core of the first amendment and have been reiterated by the Supreme Court. In *Abood v. Detroit Board of Education* the Court observed, "For at the heart of the First Amendment is the notion that an individual should be free to believe as he will and that in a free society one's beliefs should be shaped by his mind and his conscience rather than coerced by the State."[97]

Ideas, which are the product of the human mind, are the goods of the marketplace. Without ideas there could be no marketplace. Moreover, if the marketplace is to fulfill its function of truth seeking, all ideas must be available for consideration.

The final element of the marketplace is the communication of ideas. The focus of concern here is with the channels of communication and not the content. Any interference with these channels of communication will restrict the number of ideas available to the marketplace. In keeping open the channels of communication the Supreme Court has found it necessary to give constitutional protection to activities that are not speech.

A prime example in which the Court sought to keep the channels of communication open is *Buckley v. Valeo.*[98] In this case the key provisions of the Federal Election Campaign Act[99] were challenged as abridging the first amendment freedom of speech. Of particular concern was the provision which set a $1000 limit for expenditures by individuals and groups relative to a clearly identified candidate. The Court discussed the power of the federal government to control the ex-

95. Rice, *The High Cost of Thinking the Unthinkable*, PSYCHOLOGY TODAY, Dec. 1973, at 89 [hereinafter cited as Rice]; *see* note 142 *infra*. Textbook censorship is a growing phenomenon. Citizen committees have forced local school boards to ban such work as Shakespeare's plays and Webster's International Dictionary. Detroit News, Mar. 14, 1980, at 1A, col. 6.

96. I. COHEN, BENJAMIN FRANKLIN, HIS CONTRIBUTION TO AMERICAN TRADITION (1953).

97. 431 U.S. at 234-35.

98. 424 U.S. 1 (1976) (per curiam).

99. Federal Election Campaign Act Amendments of 1974, Pub. L. No. 93-443, 88 Stat. 1263 (amended 1976).

penditure of money in the political process and specifically recognized that while the expenditure of money was not, per se, a communicative act, it was so closely intertwined with expression, that any abridgment of the expediture process would be an abridgment of speech.[100] Even though the regulation did not focus on ideas expressed by an individual, it directly imposed quantity restrictions on the political communicative process, by placing a $1000 expenditure ceiling for any individual relative to any particular candidate.[101] Implicit in the Court's discussion is the proposition that any significant limitation on quantity must ultimately lead to a reduction of the quality of the speech. Such a limitation would severely limit the number of ideas available in the marketplace to further the truth-seeking process. The Supreme Court has recognized that certain activities are by nature an integral part of the communicative process and, therefore, protected by the first amendment.[102]

In light of the above discussion, it is now appropriate to focus on scientific inquiry. As previously stated, many of the activities of scientific inquiry are communicative. In order to insure that there is a meaningful exercise of this right, it will be shown that it is necessary to protect all the non-communicative aspects of scientific inquiry. It is only in this way that goals of individual and societal development, including truth seeking, can be fully realized.

Scientific inquiry can be broken down into component parts to facilitate identifying the communicative and non-communicative components. Non-communicative components will further be examined to determine whether or not each is essential to the communicative components and, thus, are necessary incidents of speech. The four essential components of scientific inquiry are: observation, formulation of hypothesis, experimentation, and communication.[103] It should be recognized that in most cases the dividing line between these components is not distinct, thereby resulting in overlap, feedback, and discontinuity. These elements will be discussed in order descending from the most to least communicative, rather than following the normal progression of the process of scientific inquiry.

a. Communication

The advancement of science has always been heavily dependent upon written and oral expression. Over the centuries, communication

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100. 424 U.S. at 16-17.

101. *Id.* at 17-22.

102. *See* note 69 *supra*.

103. This breakdown follows the steps in the scientific method previously discussed. *See* notes 56-57 and accompanying text *supra*.

among scientists and the free exchange and discussion of ideas has been the mechanism used to insure the reliability of scientific information. Free dissemination of information through a marketplace mechanism has been a tradition with scientists, and the source of its unique capability for self-correction.[104] Since the Court is willing to give general recognition to the value of the marketplace, it certainly should do so in the context of scientific inquiry.

Written expression is equally important because of the cumulative aspect of science. The barriers of time, distance, and death require the availability of written information. Each scientist, is making his contribution, relies on the work of those that have preceded him.[105] Without the basic research which produced the discovery of the double helix structure of the DNA molecule, for instance, research on recombinant DNA would not be possible.[106]

Scientific communication may arise in a wide variety of circumstances. For example, oral expression may involve the presentation of a paper at a scientific society meeting, panel discussions, private conversation in person or by telephone, or testimony before a congressional committee. Written expression may consist of letters, reports, and publications in scientific journals. All of these examples of the communicative component of scientific inquiry should be considered speech protected under the explicit language of the first amendment.

b. Observation

One of the methods by which scientists acquire information is observation. Scientific observation entails passive data gathering; that is the act of recognizing and noting natural occurrences. It is carried out directly by viewing natural phenomena or indirectly by receiving information from others. Observation is often the beginning point of scientific inquiry. One of the most famous examples of the observation of a natural phenomenon triggering the scientific process is Isaac Newton's observation of the apple falling to the ground,[107] which led to Newton's articulation of the laws of gravitation.

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104. ORIGINS OF KNOWLEDGE, *supra* note 21, at 122.

105. Newton was modest about his achievements. He once said that if he had seen further than others "it was by standing upon the shoulders of giants." F. RUTHERFORD, G. HOLTON & F. WATSON, PROJECT PHYSICS 112 (1975).

106. An example of this building process can be found in an article relating the most recent advances in the attempt to understand how the DNA code begins the process of cell division. In discussing their work the authors acknowledge the contributions of seven other scientists who prior work allowed them to proceed along the path of scientific inquiry. De Robertis & Gurdon, *Gene Transplantation and the Analysis of Development*, SCIENTIFIC AM., Dec. 1979, at 74-82.

107. W. DURANT, THE AGE OF LOUIS XIV 536-43 (1963)

Observation is just as essential to the scientific process today. The observation of such phenomena as black holes,[108] lung arteries,[109] the surface of the planet Venus,[110] and volcanoes of Jupiter's moon,[111] however, can only be made with sophisticated instruments. In the above examples, the information gathered was a necessary precondition to the advancement of science. But until the technological means of acquiring the information was available, the respective areas of science and scientific communications could not go forward. Governmental interference with the acquisition of information would similarily frustrate the underlying policies of the first amendment. Limiting observation would prevent the individual scientist from reaching his goal of self-fulfillment, since it would hinder his primary goal of seeking knowledge of the universe,[112] and would hamper his professional development within the institution of science.[113]

From society's perspective, interference with the acquisition of information will impair the truth-seeking function of the marketplace. Normally, once the data is received into the scientific community, it is thoroughly analyzed and discussed. The data is interpreted, laws are formulated, and further theories are postulated. Data obtained from observation is the fuel for the scientific process. Without new data, expansion of the body of scientific knowledge would stop. Ultimately the marketplace would become devoid of new ideas and the policy of the first amendment would be defeated.

c. Formulation of Hypotheses and Drawing of Conclusions

The formulation of an hypothesis and the drawing of conclusions are basically mental processes. This component would include all theoretical work. If any activity would be classified as a necessary precondition to the meaningful exercise of the expression, it must be an ability to think as one chooses.[114] The right to think, pursue, and

108. *A Supermassive Object in Galaxy M87,* 113 SCI. NEWS 308 (1978).

109. *Unzipping Blood Vessel Linings,* 113 SCI. NEWS 346 (1978).

110. *Probes Bound for Venus Atmosphere,* 114 SCI.NEWS 100 (1978).

111. *Voyager 1: Active Io, Jolting Jupiter,* 115 SCI. NEWS 165 (1979).

112. *See* text accompanying notes 18-20 *supra.*

113. One of the key methods of advancement within the scientific community is by publishing the results of experimentation. H. MENARD, SCIENCE: GROWTH AND CHANGE 84-128 (1971).

114. The Supreme Court has recognized the importance of this activity to the scientific process:

> Progress in the natural sciences is not remotely confined to findings made in the laboratory. Insights into the mysteries of nature are born of hypothesis and speculation. . . . For society's good—if understanding be an essential need of society—inquiries into these problems, speculations about them, stimulation in others of reflection upon them, must be left as unfettered as possible.

Sweezy v. New Hampshire, 354 U.S. at 261.

develop one's ideas is essential to the scientist because it is the essence of science to pursue knowledge, to question and investigate any subject, and to hold and state whatever conclusions naturally flow from such investigation.[115]

Like observation, the development of ideas or concepts is essential to the communicative activities of science because the marketplace could not function without the benefit of intellectual reflection. Information gathered from observation could not be fully utilized without proper interpretation. From this interpretation flow the various laws and paradigms which are the goals of scientific inquiry.

d. Experimentation

The formulation of a hypothesis will in the normal course of scientific inquiry lead to the development of experiments to prove or disprove the hypothesis. For the purpose of this analysis, experimentation refers to the active collection of data obtained from controlled conditions produced by human instigation.[116] Unlike observation, which consists of passively receiving information, experimentation involves the creation of artificial, controlled conditions under which data can be obtained, experimentation is of special concern because it may involve the creation of risks to scientists, other humans, their property, and the natural environment.[117]

The gathering of information is not unique to science. News gathering is an important prerequisite for the effective exercise of freedom of the press. In the case of reporters, the Court has recognized that active news gathering may be protected as a necessary incident to the right of freedom of the press.[118] A parallel argument can be made that since experimentation is the active information-gathering step in the process of scientific inquiry it must be protected as a necessary incident of the communicative components of scientific inquiry.[119]

Experimentation is an essential step in the scientific process[120]

115. *See* text accompanying notes 52-53 *supra.*

116. *See* text accompanying note 57 *supra.*

117. *See, e.g.,* note 221 *infra.*

118. Branzburg v. Hayes, 408 U.S. 665 (1972): "[We do not suggest] that news gathering does not qualify for First Amendment protection; without some protection for seeking out the news, freedom of the press could be eviscerated . . . . [R]eporters remain free to seek news from any source by any means within the law." *Id.* at 681-82. *See* Delgado & Millen, *supra* note 49, at 375-76.

119. This argument is more fully developed by other commentators. *See* Delgado & Millen, *supra* note 49, at 371-81; Robertson, *supra* note 52, at 1226-40.

120. While the Supreme Court has not yet expressly recognized a constitutional right to experiment, Justice Frankfurter acknowledged the importance of experimentation in the scientific process. "Freedom to reason and freedom for disputation on the basis of

because it is the component employed to acquire the data necessary to validate a hypothesis. Without experimentation the truth-seeking function of science would be severely hampered.[121] As was the case with observation, without experimental data there would be nothing to communicate and the policies underlying the first amendment would likewise be frustrated.

3. Speech Plus

On several occasions the Supreme Court has characterized activities as "speech plus." For example, in the areas of public demonstration and picketing, the Court has held that if there is both speech and conduct, the activity may receive a lesser degree of protection than is afforded pure speech.[122] This approach has been criticized by the text writers as an artificial distinction which creates more problems than it solves.[123]

Even if the analytical shortcomings of the speech plus approach are ignored, the approach still would not be applicable to scientific inquiry. The speech plus analysis deals with physical activities which are associated with a particular method of communication and which usually occur simultaneously with the communication. The activities of observation and experimentation do not occur simultaneously with communication but are a necessary precondition to effective communica-

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observation and experiment are the necessary conditions for the advancement of scientific knowledge. A sense of freedom is also necessary for creative work in the arts which, equally with scientific research, is the concern of the university." Sweezy v. New Hampshire, 354 U.S. at 263 (Frankfurter, J., concurring) (quoting THE OPEN UNIVERSITIES IN SOUTH AFRICA 10-12).

See also Reilly v. Pinkus, 338 U.S. 269 (1949), in which the Court stated: "[I]n the science of medicine, as in other sciences, experimentation is the spur of progress. It would amount to condemnation of new ideas without a trial to give the . . . power to condemn new ideas as fraudulent solely because some cling to traditional opinions with unquestioning tenacity." *Id.* at 274.

121. During the infancy of science the Greeks made no clear delineation between science and philosophy. Science was based mostly upon observation and reflection. Experimentation was not a part of early science. *See* STEARNS, *supra* note 26, at 8; WOODBRIDGE, note 26 *supra*. *See also* note 28 *supra*.

122. In *Buckley* the Supreme Court made the following observation:

> [I]n *Cox v. Louisiana*, 379 U.S. 559 (1965), the Court contrasted picketing and parading with a newspaper comment and a telegram by a citizen to a public official. The parading and picketing activities were said to constitute conduct "intertwined with expression and association," whereas the newpaper comment and the telegram were described as a "pure form of expression" involving "free speech alone" rather than "expression mixed with particular conduct."

424 U.S. at 17 (quoting 379 U.S. at 563-64).

123. TRIBE, *supra* note 46, at 598-601.

tion.[124] Additionally, these activities are not associated with any particular method of communication which might be used by the scientist. Thus, it is more appropriate to consider the physical activities involved in scientific inquiry as a necessary incident rather than "speech plus".

4. Constitutional Standards of Review Under the First Amendment

The Supreme Court has never developed a comprehensive set of tests to determine the validity of a governmental action which abridges speech.[125] During the past few decades the spectrum of attitudes of the various Justices on the Court has ranged from a view that the right of expression is absolute,[126] to one that the right can be infringed upon a showing of a clear and present danger,[127] to one allowing abridgment if government interest outweighs the value of the communication.[128]

An examination of the cases indicates that the test to be applied in a particular situation depends first upon whether governmental regulation is directed at speech; *i.e.*, is content neutral.[129] If the regulation is aimed directly at the expression or the communicative impact of the activity, the abridgment will be unconstitutional unless the government demonstrates that the speech or ideas represent a "clear and present danger,"[130] are defamatory[131] or obscene,[132] or come within one

124. The Supreme Court found the payment of money in the political context did not constitute any "plus" conduct stating, "Yet this Court has never suggested that the dependence of a communication on the expenditure of money operates itself to introduce a nonspeech element or to reduce the exacting scrutiny required by the First Amendment." Buckley v. Valeo, 424 U.S. at 16. Observation and experimentation, like the payment of money, are the preconditions to speech and necessary incidents that must be protected.

125. POLITICAL AND CIVIL RIGHTS IN THE UNITED STATES 51-59 (N. Dorsen, P. Bender & B. Neuborne eds. 1976); *see generally* TRIBE, *supra* note 46, at 580-601.

126. In Barenblatt v. United States, 360 U.S. 109, 134-62 (1959) and Konigsberg v. State Bar, 366 U.S. 36, 56-80 (1961), Justices Black and Douglas in their dissents expressed the view that first amendment rights are absolute; *see also* Black, *The Bill of Rights*, 35 N.Y.U. L. REV. 865 (1960); Kalven, *Upon Rereading Mr. Justice Black on the First Amendment*, 14 U.C.L.A. L. REV. 428 (1967).

127. Schenck v. United States, 249 U.S. 47, 52 (1919); Torke, *Some Notes on the Proper Uses of the Clear and Present Danger Test*, 1978 B.Y.U. L. REV. 1.

128. United States v. O'Brien, 391 U.S. 367 (1968), Ely, *Flag Desecration: A Case Study in the Roles of Categorization and Balancing in First Amendment Analysis*, 88 HARV. L. REV. 1482 (1975); Gunther, *In Search of Judicial Quality on a Changing Court: The Case of Justice Powell*, 24 STAN. L. REV. 1001 (1972).

129. TRIBE, *supra* note 46, at 580.

130. Brandenburg v. Ohio, 395 U.S. 444 (1969) (per curiam).

131. Gertz v. Robert Welch, Inc., 418 U.S. 323 (1974).

132. Miller v. California, 413 U.S. 15 (1973).

of the other narrow categorical exceptions;[133] or that the governmental impingement is necessary to further a compelling state interest.[134] If the regulation advances a substantial governmental interest, other than controlling the ideas or information generated by scientific inquiry, then an incidental abridgment will be permitted if its restriction is no greater than required to the furtherance of the governmental interest.[135]

a. Restraints Directed at Expression

(i) Protection from Imminent Lawless Action

It has long been recognized that the state has a compelling interest in protecting its citizens from the dangers of imminent lawless action. Any state regulation that seeks to protect this interest must satisfy the requirements of what has become known as the clear and present danger test. The clear and present danger test was first articulated in *Schenck v. United States,*[136] and refined in a series of cases culminating in *Whitney v. California*[137] in which Justice Brandeis stated:

> [N]o danger flowing from speech can be deemed clear and present, unless the incidence of the evil apprehended is so imminent that it may befall before there is opportunity for full discussion. If there be time to expose through discussion the falsehood and fallacies, to avert the evil by the processes of education, the remedy to be applied is more speech, not enforced silence. Only an emergency can justify repression.[138]

Subsequently, in *Dennis v. United States,*[139] the Court, while referring to *Whitney,* retreated from the strictness of the test. Finally in *Brandenburg v. Ohio*[140] the Court restricted the tests of the prior cases, stating that a state may not "forbid or proscribe advocacy of the use of force or of law violation except where such advocacy is directed to inciting or producing imminent lawless action and is likely to incite or produce such action."[141]

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133. For example, the state has a compelling interest in protecting its citizens against false advertising. Virginia State Bd. of Pharmacy v. Virginia Citizens Consumer Council, 425 U.S. 748 (1976).

134. Ohralik v. Ohio State Bar Ass'n, 436 U.S. 447 (1978).

135. United States v. O'Brien, 391 U.S. at 381.

136. 249 U.S. at 52.

137. 274 U.S. 357 (1927).

138. *Id.* at 377 (Brandeis, J., concurring).

139. 341 U.S. 494 (1951).

140. 395 U.S. 444 (1969) (per curiam).

141. *Id.* at 447.

In order to qualify for analysis under the clear and present danger test, a case must, in the first instance present the possibility that the speech would lead to imminent violence or other lawless actions. In the area of scientific inquiry this situation could arise when a scientist presents the results of his research to a hostile audience, but it would be rare, since most scientific presentations would not generate anger or hostility of such a dangerous degree.

Consider the situation where a geneticist presents a speech based on his own research from which he has concluded that because of different genetic development a particular race has a lower average intelligence level than other races.[142] The presentation of a speech on that subject could give rise to two different motivations for a governmental prohibition of the presentation. First, the information contained in the speech could have severe social, economic, and political consequences. Such information would disrupt present governmental programs aimed at achieving racial equality.[143] The speech could also result in psychological trauma to individual members of that race. In spite of these adverse consequences, the clear and present danger test as currently articulated would not justify governmental intrustion. The "incidence of the evil apprehended" is not so imminent that there is no opportunity for full discussion.[144] Whether the views of the scientist are true or false plays no part in justifying government prohibition under this theory. If the scientist's conclusions are true, the test provides no justification for prohibition. If the theory is false there would be "time to expose through discussion the falsehood and fallacies, to avert the evil by the process of education . . . ."[145]

The second reason for government intervention would arise not so much from the content of the speech, but because of the immediate circumstances surrounding his presentation and the potential for violence. Under the *Brandenburg* test two circumstances must be considered: the state of mind of the speaker and the potential for adverse audience reaction. If our scientist merely intends to convey the results

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142. In 1969, Arthur R. Jensen published an article entitled *How Much Can We Boost I.Q. and Scholastic Achievement?* in which he presented evidence that blacks, as a group, score lower on I.Q. tests than whites. Based on his study, Jensen suggested that heredity may have more effect than environment in determining intelligence and concluded that programs of environmental enrichment were doomed to failure. 39 HARV. EDUC. REV. 1 (1969). Shortly thereafter, William Schockley, a Stanford physicist and Nobel laureate, concluded that blacks were genetically inferior and proposed to teach a course at Stanford based on his views. Rice, *supra* note 95, at 89.

143. The presentation also could have political consequences since such scientific evidence contradicts one of the fundamental premises underlying our whole politicial system, namely that "all men are created equal."

144. Whitney v. California, 274 U.S. at 377.

145. *Id.*

of his work to an audience, *i.e.*, any group of listeners, he could not be prohibited from speaking. On the other hand, if he intended to incite imminent lawless action by his audience, then the first part of the test would be satisfied.[146]

Presuming the first element of the test is satisfied, it is also necessary that the audience, given the surrounding circumstances, is likely to respond to the speech in such a way as to produce the lawless action.[147] Some of the factors which might be significant in applying test are: size of audience, racial mix, location of speech, prior events, and weather conditions. For example, a speech given to a group of fellow scientists at an annual meeting in a resort area seems much less likely to produce imminent violence as a presentation to a gathering of members of the race in question on their home grounds.[148]

Because of the nature of the clear and present danger test, it would never be appropriate to use it in evaluating governmental regulation which seeks to prohibit observing, hypothesizing, or experimenting. Since the vast majority of scientific work is done in private, it is seldom communicated to the public at large or in a posture of advocacy. Finally, with the limitations of the clear and present danger test it is most likely that the state will seek to justify any direct infringement on the basis of some other compelling interest.

(ii) Other Compelling State Interests

In addition to protecting citizens from the dangers of imminent lawless action, the state is permitted to abridge expression directly when advancing a compelling interest.[149] These compelling interests arise in a limited number of circumstances wherein the state seeks to protect itself or its citizens from harm caused by the communication of ideas or opinions.[150] In determining whether there is, in fact, a compel-

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146. 395 U.S. at 447.

147. An address either to members of the "inferior race" for the purpose of inciting them to riot and thus demonstrating their intellectual inferiority or an address to members of a "superior race" for the purpose of inciting them to commit violence upon the inferior race would satisfy the test.

148. In May of 1973, Hans J. Eysench, a British psychologist, gave a lecture at the London School of Economics on race and intelligence based on views similar to Jensen's. As he began his speech, he was attacked by students who cut his nose, pulled his hair, and broke his glasses. In Jensen's case, demonstrators invaded his classes at the University of California and Berkeley and disrupted his lectures with heckling and bomb threats. Rice, *supra* note 95, at 89, 92.

149. *See* TRIBE, *supra* note 46, at 580-84.

150. In Near v. Minnesota, 283 U.S. 697 (1931), Chief Justice Hughes gave the following illustrations of exceptional cases involving direct infringement and justifying prior restraint: (1) restraints during wartime to prevent the disclosure of military deployments

ling interest which would justify a prior restraint, the Court has shown a willingness to go beyond a broad assertion by the state that a compelling interest exists and to determine the existence of the interest for itself.[151] For example, in the area of national security, the Court has held that the mere assertion of some general danger to national security is not sufficient to justify a prior restraint of speech. The Court has required the government to show that disclosure "must inevitably, directly, and immediately cause the occurrence of an event kindred to imperilling the safety of a transport already at sea . . . ."[152] There are two requirements necessary to justify a prior restraint: (1) the injury must be certain to occur and (2) the harm must be irreparable.[153] A fortiori it must be a situation in which more speech will not be an alternative remedy.

Applying these concepts to scientific inquiry, the government may seek to justify a prior restraint to protect itself or its citizens from imminent, irreparable harm.[154] This harm might arise because the knowledge gained from scientific inquiry is considered dangerous in and of itself, or the knowledge gained from scientific inquiry, if misused or abused, could lead to harm or injury.

In seeking to protect itself, the government may invoke national security as a justification for restrictions on scientific inquiry. In most cases the prohibition would be directed at the disclosure of information gained from scientific work.[155] For example, the government may

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or obstruction of the military effort, (2) enforcement of obscenity laws, and (3) enforcement of laws against incitement to acts of violence or revolution. *Id.* at 716.

The Court also upheld a direct infringement involving a subsequent restraint involving client solicitation by attorneys. The Court recognized the state's compelling interest "in preventing those aspects of solicitation that involve fraud, undue influence, intimidation, overreaching and other, 'vexatious conduct.'" Ohralik v. Ohio State Bar Ass'n, 436 U.S. 447, 462 (1978).

151. *See, e.g.*, New York Times Co. v. United States, 403 U.S. 713 (1971) (per curiam).

152. *Id.* at 726-27 (Brennan, J., concurring) (citing Near v. Minnesota, 283 U.S. at 716).

153. 274 U.S. at 377 (Brandeis, J., concurring).

154. The state also could abridge scientific inquiry through a subsequent restraint. For example, it could impose civil or criminal penalties for publishing false data. Such situations would probably be dealt with in the same way as defamatory statements. *See* Gertz v. Robert Welch, Inc., 418 U.S. 323 (1974); New York Times Co. v. Sullivan, 376 U.S. 254 (1964).

155. In the fall of 1979, the government sought to enjoin the publication of a magazine containing an article which showed a cross section of a hydrogen bomb and a comprehensive description of radiation coupling, along with two other concepts not found in the public realm. The government claimed that this information was "born classified" and disclosure would harm national security. The district court issued a preliminary injunction finding that "publication or other disclosure of the Secret Restricted Data contained in the Morland article would irreparably harm the national security of the United States." United States v. Progressive, Inc., 467 F. Supp. 990 (W.D. Wis.), *dismissed mem.*, 610 F. 2d 819 (7th Cir. 1979). The Justice Department subsequently abandoned its efforts when the information was published elsewhere. N.Y. Times, Sept. 18, 1979, at Al, col. 6.

assert a compelling interest in preventing the disclosure of information gained from research on nuclear weapons, new concepts for tracking missiles or satellites, and intelligence-gathering techniques involving satellites. It is also possible, however, for the restriction to be directed at the other steps in the scientific process. The government might achieve the same result by prohibiting the experimentation necessary to generate the knowledge.

A prior restraint on scientific inquiry would be justified if the state could show that an injury was certain to occur and the harm caused would be irreparable. In the case of national security the government would assert that if information generated by scientific inquiry is obtained by a hostile foreign power it would be dangerous in and of itself since it could affect treaty negotiations or, alternatively, that the information would upset the international balance of power. It could also be argued that certain information is dangerous because it could be used to develop technologies militarily advantageous to our enemies.[156]

Assuming that the government sustains its burden of establishing that these injuries are certain to occur, it must also establish that more speech or post-publication punishment will not be a suitable remedy. Once the scientific information goes beyond the borders of this country, control of its application escapes the jurisdiction of the United States government. Therefore, the only practical stage at which control may be exerted is at the scientific level. In this situation, more speech within the United States cannot prevent the harm. The potential abuse or misuse of scientific information by foreign powers, gives rise to a compelling state interest justifying a state interference with science.[157]

In addition to protecting itself, the state may occasionally seek to protect its citizens from harm caused by ideas or information. In certain situations the state may claim that information gained from scientific inquiry can, in and of itself, cause harm when communicated to the public. The state of Arkansas sought to protect the mental and

156. That the knowledge obtained from scientific inquiry might be abused or misused by the development of harmful technologies is not normally a sufficient justification for a prohibition of inquiry, because, as a less restrictive alternative, the governmental interest can be asserted at the development or the marketing stage to prevent harm. The first amendment policy of having a free exchange of ideas which can be tested in the marketplace would outweigh any governmental interest that seeks to protect its citizens by keeping them in a state of ignorance.

157. In these cases, there remains a serious problem with overly broad security orders. Security orders, unlike other administrative regulations, are not subject to the normal open procedures which include notice, hearings, standards, and judicial review. *See, e.g.*, 5 U.S.C. § 552(b)(1) (1976). Given the existence of a constitutional right of scientific inquiry, it will be necessary to re-evaluate the process by which the decisions to classify information are made.

emotional well-being of its citizens by enacting a statute which precluded the teaching of the Darwinian theory of evolution.[158] The statute was clearly an attempt by the state to control knowledge which it considered dangerous or offensive to the religious beliefs of a number of its citizens.

Advances in the areas of external human fertilization,[159] fetal research,[160] recombinant DNA,[161] and cloning [162] have likewise raised issues concerning the potential danger to citizens from the knowledge gained from research.[163] The knowledge gained from scientific work may be considered "dangerous" in two respects. First, the knowledge may be used by the government or others to create technologies which could result in physical, moral, ethical, or social harm. Research into the chemistry of the human mind could lead to the development of

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158. The statute read:

> § 80-1627. Doctrine of ascent or descent of man from lower order of animals prohibited.—It shall be unlawful for any teacher or other instructor in any University, College, Normal, Public School, or other institution of the State, which is supported in whole or in part from public funds derived by State and local taxation to teach the theory or doctrine that mankind ascended or descended from a lower order of animals and also it shall be unlawful for any teacher, a textbook commission, or other authority exercising the power to select textbooks for above mentioned educational institutions to adopt or use in any such institution a textbook that teaches the doctrine or theory that mankind descended or ascended from a lower order of animals.

ARK. STAT. ANN. § 80-1627 (1960), *reprinted in* Epperson v. Arkansas, 393 U.S. 97, 99 n.3 (1968).

The United States Supreme Court struck down the statute because it improperly promoted a particular religious view of the origins of man. *Id.* at 107-09.

Arkansas has not given up its attempt to legislate the teaching and contents of science within the public schools. A law which will be effective in the fall of 1982 requires the teaching of creationism along with the theory of evolution. SCI. NEWS, April 4, 1981, at 222.

159. *See* Flannery, Weisman, Lipett & Braverman, *Test Tube Babies: Legal Issues Raised by In Vitro Fertilization*, 67 GEO. L. J. 1295 (1979); Grobstein, *External Human Fertilization*, SCIENTIFIC AM., June 1979, at 57.

160. Gaylin & Lappee, *Fetal Politics: The Debate on Experimenting with the Unborn*, ATLANTIC MONTHLY, May 1975, at 66. Pilon & Juliana, *Cost-Benefit Ethics and Fetal Research*, 3 HUMAN LIFE REV. 63 (1977).

161. Bereano, *Recombinant DNA: Issues on the Regulation of Basic Scientific Research*, 20 IDEA 315 (1979); Berger, *Government Regulation of the Pursuit of Knowledge: The Recombinant DNA Controversy*, 3 VT. L. REV. 83 (1978).

162. *All About Clones*, NEWSWEEK, March 20, 1978, at 68; Kinney, *Legal Issues of the New Reproductive Technologies*, 52 CAL. ST. B.J. 514 (1977).

163. In the area of recombinant DNA research, fear has been expressed that the altruistic aims of the work may fall under the heartless rules of the marketplace. B. HARING, ETHICS OF MANIPULATION 159-211 (1975). It has also been argued that if the publication of scientific knowledge results in social consequences to any person, the truth is not worth knowing. LURIA, BIOLOGICAL ROOTS OF ETHICAL PRINCIPLES IN GENETICS AND THE LAW 409 (A. Milunsky & G. Annas eds. 1975).

techniques which would make it possible for the government control large segments of the population.[164] Second, the new scientific information may be perceived by some to improperly influence an individual's ideas or beliefs. For example, some believe that the present concept of the family as an institution will be destroyed if through the use of new medical techniques life is procreated outside of the family setting.[165]

Outside the area of national security, it is highly unlikely that the government will ever be able to suppress scientific inquiry on the basis of "dangerous knowledge." While the first amendment is not an absolute bar to prior restraints, the Supreme Court has clearly stated that any such retraint comes to the court bearing a heavy presumption against validity.[166]

When the first amendment was adopted, Congress was well aware of the evils that flowed from the English licensing system which attempted to control dangerous knowledge by requiring prior approval of the state or church authorities before publication.[167] Today, any attempt to control dangerous knowledge outside of the area of scientific inquiry would be unanimously recognized as contrary to the dictates of the first amendment. That the knowledge is scientific should not lead to a different result. Even if new scientific knowledge might ultimately be used for illegal or unethical purposes, this should not, by itself, justify a prior restraint. In these situations the alternative of more speech is available to counteract any perceived improper use. Additionally, the state will be able to control the misuse of such knowledge at the technological level.

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164. G. ORWELL, NINETEEN EIGHTY-FOUR (1949).

165. As a result of solicitation by the Ethics Advisory Board of the Department of Health, Education, and Welfare, the following comments concerning in vitro fertilization and embryo transfer were received:

> [T]here will be a strong demand for such extramarital uses of the clinical procedures—a demand which, if fulfilled, will further compromise "the virtues of family, lineage, and heterosexuality" or weaken "the taboos against adultery and even incest."
>
> . . . .
>
> Other potential consequences considered adverse by some expert witnesses and commentators include:
>
> a. The development of commercial ovum and embryo banks.
>
> b. The genetic selection or manipulation of early embryos.
>
> c. The transfer of nuclei from adult individuals to early embryos, or cloning.
>
> d. Extracorporeal gestation, or bringing an embryo all the way to viability in the laboratory.

Protection of Human Subjects; HEW Support of Human In Vitro Fertilization and Embryo Transfer: Report of the Ethics Advisory Board, 44 Fed. Reg. 35,033, 35,045 (1979) (footnotes omitted).

166. New York Times Co. v. United States, 403 U.S. at 714; Bantam Books, Inc. v. Sullivan, 372 U.S. 58, 70 (1963).

167. *See* Near v. Minnesota, 283 U.S. at 713.

b. Restraints Not Directed at Expression

(i) The Test for Indirect Restraint

The government might seek to regulate scientific inquiry, not because of the communicative content of scientific inquiry, but because of the governmental interests in the health and safety of its citizens or the protection of the natural environment.[168] The advancement of these interests may result in an indirect restraint on scientific inquiry. Problems of indirect restraint most often arise when the government seeks to control the method used by a speaker to gather or disseminate ideas or information.[169]

A government regulation which results in an indirect restraint on speech is permissible if (1) it is within the constitutional power of the government, (2) it furthers an important or substantial government interest, (3) the governmental interest is unrelated to the suppression of free expression, (4) the restriction is incidental, and (5) it is no greater than is essential to the furtherance of the governmental interest.[170]

In the first instance any governmental regulation must be based on proper constitutional authority; *i.e.*, the interest sought to be advanced must be one of proper concern for the government. In the case of state governments, the basis is normally the police power, which encompasses the power to protect or advance the public health, safety, or welfare.[171] In the case of the federal government, the authority must flow from one of the powers enumerated in the constitution; *e.g.*, the commerce power.[172]

An examination of first amendment decisions indicates that the Supreme Court has recognized the following interests as substantial enough to justify the indirect abridgment of the freedom of expression: Protection of the selective service system,[173] national security,[174] grand

168. By way of analogy, the government may seek to insure a proper atmosphere for children attending school by barring noisy demonstrations on streets adjoining schools while classes are in session. *See* Grayned v. City of Rockford, 408 U.S. 104 (1972).

169. Thus, a governmental regulation prohibiting the use of sound amplification equipment in residential neighborhoods, while seeking to advance the government's interests in protecting the well-being and tranquility of the community, would restrict an activity which conveys information. *See* Kovacs v. Cooper, 336 U.S. 77 (1949).

170. This test was articulated by the Supreme Court in United States v. O'Brien, 391 U.S. 367, 377 (1968).

171. For a classic discussion of state police power, see Lawton v. Steele, 152 U.S. 133 (1894) (regulation of the method of fishing); Smith v. Maryland, 59 U.S. (18 How.) 71 (1855) (regulation of the method of taking oysters).

172. *See* TRIBE, *supra* note 46, at 225-27.

173. In United States v. O'Brien, in affirming a conviction for knowingly destroying a certificate issued by the Selective Service System, the Court held that Congress has a legitimate and substantial interest in preventing the destruction of draft cards to insure the availability of registrants for induction. 391 U.S. at 380.

174. Zemel v. Rusk, 381 U.S. 1, 14-15 (1965).

jury investigations,[175] and the proper functioning of the penal system.[176]

The mere existence of a substantial interest, however, is not sufficient to justify an indirect restraint. The regulations also must further the interest asserted by the government. In *Buckley v. Valeo*[177] the government argued that the expenditure ceiling of $1000 a year per candidate in the Federal Election Campaign Act was necessary to stem the reality or appearance of corruption in the election process. The Supreme Court recognized that this goal was within congressional authority but nevertheless struck down the provision because it failed to further this interest.[178] The Court analyzed goals of the statute in light of its own experience and concluded that "[i]t would naively underestimate the ingenuity and resourcefulness of persons and groups desiring to buy influence to believe that they would have much difficulty devising expenditures that skirted the restriction on express advocacy of election or defeat but nevertheless benefited the candidate's campaign."[179] The Court thus decided Congress had misjudged the effectiveness of this provision as a means of checking political corruption, and therefore found the expenditure portion of the statute to be an unconstitutional abridgment of free expression.

When dealing with areas in which it has expertise, the Court appears to be willing to substitute its own judgment for that of the legislative branch.[180] In the area of science, however, the Court may not have the expertise possessed by Congress or administrative agencies and may be unwilling to substitute its judgment for theirs should a

175. In requiring that newsmen appear before a grand jury to give testimony, the Court recognized the public interest in law enforcement and in ensuring effective grand jury investigations. Branzburg v. Hayes, 408 U.S. 665, 690 (1972).

176. In evaluating a state prison regulation relating to the censorship of mail, the Court held that there was a "legitimate governmental interest in the order and security of penal institutions [that justified] the imposition of certain restraints on inmate correspondence." Procunier v. Martinez, 416 U.S. 396, 412-13 (1974).

177. 424 U.S. 1 (1976) (per curiam).

178. *Id.* at 47-48. On the other hand, the Court found that the portion of the Act that limited campaign contributions did further the governmental interest of a corruption-free election process. *Id.* at 26-27.

179. *Id.* at 45.

180. The Court has engaged in this type of analysis when the restriction was directed at the speech itself. For example, the prohibition on price advertising of prescription drugs did not advance state interest in maintaining high professional standards for pharmacists. Virginia State Bd. of Pharmacy v. Virginia Citizens Consumer Council, 425 U.S. 748, 766-70 (1976). In another situation the Court found that the prohibition of "for sale" signs on residential real estate did not advance the state's interest in promoting racially integrated housing. Linmark Assocs. v. Township of Willingboro, 431 U.S. 85, 94-95 (1977). Finally, in Village of Schaumburg v. Citizens for a Better Environment, 444 U.S. 620 (1980), the Court, while recognizing the village's interest in protecting its citizens from fraud, crime, and undue annoyance, struck down as overbroad an ordinance that prohibited solicitations by unqualified charitable organizations. *Id.* at 639.

case arise involving the regulation of scientific inqury.[181] Furthermore, if the Court does attempt to determine whether the regulation furthers a particular goal, the judgment must be based on either its own insufficient expertise or on a reevaluation of the expert testimony presented at the trial of the case. It appears that the Court at present is ill-equipped to determine whether a particular regulation of scientific inquiry furthers an important government interest.

The requirement that the government's asserted interest must be unrelated to the suppression of free expression is really only another way of saying that the reglulation must be facially neutral; that is, it must not state or imply an intent to suppress ideas or information. It has been argued by commentators that even a facially neutral regulation may be struck down if it was motivated by an intent to directly abridge speech.[182] The right of free expression would be meaningless if the government could accomplish indirectly that which it could not accomplish directly. The Supreme Court, however, has shown an unwillingness to examine the motives of legislative bodies.[183]

A facially neutral regulation must only incidentally abridge freedom of expression. If such a regulation effectively cuts off access or leaves too little access to the channels of communication, it is unconstitutional.[184] A municipality, for example, may enact regulations designed to further its interest in keeping streets and sidewalks free of litter. A regulation banning the distribution of all handbills to futher this inter-

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181. This reluctance to evaluate complex, technical subjects has already arisen in environmental law. In Vermont Yankee Nuclear Power Corp. v. Natural Resources Defense Council, Inc., 435 U.S. 519 (1978), the Court in reviewing certain rule making activities of the Atomic Power Commission stated, "The fundamental policy questions [nuclear energy] appropriately resolved in Congress . . . are *not* subject to reexamination in the federal courts under the guise of judicial review of agency action." *Id.* at 558 (emphasis in original). *See also* Rodgers, *A Hard Look at Vermont Yankee: Environmental Law Under Close Scrutiny,* 67 GEO. L.J. 699 (1979).

182. TRIBE, *supra* note 46, at 591-98. *See generally* A. BICKEL, THE LEAST DANGEROUS BRANCH 208-21 (1962); Alfange, *Free Speech and Symbolic Conduct: The Draft-Card Burning Case*, 1968 SUP. CT. REV. 1; Brest, *Palmer v. Thompson: An Approach to the Problem of Unconstitutional Legislative Motive,* 1971 SUP. CT. REV. 95; Ely, *Legislative and Administrative Motivation in Constitutional Law,* 79 YALE L.J. 1205 (1970) [hereinafter cited as Ely].

183. In *O'Brien* the Court reiterated, "The decisions of this court from the beginning lend no support whatever to the assumption that the judiciary may restrain the exercise of lawful power on the assumption that a wrongful purpose or motive has caused the power to be exerted." 391 U.S. at 383 (quoting McCray v. United States, 195 U.S. 27, 56 (1904)). *But see* Village of Arlington Heights v. Metropolitan Hous. Dev. Corp., 429 U.S. 252 (1977), where the court held that a violation of the equal protection clause could be established by a showing that a law was passed with a racially discriminatory intent or purpose. *Id.* at 264-68.

184. TRIBE, *supra* note 46, at 682-83.

est would not, however, be considered an incidental restraint since it has foreclosed a method of communication protected by the first amendment.[185]

Finally, a regulation must be no greater than is essential to the furtherance of the governmental interest. The Supreme Court in *Martin v. Struthers*[186] struck down a municipal ordinance which prohibited ringing door bells to distribute pamphlets since the privacy of individuals could be protected by the less drastic alternative of making it a criminal offense to ring a door bell after a home owner has made it apparent that he does not wish to be disturbed.

While it is possible that the government might indirectly restrain communication, observation, and formation of hypotheses, experimentation is more likely to be affected since it is this component which generates most of the potential problems and is least like pure speech. When the government enacts regulations it most likely will be on the basis of advancing its interest in protecting its citizens. Protection may be required either because the experiment involves human subjects or the experiment imposes an unacceptable danger or harm to the public at large.

(ii) Human Experimentation

Assuming that experimentation is a necessary incident of speech, the regulation of experimentation with human subjects by the state would be permissible only if its satisfied the five point *O'Brien* test.[187] Although it was not formulated with regulation of science in mind, to illustrate how this test might operate in a typical regulatory setting, it will be applied to the existing HEW regulations on human experimentation.[188] The regulations expressly seek to safeguard the rights of sub-

185. The Supreme Court, in striking down an ordinance prohibiting the distribution of handbills because it allowed too little breathing space for communicative activities stated:

> Mere legislative preferences or beliefs respecting matters of public convenience may well support regulation directed at other personal activities, but be insufficient to justify such as diminishes the exercise of rights so vital to the maintenance of democratic institutions.
>
> . . . .
>
> We are of opinion that the purpose to keep the streets clean and of good appearance is insufficient to justify an ordinance which prohibits a person rightfully on a public street from handing literature to one willing to receive it.

Schneider v. State, 308 U.S. 147, 161-62 (1939). *See also* Talley v. California, 362 U.S. 60 (1960).

186. 319 U.S. 141, 148 (1943).

187. *See* note 170 and accompanying text *supra*.

188. Protection of Human Subjects, 45 C.F.R. §§ 46.101-.211 (1980). Although these regulations are applicable only to HEW-funded research, they will be discussed as if they were applicable to all experimentation.

It could be argued that while the regulations on their face are limited to controlling ject at risk; that is, those subjects who may be exposed to the possibility of physical, psychological, or social injury.[189] This goal is carried out by requiring that the experimenter obtain the informed consent of the subject as well as prior administrative approval.[190]

The first question which must be considered is whether the protection of subjects at risk is within the constitutional power of the governmental entity which has promulgated the regulation. If the regulations are promulgated by a state government, then under the concept of police power the state is able to protect or advance its interests in protecting the individual from tortious or criminal conduct.[191] On the other hand, if the regulations are imposed by the federal government on all experimentation rather than as a condition to obtaining federal grants, then the regulations must be based on specific constitutional power.[192]

The second element of the test requires that the regulations further an important or substantial governmental interest. In this example the two methods chosen by the government to protect the individual are administrative approval of the experiment and informed consent.[193] The

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grant money for research, they act as a de facto regulation of all research because the federal government provides the vast majority of the funds for this work. A denial of federal grants, therefore, is the equivalent of a legal prohibition.

189. *Id.* §§ 46.102, .103(b). While the regulations do not detail specific injuries, one could presume the drafter had in mind tortious conduct such as assault, battery, intentional infliction of emotional distress, invasion of privacy, or criminal conduct such as manslaughter or other statutory crimes. *See generally* Greenblatt, *The Ethics and Legality of Psychosurgery,* 22 N.Y.L. SCH. L. REV. 961 (1977) [hereinafter cited as Greenblatt].

190. 45 C.F.R. §§ 46.104, .109 (1980).

191. *See* Greenblatt, *supra* note 189, at 975-80.

192. The requirement that federal legislation be based on a specific constitutional power is part of the doctrine of enumerated powers. TRIBE, *supra* note 46, at 225. The most likely basis for supporting federal regulation of human experimentation would be the commerce power. *Id.* at 238-44.

193. 45 C.F.R. § 46.102 (1980). The regulations give a fairly extensive definition of informed consent.

> (c) "Informed consent" means the knowing consent of an individual or his legally authorized representative, so situated as to be able to exercise free power of choice without undue inducement or any element of force, fraud, deceit, duress, or other form of constraint or coercion. The basic elements of information necessary to such consent include:
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> (1) A fair explanation of the procedures to be followed, and their purposes, including identification of any procedures which are experimental;
>
> (2) A description of any attendant discomforts and risks reasonably to be expected;
>
> (3) A description of any benefits reasonably to be expected;
>
> (4) A disclosure of any appropriate alternative procedures that might be advantageous for the subject;
>
> (5) An offer to answer any inquiries concerning the procedures; [and]

consent requirement would indeed further the governmental interest since it protects a person against fraud or duress by insuring that he is not the unwilling subject of a scientific experiment or participates in the experiment without knowing the risks. If consent is obtained, however, it is unclear from the regulations exactly what interest the other requirement, prior administrative approval, seeks to further. If the regulations have as their sole purpose the protection of the subject from his own folly, they must be struck down as a violation of the subject's right of privacy.[194] If the regulations seek to further some other interest, they are silent as to what that interest may be. Other interests may include minimizing welfare costs incurred because of the inability of the subject to care for himself or his dependents and preventing the injuries and death of subjects because they will be so alarming, widespread and of such grave dimensions that they threaten the very fabric of society.[195] Assuming that the regulations were redrafted so as to reflect a proper interest, a court could determine whether the provisions for administrative review further that interest.[196]

> (6) An instruction that the person is free to withdraw his consent and to discontinue participation in the project or activity at any time without prejudice to the subject . . . .

Id. § 46.103(c).

Even with the above definition, however, there are significant legal problems with what the courts will accept as informed consent, particularly when a legally authorized representative is involved. It has been argued, for example, that a mother who is about to abort a fetus is not capable of giving informed consent. Markey, *Federal Regulation of Fetal Research: Toward a Public Policy Founded on Ethical Reasoning,* 31 U. MIAMI L. REV. 675, 684 (1977); Siegal, *A Bias for Life,* 4 HUMAN LIFE REV. 109, 116 (1975).

Another troublesome problem is that certain classes of individuals may never be capable of giving informed consent. In *Kaimowitz v. Department of Mental Health,* a Michigan circuit court concluded that involuntarily detained mental patients cannot give informed and adequate consent to experimental psychosurgical procedures on the brain. Civil No. 73-19, 434-AW (Cir. Ct. Wayne County Mich., July 10, 1973), *reported in part in* 42 U.S.L.W. 2063 (1973). The court's opinion is reproduced in A. BROOKS, LAW, PSYCHIATRY AND THE MENTAL HEALTH SYSTEM 902-24 (1974). *See also* 2 ENCYCLOPEDIA OF BIOETHICS 751-66 (1978).

Finally, since the entire process of scientific inquiry deals with unknown quantities, there is always the problem of having sufficient information to determine the degree of risk that will be actually faced. Thus truly "informed" consent may be illusive.

194. In analyzing the constitutionally of a statute which required the wearing of a protective helmet by motorcyclists a court stated: "We accept . . . the fundamental tenet that the relationship between the individual and the state leaves no room for regulations which have as their purpose and effect *solely* the protection of the individual from his own folly." State v. Cotton, 516 P.2d 709, 710 (Hawaii 1973) (emphasis in original).

195. *Id.*; People v. Poucher, 398 Mich. 316, 320, 247 N.W.2d 798, 800 (1976).

196. Recent advances in several areas of science have raised difficult definitional problems concerning whether a subject is human. In the area of external human fertilization there is a question as to whether or not the joining of the sperm and egg creates a human subject. If the subject is not human it is doubtful that the state could prohibit all research

Turning to the third requirement of the *O'Brien* test, that the governmental interest is unrelated to suppression of free expression, the regulations are on their face neutral since they are not directed at the ideas or information to be gained from the experimentation. These regulations are merely restrictions on time, place, and manner since they do not preclude research.

The fourth *O'Brien* test element deals with the incidental nature of the restriction. The requirement of consent would most likely be considered to have only an incidental impact on expression since it allows sufficient "breathing room" for experimentation.[197] Similarly, the requirements for administrative review appear on their face to be no more than an incidental restraint. Theoretically, this review procedure will not have the effect of foreclosing or severely restricting experimentation with human subjects, but as a practical matter, it may be found that the discretion to approve or disapprove a grant is overly broad.[198] The basic standard in the regulation permits an institutional review board to deny approval if it feels that the risks to the subject are outweighed by the sum of the benefits to the subject and the value of the knowledge to be gained from the experiment.[199] The regulations contain no objective criteria for valuing either benefits or knowledge, thus relegating the process to a subjective weighing of values.

The fifth *O'Brien* criterion requires that the regulation be no greater than is essential to advance the government's interest. The requirement of obtaining informed consent appears to be the least restrictive means of futhering the governmental interest in protecting its citizens against fraud or duress. The requirement is relatively unintrusive since it does not administratively or financially overburden the researcher or the subject. Attempting to apply this criteria to the administrative review board, however, is very difficult. As previously mentioned, the regulations do not express a specific governmental interest to be advanced by the adminstrative review board. Therefore, it is impossible to determine if the least restrictive means have been chosen to further an unstated interest.

In the area of fetal research, a number of states have sought to con-

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in this area. The state's interest would probably be limited to regulating the humane use of experimental subjects. *See* Grobstein, *External Human Fertilization*, SCIENTIFIC AM., June 1979, at 57.

197. *See* Ely, *supra* note 182, at 1335-36; *see generally* TRIBE, *supra* note 46, at 682-83.

198. In Saia v. State, 334 U.S. 558 (1948), the Court found that because of a lack of standards in the ordinance, a sound truck permit system was an unconstitutional abridgment of the right of free speech. While admitting that the government has a right of regulation, the Court held that when discretion is granted to a state official, sufficient standards must be present to assure that the power is not abused.

199. 45 C.F.R. § 46.102(b) (1980).

trol scientific inquiry by enacting criminal laws which severely restrict or prohibit research on fetal subjects.[200] Assuming that these statutes operate as an indirect restraint on the constitutional right of scientific inquiry, they also must satisfy the five point *O'Brien* test.[201] The first point of the test requires that the intent sought to be advanced must be one of proper concern for the state. While these statutes do not precisely state what interest is being promoted, even if that interest is the protection of human subjects they may be, at least in part, unconstitutional.

In *Roe v. Wade*[202] the Supreme Court struck down a Texas criminal statute which prohibited abortions except with respect to those procured or attempted upon medical advice for the purpose of saving the life of the mother.[203] The Court set forth interests which could become compelling and thus justify the regulation of abortion.[204] While specifically recognizing that the state had an important and legitimate interest in potential life, the Court held that this interest does not become compelling until the point of viability.[205] The Court also held that a fetus is not a person within the meaning of the fourteenth amendment.[206] Based upon this rationale, the Court determined that a woman's right of privacy had precedence over a state's interest until the point of viability.

In light of *Roe* a state cannot justify its restrictions on fetal research by asserting that the fetus is a legal person. If the statutes are to be sustained, it would have to be on the basis of protecting potential human life. Because there was a direct infringement of a fundamental right in *Roe*, the Court required the state's interest rise to the level of "compelling."[207] Assuming that the fetal research statutes only indirectly abridge the right of scientific inquiry, the state's infringe-

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200. CAL. HEALTH & SAFETY CODE § 25956 (West Supp. 1981); ILL. ANN. STAT. ch. 38, §§ 81-32,-32.1 (Smith-Hurd Supp. 1980); IND. CODE § 35-1-58.5-6 (Burns 1979); KY. REV. STAT. ANN. § 436.026 (Baldwin 1975); LA. REV. STAT. ANN. § 14:87.2 (West 1974); ME. REV. STAT. tit. 22, § 1593 (Supp. 1979); MASS. ANN. LAWS ch. 112, § 12J (Michie/Law. Co-op Supp. 1981); MINN. STAT. ANN. § 145.422 (West Supp. 1981); NEB. REV. STAT. § 28-342 (1979); N.D. CENT. CODE 14-02.2-01 (Supp. 1977); OHIO REV. CODE ANN. § 2919.14 (Page 1975); PA. STAT. ANN. tit. 35, § 6605 (Purdon 1977); S.D. CODIFIED LAWS ANN. § 34-23A-17 (1977); UTAH CODE ANN. § 76-7-310 (1953).

201. *See* text accompanying note 170 *supra*.

202. 410 U.S. 113 (1973).

203. *Id.* at 166-67.

204. The three interests recognized are the state's interests in the mother's health, maintaining proper medical standards, and protecting potential life. *Id.* at 163-64.

205. The Court said, "With respect to the State's important and legitimate interest in potential life, the 'compelling' point is at viability." *Id.* at 163.

206. *Id.* at 157-58.

207. *Id.* at 155, 162-64.

ment could be justified if the interest is substantial or important rather than compelling.[208]

Various statutes impose liability depending on whether the experiment is carried out *in utero* or *ex utero* and also on the status of the fetus;[209] that is whether the fetus is live, viable, or about to be aborted. To the extent that the statutes protect a live fetus *in utero* they would be consistent with the state's interest in protecting potential life.[210] This interest would attach at the beginning of biological life and continue as long as the potential for human life exists.[211]

On their face, these statutes satisfy the second and third elements of the *O'Brien* test since they further the important interest in protecting potential life and do not appear to be aimed directly at the suppression of scientific inquiry. The fourth element of the *O'Brien* test requires that the statutes be no more than an incidental restraint on scientific inquiry. Those statutes which would preclude all research obviously violate this requirement.[212] Most statutes do permit some research and each would have to be analyzed to determine if sufficient breathing room was allowed. At minimum the statutes should allow scientific inquiry which would not jeopardize potential life. Finally, the *O'Brien* test requires the restriction in these statutes be no greater than that essential to the furtherance of the governmental interest. Those statutes that impose criminal liability may violate this require-

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208. The Court specifically recognized this distinction. *See id.*

209. In the area of *in utero* fetal research, Utah, in UTAH CODE ANN. § 76-7-301 (1953), prohibits all experimentation with unborn children. Massachusetts, in MASS. ANN. LAWS ch. 112, § 12J (Michie/Law. Co-op Supp. 1981), and North Dakota, in N.D. CENT. CODE § 14-02.2-01 (Supp. 1977), prohibit experimentation with any live human fetus whether before or after expulsion from the womb, unless the procedures are incident to the study of a human fetus while in its mother's womb and such procedures do not substantially jeopardize the life or health of the fetus. Maine (ME. REV. STAT. tit. 22, § 1593 (Supp. 1976)), Indiana (IND. CODE ANN. § 35-1-58.5-6 (Burns 1979)), and Ohio (OHIO REV. CODE ANN. § 2919.14(A) (Page 1975)), forbid all *ex utero* experimentation without reference to the fetus being viable, non-viable, or dead. California (CAL. HEALTH & SAFETY CODE ANN. § 25956(a) (West Supp. 1981), Massachusetts (MASS. ANN. LAWS ch. 112, § 12J (Michie/Law. Co-op Supp. 1981), and North Dakota (N.D. CENT. CODE § 14-02.201 (Supp. 1977)) forbid all *ex utero* experimentation on live fetuses, except to preserve the life or health of the fetus.

210. The public ward theory might also justify control of *in utero* experimentation. The state might claim that such statutes are necessary to prevent the social and financial burden resulting from the birth of physically or mentally handicapped children. Based on this approach, the Massachusetts statute prohibiting any experiment which substantially jeopardized the health or life of the fetus which is carried to term could be justified. MASS. ANN. LAWS ch. 112, § 12J (Michie/Law. Co-op Supp. 1981).

211. Under this approach, the state would have an interest even in the situation of a fetus which is about to be aborted.

212. *See* IND. CODE § 35-1-58.5-6 (Burns 1979); OHIO REV. CODE ANN. § 2919.14(A) (Page 1975).

ment in that they may deter legitimate research by causing a scientist to be unnecessarily cautious.

In the case of *ex utero* research, the existence of a state interest will depend upon whether the potential for life is present. If the fetus is *ex utero* and viable it is a human person and a state is entitled to give it full protection. If the fetus is *ex utero* and non-viable it appears that the state could not justify a restriction on research on the basis of protecting potential human life.[213]

(iii) Experiments Which Impose Risk on the Public

The state may also regulate scientific inquiry which causes injury or imposes risk upon the public,[214] provided the five point *O'Brien* test is satisfied.[215] The first three elements of the test pose no unusual problems when considering regulation of scientific inquiry in this context.[216] Nevertheless, when regulations are intended to protect the public at large and involve risk assessment, there is a possibility that they will not permit sufficient breathing room for scientific inquiry. As required by the fourth and fifth element of the *O'Brien* test, the court should use a balancing process to determine whether there is sufficient breathing room. The courts will weigh the extent to which scientific inquiry is prohibited against the magnitude of the benefits attained by enforcing the regulation. For example, research studying the genetic mutation of the bubonic plague bacillus would create certain risks to the public but it would provide science with potentially useful knowledge. In determining the extent of governmental interest, four risk factors should be considered: (1) the probability that an event may occur, (2) the probability of harm to any particular person or entity, (3) the seriousness of the harm if it occurs, and (4) the number of persons or entities affected if the harm arises. The risks are then weighed against the value of the knowledge gained from the work to determine whether regulation or prohibition of the work would be justified.

To provide a framework for analysis, while recognizing the desire of society to protect human life whenever possible, all research will be

213. A secondary interest similar to that which justifies legislation requiring humane treatment of animals might be used to justify regulation, but not prohibition of *ex utero* experiments on a non-viable fetus. *See* Burr, *Toward Legal Rights for Animals*, 4 ENVT'L AFF. 205, 209-16 (1975).

214. The term harm to the public includes not only death or bodily injury to human beings but also activities which can directly endanger life by damaging the environment or ecosystem. This section differs from the prior section in that the public is not the subject matter of the experiment and also because consent is impossible.

215. *See* text accompanying note 170 *supra*.

216. Regulations that seek to protect citizens from vaguely defined perils such as psychological or social injury, *see, e.g.*, 45 C.F.R. § 46.103(b) (1980), may be insufficient to satisfy the first requirement of the *O'Brien* test.

placed into two categories. First, if an event may occur which will certainly result in death or serious injury to one or more persons, a presumption would arise that the state's interest in protecting human life outweights the value of the knowledge to be gained.[217] In the case of the bubonic plague research, even if there is a relatively low probability that the bacillus will escape the laboratory, the fact that death or serious injury is certain to occur if it does escape would trigger the presumption. This presumption could be overcome by the presentation of evidence that the knowledge to be gained is of crucial importance to the advancement of scientific or social goals.

The second category would encompass all other experimental work. To justify a prohibition the state must establish either that the knowledge to be gained is trivial or insignificant, or that the scope or extent of the harm will be of such magnitude that it outweighs the value of the knowledge to be gained. If serious injury or death is probable rather than certain, or if only minor injury to persons or damage to property is certain to occur, no presumption on behalf of the state will arise.

While the application of the balancing process appears straightforward, when applied to a particular situation, it becomes readily apparent that the quantification of the various factors may be formidable. Some of the problems include choosing the proper units to measure risk and value (*i.e.*, dollars, lives lost, aesthetics), making value judgments in these units (*i.e.*, the dollar value of a human life), and determining the probability of the occurrence of an event without extensive prior experience.[218] Notwithstanding these difficulties, it will be necessary in many cases to quantify these factors. The process should not, however, be reduced to a purely mathematical operation.

Situations requiring the use of the balancing process could arise in a broad spectrum of factual settings. At one extreme, both the occurrence of the event and the harm may have a high degree of probability. For example, the above parameters might be present in an experiment that seeks to study earthquakes by triggering an earthquake

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217. When it is certain that an event will occur which will cause injury, no further balancing is necessary and the state may prohibit the work since no one may justify committing a tort or crime on the basis that it is a constitutionally protected activity. *See, e.g.*, Branzburg v. Hayes, 408 U.S. at 691.

218. Before weighing can occur, it is necessary to quantify the various risks as well as the value of the scientific knowledge to be gained. This process has received much attention under the headings of "cost-benefit analysis" or "risk assessment." There is significant disagreement as to the methodology as well as the ultimate usefulness of this process. Page, *A Generic View of Toxic Chemicals and Similar Risks*, 7 ECO. L.Q. 207 (1978); *Symposium: Risk-Benefit Assessment in Governmental Decision Making*, 45 GEO. WASH. L. REV. 901 (1977).

which measures 9.5 on the open-ended Richter scale along the San Andreas Fault. Calculations show that there is an eighty percent probability that the tremors and shockwaves would extend into densely populated areas causing death to one or more persons.

At the other end of the spectrum, both the occurrence of the event and the harm may have a very low probability. Scientists at M.I.T., for example, may wish to orbit a satellite observatory to study the formation of black holes and x-ray emitting stars.[219] When the satellite falls back to earth, as it ultimately will, there is a one in a billion chance (.0000001%) that a window would be broken or some other injury caused by the remains of the satèllite.

In applying the balancing test to the first example, the state would be justified in a prohibition of the experiment. The event, if it did occur, would cause death to one or more persons. Since the sole purpose of the experiment was to verify calculations based on prior naturally occurring events, the value of the work, while slightly advancing scientific knowledge, would not rebut the presumption in favor of the government. Conversely, under the facts of the second example, the state would not be justified in prohibiting the experimentation. Even though the event is certain to occur, the likelihood of any harm is very remote and any injury would be of a minor nature. When these factors are weighed against the value of knowledge of the origins and nature of the universe, the balance must be struck in favor of the research.

Between the two extremes suggested above lies a set of problems which will be more difficult to solve. Recombinant DNA research presents a situation in which there is some probability that an event could occur which will result in an unknown degree of harm.[220] The primary concern is the escape of the recombinant DNA from the laboratory.[221] The probability of the containment failure will depend

219. Black hole stars are described in detail by Isaac Asimov in THE COLLAPSING UNIVERSE (1977).

220. Recombinant DNA research can be described as the process by which scientists manipulate the genetic structure of a cell either by removal of chromosomes or by addition of chromosomes to a cell. The term "recombinant" refers to the process by which scientists chemically cut the DNA molecule apart, insert new chromosomes and then recombine its various fragments or portions into a new molecule. For a scientific discussion of the process, see Cohen, *The Manipulation of Genes*, SCIENTIFIC AM., July 1975, at 24.

221. In considering the problems of DNA recombinant research, a House Subcommittee made the following observations:

> At the basic research level, opponents enter the philosophical level of debate and challenge the ability of investigators to ever quantify the benefits or the risk in a fashion to permit evaluation and intelligent decision making. The fear has been expressed that DNA recombinant research may somehow adversely affect the diversity of natural gene pools. . . .
>
> There are frequent and detailed analogies drawn between the dilemmas con-

upon the laboratory procedures followed in a particular experiment.[222] These procedures may vary from the use of material in unprotected labs to the employment of a biologically sealed room using filtered air and glove boxes. Depending upon which procedure is used, the probability of a containment failure varies widely.[223]

If containment fails, then the probability of any harm occurring must be assessed. Depending upon the ability of the organism to survive

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> fronted in the current nuclear power debates and the basic research proposals in the field of DNA recombinant research. Statements, occasionally in the form of demands, have been made that a full moratorium on all DNA recombinant research should be instituted until all of the social, legal and moral implications of this research have been thoroughly examined. Chargaff, for example, discussed the "awesome irreversibility of what is being contemplated." . . .
>
> While it is more difficult to criticize the value of DNA recombinant work from the perspective of potential therapeutic applications, even here there are strong opposing opinions. Part of this concern is directed toward the fact that much of the research involves the use of E. coli, a microorganism which is a common inhabitant of the human intestine. Since this is an organism already adapted to the human environment, the concern is that accidents might result in easy entry and infection of human beings.
>
> If the host with the recombinant molecule carried all or part of an oncogenic virus, for example, or now had an unexpected resistance to drug therapy, or could produce some new and unexpected toxin, then human beings might be exposed to a disease which could reach epidemic proportions. The arguments about probabilities of escape, probabilities of survival if escape does occur, and probabilities that such an escaped host would indeed be pathogenic are described as impossible to calculate and therefore meaningless in terms of evaluating potential risk. The position is that the opportunity for risk exists and therefore the research should not be conducted.

STAFF OF SEN. COMM. ON SCIENCE AND TECHNOLOGY, 94th Cong., 2d Sess., REPORT ON GENETIC ENGINEERING, HUMAN GENETICS, AND CELL BIOLOGY 36-37 (Comm. Print 1976) [hereinafter cited as REPORT ON GENETIC ENGINEERING].

222. The proposed federal guidelines define the terms:

> Containment is both physical and biological. *Physical* containment involves the isolation of the research by procedures that have evolved over many years of experience in laboratories studying infectious micro-organisms. P1 containment—the first physical containment level—is that used in most routine bacteriology laboratories. P2 and P3 afford increasing isolation of the research from the environment. P4 represents the most extreme measure used for containing virulent pathogens, and permits no escape of contaminated air, wastes, or untreated materials. *Biological* containment is the use of biological agents that are crippled by mutation so as to be incapable of surviving under natural conditions.

Recombinant DNA Research, Proposed Revised Guidelines, 43 Fed. Reg. 33,042, 33,052 (1978) [hereinafter cited as 1978 Proposed Guidelines]. *See also* Recombinant DNA Research, Guidelines, 41 Fed. Reg. 27,902, 27,912-21 (1976).

223. For example, in changing the location of an experiment from an open-front biologically safe cabinet (P3) to a certified gas tight containment chamber (P4) there is at least a 10,000 to 100,000 reduction in probability of escape. Where biological containment is used, by requiring the use of a particular host vector system (HV2), the probability of escape is less than 1 in 100,000,000. 1978 Proposed Guidelines, *supra* note 222, at 33,053.

and propagate, as well as its potential to cause injury, there will be varying probabilities of harm.[224]

The third factor, the seriousness of the injury, can be anything from a common cold to death.[225] Because DNA research involves a wide variety of organisms, it is not possible to regulate based on broad, general categories. Each classification of organism presents its own potential for harm. If the agent which escapes is certain to cause death or serious injury, a presumption would arise that the state's interest in prohibition outweighs the value of the knowledge gained from the work.[226] The presumption could be rebutted by the proponent of the work presenting evidence that the knowledge to be gained is of crucial

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224. Because of the nature of this work, it presents the risk of producing by recombination of genetic characteristics a life form which might inadvertently escape into the environment and (1) produce human cancer or some other widespread infection, (2) increase antibiotic resistance in pathogenic organisms, (3) permit the survival of pathogens in environments not normally amenable to survival, or (4) possibly upset the natural evolutionary process. REPORT ON GENETIC ENGINEERING, *supra* note 221, at 36-37.

In May of 1981, a special governmental investigation found that Martin J. Cline had improperly used recombinant DNA within a human subject. This is the first violation of the guidelines for the use of recombinant DNA which also violated the guidelines for human experimentation. No apparent harm to the human subjects was reported. SCI. NEWS, June 6, 1981, at 357.

225. Death might be caused by such pathogenic agents as Dengue virus or Schistososma Mansoni.

226. Because of the seriousness of the potential injury the present HEW regulation prohibits the following work:

> I-D. *Prohibitions.* The following experiments are not to be initiated at the present time:
>
> I-D-1. Formation of recombinant DNA's derived from the pathogenic organisms classified(*1*) as class 3, 4, or 5(*2*) or from cells known to be infected with such agents, regardless of the host-vector system used.
>
> I-D-2. Deliberate formation of recombinant DNA's containing genes for the biosynthesis of potent toxins (e.g., . . . venoms from insects, snakes, etc.).
>
> I-D-3. Deliberate creation by the use of recombinant DNA of a plant pathogen with increased virulence and host range beyond that which occurs by natural genetic exchange.
>
> I-D-4. Deliberate release into the environment of any organism containing recombinant DNA.
>
> I-D-5. Deliberate transfer of a drug resistance trait to micro-organisms that are known to acquire it naturally, if such acquisition could compromise the use of a drug to control disease agents in human or veterinary medicine or agriculture.
>
> I-D-6. Large-scale experiments (e.g., more than 10 liters of culture) with organisms containing recombinant DNA's, unless the recombinant DNA's are rigorously characterized and are shown to be free of harmful genes.(*3*)
>
> We differentiate between small- and large-scale experiments with organisms containing recombinant DNA's because the probability of escape from containment barriers normally increases with increasing scale.

43 Fed. Reg. 33,070 (1978).

importance to the advancement of science.[227] If the escape of the agent presents only a chance of permanent injury or death, then the work should be permitted unless the state establishes that the knowledge to be gained is de minimis or, that the scope or extent of harm will be of such magnitude that it outweighs the value of the knowledge to be gained. For example, the escape of foot and mouth disease virus, or sheep pox virus could cause widespread damage to animal herds, but not present a health hazard to humans. Once the state establishes that this widespread damage would occur, then the burden would shift to the proponent of the work to present evidence that the value of the knowledge to be gained from the work outweighs the harm.

In the above example, as well as other cases, there is the recurring problem of the value of scientific knowledge. In making this value judgment, the court should determine the degree to which the particular scientific knowledge is critical to the advancement of science in that area and the importance of the research to society. If biochemists were prohibited from doing recombinant DNA work it would severely hamper further efforts to decode human genes which may ultimately lead to an understanding of the causes of many hereditary diseases.[228]

Finally, even if the regulations satisfy the first four elements of the *O'Brien* test, they also must employ the least restrictive means of regulation. If the state can minimize or eliminate the risk involved by the use of reasonable time, place, and manner restrictions rather than the prohibition, it must do so. This approach has been used in the present HEW regulations specifying physical and biological containment procedures to be used in carrying out recombinant DNA experiments.[229]

The five point *O'Brien* test was formulated by the Court to deal with indirect restraints on free speech. It is apparent that this test can be successfully employed to evaluate government regulation of scientific inquiry. The application of this test will provide the necessary guidance for the drafting of regulations which do not infringe on the right of scientific inquiry. By employing the *O'Brien* test it will be possible to give full protection to the right of scientific inquiry while allowing the government to advance its legitimate interests.

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227. This procedure is recognized under current HEW regulations:

> Experiments in these categories may be excepted . . . from the prohibitions . . . [as described in note 223] provided that these experiments are expressly approved by the Director, NIH, on recommendation of the Recombinant DNA Advisory Committee after appropriate notice and opportunity for public comment. In making such exceptions, weight will be given both to scientific and societal benefits and to potential risks.

Id.

228. Goodman, *Genetic Engineering and Biochemistry*, in SCIENCE FACT 128-35 (F. George ed. 1978).

229. *See generally* 43 Fed. Reg. 33,069-178 (1978).

B. *Scientific Inquiry as a Fundamental Right Standing Alone*

While the first amendment provides a basis for supporting a constitutional right of scientific inquiry, it is not the only, nor even possibly the best, basis for this right. The Supreme Court has recognized certain rights not expressly enunciated in the Constitution as so basic and fundamental that they are entitled to constitutional protection. The right to travel, for example, is not specifically mentioned anywhere in the Constitution, yet the Court as early as 1849 found such a right to exist.[230] Justice Stewart has suggested that the reason for its absence is that the right is so elementary that the founding fathers felt it was unnecessary to provide for it specifically.[231]

Other rights not explicitly mentioned in the Constitution but which nevertheless receive its protection include the right of privacy,[232] family rights,[233] the right to be free from intellectual coercion by the government,[234] the right to obtain useful knowledge,[235] and the right to vote and to have one's vote be worth as much as another's.[236]

Since the language of the Constitution is not the source of the above enumerated rights, it is necessary to go beyond it. It has been suggested that there are two other possible sources from which fundamental rights flow. One is the constitutional structure and the values which that structure implies;[237] the second possible source is the Court itself.[238]

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230. In his dissenting opinion in the Passenger Cases, 48 U.S. (7 How.) 283 (1848), Chief Justice Taney stated:

> For all the great purposes for which the Federal government was formed, we are one people, with one common country. We are all citizens of the United States; and, as members of the same community, must have the right to pass and repass through every part of it without interruption, as freely as in our own States.

Id. at 492. *See also* New York v. O'Neil, 359 U.S. 1, 6-8 (1959); *id.* at 12-16 (Douglas, J., dissenting); Edwards v. California, 314 U.S. 160, 177-81 (1941) (Douglas, J., concurring); *id.* at 181 (Jackson, J., concurring); Twining v. New Jersey, 211 U.S. 78 (1908); Williams v. Fears, 179 U.S. 270, 274 (1900).

231. United States v. Guest, 383 U.S. 745, 758 (1966).

232. *See* Whalen v. Roe, 429 U.S. 589 (1977); Roe v. Wade, 410 U.S. 113, 133 (1973); Griswold v. Connecticut, 381 U.S. 479 (1965).

233. Moore v. City of East Cleveland, 431 U.S. 494 (1977).

234. West Viriginia State Bd. of Educ. v. Barnette, 319 U.S. 624 (1943). *See* Wooley v. Maynard, 430 U.S. 705 (1977); Tribe, *supra* note 46, at 899-902.

235. Pierce v. Society of Sisters, 268 U.S. 510 (1925); Meyer v. Nebraska, 262 U.S 390 (1923).

236. Wesberry v. Sanders, 376 U.S. 1 (1964); Baker v. Carr, 369 U.S. 186 (1962).

237. Lupu, *Untangling the Strands of the Fourteenth Amendment,* 77 MICH. L. REV. 981, 1031 (1979) [hereinafter cited as Lupu]. In his article, Professor Lupu postulates that structural concerns moved the Court to protect the right of interstate travel, and possibly certain voting rights. *Id.*

238. The cases involving a right of privacy can be grouped under this heading. *Id.* at 1032. The validity of, as well as the theoretical basis for, this second source has been the

1. Sources Within the Constitution—A Structural Basis

While the right of scientific inquiry is not expressly authorized in the Constitution, the word science does appear within the text of the document. The Constitution's patent clause provides: "[t]he Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."[239]

While there is a lack of specific historical and legal authority explaining the background of this clause, a number of unstated premises can be inferred from its presence. First of all, the mere presence of the term science in this clause indicates that science and the scientific process were known to the founding fathers. Second, given the limited number of topics addressed in the Constitution, apparently the drafters felt that science was of such importance that its progress should be promoted by federal governmental protection. Third, the drafters recognized that the principal agents in the promotion of science and the useful arts were authors and inventors. Fourth, this clause directs Congress to promote science and the useful arts, not by granting to authors and inventors the exclusive rights to their writings and discoveries but by securing them. From this it can be inferred that individuals already possessed these rights and that the government was only furnishing protection.[240] Finally, and most importantly, if authors and inventors had an exclusive right to their writings and inventions, the drafters must have presupposed freedom to engage in the activities which produced these products.

While there is little historical material which would refute the above inferences, two potential problems must be considered. It might

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subject of much debate. There are critics who assert that only those activities should be protected which are specifically referred to in the text of the Constitution or where there are demonstrable standards to guide the Court. Griswold v. Connecticut, 381 U.S. at 510-24 (Black, J., dissenting).

Others have argued against the process of finding fundamental rights by making a judicial value judgment since it is too subjective. Professor Ely states that such criteria as natural law, neutral principles, reason, or the idea of progress are not adequate standards. Ely, *The Supreme Court 1977 Term—Foreword: On Discovering Fundamental Values*, 92 HARV. L. REV. 5, 22-54 (1978).

Those who support the use of judicial value judgments argue with equal vigor that it is possible for the Court to formulate fundamental rights using proper standards. Tushnet proposes the following criteria as a standard: (1) general agreement on the social importance of that right and (2) the settled weight of responsible opinion. Tushnet, *The Newer Property: Suggestions for the Revival of Substantive Due Process*, 1975 SUP. CT. REV. 261.

239. U.S. CONST. art. I, § 8, cl. 8.

240. H. Forman, in 200 YEARS OF ENGLISH & AMERICAN PATENT, TRADEMARK & COPYRIGHT LAW 27 (ABA ed. 1977).

be argued that the term science as used in the patent clause would not include science as we know it today. During the revolutionary period the term science had a broader meaning than it has now.[241] It encompassed all bodies of organized knowledge including natural philosophy and natural history,[242] two disciplines which encompassed the study of subjects which were the forerunners of modern sciences such as physics, zoology, and astronomy.[243] Since natural philosophy and natural history were included within the term science, modern science would also be included.

The second potential problem arises because the patent clauses employ the term inventor rather than scientists. At the time the Constitution was drafted, inventor meant, first, one who discovers; and second, one who creates something new.[244] The first meaning would include the activity of experimentation as carried out by modern scientists. The goal of any experiment is to find or discover information about the universe. Therefore, the term inventor as used in the patent clause is certainly broad enough to include the present day scientist.

Given that science is found within the structure of the Constitution and that scientific inquiry is basically a search for knowledge,[245] additional support for a fundamental right can be found in the decisions of the Supreme Court. On a number of occasions the Court has recognized a right to pursue knowledge. The Court has associated this fundamental right with a number of amendments. In *Meyer v. Nebraska* the

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241. In the seventh edition of Johnson's Dictionary, "science" is defined as: "1. Knowledge 2. Certainty grounded on demonstration 3. Art attained by precepts, or built on principles 4. Any art or species of knowledge 5. One of the seven liberal arts: grammar, rhetorick, logick, arithmetick, musick, geometry, astronomy." JOHNSON'S DICTIONARY (7th ed. 1785).

242. It is interesting to note that James Madison, one of the authors of the patent clause, initially suggested the following language for the clause: "To encourage by premiums and provisions, the advance of useful knowledge and discoveries. To secure to literary authors their copy rights for a limited time." 1 A. DELLER, WALKER ON PATENTS § 10, at 74 (1964) [hereinafter cited as DELLER]. When adopted by the Constitutional Convention without dissent the phrase "the advance of useful knowledge and discoveries" was replaced with the phrase "to promote the progress of science and the useful arts." *Id.* at 73-75. Thus, it may be inferred that the convention considered progress of science and useful knowledge to be equivalent terms.

243. STEARNS, *supra* note 26, at 7. In Benjamin Franklin's proposal for the formation of an American Philosophical Society, subtitled "a proposal for promoting useful knowledge . . . ," he suggested that various topics including botany, medicine, geology, mathematics, and chemistry ought to be discussed. He also suggested that there always be "at least seven members viz. a physician, a botanist, a mathematician, a chemist, a mechanician, a geographer and a general natural philosopher." BENJAMIN FRANKLIN READER 319 (Goodman ed. 1945).

244. DELLER, *supra* note 242, § 10 at 89-90. It is this second definition which has become the popular meaning of the term.

245. *See* text accompanying notes 18-20 *supra*.

court stated that the term liberty in the fourteenth amendment included the right to acquire useful knowledge.[246] In *Griswold v. Connecticut* Justice Douglas, after citing *Meyer*, stated: "[t]he State may not, consistently with the spirit of the First Amendment contract the spectrum of available knowledge."[247]

Logically, if the Court is willing to protect such a right in the general sense, it would certainly do so in the specific case of scientific inquiry. This conclusion is further reinforced by Justice Douglas' observation, in discussing the the purpose of the patent clause, that "[t]he invention to justify a patent had to serve the ends of science—to push back the frontiers of chemistry, physics, and the like; to make a distinctive contribution to scientific knowledge."[248] Since the purpose of the patent clause was to advance scientific knowledge and the Court has recognized the importance of the pursuit of knowledge, it appears to follow that the scientist would have the right to engage in the pursuit of knowledge through scientific inquiry.

In addition to the patent clause, other sections of the Constitution assume a close working relationship between science and government. One author notes these examples:

> That the power over coinage, weights, and measures would necessarily entail highly technical expert advice and scientific experimentation was axiomatic to educated men. A census was provided not so much because of curiosity as because the political compromises made it necessary; nevertheless the men of that time could visualize scientific uses for it.[249]

The patent clause provides a structural basis supporting a constitutional right of scientific inquiry. This conclusion flows from a logical analysis of the clause itself and is further supported by an examination of the historical context in which the clause was drafted.[250]

2. Sources Outside the Constitution

The Supreme Court has recognized the existence of certain fundamental rights not specifically mentioned in the Constitution prin-

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246. 262 U.S. 390, 399 (1923). For a discussion of the case, see note 251 *infra*.

247. 381 U.S. at 482. For a discussion of the case, see note 251 *infra*. *See also* Wieman v. Updegraff, 344 U.S. 183 (1952), where Justice Frankfurter stated: "By limiting the power of the States to interfere with freedom of speech and freedom of inquiry and freedom of association, the Fourteenth Amendment protects all persons, no matter what their calling." *Id.* at 195 (Frankfurter, J., concurring).

248. Great Atl. & Pac. Tea Co. v. Supermarket Equip. Corp., 340 U.S. 147, 154 (1950) (Douglas, J., concurring).

249. A. Dupree, Science in the Federal Government 6 (1957).

250. *See* text accompanying notes 251-301 *infra*. While this historical analysis is intended to support the second source of fundamental rights, it also lends support to the structural analysis.

cipally by an expansive interpretation of the ninth and fourteenth amendments.[251] In doing this the Court has stated the test somewhat differently in each situation rather than formulating a single test for the determination of fundamental rights in all situations.[252]

Professor Lupu has distilled the various statements of the Court into a two-part test to determine whether a right will receive protection under our Constitution. "(1) Historically, American institutions must have recognized the liberty claim as one of paramount stature," and

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251. In Meyer v. Nebraska, 262 U.S. 390 (1923), a Nebraska statute which prohibited the teaching of foreign languages until after the eighth grade was at issue. The Court struck down the statute as an unreasonable infringement on "the liberty guaranteed . . . by the 14th amendment." *Id.* at 399.

An ordinance that limited the occupancy of a dwelling unit to members of a single family was at issue in Moore v. City of East Cleveland, 431 U.S. 494 (1977). The Court found that the statute as applied to the appellant and her grandsons was a violation of their substantive due process rights guaranteed under the fourteenth amendment. Id. at 499-500.

In Griswold v. Connecticut, the Court struck down a Connecticut anti-contraception statute. Three concurring Justices relied on the ninth and fourteenth amendments. *See* 381 U.S. at 486-99 (Goldberg, J., concurring).

In Wisconsin v. Yoder, 406 U.S. 205 (1972), the Court held that the state could not compel members of the Amish faith to send their children to high school until age 16. This was based upon the Court's reading of the first and fourteenth amendments. *Id.* at 234.

The right to privacy was found to exist within the fourteenth amendment by the Court in Roe v. Wade, 410 U.S. at 153. For a discussion of *Roe*, see text accompanying notes 202-06 *supra*.

252. Justice Harlan, in Poe v. Ullman, 367 U.S. 497 (1961), recognized the difficulty in formulating an all inclusive test when he stated:

> [T]he full scope of the liberty guaranteed by the Due Process Clause cannot be found in or limited by the precise terms of the specific guarantees elsewhere provided in the Constitution. This "liberty" is not a series of isolated points pricked out in terms of the taking of property; the freedom of speech, press, and religion . . . and so on. It is a rational continuum which, broadly speaking, includes a freedom from all substantial arbitrary impositions and purposeless restraints . . . .

Id. at 543 (Harlan, J., dissenting).

One of the first articulations of the scope of the term "fundamental right" came in *Meyer* where Justice McReynolds observed,

> [Liberty] denotes not merely freedom from bodily restraint but also the right of the individual to contract, to engage in any of the common occupations of life, to acquire useful knowledge, to marry, establish a home and bring up children, to worship God according to the dictates of his own conscience, and generally to enjoy those privileges long recognized at common law as essential to the orderly pursuit of happiness by free men.

262 U.S. at 399. In *Wisconsin v. Yoder*, the right was recognized as fundamental because it reflected "strong tradition" founded on "the history and culture of Western civilization." 406 U.S. at 232. Justice Goldberg, concurring in *Griswold*, spoke of a right that is fundamental and deeply rooted in our society. 381 U.S. at 491. In *Moore* the Court protected the sanctity of the family "because the institution of the family is deeply rooted in this Nation's history and tradition." 431 U.S. at 503.

"(2) Contemporary society must value the asserted liberty at a level of high priority."[253]

a. The Historical Role of Science

As will be demonstrated in the following material, America historically has recognized scientific inquiry as a liberty of paramount stature. From the earliest colonial times, the growth of American political and educational institutions paralleled the development of science and the philosophy of Enlightenment.[254] Indeed, the maturing of the United States was intertwined with the growth of Enlightenment.

The scientific work of Isaac Newton in England during the seventeenth century sparked the beginning of the Enlightenment Era in Europe.[255] Newton's method of inquiry consisted of three basic steps: the observing of the events, the accurate recording of events, and the discerning of natural laws from these observations.[256] Through the use of this method, Newton developed the law of universal gravitation. While the scientific principles he discovered would be the foundation of physics until Einstein's work 250 years later, his scientific way of thinking had an equally important impact beyond the boundaries of pure science.

Newton's method of ordering the inanimate universe provided an intellectual tool by which man could seek to discern the laws which govern the broad spectrum of human activities.[257] The Newtonian approach was the basis for the work of many writers in diverse areas including John Locke (epistemology), David Hume (ethics and morality), Adam Smith (economics), Locke and Voltaire (politics), Thomas Ried (moral philosophy), and finally, William Petty, Michel Turgot, Jean

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253. Lupu, *supra* note 237, at 1040-41.

254. Enlightenment was a movement of thought and belief, developed from interrelated conceptions of God, reason, nature, and man, to which there was wide assent in Europe during the 17th and 18th centuries. Its dominant conviction was that right reasoning could find true knowledge and could lead mankind to felicity.

255. If any one event can be designated the starting point for the Era it would be the 1687 publication of Isaac Newton's *Philosophical Naturals Principia Mathematic* by the Royal Society in London. The Royal Society itself and been formed in 1663 for the promotion of seeking new knowledge, particularly of a scientific nature. From its beginning until 1783, 39 of the individuals elected to the society were from North America. STEARNS, *supra* note 26, at 107-08.

256. A letter written by Benjamin Franklin 90 years later confirmed this as his process of inquiry: "[B]ut I approve much more your method of philosophizing which proceeds upon actual observations, makes a collection of facts and concludes no farther than those facts will warant." C. VAN DOREN, BENJAMIN FRANKLIN 660 (1938) [hereinafter cited as VAN DOREN].

257. B. HINDLE, THE PURSUIT OF SCIENCE IN REVOLUTIONARY AMERICA 1735-1789, at 318 (1956) [hereinafter cited as HINDLE]; WILLS, *supra* note 76, at 95.

Condordet, and Francios-Jean Chastellus (government).[258] These individuals, among others, constituted the bridge between Newtonian science and the political concerns of the American colonies.

The colonial leaders of the mid-eighteenth century, while appreciating the practical consequences of science in such areas as farming and manufacturing, also sought to apply the principles of science to human affairs. "The Enlightenment recognized no fundamental differences between knowledge of physics and astronomy and knowledge of government and economics."[259] Many persons, including many political leaders, believed that application of the Newtonian process to all human endeavors would utlimately yield laws as precise as the physical sciences.[260]

Science during the period in question was not a separate category engaged in by a specialist, rather it was a philosophical outlook that applied the principles of Bacon and Newton to all human endeavors.[261] Research in "hard" sciences like physics, chemistry, and astronomy was not of overwhelming importance during this period. While many hoped that the application of hard science would result in technological innovation, the true importance of science was not the practical, technical consequences but the intellectual framework that was applied to so many human endeavors.

Discovering historical information to substantiate the assertion that Newtonian thought was part of the intellectual process of the time is very difficult.[262] Because of its broad acceptance there was little discussion of the fundamental principles. In order to establish that American institutions held scientific inquiry in high esteem, one must examine the attitudes, education, and accomplishments of the leaders of these institutions.

During the eighteenth century, the curricula of various colleges were fairly uniform. All students studied basically the same material; there was no system of electives as presently exists in higher educa-

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258. Francois-Jean Chastellus had a calculus by which one could determine whether or not a particular ruler was a tyrant. *See* WILLS, *supra* note 76, at 111-48.

259. HINDLE, *supra* note 257, at 377.

260. Hindle observes, "Acceptance of prevailing political concepts rested upon and demanded acceptance of the central importance of science. The more the Americans clarified their own political position, the more it came to seem desirable to promote science in all its phases." *Id.* at 382.

261. STEARNS, *supra* note 26, at 5-6.

262. From a modern perspective, it is equivalent to trying to generate material to support the position that the free enterprise system was accepted by the vast majority of individuals in the United States during the 1950-60's. If one cannot use public opinion polls, which did not exist during the early American history, what may be used to prove the proposition?

tion.[263] One scholar has estimated that twenty to twenty-five percent of college study was devoted to scientific topics.[264] An examination of the textbooks and teaching approaches of the time reveals that the principles of Newton and the Englightenment predominated.[265] Thus, graduates of eighteenth century American universities were well versed in science and scientific thought. They were familiar with the simplicity and perfection of Newton's laws and were taught that the use of Newton's rational scientific methods would lead to true knowledge.

Many of these university graduates went on to become the leaders of the American revolution. Of the fifty-six signers of the Declaration of Independence, twenty-six had college educations.[266] In addition to those with college training, another thirteen signers received less formal education by tutors or professional training in law or medicine.[267] Others who also played an important role in the revolution and who would go on to help draft the Constitution were also university trained.[268]

Further evidence supporting the importance of science in this period can be found in the scientific interests and accomplishments of many of the Revolutionary leaders. George Washington was a surveyor and agronomist, Nathaniel Green was a manufacturer and inventor, Josiah Bartlett was a medical authority, and Manasseh Cutler an astronomer and botanist.[269]

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263. T. HORNBERGER, SCIENTIFIC THOUGHT IN THE AMERICAN COLLEGES 22-34 (1946) [hereinafter cited as HORNBERGER].

264. The list included mathematics, natural philosophy, chemistry, agriculture, astronomy, and natural history. *Id.* at 29.

265. *Id.* at 48-69. *See also* D. STRUIK, YANKEE SCIENCE IN THE MAKING 24-26 (1948) [hereinafter cited as STRUIK].

266. Harvard: Samuel Adams (1740), John Adams (1755), Robert Paine (1749), Elbridge Gerry (1762), William Ellery (1747), William Williams (1751), William Hooper (1760). Yale: Oliver Wolcott (1747), Philip Livingston (1737), Lewis Morris (1746), Lyman Hall (1747). College of Philadelphia (now Univ. of Pa.): Francis Hopkinson (1757), William Paca (1759). Princeton: Benjamin Rush (1762), Richard Stockton (1748). William & Mary: Carter Braxton (1761), Benjamin Harrison, Thomas Jefferson (1760-62). Foreign Studies: John Witherspoon (Univ. of Edinburg, 1739), James Wilson (Univ. of Edinburg, 1763) Charles Carroll (French Jesuit Colleges), Richard Henry Lee (Wakefield, England), Thomas Nelson (Christ College, Cambridge, England), John Penn (Univ. of Geneva 1747-51), Edward Rutledge (London), Arthur Middleton (England).

267. Doctors: John Bartlett, Matthew Thornton. Lawyers (with date of admission): Roger Sherman (1754), Jason Smith (1745), George Ross (1750), George Read (1753), Thomas McKean (1754), Samuel Chase (1761), Thomas Stone (1764), George Wythe, George Walton (1774), Thomas Heyward (1771). Education by private tutor: Francis Lightfoot Lee, John Morton.

268. Alexander Hamilton attended Kings College, James Madison was a graduate of Princeton (1771), and both John Marshall and James Monroe attended William and Mary College.

269. STRUIK, *supra* note 265, at 40.

David Rittenhouse, one of America's first astronomers, was also active in the American Revolution.[270] He was close to the Adams faction in Congress[271] and was also a personal friend and long-time correspondent of Jefferson.[272] Jefferson considered Rittenhouse America's supreme mechanic.[273]

John Adams, who is best remembered for his leadership in the fight for the adoption of the Declaration of Independence, showed considerable support for, and interest in, science.[274] After receiving his formal education in science and mathematics at Harvard he continued to pursue his interest in these areas. His library contained works by Archimedes, Euclid, Newton, Halley, Buffon, and Linaeus.[275] Adams was also interested in scientific collections and while in France visited such collections when time permitted.[276] So great was Adams' devotion to the advancement of science that even the war could not deter his efforts. In 1779 he persuaded the Massachusetts General Court to charter the American Academy of Arts and Sciences.[277] Adams, as well as such famous political leaders as John Hancock and James Bowdorn, were among the sixty-two charter members.[278]

Adams' great interest in science also influenced his view of political events and the operation of government. He viewed the events sur-

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270. *See* WILLS, *supra* note 76, at 100-14.

271. All of the delegates to Congress had received complimentary copies of his great address on astronomy. *Id.* at 31.

272. *Id.* at 30.

273. The term mechanic meant one who dealt with Newtonian physics. *Id.* at 100.

274. *See* STRUIK, *supra* note 265, where the author writes:

> John Adams' scientific interests are illustrated in a letter to Benjamin Waterhouse, concerning the education of his son, John Quincy Adams, in Paris. In this letter Adams writes that he "attempted a sublime flight" and after the books of Euclid in Latin, plane trigonometry, algebra and conic sections, tried to give him "some idea of the differential method of calculation of the Marquis de l'Hopital, and the method of fluxions and infinite series of Sir Isaac Newton."

Id. at 362.

275. *Id.* at 42.

276. *Id.* at 43.

277. The Academy was organized by Adams with the help of James Bowdorn, Dr. Samuel Cooper, Manasseh Cutler, and Ipswich Hamlet. STEARNS, *supra* note 26, at 683. The goals and purposes of the Academy are stated in its charter:

> As the Arts and Sciences are the foundation and support of agriculture, manufacture and commerce; as they are necessary to the wealth, peace, independence, and happiness of the people; as they essentially promote the honor and dignity of the government which patronizes them; and as they are most effectually cultivated and diffused through a State by the forming and incorporating of men of genius and learning into public societies . . . .

STRUIK, *supra* note 265, at 44.

278. STRUIK, *supra* note 265, at 44-45.

rounding the Revolution as a process open to scientific observation and description.[279] When the Constitution was criticized as not sufficiently scientific, Adams sought to refute the charge by using the scientific method to analyze the parallel growth of science and government.[280]

Thomas Jefferson was in the forefront of scientific thought in Revolutionary America. While Jefferson enjoyed tinkering and proposing ideas and theories, he was not an experimenter like Franklin.[281] Jefferson adopted the scientific or Newtonian philosophy and applied it to all his endeavors. This outlook is clearly reflected in his two major writings. The first was the Declaration of Independence: "The Declaration's opening is Newtonian. It lays down the law . . . these few words put us firmly in the age of scientific revolution. In the flow of things there is perceivable necessity, a fixity within flux."[282] In his book *Inventing America*, Gary Wills devotes a seventy page section to showing how Jefferson's Newtonian outlook was reflected in the Declaration of Independence.[283] Jefferson's approach was not scientific in today's technical sense, but it was as if the glasses by which he viewed the world were tinted with the colors of science.

Jefferson's second major writing, and his only book-length work, was *Notes on the State of Virginia*.[284] As noted by one editor, the book is representative of the Newtonian approach in its clear observation and recording of detailed descriptions. In a time when most scientific activity in America consisted of gathering information of the natural world, this book stands out as a prime example of scientific work.[285]

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279. WILLS, *supra* note 76, at 95.

280. Hindle states:

> John Adams' *Defence of the Constitutions* was an endeavor to refute the charge by applying scientific principles to the evaluation of government. "The arts and sciences, in general," he began, "during the three or four last centuries, have had a regular course of progressive improvement . . . is it not unaccountable that the knowlege of the construction of free governments, in which the happiness of life, and even the further progress of improvement in education and society, in knowledge and virtue, are so deeply interested, should have remained at a full stand for two or three thousand years?" He went on the classify and characterize many ancient and modern governments much as the botanists classified their plants.

HINDLE, *supra* note 257, at 377.

281. WILLS, *supra* 76, at 99, 131.

282. *Id.* at 93.

283. *Id.* at 91-164.

284. THE LIFE AND SELECTED WRITINGS OF THOMAS JEFFERSON 187-288. (A. Koch & W. Peden eds. 1944) [hereinafter cited as LIFE AND SELECTED WRITINGS].

285. In introducing the work, the editors state:

> Important not only as a notable contribution to American scientific writing (formulating priciples of scientific geography later developed by von Humboldt), it has been praised by reputable twentieth-century historians of science as the most in-

In the case of Jefferson it is fairly easy to determine the influences that helped shape his ultimate philosophy. Professor William Small and Lieutenant Governor Francis Fauquier were two of the key influences on young Jefferson while he studied at the College of William and Mary,[286] and when he subsequently studied law. Both men can be directly linked to the philosophy of the Enlightenment. William Small, the Scottish professor, was extensively trained in Enlightenment thought[287] and, as a professor of natural philosophy, was responsible for teaching many categories of modern science.[288] He was one of the bridges between Newtonian physics and men like Jefferson who acted upon the Newtonian belief that even human actions were governed by natural laws.

Francis Fauquier was born in London and resided as a country gentlemen in Hertfordshire until sent to represent the Crown's interest in Virginia. His family background and professional life included a number of connections to science.[289] It is not unlikely that his interest in the science influenced Jefferson.

Jefferson's noted biographer, Dumas Malone, summarized this formative period of his life by saying:

> There is little question that, before he stepped on the public stage, he had arrived at his abiding conviction that human intelligence can unlock not only the treasure house of the past but also the secrets of the universe, thus leading mankind onward to a richer and better life, and that he personally was proceeding on that assumption.[290]

Evidence of Jefferson's attitude toward the importance of Newtonian reasoning can be found in his correspondence, much of it coming after his two terms as President.[291] Later in his life Jefferson referred

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> fluential scientific book written by an American. The Notes continue to be of interest for the clarity, vigor, and occasional beauty of Jefferson's prose.

Id. at 186.

286. D. MALONE, JEFFERSON THE VIRGINIAN 102-03 (1948) [hereinafter cited as MALONE].

287. For a discussion of the broad impact of Scottish thinking on Americans, see WILLS, *supra* note 76, at 175-80. Some of Professor Small's friends included James Watt (inventor of the steam engine) and Erasmus Darwin (grandfather of Charles Darwin and active in science himself). MALONE, *supra* note 286, at 53.

288. When Jefferson arrived, "[Small] was there, teaching physics, metaphysics, and mathematics, and through force of circumstances was soon teaching practically everything else." MALONE, *supra* note 286, at 51. Another author considers Small to have been the greatest rival of Professor Winthrop of Harvard. HORNBERGER, *supra* note 263, at 61.

289. MALONE, *supra* note 286, at 76.

290. *Id.* at 101.

291. In a 1789 letter to Dr. Willard, President of Harvard, Jefferson commented upon how open the field of natural history, botany, mineralogy, and zoology in America appeared to be:

> It is the work to which the young men, whom you are forming, should lay their hands. We have spent the prime of our lives in procuring them the precious bles-

to Bacon, Locke, and Newton as the trinity of immortals that initiated the great intellectual revolution of the Enlightenment.[292] While "Jefferson did not introduce the Enlightenment into the colonies . . . he became its almost perfect embodiment and, after Franklin, its most conspicuous apostle on this side of the Atlantic."[293]

No man did more for the advancement of science during the Revolutionary period than Benjamin Franklin, an authentic American hero. He was a great scientist in his own right, a leader in the promotion of scientific education and scientific organizations, inventor, author, and diplomat.[294]

Franklin was probably America's first true experimentalist. His best known work was in the field of electricity. In the six years between 1746 and 1752 Franklin made his fundamental contributions in this area when he flew the famous kite establishing that lightning was electricity and had a fluid nature.[295] Through periodic publications he informed the scientific world of his work in electricity.[296] Because of his remarkable efforts in this area, he received several awards, the admiration and respect of scientists worldwide and the wondrous praise of the public.[297] Throughout his life Franklin continued to pursue scientific questions. As was typical of the period, the scope of his interest

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> sing of liberty. Let them spend theirs in showing that it is the great parent of science and of virtue; and that a nation will be great in both, always in proportion as it is free.

LIFE AND SELECTED WRITINGS, *supra* note 284, at 468.

In a letter to General Kosciusko in 1810, Jefferson discussed his life at Monticello, and his new role helping young men in their studies. "In advising the course of their reading, I endeavor to keep their attention fixed on the main object of all science [*i.e.*, knowledge gained by Newtonian thought] the freedom and happines of man." *Id.* at 600.

A final example can be found in the last letter Jefferson is known to have written. In this June 1826 letter he reflected upon the 50th anniversary of American independence and stated:

> That form [of government] which we have substituted, restores the free right to the unbounded exercise of reason and freedom of opinion. All eyes are opened, or opening, to the rights of man. The general spread of the light of science has already laid open to every view the palpable truth, that the mass of mankind has not been born with saddles on their backs, nor a favored few booted and spurred, ready to ride them legitimately, by the grace of God. These are grounds of hope for others.

Id. at 729-30.

292. MALONE, *supra* note 286, at 101.

293. *Id.* at 101-02.

294. *See generally* VAN DOREN, *supra* note 256.

295. *Id.* at 156-64.

296. Some of his publications included *Opinions and Conjectures, concerning the Properties and Effects of the Electrical Matter* (1749) and *Experiments and Observations on Electricity* (1751). His writings were translated into French, German, and Italian, and even as late as 1769 he was releasing an updated 4th edition. *Id.* at 160, 162, 171, 248.

297. *Id.* at 174, 661.

encompassed meteorology, zoology, physics, chemistry, geology, and oceanography.[298]

Franklin also sought to promote science among the various societal institutions of the period. As early as 1743, Franklin outlined a comprehensive plan for the cooperative promotion of science on an intercolonial basis. Within a year, his plan was begun with the formation of the American Philosophical Society.[299] Franklin also argued forcefully in favor of advanced training in the useful arts and sciences by the formation of a college in Pennsylvania.[300] In all of these endeavors, Franklin displayed his belief in the noble dream of the Enlightenment, that Man, by studied effort, could unlock the secrets of the universe and apply them to increase his power "over matter and multiply the conveniences or pleasures of life."[301]

As has been shown, science was an integral part of the lives of the founding fathers. These men incorporated their scientific perspective and approach into the developing American institutions. By the time the Declaration of Independence was drafted, science was central to the thought of many American leaders and provided a mechanism and intellectual basis for the Revolutionary argument and for the subsequent formation of a constitutional government. The founding fathers also believed that science would provide the information and technology necessary to advance the material well-being of America's citizens, allowing them to fully enjoy the liberties secured for them by their government. During the next century this heritages was not abandoned: the infant American science began to develop into the modern giant we know today. Modern American institutions impliedly demonstrate that inquiry is a right of paramount stature because science became a part of the very fabric of these institutions.

b. Value to Contemporary Society

In order to achieve the status of a fundamental right, contemporary society must highly value scientific inquiry.[302] Unlike other

298. In the area of meteorology, Franklin suggested a theory for the movement of air masses as creating storm fronts, he conducted experiments concerning the actions of ants and pigeons, made a proposal on the nature of light, and conducted an observation of a whirlwind. Later while in England he helped Hadley conduct chemical experiments on evaporation. He also conducted experiments to show how different colors of cloth absorbed light and the sun's heat. Other scientific efforts included observations and theories concerning geology, and various experiments on the motion of water. *Id.* at 174-82, 278, 295, 660, 442.

299. *Id.* at 138-41.

300. Franklin drafted a detailed proposal entitled "Proposals Relating to the Education of Youth in Pennsylvania" (1743). *Id.* at 189-93.

301. HINDLE, *supra* note 257, at 1.

302. While there are no cases which expressly mandate this second requirement, it is the logical consequence of the process that seeks to discover unenumerated rights. This

claimed liberties such as the right to an abortion or homosexual rights,[303] scientific inquiry has broad public support and does not stimulate social abhorrence. Perhaps no single activity is held in higher esteem by the public than science.[304] The importance of science is demonstrated by the National Science and Technology Organization Priorities Act of 1976.[305] In this Act, Congress acknowledged the profound impact of science on society and the interrelation of scientific, economic, social, political, and institutional factors and declared that: "the general welfare, the security, the economic health and stability of the Nation, the conservation and efficient utilization of its natural and human resources, and the effective functioning of government and society require vigorous, perceptive support and employment of science and technology in achieving national objectives . . . ."[306]

Congress specifically found that science "when properly fostered, applied, and directed, can effectively assist in improving the quality of life," in resolving critical problems, in strengthening the Nation's international economic position, and in furthering foreign policy objectives.[307] Congress also found that federal funding of science was indispensable to sustained national progress and human betterment.[308]

Not only has Congress recognized that science has been important to our society, but it has turned to science to help solve national problems. Congress has stated:

> The six broad national goals to which science and technology are called upon to contribute are (1) those of foreign policy, (2) a healthy national economy, (3) the special needs of food and energy, (4) the national security in its broadest sense, (5) the national health, and (6) a satisfying total environment, natural and man-made, urban and rural.[309]

Science can effect foreign policy in a number of different ways. It has been recognized that technology transfer (the by-product of science) plays an important role in establishing relations with the

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element of the test may be an important factor in the Court's subjective decision to grant certiorari. Lupu, *supra* note 237, at 1047-50.

303. *Id.* at 1046.

304. Evidence of surveys conducted in 1972, 1974, and 1976 indicates that the public continues to have an overwhelmingly positive general reaction to science and technology. The public's esteem for scientists in 1976 was second only to its esteem for physicians. Seventy-one percent of the populace consider that science and technology have changed life for the better. Only seven percent consider the change to have been for the worse. *Contrary to Fears, Public is High on Science*, 199 SCIENCE 1420-23 (1978).

305. 42 U.S.C §§ 6601-6671 (1976, Supp. I 1977, Supp. II 1978 & Supp. III 1979).

306. 42 U.S.C. § 6601(a)(1).

307. *Id.* § 6601(a)(3).

308. *Id.* § 6601(a)(4).

309. H.R. REP. No. 595, 94th Cong., 2d Sess. 30 (1976), *reprinted in* [1976] U.S. CODE CONG. & AD. NEWS 880, 908.

Soviet Union, Eastern Europe, and the People's Republic of China.[310] Foreign policy goals can also be furthered by the creation and severance of scientific ties.[311] Finally, science can be a component of the aid provided to third world countries.[312]

The national economy is dependent upon a vigorous science program. Over sixty-billion dollars per year is expended by the government and private sector on basic research, applied research, and development.[313] Science is an increasingly indispensable source of improvement to the entire economy.[314] The knowledge gained by scientific inquiry engenders inventions, techniques, and processes that produce innovations and efficiencies throughout our economic and social systems.[315] This broad-based technology in turn generates the abundance of material goods and services that support the high standard of living in the United States.[316]

Science also is important at a more fundamental level. Were it not for the significant achievements of the agricultural scientist, society's ability to feed itself would be in jeopardy. Some of the breakthroughs include the development of high-yield, disease-resistant varieties of plants; chemical and biological control of weeds, pests, and diseases; and the genetic control of livestock production.[317] If world population

310. OFFICE OF TECHNOLOGY ASSESSMENT, TECHNOLOGY AND EAST-WEST TRADE (Nov. 1979).

311. As part of the normalization of relations between the United States and the Peoples Republic of China, a five-year umbrella agreement delineating rules for cooperative research and scientific exchanges has been signed. *U.S.-Sino Agreements on Science*, 115 SCI. NEWS 83 (1979).

In response to the Soviet invasion of Afghanistan, the Council of the National Academy of Science voted to suspend all symposia, seminars, and workshops for a period of six months. *NAS Cuts Soviet Tie*, 117 SCI. NEWS 135 (1980).

312. The United States, through NASA, made available a communications satellite to India so that programs on family planning, agriculture, and adult education could be broadcast to 4000 Indian villages. *U.S. Discusses Progress and Challenges in Space Technology and Law in U.N. Outer Space Committee*, DEP'T STATE BULL. 206, 207 (1976).

313. For the 1981 federal budget, the administration has proposed $50 billion for basic research and another $36 billion for research and development. 117 SCI. NEWS 70 (1980). In addition, at least another $20 billion per year will be spent by the private sector. It has been estimated that each person engaged in research and development (R&D) generates six to ten other jobs in the economy. OFFICE OF TECHNOLOGY ASSESSMENT, APPLICATIONS OF R&D IN THE CIVIL SECTOR (June 1978) [hereinafter cited as APPLICATIONS OF R&D].

314. Rosenburg, *The Role of Science and Technology in the National Development of the United States*, in SCIENCE, TECHNOLOGY, ECONOMIC DEVELOPMENT 151-63 (W. Beranek & G. Ranis eds. 1978) [hereinafter cited as Rosenburg].

315. *See* APPLICATIONS OF R&D, *supra* note 313, at iii.

316. *See* Daniels, *Science and Human Welfare*, in SCIENCE AND CONTEMPORARY SOCIETY 201-02 (F. Crosson ed. 1967); Rosenburg, *supra* note 314, at 151-63.

317. Pickstock, *Food Resources and Population*, in SCIENCE FACT 416 (F. George ed. 1978).

continues to increase, science must continue to innovate to provide adequate food supply.[318]

Energy is one of the most difficult problems facing society.[319] All currently available energy sources suffer from severe limitations. Fossil fuels are finite and will eventually be exhausted; fission energy produces hazardous waste and the risk of nuclear disasters.[320] Modern society is dependent upon science to discover alternative energy sources.[321]

National security also is heavily dependent on science. Beginning with World War II science has played increasing role in national defense.[322] Modern warfare relies heavily on technologically sophisticated weapons.[323] A scientific breakthrough in weapons development by one country can give it an overwhelming superiority over another. Without a strong commitment to scientific research the defense posture of the United States could be greatly weakened.

The role of science in medicine has greatly expanded in the past decades.[324] As a result of the application of the knowledge gained from scientific inquiry, many new preventive, diagnostic and therapeutic tools are currently available.[325] Through the use of antibiotics, vaccines,

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318. *Id.* at 414-47. Some areas which may produce significant breakthroughs include developing man-made plants, developing self-fertilizing plants, new sources of food for animals, and intensive horticulture.

319. Cohen observes:

> The key to such a technology must be cheap and abundant energy. With cheap and abundant energy and a reasonable degree of inventiveness man can find substitutes for nearly anything: virtually unlimited quantities of iron and aluminum for metals, hydrogen for fuels and so on. Without cheap and abundant energy the options are much narrower and must surely lead back to a quite primitive existence.

Cohen, *The Disposal of Radioactive Waste from Fission Reactors*, SCIENTIFIC AM., June 1977, at 31.

320. Ausness, *High-Level Radioactive Waste Management: The Nuclear Dilemma*, 1979 WIS. L. REV. 707, 711.

321. Science may find an answer to the energy crisis in such areas as fission power, solar energy, or wind power. Conway, *Energy* in SCIENCE FACT 383-99 (F. George ed. 1978). The solution may be found in some unforeseeable area such as alcohol-producing bacteria. 116 SCI. NEWS 317 (1979).

322. The premier example was the Manhattan project which developed the first atomic bomb. LAPP, *supra* note 19, at 45-55.

323. These weapons include: ICBM missile armed with MIRV warheads, anti-ballistic missile systems, laser weapons, satellite reconaissance and surveillance systems, and chemical and biological warfare agents. Archer, *Defense and Weapons Research and Development* in SCIENCE FACT 210-23 (F. George ed. 1978).

324. OFFICE OF TECHNOLOGY ASSESSMENT, ASSESSING THE EFFICACY AND SAFETY OF MEDICAL TECHNOLOGIES (Sept. 1978).

325. During the past three decades, there has been a remarkable growth in the development and use of diagnostic technologies. A wide array of new devices has been developed, greatly extending the ability to diagnose medical problems. New technologies

and other techniques, diseases such as malaria, yellow fever, typhoid, tuberculosis, measles, and poliomyelitis have been virtually eliminated.[326] In addition, relief of pain, amelioration of symptoms, and rehabilitation are now possible for many persons who previously could not have been treated at all. These and many other advances have led to a substantial improvement in American public health.

In the future it is expected that science will provide new insights into such areas as aging, fetal development, the human mind, deciphering the genetic code, cancer, and heart disease.[327]

As can be seen from foregoing examples, science and its products have a profound impact on such diverse areas of our society as foreign policy, economics, and national defense. Nevertheless, the influence of science is even more pervasive. The scientific approach has been adopted by many of our institutions as the basic model for decision making. All branches of the federal government rely upon the scientific approach in carrying out their assigned functions.

Congress has recognized the importance of employing science and scientific knowledge in the decision-making process.[328] In areas such as air pollution control, handling of toxic substances, and operation of fisheries, Congress has mandated that the administrative agencies use scientific information as part of their regulatory activities.[329]

In order to insure continuous access to scientific information for itself, Congress has found it necessary to provide for official scientific advisors through the creation of the Office of Technology

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include automated clinical laboratory equipment, electronic fetal monitoring, amniocentesis, electrocardiography (EKG), electroencephalography (EEG), fiberoptic endoscopy of the upper and lower gastrointestinal tracts, ultrasound, mammography, and computed tomography. OFFICE OF TECHNOLOGY ASSESSMENT, POLICY IMPLICATIONS OF THE COMPUTED TOMOGRAPHY SCANNER 3-4 (August, 1978).

326. Without the basic research which discovered the three antigenic types of poliovirus, for example, the development of the Salk vaccine would not have been possible. Thomas, *Hubris in Science?* 200 SCIENCE 1459, 1461 (1978).

327. Newell, *Medicine and Surgery: To 2001*, in SCIENCE FACT 70-106 (F. George ed. 1978).

328. National Science and Technology Policy Act, 42 U.S.C. § 6601(a)(2) (1976).

329. In the Clean Air Act, the Administrator of the EPA is directed to establish a national research and development program. 42 U.S.C § 7403 (Supp. III 1979). In setting the national air pollution standards the administrator must take into account the latest scientific knowledge. *Id.* § 7408(b). Under the Toxic Substance Control Act, if the Adminstrator believes a substance presents an unreasonable risk, the substance may be subjected to a battery of tests for conditions including carcinogenesis, mutagenesis, teratogenesis, behavioral disorders, and cumulative or synergistic effects. 15 U.S.C. § 2603 (1976). In order to protect the national resource of fisheries, Congress has required the development of a fisheries management plan which makes extensive use of the biological and ecological sciences. 16 U.S.C § 1853 (1976, Supp. II 1978 & Supp. III 1979).

Assessment.[330] Congress has also provided the President with scientific advisors through the creation of the Office of Science and Technology Policy.[331] In addition to these internal advisory bodies, the government also has access to the resources of the nation's scientific community through the National Science Foundation.[332]

In addition to the acquisition of scientific information, all branches of government employ scientific methodology to varying degrees in carrying out their functions. The executive branch places an increasing reliance upon the scientific method in carrying out its responsibilities. In fact, the work of the executive branch of government has been described as the science of public administration.[333] A major component of the executive function is decision making and the steps employed in the executive decision-making process closely parallel those of the scientific method.[334] Theodore Sorensen, advisor to President John F. Kennedy has described the mechanics of White House decision making as follows:

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330. The congressional findings and declaration of purpose in the Act which created the Office of Technology Assessment state:

> (b) Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems.
>
> . . . .
>
> (d) Accordingly, it is necessary for the Congress to—
>
> (1) equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such applications . . . .

2 U.S.C. § 471 (1976). For a discussion of the Technology Assessment Act of 1972, see Hanslowe & Oberer, *Science, Technology, Law: The Good Life*, 26 J. LEGAL EDUC. 32 (1973).

331. The function of this advisor is to "advise the President of scientific and technological considerations involved in areas of national concern including, but not limited to, the economy, national security, health, foreign relations, [and] the environment." 42 U.S.C. § 6613 (1976).

332. 42 U.S.C. § 1862 (1976 & Supp. III 1979).

333. The science of public administration has been described as follows:

> Administration has to do with getting things done; with the accomplishment of defined objectives. The science of administration is thus the system of knowledge whereby men may understand relationships, predict results, and influence outcomes in any situation where men are organized at work together for a common purpose. Public administration is that part of the science of adminstration which has to do with government, and thus concerns itself primarily with the executive branch, where the work of government is done, though there are obviously administrative problems also in connection with the legislative and judicial branches. Public administration is thus a division of political science, and one of the social sciences.

Gulick, *Science, Values and the Public Administration*, in THE ADMINISTRATIVE PROCESS AND DEMOCRATIC THEORY 98 (L. Gawthrop ed. 1970).

334. *See* notes 56-57 and accompanying text *supra*.

first: agreement on the facts;
second: agreement on the overall policy objective;
third: a precise definition of the problem;
fourth: a canvassing of all possible solutions, with all their shades of variations;
fifth: a list of all the possible consequences that would flow from each solution;
sixth: a recommendation and final choice of one alternative;
seventh: the communication of that selection; and
eight: provision for its execution.[335]

As can be seen, these steps include data gathering, data analysis, formulation of hypotheses, the drawing of conclusions, communication and finally experimentation, which is analogous to the implementation of the decision.[336]

Although the decision-making process in Congress is more complex, it too incorporates many of the basic elements of the scientific approach. The committee structure, which is the beginning point for congressional action, performs the data gathering and much of the preliminary analysis.[337] From the preliminary work of the committees, Congress formulates a hypothesis in the form of a bill. This bill, when enacted and implemented as a statute becomes an experiment to test the hypothesis. Depending upon the results of the experiment there may be further amendments of the statute.[338]

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335. T. SORENSEN, DECISION-MAKING IN THE WHITE HOUSE 18-19 (1963). Sorensen notes that this theoretically ideal process is subject to limitations. *Id.* at 22-42.

336. *See* text accompanying note 103 *supra.* The scientific approach was used by the Johnson administration in connection with a budget system. The program was developed to enable the government to:

1. Identify our national goals with precision and on a continuing basis;
2. Choose among those goals the ones that are most urgent;
3. Search for alternative means of reaching those goals most effectively at the least cost;
4. Inform ourselves not merely on next year's cost, but on the second, and third, and subsequent years' costs of our programs;
5. Measure the performance of our programs to insure a dollar's worth of service for each dollar spent.

Johnson, *A Statement by the President*, in THE ADMINISTRATION PROCESS AND DEMOCRATIC THEORY 8 (L. Gawthrop ed. 1970).

337. F. CUMMINGS, CAPITOL HILL MANUAL 39-58 (1976); M. JEWELL & S. PATTERSON, THE LEGISLATIVE PROCESS IN THE UNITED STATES 416-43 (1977).

338. This would appear to be the basic approach of Congress in dealing with the social and environmental issues of the 1960's-70's. This is not to suggest that other factors, politicial, emotional or economical, etc. did not help shape the final outcomes, but the methodology was scientific. In the case of the Clean Air Act, the basic act was passed in 1970 (Pub. L. No. 91-604, 84 Stat. 1676) and was subsequently amended in 1973 (Pub. L. No. 93-15, 87 Stat. 11), 1974 (Pub. L. No. 93-319, 88 Stat. 246), and 1977 (Pub. L. No. 95-95, 91 Stat. 685).

In addition to the concepts of scientific public adminstration, administrative agencies are also subject to the Adminstrative Procedure Act.[339] Through the judicial review provisions of the Act, Congress has, in effect, required all agencies to employ the scientific method in their decision making.[340]

The scientific approach to decision making has been so widely used in this society over such a long period of time that it is sometimes forgotten that an indentifiable, unique process has been adopted. Alternatives for decision making are also available: intuition or political instinct, political doctrine or religious faith, tradition, and personal feelings, for example.

Governmental decisions based on religious faith occur routinely in the Middle East. Perhaps the most extreme example is the recent Iranian Constitution which puts all political decisions into the hands of religious leaders.[341] Tradition can also affect government policy and decision making. The official policy of apartheid, followed by the South African government, for example, is based substantially upon tradition rather than scientific reasoning.[342] Politicial decisions also are made on the basis of intuition and feelings[343] or upon whim.[344]

Science is largely responsible for many of the values which we accept

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339. The Administrative Procedure Act, 5 U.S.C. § 551 (1976).

340. The APA states that in judicial review a court shall:

> (2) hold unlawful and set aside agency action, findings, and conclusions found to be—
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> (A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law;
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> . . .
>
> (D) without observance of procedure required by law;
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> (E) unsupported by substantial evidence . . .
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> (F) unwarranted by the facts to the extent that the facts are subject to trial de novo by the reviewing court.

Id. § 706.

341. The new constitution is based on strict Moslem law proclaimed in the Koran. "Key to the clergy's control is a Council of Guardians made up of religious leaders who must approve measures passed by the Assembly." For the first time Moslem Mullahs are given complete domination over Islamic life. U.S. NEWS AND WORLD REP., Dec. 10, 1979, at 22.

342. For many years in most countries Blacks were thought of as inferior. This tradition is still alive today in South Africa. THE NATION, Aug. 11, 1979, at 104.

343. For example, Communist China's recent "cultural revolution" appears to have been produced by Chairman Mao's fears of the rising intelligentsia. A. Topping, *Since 1966, A Kaleidoscope of Changes*, in REPORT FROM RED CHINA 162-65 (F. Ching ed. 1971). S. Topping, *New Dogma, New Maoist Man*, in REPORT FROM RED CHINIA 258-65 (F. Ching ed. 1971).

344. One Western diplomat described Uganda's Idi Amin as "animal-shrewd—like a cornered animal who made political decisions instinctively." NEWSWEEK, Mar. 7, 1977, at 29-35. During his regime Amin seemed content to allow ruination as long as his personal authority remained undiminished. AMERICA, Jan. 15, 1977, at 26-27.

today as permanent and self-evident.[345] We are living in a society permeated by the scientific outlook and ethic.[346] The primary component of the scientific ethic is the habit of truth; *i.e.*, the habit of testing and correcting a concept by its consequences in experience.[347] From the habit of truth and the scientific spirit have come such values as respect for the individual, acceptance of the process of dissent, and recognition of the value of freedom of thought and inquiry.[348]

In summary, scientific inquiry is of vital importance to our modern society.[349] Science has a profound impact on all of our economic, social, and political institutions. It is a significant factor in solving many of today's national problems. Science is directly responsible for the material well-being and strength of our nation. The knowledge gained from scientific inquiry consistently has been applied to all levels of our society. The scientific method has been adopted by the government as a basis for carrying out its various functions. Finally, the scientific ethic has helped shape the values of our society.

Without science and scientific inquiry the founding fathers' goals for individual and national self-fulfillment would have been far more difficult to achieve. Scientific inquiry, from both a historical standpoint and a modern perspective, is an activity of paramount stature and thus entitled to protection as a fundamental right.

C. *Standards of Review*

Assuming that scientific inquiry is a constitutionally protected right, there remains the critical task of developing the proper standard of

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345. HUMAN VALUES, *supra* note 20, at 51.

346. ORIGINS OF KNOWLEDGE, *supra* note 21, at 133.

347. This habit of truth was suggested by Bronowski.

> In science and in art and in self-knowledge we explore and move constantly by turning to the world of sense to ask "Is this so?" This is the habit of truth, always minute yet always urgent, which for four hundred years has entered every action of ours; and has made our society and the value it sets on man, as surely as it has made the linotype machine and the scout knife, and *King Lear* and the *Origin of Species* and Leonardo's *Lady with a Stoat*.

HUMAN VALUES, *supra* note 20, at 46.

348. *See generally id.* at 20. "Science like the arts or literature, is necessary to a free society. It establishes a method of intelligent thought and thereby enhances liberty. It dignifies the human spirit, as do art and poetry. Scientific inquiry is an expression of freedom." Rieser, *The Role of Science in the Orwellian Decade*, 184 SCIENCE 486, 489 (1974).

349. Science is also the greatest hope of the human race.

> [T]he heritage of science is a heritage of hope. By greater understanding, not only of the physical and biological worlds but also of ourselves and the world of human society, we can push the evolutionary parameters toward human betterment and build a happier world for the human race even out of the fires of catastrophe.

Boulding, *Science: Our Common Heritage*, 207 SCIENCE 831, 836 (1980).

review. Because of the wide variety of fact situations in which the rights beyond those enumerated in the Constitution arise, no one standard of review has been articulated.[350] Depending upon the particular right involved, the standard of review ranges from requiring merely a rational basis,[351] to requiring an important state interest[352] or a compelling interest[353] to justify state interference. It appears that the applicability of the different tests is a function of the nature of the right asserted and the context in which it arises.[354] The more socially significant the right, the stricter the standard of review.

In light of the important role which scientific inquiry plays in the functioning of our society it would be inappropriate to employ the rational basis standard. Under this standard a government regulation will be upheld if it furthers a legitimate governmental objective.[355]

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350. Professor Tribe has observed:

> The resulting rights have been located in the "liberty" protected by the due process clauses of the fifth and fourteenth amendments. They have been cut from the cloth of the ninth amendment—conceived as a rule against cramped construction—or from the privileges and immunities clauses of article IV and of the fourteenth amendment. Encompassing rights to shape one's inner life and rights to control the face one presents to the world, they have materialized like holograms from the "emanations" and "penumbras"—most recently dubbed simply the "shadows"—of the first, third, fourth, and fifth amendments. They elaborate the "blessings of liberty" promised in the Preamble, and have been held implicit in the eighth amendment's prohibition against cruel and unusual punishment. Wherever located, they have inspired among the most moving appeals to be found in the judicial lexicon.

TRIBE, *supra* note 46, at 893-94 (footnotes omitted).

351. In Kelley v. Johnson, 425 U.S. 238 (1976), the Court upheld a regulation governing hair grooming for police officers since the patrolman involved could not demonstrate that there was no rational connection between the regulation and the goal of promoting safety of persons and property. *Id.* at 247.

352. In Moore v. City of East Cleveland, 431 U.S 494 (1977), the court held that because the city's zoning ordinance intruded upon the fundamental rights of the family the usual judicial deference to the legislature was inappropriate. The Court stated that "when the government intrudes on choices concerning family living arrangements, this Court must examine carefully the importance of the governmental interests advanced and the extent to which they are served by the challenged regulation." *Id.* at 499.

353. See notes 202-07 and accompanying text *supra. See generally* Lupu, note 237 *supra*; Perry, *Substantive Due Process Revisited: Reflections on (and Beyond) Recent Cases*, 71 NW. L. REV. 417 (1977) [hereinafter cited as Perry]; Perry, *Abortion, The Public Morals, and the Police Power: The Ethical Function of Substantive Due Process*, 23 U.C.L.A. L. REV. 689 (1976).

354. An example of this distinction is provided by Tribe:

> Thus a purpose adequate to justify regulating the quality of brake linings might not serve to justify requiring the wearing of seat belts. And one sufficient to justify such a requirement might in turn be thought insufficient to sustain a requirement targeted at a more insular group—motorcyclists, for example, instead of automobile drivers.

TRIBE, *supra* note 46, at 891.

355. Perry, *supra* note 353 at 419, 422.

With this test almost "any governmental objective is legitimate which seeks to protect psychological, as well as physical, health or to promote the economic, political, or even aesthetic well being of the citizenry."[356] This test leaves very little room for weighing the importance of the claimed right against the governmental objective. Even more importantly, the burden of proof is on the claimant to establish that there is no rational connection between the regulation and the state interest.[357] Because of the important role which scientific inquiry plays both in the individual self-fulfillment of the scientist and the development of society, the rational basis test is insufficient to protect the right of scientific inquiry.

Given the fundamental nature of the right of scientific inquiry a more strict standard is required. When dealing with fundamental or basic rights the Court has required that there be a substantial, important, or compelling state interest. Furthermore, when these rights are involved the burden falls upon the state to demonstrate that there is a sufficient interest and the regulation is closely tailored to effectuate only those interests.[358] The standard would require that the regulation (1) be within the constitutional power of the government, (2) further an important or substantial governmental interest, and (3) be no greater than is essential to the furtherance of the governmental interest. The standard will permit the fullest possible exercise of the basic right of scientific inquiry while still allowing the state to protect itself and the health and safety of its citizens.

This standard should be used in all cases in which the state seeks to regulate scientific inquiry. In the first instance the activity involved must satisfy the two-part definition of scientific inquiry.[359] Once the claimant establishes that the activity is scientific inquiry, the burden shifts to the government to establish that its regulation meets the requirements of the three-point fundamental right standard. The standard is essentially the same as the *O'Brien* test.[360] Because of this similarity, the analysis of any case will follow the same pattern as that of the *O'Brien* test. Thus the results reached in the above examples of the fetal research, recombinant DNA, national security, and human experimentation will be the same.

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356. *Id.* at 424 (footnotes omitted).

357. Kelley v. Johnson, 425 U.S. at 247. Using this approach it would be possible for a local government to prevent the construction of a large solar collector which would be used to study the fundamental characteristics of energy conversion by solar cells. The local government could justify the regulation based on aesthetic and potential traffic congestion due to sightseers. *See generally* Berman v. Parker, 348 U.S. 26 (1954).

358. This test was set forth in Zablocki v. Redhail, 434 U.S. 374, 388 (1978), where the Court struck down a statute which interfered with the fundamental right of marriage.

359. *See* text accompanying notes 52-53 *supra.*

360. *See* text accompanying note 170 *supra.*

IV. Conclusion

Science and its products have already exerted a profound impact on society and will continue to do so. As scientific knowledge grows, so does man's ability to affect and manipulate himself and his environment. The changes and the risks created by scientific inquiry will inevitably lead to a greater demand for governmental control. This article proposes various approaches which can be used to balance the right of scientific inquiry and the state's interest in protecting itself and its citizens.

Before meaningful regulation is possible, the nature of scientific inquiry must be more fully understood. Its goals and methods must be examined to determine which activities can be properly designated as scienfitic inquiry. Based upon this examination, the authors have proposed a legal definition of scientific inquiry.

Once the nature of scientific inquiry is examined, it is possible to establish a constitutional right to engage in this activity either under the first amendment analysis or as a fundamental right standing alone. The first amendment approach offers the advantage of allowing analysis to proceed along familiar, well traveled paths, but it presents the disadvantage of not accomodating the unique character of scientific inquiry and of requiring that certain of its non-speech components be characterized as speech or incidents of speech. The "Achilles Heel" of the first amendment approach lies in its requirement that experimentation must be categorized as speech or necessary incident of speech. If this categorization is not accepted, the whole analysis falls apart. The fundamental right approach, while having the disadvantage of being novel, offers the advantage of fitting readily within the mold of presently recognized fundamental rights. The latter approach is preferable. Because it accommodates the unique character of science, it allows the Court to deal directly with scientific inquiry without resorting to artificial characterization. This approach will also allow the Court maximum flexibility in dealing with the complex issues which will inevitably arise. Whichever approach is adopted, the standard of review and analysis would be equivalent.