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Article

*355 INTANGIBLE INVENTIONS: PATENTABLE SUBJECT MATTER FOR AN INFORMATION AGE

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In our present era dominated by information-processing advances, the nature of useful inventions and patentable discoveries is changing. New methods of information processing have proven to be useful tools in a wide variety of consumer, business, and engineering contexts. This Article considers how patentability standards should respond. Specifically, the Article seeks to determine how the patentable subject matter boundaries of the patent system should be redrawn to ensure that patent rights serve the same valuable incentive functions concerning intangible innovations in information processing that these rights have served towards earlier types of physical engineering.

Until recently, intangible and tangible discoveries occupied two distinctly different positions in patent law. New discoveries of intangible intellectual concepts or scientific relationships generally received no protection. [FN1] Intangible discoveries of these sorts were viewed as important analytic constructs and communication aids that should be freely available to all users. [FN2] In contrast, new discoveries of *356 tangible, useful items such as new machines, chemicals, or manufacturing processes qualified for substantial patent protections. [FN3] Tangible discoveries providing society with access to these types of new and beneficial physical objects and processes were protected by patent laws, placing the making, use, and sale of these inventions under the exclusive control of their inventors for the life of a patent, currently a period of twenty years from the patent application date. [FN4]

Recent developments in computer technology and related business practices are forcing courts to rethink this simple dichotomy. [FN5] A wide variety of information-processing advances embedded in software products and, more recently, innovative business methods have been sought to be patented in the last decade. [FN6] While many of *357 these products and methods have been undeniably useful, the differences between these intangible information-processing advances and unpatentable intellectual discoveries have been troublingly narrow.

New designs for software and computer-based business practices often turn on new methods of information handling. [FN7] These new information-handling methods resemble the sorts of intangible ideas and thought processes that

have traditionally fallen outside of patent protections. However, these new designs are undeniably useful and, in this respect, resemble earlier types of patent- protected machine and physical process designs. Confronted with the useful, yet intangible character of many software advances and related business-method improvements, federal courts have recently redefined the boundaries of patentable subject matter to include a substantial range of intangible discoveries. [FN8] By rethinking the role of patents in encouraging technological development and adjusting the range of patentable inventions to match the changing nature of technological development, courts are redefining standards of patentable subject matter for an information age.

The new standards that are emerging from this process include a growing body of principles for separating patentable intangible discoveries with constant, predictably useful relationships to physical contexts from other unpatentable intangible discoveries lacking these sorts of relationships. [FN9] These new standards recognize that some *358 intangible discoveries have immediate utility because they have an analytic relationship to a physical context even if the discoveries do not incorporate any physical features of the context themselves. [FN10] In short, developing patentability standards identify a range of technological yet intangible discoveries that help users deal with physical surroundings, but which involve no physical components themselves.

These new standards for identifying patentable subject matter in intangible discoveries must address a number of difficult questions: What sorts of linkage to a physical environment should be required to distinguish a patentable method for interpreting or controlling that environment from a mere intangible description of the characteristics of the environment and the scientific principles governing the environment? What features of an intangible discovery should an inventor be required to understand in order to qualify for a patent? What are the key features of an intangible discovery that must be disclosed, corresponding to the structural features or relationships that are required to be stated to gain a patent for a physical invention? Will there be an undesirable intellectual "spillover" effect of patents on intangible discoveries--that is, will allowing patents for intangible discoveries, coupled with imprecise enforcement of those patents, place undesirable restrictions on reuse of the intellectual or scientific concepts embedded in the discoveries? Answers to these sort of questions are only beginning to develop as courts confront an increasing number of disputes concerning patents on intangible discoveries and attempt to clarify the governing patent law standards.

This Article examines the important changes federal courts are making in patentable subject matter standards for intangible inventions. The discussion begins with an evaluation of the technological and institutional pressures driving the development of new patentable subject matter standards for intangible inventions. The analysis then continues with a brief review of past tests for patentable subject matter. It describes why courts applying these earlier tests generally looked for a physical transformation in the operation of a device or process and precluded patenting if such a transformation was missing. The analysis then contrasts these older tests with the new *359 standards that federal courts have developed for intangible inventions, standards that include a broad range of nonphysically transformative inventions within the range of patentable subject matter.

The Article goes on to propose new standards for distinguishing patentable, useful inventions having intangible content from unpatentable intellectual and scientific discoveries. These distinguishing features are described here with the hope of influencing public debate and judicial analyses as tests for identifying patentable subject matter in intangible discoveries are clarified in judicial opinions and other legal standards.

I. The Need for New Patentable Subject Matter Standards

A. Technological Pressures

Significant changes in modes of technological design create corresponding pressures for new patentable subject matter standards. [FN11] Since the advent of computer processing of information, technological design efforts have placed new emphasis on the information-processing features of business and social practices. [FN12] Patent law *360 standards governing intangible methods of information processing are increasingly important because information-processing advances are more and more the central features of new designs for products and processes that are highly useful in business and individual activities.

Aided by increases in computing power and new information-processing schemes, companies adopting innovative business methods and communication tools such as the Internet have created the core of an evolving information-based economy. [FN13] The resulting advances in new and useful business offerings are rapidly changing our daily lives. Unlike innovations in earlier eras, however, many of the advances produced by this information-based economy do not involve new physical devices, materials, or processes. Rather, many important advances--such as most new applications of the Internet--involve intangible information-processing steps with useful consequences. [FN14]

This type of information-processing innovation contrasts with the physically transformative innovations in devices, materials, and manufacturing processes that characterized an earlier era of industrial development. While its impact is already significant, information-processing innovation seems likely to produce additional important changes over the next few years. To provide but a few examples, significant and pervasive changes are probable in such information-processing applications as computer-based record keeping and analysis, Internet-facilitated business transactions, personal computer usage, and computer-based wireless communication. The results will reshape our individual activities, our interactions with persons and communities around us, and our relationships to government officials and others who act on our behalf. In short, information-processing *361 innovation is at the heart of many of the most important changes now underway in our individual, social, business, and governmental activities.

B. Institutional Needs

Ambiguous patent law standards can lead to excessive curtailment of activities under overly broad threats of patent enforcement. [FN15] Ambiguous standards can also produce wasteful efforts to evaluate and enforce patent rights where the scope of those rights is rendered obscure by uncertain standards. As they are clarified, new patent law standards governing intangible information-processing inventions promise to be highly important in a number of administrative, judicial, and private contexts. The need for clarification and consistency of patentable subject matter assessments in each of these institutional contexts provides further pressure for the development of new patentability standards governing intangible inventions.

In an administrative context, patent applicants will look to these new standards to shape their patent claims for intangible inventions so as to include the features necessary to qualify for patents. [FN16] Patent *362 examiners at the United States Patent and Trademark Office (PTO) need new standards to ensure thoroughness and consistency as they accept or reject patent applications covering new information-processing relationships or procedures. [FN17]

Clarity concerning patentable subject matter tests for intangible inventions will also help businesses and individuals to shape and plan a variety of private actions. Businesses will consider the availability of patents on intangible innovations in determining whether to channel resources into the development of these types of innovations or into other, more productive ventures. [FN18] Individuals considering transfers of *363 patent rights concerning intangible inventions [FN19] or investments in companies holding patents on intangible inventions will apply these standards to assess the validity and value of the patents involved. [FN20] *364 Similarly, companies considering activities or products falling within particular information-processing patents will need to predict whether the patents involved will be enforceable and, therefore, an impediment to the companies' planned actions. [FN21]

Finally--and perhaps most importantly--courts called upon to enforce patents covering intangible discoveries will need clear standards to determine which, if any, portions of the patents are valid and enforceable. [FN22] These last assessments will not only determine the legitimacy of monetary and injunctive relief in the cases before the courts, they will also tend to establish persuasive interpretations of the patents involved, thereby indicating to other potential infringers the need, if any, to gain licenses to use the patented inventions or to design around those inventions to produce noninfringing substitutes. [FN23]

*365 C. Policy Goals

The policy goals underlying patentable subject matter standards also suggest a need to make changes in these standards to accommodate intangible inventions. Patentable subject matter standards have a narrow but important role in patent law. [FN24] In order to appreciate the policy goals of patentable subject matter standards, it is necessary to understand portions of the patent law context surrounding these standards.

Patentable subject matter standards are but one of several types of tests that an invention must satisfy to qualify for a patent. [FN25] Each of these tests serves a somewhat different function in identifying inventions that warrant a patent. By understanding the other tests for gaining a patent and the purposes that those other tests serve, we can identify the separate purposes to be promoted by patentable subject matter standards. Those purposes can in turn help us to define the proper scope of patentable subject matter standards as they apply to intangible inventions.

In the discussions of patentable subject matter standards throughout this Article, it is assumed for the sake of simplicity that the patentability of the intangible inventions being examined turns solely on whether or not those inventions constitute patentable subject matter. That is, all other issues regarding the patentability of the inventions are assumed, for the purposes of the discussions here, to be resolved in favor of the patentability of those inventions. However, in assessments of real patent applications concerning intangible inventions, a finding of patentable subject matter will seldom lead directly to a finding that the invention involved warrants a patent. [FN26]

Rather, even if patentable subject matter is present in a given invention, the availability of a corresponding patent will often be far from certain. Tests for patentable subject matter serve a "gatekeeper" *366 function, identifying the range of innovations for which other fundamental considerations leading to the granting or withholding of a patent need to be assessed. An innovation that includes patentable subject matter is just potentially patentable. Whether a patent on such an invention should issue still turns on other important factors including: whether the same invention has already been publicly disclosed by another party; [FN27] whether the

invention, while new, is just an obvious variation of a previously disclosed design or practice; [FN28] and whether a timely patent application has been submitted. [FN29]

Thus, for example, if a new type of business method for identifying probable customers for a particular type of business is deemed to be patentable subject matter, a patent would not automatically issue. Rather, a patent covering this business method would only be appropriate if there was no evidence of prior public use or disclosure of the method at the time it was asserted to have been invented; if the method did not seem to be a mere obvious variation of other business methods already in use at that time; and if the developer of the method submitted a timely patent application. [FN30]

In essence, recent changes involving a broader acceptance of intangible inventions as potentially patentable subject matter ensure that these types of inventions are not categorically rejected for patenting, but are instead assessed in terms of the individual characteristics of particular inventions. As one observer noted with respect to business method patents, recent case holdings "do[] not necessarily lower the standard for obtaining patents on business methods. The . . . holding[s] merely shift[] the patent inquiry away from the 35 U.S.C. ¤ 101 subject matter analysis to the novelty, utility, nonobviousness, and specification inquiries. This shift implies only that business method claims will be analyzed individually rather than collectively." [FN31]

*367 Assessments of the utility, novelty, and nonobviousness of intangible inventions and the timeliness of corresponding patent applications will require invention-specific fact finding and analysis. These newly important inquiries and analyses will, in turn, raise several types of problems that the patent system has previously avoided by excluding intangible inventions from patenting as a group. These problems include weaknesses in the patent examination system due to gaps in available records of publicly disclosed designs (commonly referred to as "prior art") that are needed to assess the novelty and nonobviousness of current intangible inventions, and a lack of training and expertise of patent examiners in computer and business methods that are relevant to many intangible inventions. [FN32] Other potential problems relate to the possibility that intangible inventions may lack clear means to measure novelty--that is, these inventions may be so ill-defined that the assessment of whether they are different from prior intangible information- processing methods may be difficult. [FN33] Similarly, the principles for assessing the scope and inventive significance of differences between prior intangible practices and a new intangible invention may be uncertain, leading to unusual difficulty in assessing the obviousness of the new invention in light of existing practices at the time of the invention. [FN34]

*368 While these types of problems are not insubstantial, some of them are clearly temporary. [FN35] As patents and other prior art documents covering intangible inventions are created with increasing frequency, gaps in prior art records will narrow. Existing prior art records will also become more easily accessible to patent examiners as growing numbers of patents for intangible inventions are examined and corresponding sources of prior art materials are identified. Standards for evaluating the novelty and nonobviousness of intangible inventions should be clarified as more and more patent applications concerning these inventions are evaluated by PTO examiners and courts. While there will be a period of uncertainty, there is no indication that these temporary problems concerning the evaluation of intangible invention patents will be any more serious than comparable problems concerning other technologies which were once thought to be unpatentable, and then were included in patentable subject matter through statutory or case law changes. [FN36]

In sum, a broad view of patentability does not automatically mean a large number of patents. [FN37] Rather, recognizing that a category of innovations constitutes patentable subject matter simply secures the opportunity for a few innovations within the category that are new, *369 nonobvious, and the subject of timely patent applications to qualify for patent protections and rewards.

The promise of patent rewards will generally encourage innovation and invention disclosures concerning patentable designs. Hence, the choice of which categories of innovations we view as patentable subject matter is essentially a choice of where we wish the powerful incentives of the patent system to have effect and to promote innovation, invention disclosures, and associated public benefits. This Article argues that the incentive tool of patent rewards should be broadly applied to achieve correspondingly broad public benefits. [FN38]

II. Sources of Patentable Subject Matter Standards

Patentable subject matter is defined through a combination of constitutional, legislative, and judicial standards. Constitutional provisions authorizing Congress to establish a patent system and associated patent rights indicate that these rights are to be limited to certain types of discoveries. [FN39] Statutory language implementing these constitutional provisions currently limits patentable subject matter to four categories of potentially patentable inventions. [FN40] However, judicial analyses have interpreted the statutory categories very broadly and have developed additional tests beyond membership in these categories for determining the presence of patentable subject matter. [FN41] Judicial analyses also have identified several types of discoveries that are unpatentable because they lack either the inventive synthesis or practical application needed for patenting. [FN42] Each of these sources of patentable subject matter standards is examined briefly in this section.

A. Constitutional Sources

1. The constitutional text

The Constitution provides that Congress shall have the power "[t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their *370 respective Writings and Discoveries." [FN43] This grant of congressional power is unusual in that it is one of the few in the Constitution that specifies the purposes and goals of the power granted. [FN44]

In order to appreciate the goals that the Framers of the Constitution sought to further through this provision, it is necessary to understand the somewhat complex linguistic structure used in this constitutional passage. This is an example of a "balanced sentence," a form of formal drafting common at the time the Constitution was written. In this form of drafting, the two components of the first portion of the passage (referring to the progress of science and the progress of useful arts) were linked to the corresponding two components of the last portion of the passage (referring to the exclusive right of authors to their respective writings and the exclusive right of inventors to their respective discoveries). The first component of the first portion of this passage (the progress of science) was related to the first component of the second portion (the protection of the exclusive right of authors to their respective writings). The second component of the first portion (the progress of useful arts) was related to the second component of the second portion (the protection of the exclusive right of inventors to

their respective discoveries). Thus, this clause authorized Congress to create an intellectual property system in which the "Progress of Science" was to be promoted through the protection of "Writings" of "Authors" and "the Progress of . . . useful Arts" was to be promoted through the protection of "Discoveries" of "Inventors." [FN45]

The "science" in this formulation did not mean natural science as we now know it, but rather "knowledge" or "learning" in a broader sense. [FN46] Hence the promotion of science through the protection of *371 works of authors meant the promotion of knowledge and learning through the granting of exclusive rights to authors providing them with temporary control over certain uses of their writings. Congress's exercise of these powers is reflected in our present day copyright statutes. [FN47]

The authorized scope of the patent system is, therefore, dependant on the other portion of this constitutional language which provides for the creation of intellectual property rights in discoveries as a means to promote the progress of the useful arts. Understanding the meaning of this last term is obviously critical to understanding the goals and congressional powers that this passage addresses. Unfortunately, the intended meaning of the useful arts to be advanced by patents remains obscure.

2. Judicial interpretations of the constitutional text

a. constitutional limits on patentable subject matter

In Graham v. John Deere Co., [FN48] the Supreme Court noted that the above constitutional language places limits on Congress's ability to grant patent rights:

> At the outset it must be remembered that the federal patent power stems from a specific constitutional provision which authorizes the Congress "To promote the Progress of . . . useful Arts. . . ." The clause is both a grant of power and a limitation. This qualified authority, unlike the power often exercised in the sixteenth and seventeenth centuries by the English Crown, is limited to the promotion of advances in the "useful arts." . . . The Congress in the exercise of the patent power may not overreach the restraints imposed by the stated constitutional purpose. [FN49]

As an example of the limiting impact of the constitutional provisions addressing patents, Congress could not authorize a patent that would withdraw access to information already in the public *372 domain. Such a patent would reduce rather than expand the range of useful knowledge presently available to the public and would therefore hinder the progress of the useful arts. As the Court noted in Graham: "[i]nnovation, advancement, and things which add to the sum of useful knowledge are inherent requisites in a patent system which by constitutional command must 'promote the Progress of . . . useful Arts.' This is the standard expressed in the Constitution and it may not be ignored." [FN50]

While the Supreme Court has not ruled directly on the point, the implication of the Court's discussion in Graham is that Congress may not rely on its patent powers to award patents that promote progress outside of the useful arts. [FN51] Even if they did promote the production or disclosure of some additional form of knowledge, patents addressing types of knowledge outside the useful arts would be unlikely to promote those arts. Such patents, like those criticized in Graham, would be invalid for failure to promote the sole constitutionally approved goal for patents.

b. from "useful arts" to "technological innovation"--shifting points of reference in judicial interpretations

For many years, courts gave little attention to the scope of the "useful arts" that patents were intended to further. New designs for physical devices and processes with practical utility were assumed to fall within the useful arts with almost no consideration of whether other discoveries might qualify as well.

When expanding technological knowledge forced courts to consider whether designs for new types of practical items and processes fell within the useful arts, several courts concluded that the term "useful arts" was an outmoded reference to knowledge about what we now call "technology." These courts interpreted the useful arts as being coextensive with the "technological arts." [FN52] This *373 approach tied assessments of patentable subject matter to current discussions among engineers and others about the nature and distinctive features of technological knowledge and innovation. [FN53] Expecting to rely on insights about technology in the engineering, scientific, and business communities, courts hoped to define the scope of patentable subject matter by defining the range of technology.

Unfortunately, the scope of technology has proven to be no easier to define than the scope of the useful arts. [FN54] While technology certainly involves artificial--that is, human-created--things or procedures, this feature does not distinguish technology from many other human creations, such as literature or music, which are useful and beneficial in our lives. As John R. Thomas noted:

> [A]rticulation of a useful typology between technology and other aspects of human culture has proven exceptionally difficult. Human engagement with the artificial has become so complete that distinguishing technological things from those that are not has perplexed not only the courts, but even epistemologists and the most accomplished of technological observers. [FN55]

While the task of identifying the distinctive features of technological knowledge is certainly complex, this Article argues that the task of defining technological knowledge need not be completed in its entirety in order to delineate the proper scope of patentable subject matter. We need not fully understand what technology is, but rather need only understand how we develop, transmit, and use technological knowledge. Since patent incentives are concerned with the growth and dissemination of useful knowledge, determining the proper subject matter scope of patent incentives and controls requires an understanding of effective steps for developing and transmitting technological knowledge and a further understanding of the means whereby patent rewards can encourage these steps.

*374 As courts that have equated technological advances with patentable subject matter have assumed, there are distinctive and functionally important differences between the development and dissemination of technological information and the acquisition and dissemination of other types of useful knowledge. [FN56] These differences--particularly differences in the purposes and means for distributing technological information--form the basis for subject matter limits on patent rights and incentives. Patentable subject matter standards limiting patents to types of inventions that are capable of being described in terms of technological information and being made available to the public through transfers of this type of information will tailor patent incentives to the full range of technological means for solving widely encountered practical problems. In short, where technological solutions can be effectively developed and disseminated, patent incentives should attach.

The distinctive features of technological information transfers and the boundaries on patentable subject matter that these features imply are examined in later sections of this Article. [FN57]

3. Commentators' reconstructions of the useful arts

Responding to the failure of federal courts to adopt consistent views in this area, a number of commentators have attempted to identify the essential features of the useful arts as they are addressed in the Constitution. [FN58]

a. useful arts as engineering techniques

To some observers, the term "useful arts" as used in the Constitution means useful techniques or crafts which are developed through engineering. [FN59] Under this view, the promotion of the useful arts through the protection of the works of inventors means the promotion of what we might now refer to as practical engineering through grants of exclusive rights to discoverers of new engineering designs or techniques. This approach emphasizes the constitutional focus on "useful" knowledge and avoids tying the beneficial impacts *375 of the patent system to any particular level of technical knowledge. Further, within this framework, the patent system is concerned with expanding the boundaries of useful engineering knowledge regardless of where those boundaries presently stand. [FN60]

While a desirable beginning, equating useful arts with engineering techniques does not provide a meaningful way to distinguish between useful engineering knowledge, which the patent system should further, and other types of useful knowledge that have some practical utility, but which the patent system was not intended to reach. This type of approach simply shifts the point of ambiguity from determining the reach of useful arts to determining the scope of engineering. A deeper understanding of the important characteristics of engineering knowledge and the ways that patent rights can increase and disseminate engineering knowledge is needed to clarify the proper boundaries of patentable subject matter and the patent system. These features are addressed at a later point in this Article. [FN61] Once these features are understood, patent rights can be limited to situations where they are likely to have a beneficial impact on the generation and dissemination of new engineering knowledge.

b. useful arts as industrial activities

Some commentators have expressed the view that the useful arts referred to in the Constitution include only industrial activities. For example, according to Alan L. Durham, "[i]t is reasonable to conclude that industry is what the Framers intended to encourage by exclusive rights and that industry is what they meant by the 'useful arts." ' [FN62]

While industrial activities were probably at the core of the activities that the patent system was intended to promote, there is no indication that the drafters of the Constitution intended the patent system to promote only industrial activities as opposed to non-industrial business activities or consumer activities. Rather, the drafters of the Constitution seem to have purposefully used broader language, directing the patent system to the promotion of the "useful arts" instead of just the "industrial arts." [FN63]

*376 Indeed, a restricted vision of the patent system that sees the only goal of the system as being the furtherance of industrial activities ignores the important role of the patent system in enhancing everyday activities in private settings and nonindustrial business contexts. Our most commonly invoked paradigm of the patentable invention--the better mousetrap [FN64]--is primarily a means to improve private rather than industrial activities. This type of improvement in nonindustrial activities was probably as much a part of the goals of the drafters of the Constitution's patent clause as was the improvement of industrial activities. Thus, while the improvement of industrial activities is an important aim of the patent system, it is not the

sole objective of that system. [FN65] Consequently, the range of patentable subject matter and activities furthered by patent incentives should not be restricted to items and practices used in industrial activities.

c. useful arts as a historical specialty

Another group of analysts has viewed the useful arts referred to in the Constitution as a craft domain defined by historical practices. This approach attempts to define the useful arts in terms of the types of industrial and mechanical arts that were present when the Constitution was drafted and the types of specialists who pursued those arts. [FN66] According to this view, drafters of the Constitution probably felt that the useful arts "embraced the so-called industrial, mechanical and manual arts of the 18th century." [FN67] To translate this range of activity *377 into today's world, commentators adopting this view would consider the types of persons involved in these eighteenth-century activities and how those persons' efforts were conducted and promoted at the time the Constitution was written. Once these are identified, current limits on patentable subject matter could be adjusted to provide the same type of assistance to comparable parties in today's engineering design fields. Overall, this approach to interpreting the patent clause of the Constitution seeks to identify the historical innovation and knowledge dissemination processes which the patent system was intended to further and to direct the patent system toward our present counterparts to these historical processes. [FN68]

Persons who practiced in the useful arts in the eighteenth century were largely manual laborers of limited education who carried out their work in accordance with specialized knowledge about how "to do practical things in practical ways to satisfy the physical needs of mankind." [FN69] These individuals accumulated and applied knowledge in the useful arts as distinguished from the "cultural arts" studied and taught in universities. [FN70] Cultural arts, which were taught and furthered through universities, included grammar, logic, arithmetic, music, painting, poetry, and drama. [FN71]

Processes for promoting the useful arts operated outside of university programs. These processes enhanced practical design knowledge through the accumulation of bodies of design information. [FN72] Bodies of design information were gathered and transferred to practitioners as means of solving specific design problems without the knowledge systemization and formal presentation that were characteristic of knowledge taught in universities. [FN73]

The interpretation that the useful arts encompass modern counterparts of these eighteenth-century activities provides us with *378 some useful guidance. It suggests that the useful arts include modern design fields that are governed at least in part by unsystematized practical knowledge rather than just the more systematized knowledge built up through scientific and mathematical discoveries. The patent system should certainly promote the discovery and disclosure of unsystematized knowledge about useful items and processes. However, delineating the useful arts as they may have existed in the eighteenth century does not provide a viable means to distinguish between types of unsystematized practical knowledge gathering that the patent system should and should not promote. The types of unsystematized, but useful information the patent system should encourage inventors to accumulate and disseminate is still left largely undefined. This is the case because the essential features distinguishing patentable advances from other useful discoveries in the eighteenth century remains uncertain, leaving us with few if any general principles to use in constructing current standards.

d. useful arts as means for physical coping

A more precise definition of the useful arts has focused on the notion that these arts are concerned with knowledge about how to organize or transform physical features of our surroundings to our practical advantage. [FN74] For example, in Alan L. Durham's view, "the real key to the most fundamental attribute of the useful arts, especially as to procedures, [is that the useful arts] all relate to controlling the forces and materials of nature and putting them to work in a practical way for utilitarian ends serving mankind's physical welfare." [FN75] In short, adherents to this view contend that the useful arts specify techniques for useful transformations of physical environments through physical items and processes. [FN76]

Under this interpretation of the useful arts, an advance falls within the useful arts if either the advance's means or ends of operation--i.e., its results--involve physical transformations. [FN77] Physically transformative means and ends are not both required. [FN78] Thus, a new *379 electronic calculator design that entails new physical means--i.e., new calculator circuits--to pursue a nonphysical end--i.e., improved calculations--is within the useful arts because it constitutes a new design for a physical tool. Similarly, an intangible data analysis practice used to evaluate temperature readings from a rubber mold and to signal when the mold should be opened at the end of a molding cycle is also within the useful arts. This sort of procedure entails non-physical means--i.e., data analysis steps--to accomplish a physical end--i.e., the opening of the rubber mold. This type of advance entails a new, improved way to use an existing physical tool, in this case a rubber mold.

In several recent cases discussed later in this Article, [FN79] federal courts have rejected the view that the useful arts--and the corresponding range of patentable inventions--are limited to physical design problems. In an age when new computer capabilities have made possible diverse types of useful information-processing discoveries, the maximum range of beneficial new inventions is probably encouraged not by limiting patents to physical designs, but rather by extending patentable subject matter and patent incentives to these new types of useful but intangible information-processing discoveries. Hence, limiting patentable subject matter to the types of physical inventions that dominated earlier eras is probably unwise.

Even if a physical transformation or structure is not a necessary feature of a patentable invention, inventions achieving physical transformations or including physical structures may provide good examples of more basic characteristics that are needed in patentable inventions. For example, an invention producing physical transformations in a surrounding environment or incorporating physical operating structures that interact in a useful way with a physical environment may have a consistency of operation and utility that should be fundamental requirements of patentable subject matter. [FN80] The presence of such regular operations and predictable utility are criteria that may be valuable in distinguishing patentable discoveries from other, less consistently valuable types of intangible creations. [FN81] I will return to the notion that regular operation and *380 consistent utility may serve as standards for patentable subject matter at a later point in this Article. [FN82]

B. Congress's Statutory Implementation

1. The statutory text

Section 101 of the Patent Act of 1952 contains Congress's most recent statutory definition of patentable subject matter (sometimes referred to as

"statutory subject matter"). [FN83] This statutory definition provides that "[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." [FN84] The "conditions and requirements of this title" referred to in this definition include requirements that a patentable invention be novel, a nonobvious advance over prior designs, the subject of a timely patent application, and described completely in the patent application. [FN85] Thus, an invention which meets the statutory definition of patentable subject matter must still meet these additional statutory tests in order for a patent to be warranted for that invention. [FN86]

2. Judicial interpretations of the statutory categories

The Supreme Court has stated that the four categories of patentable subject matter mentioned in the Patent Act--processes, machines, manufactures, and compositions of matter--describe the full range of patentable subject matter. [FN87] However, due to concern about excluding new types of useful advances from patent incentives, the Court has interpreted the four statutory categories very broadly, to the extent that these categories provide little, if any, guidance about *381 the minimum content of a patentable invention. [FN88] The Court has taken two approaches in broadening its views about the scope of the statutory categories of patentable subject matter.

In some analyses, the Court has stretched the meaning of the terms describing the statutory categories significantly beyond the common meaning of those terms. [FN89] The result is that these terms seem to impose few limits on statutory subject matter. [FN90] For example, in one case newly engineered bacteria were held to be patentable subject matter on the grounds that the bacteria constituted both new manufactures and new compositions of matter. [FN91] The bacteria were found to be "manufactures" because the bacteria were artificially constructed by human effort. [FN92] The bacteria were also found to be new "compositions of matter" because they entailed human- controlled assemblies of matter in new combinations and structures. [FN93] While these conclusions are not irrational, they certainly reflect very broadly inclusive interpretations of the statutory terms defining the categories of patentable inventions.

In other analyses of patentable subject matter, the Court has taken a second approach which treats inventions within the statutory categories as illustrations of certain fundamental features that patentable inventions must possess. [FN94] Under this approach, the key to identifying patentable inventions is not a mechanical comparison of assertedly patentable discoveries with the statutory categories, but rather a search within these discoveries for more fundamental features which must be present in patentable subject matter. [FN95] These essential *382 features which distinguish patentable subject matter from other intellectual advances have not been analyzed in depth by the Supreme Court, but have been considered more thoroughly by lower federal courts. [FN96] The analyses of lower federal courts in this area are discussed in the next subsection of this Article. Despite its failure to undertake its own analyses of the necessary invention features defining the boundaries of patentable subject matter, the Supreme Court has suggested that these boundaries should be broadly construed. [FN97] According to the Court, a broadly inclusive view of patentable subject matter is appropriate because "Congress intended statutory subject matter to 'include anything under the sun that is made by man." ' [FN98]

C. Judicial Tests for Patentable Subject Matter

Taking its cue from the Supreme Court's refusal to look exclusively to the statutory categories in identifying patentable subject matter, the Court of Appeals for the Federal Circuit has on several occasions turned away from the statutory categories and instead considered whether particular inventions had certain essential characteristics needed in patentable subject matter. [FN99] Specifically, the Federal Circuit court has looked to whether inventions are defined in specific terms and produce results with practical utility. [FN100] As the court explained in State Street Bank & Trust Co. v. Signature Financial Group, Inc.: [FN101]

*383 The question of whether a [patent] claim encompasses statutory subject matter should not focus on which of the four categories of subject matter a claim is directed to--process, machine, manufacture, or composition of matter--but rather on the essential characteristics of the subject matter, in particular, its practical utility. [FN102]

Using this approach, in In re Alappat, [FN103] the court held that a new device is patentable subject matter if it constitutes a specific machine that produces a useful, concrete, and tangible result. [FN104] The Federal Circuit's current standards indicate that "the essential characteristics and practical utility of [a claimed invention] are more important than determination of which category the claims are directed to. Therefore, the primary criterion for meeting patentability under ¤ 101 is that the invention must product [sic] a useful, concrete, and tangible result." [FN105]

While the Federal Circuit's recent decisions seem to diminish the importance of the terminology used in the Patent Act to describe the categories of patentable subject matter, [FN106] these decisions do not as yet provide a clear image of the "specific" features and "useful, concrete, and tangible results" that a process or device must have in order to constitute patentable subject matter. A later portion of this Article proposes a systematic approach for identifying the necessary features of patentable subject matter. [FN107] Greater clarity concerning these features will be useful in guiding patent applicants and shaping future federal court decisions in this area.

D. Special Doctrines Limiting Patentable Subject Matter

Separate from the generally applicable tests federal courts have used for identifying patentable subject matter, these courts have also developed a number of narrowly focused doctrines that limit the scope of patentable subject matter. [FN108] These doctrines focus on specific *384 types of discoveries that are excluded from patentable subject matter. [FN109] The doctrines define essentially negative tests for patentability, precluding a given discovery from obtaining a patent if it falls within one of the doctrines. [FN110]

Limiting doctrines of this sort have been developed on a variety of grounds. [FN111] Most of these limiting doctrines are aimed at keeping specific types of discoveries freely available to the public by ensuring that patent controls will not limit public access to those discoveries. [FN112] The most commonly applied patent-limiting doctrines have dealt with mathematical and information-processing algorithms, scientific discoveries, naturally occurring items, mental steps, and printed matter. [FN113] These limiting doctrines are described briefly in this section with emphasis on how the doctrines may relate to the patentability of intangible inventions.

1. Algorithms

Algorithms--sequences of steps for handling information, usually to solve a particular type of information analysis problem [FN114]--are *385

unpatentable of themselves. [FN115] Courts have derived this rule from several policies underlying patent law. [FN116]

First, the treatment of algorithms is informed by the basic notion that abstract ideas should not be patentable because such ideas are not practical applications of themselves and thus do not achieve the type of practical utility that the patent system was designed to further. [FN117] An algorithm, before it is applied to solve a particular practical problem, is simply an idea about the relationship between input and output information--that is, about the analytic steps that will transform the input information into the output information. [FN118] The mathematical calculations or information-processing steps--divorced from any application in which they may have direct practical importance--are too devoid of societal benefit to warrant patent rewards. Until they are linked to a practical context, they lack the type of useful results that patent laws are designed to further. To ensure that patent enforcement costs--including costs due to restrictions on public access to discoveries and transaction costs of patent enforcement--are incurred only where society has received useful benefits from patented inventions, patentable subject matter is restricted to applied, useful inventions rather than just abstract ideas that may lead to such inventions. [FN119]

Mathematical formulas or definitions of mathematical relationships are also unpatentable under this same rule. [FN120] These are but specialized means for describing information relationships, indicating how information of one form--i.e., that on one side of a *386 mathematical equals sign--can be reliably transformed into another form--the information on the other side of the equals sign. [FN121]

Second, as an additional basis for withholding patents from newly discovered algorithms, courts have recognized the need to keep unapplied algorithms freely available for use in later intellectual and engineering activities. [FN122] Such basic truths or expressions of these truths are excluded from patentability, in part, because they comprise "the basic tools of scientific and technological work" which are too important to technological progress to be allowed to be controlled by one party. [FN123]

Third, potentially important, but as yet unapplied algorithms are also excluded from patentability to ensure that the lure of patent rewards encourages inventors to combine these algorithms with practical implementation details to produce applications based on the algorithms. [FN124] Withholding patent rights until an algorithm is translated into a practical application encourages the completion of the inventive process to the point of specifying this sort of application. As noted by leading patent commentator Donald Chisum:

> Theoretical or abstract discoveries are excluded [from patentable subject matter] as are discoveries, however practical and useful, in nontechnological arts, such as the liberal arts, the social sciences, theoretical mathematics, and business and management methodology. This focus on technology explains the preoccupation of patent law with means. A patent can issue only for a new means of achieving a useful end or result. Those who articulate new problems or recognize new needs frequently make valuable contributions to society but cannot look to the patent system for reward unless they go on to find a new and specific process, machine, manufacture, or composition of matter that solves the problem or meets the need. [FN125]

The difficulty with the judicial doctrines excluding algorithms and other abstract ideas from patentability lies in determining when an abstract, unpatentable discovery is coupled with sufficient practical *387 implementation details to create a useful, patentable invention. [FN126] In some design settings, specialized information handling algorithms may lead to practical applications with little application design effort beyond the

specification or discovery of the algorithms. [FN127] In these situations, discovery of the algorithms will be tantamount to discovery of the application. Granting a patent for such an algorithm-based invention may appear to give patent rewards for the discovery of the abstract information-handling algorithm that made the invention possible.

Until recently, federal courts assessed the patentability of algorithm-based discoveries under what was called the Freeman-Walter test for patentable subject matter. [FN128] This special test was developed to identify patentable subject matter in advances that were based in part on new information-processing methods. [FN129] This standard arose out of the efforts by lower courts to understand and give force to the Supreme Court's decision in Gottschalk v. Benson. [FN130] In Benson, the Supreme Court unanimously held that a new information-processing method for translating one form of numerical representation data into another was not patentable subject matter. [FN131] Unfortunately, the Court gave a somewhat incoherent explanation of its holding, noting that the claimed invention involved a "mathematical algorithm" and that the issuance of the patent sought would improperly preempt usage of that algorithm. [FN132]

Because the Court provided very little guidance about how to identify software advances that incorporated algorithms in the manner found objectionable under Benson, the Benson decision created serious problems for lower federal courts as they reviewed software-based patents and other patents addressing information-processing *388 advances. [FN133] The Court of Customs and Patent Appeals (C.C.P.A.) responded by fashioning a software patentability standard that was consistent with the Benson decision, but which (at least in theory) applied special patentability standards only to a narrow range of software advances. [FN134] The C.C.P.A.'s aim was to specify special patentability tests only for the specific types of algorithm-based advances which were of concern in Benson, leaving further types of software-based inventions subject to the regular patentability standards applied to other sorts of technological advances. [FN135] The result was the Freeman-Walter test for software patentability, a special patentable subject matter test for software advances involving applications of mathematical algorithms. [FN136]

The Freeman-Walter test was comprised of two parts. [FN137] The first part of the Freeman-Walter test examined whether an invention involved an application of a mathematical algorithm. [FN138] If so, the *389 second part determined whether granting patent restrictions on the use of that invention would preempt all use of the algorithm. [FN139] If the answer to either question was no, the Freeman-Walter test indicated that the invention was patentable subject matter and that a patent should issue if other tests for patentability (e.g., novelty, non-obviousness, etc.) were met. [FN140]

The second part of the Freeman-Walter test was deemed not to be satisfied (meaning that the invention under review involved patentable subject matter) if the claimed invention used a mathematical algorithm to calculate or determine information that was relied on in some further fashion to redefine the structure of the invention. [FN141] That is, the second step of the Freeman-Walter test was interpreted in a way that found patentable subject matter in an algorithm-based invention if information processing in accordance with the algorithm was used in some functionally significant way to redefine the physical attributes or operations of the invention. [FN142]

The two parts of the Freeman-Walter test served different functions. The first part served as a screening test for determining if the detailed analyses of the second step were necessary. [FN143] These further analyses were needed if a claimed advance involved the type of invention which raised special concerns in Benson--i.e., an advance based on a mathematical algorithm. [FN144]

*390 The second part constituted the heart of the standard. It assessed whether a mathematical algorithm recited in a patent claim was described as no more than a disembodied calculation or was rather described in combination with other invention elements in such a way that the algorithm had functional significance. [FN145] This was the case if information processing in accordance with the algorithm was used to dictate structural features or operational restrictions incorporated in the invention. [FN146] In essence, this second step in the Freeman-Walter test examined whether the patent claim addressed a practical application of a mathematical algorithm because information processing was being used to define some useful or desirable feature of the claimed invention. To resolve this question, courts were forced to consider ways in which abstract information-processing procedures could be translated into useful advances. [FN147]

As will be discussed below, the overall Freeman-Walter test has been rejected in recent court decisions. [FN148] However, current patentable subject matter standards still turn on whether assertedly patentable advances produce certain types of practically useful results. [FN149] The second portion of the Freeman-Walter test may still be helpful in evaluating the practical contents of information-processing based inventions. This portion of the Freeman-Walter test, focusing on the elements needed in a practical application beyond just an information-processing algorithm, may be useful in interpreting advances based on information-processing methods and in identifying those advances with sufficient practical features to constitute patentable subject matter.

During the years they used the Freeman-Walter test, courts often applied the test unevenly. There were several reasons why the Freeman-Walter test was difficult to apply consistently. First, courts adopted varying notions of what constituted a "mathematical algorithm" for purposes of the first part of the test. [FN150] Where a narrow *391 view of mathematical algorithms was applied, inventions were easily found not to involve algorithms and, hence, to be outside the special patentability limitations imposed by the Freeman-Walter test. [FN151] By adopting narrow interpretations of the first "gatekeeper" step of the Freeman-Walter test, courts supporting broad views of software patentability had a means to find patentable subject matter in many software patent applications. [FN152] However, no clear test for identifying algorithm-based software was ever developed, and detailed analyses under the second part of the Freeman-Walter test were undertaken haphazardly. [FN153]

Courts also varied widely in their views about the types of patent claims that would preempt the use of a mathematical algorithm and thereby render the claims improper under the second part of the Freeman-Walter test. [FN154] Courts generally agreed that patent claims directed towards the use of algorithms in narrowly defined contexts would not preempt all use of the same algorithms. [FN155] For example, *392 patents which only claimed control over the use of an information-processing algorithm to achieve a particular physical result or a particular restriction on the operation of a device or process were viewed as being addressed to patentable subject matter because these patents could be enforced without constraining all use of the algorithm involved. [FN156] Because they would not impose the broad preemption of algorithm use that was of concern in Benson, these sorts of narrowly drafted claims linking the use of an algorithm to specified physical results or effects were held to describe patentable subject matter under the second portion of the Freeman-Walter test. [FN157] Unfortunately, this is where the agreement of most courts ended. There was little agreement on how limitations on algorithm use should be framed to claim patentable subject matter in an information-processing advance having no physical results or impacts. [FN158]

Some progress was made in identifying types of information-processing patent claims that were not sufficient--i.e., that did not state patentable subject matter. These negative rules regarding patentable subject matter mostly arose out of controversies involving software-based inventions. [FN159] Certain types of physical invention features included in patent claims were deemed not to be sufficiently limiting and were simply ignored in analyses of those claims. For example, a field of use restriction on the employment of a mathematical algorithm--that is, a limitation of the use of an algorithm to analyses in a particular field such as geology or acoustics--was deemed to be an insufficient restriction to narrow the claimed use of the algorithm to patentable subject matter. [FN160] Likewise, restrictions requiring the use of an algorithm in conjunction with a specific data input or output method were deemed to be insubstantial limitations that would not restrict algorithm-based patent claims to a *393 particular application or physical setting. [FN161] Hence, these types of restrictions in patent claims covering software implementations of new algorithms were not deemed to be sufficiently narrow and specific to define patentable software applications under the Freeman-Walter test. [FN162] However, the nature of claim restrictions that would be sufficiently narrow under the test was never completely resolved, resulting in inconsistent patterns of holdings that particular claims did or did not preempt the use of software-implemented mathematical algorithms. [FN163]

Finally, in State Street Bank & Trust Co., [FN164] the Federal Circuit court explicitly rejected the Freeman-Walter standard as a test for identifying patentable subject matter in information-processing inventions. The court explained this rejection as follows:

> After Diehr[[FN165]] and Chakrabarty,[[FN166]] the Freeman-Walter-Abele test has little, if any, applicability to determining the presence of statutory subject matter. As we pointed out in Alappat,[[FN167]] application of the test could be misleading, because a process, machine, manufacture, or composition of matter employing a law of nature, natural phenomenon, or abstract idea is patentable subject matter even though a law of nature, natural phenomenon, or *394 abstract idea would not, by itself, be entitled to such protection. The test determines the presence of, for example, an algorithm. Under Benson, this may have been a sufficient indicium of nonstatutory subject matter. However, after Diehr and Alappat, the mere fact that a claimed invention involves inputting numbers, calculating numbers, outputting numbers, and storing numbers, in and of itself, would not render it nonstatutory subject matter, unless, of course, its operation does not produce a "useful, concrete and tangible result." After all, as we have repeatedly stated,
>
> every step-by-step process, be it electronic or chemical or mechanical, involves an algorithm in the broad sense of the term. Since ¤ 101 expressly includes processes as a category of inventions which may be patented and ¤ 100(b) further defines the word "process" as meaning "process, art or method, and includes a new use of a known process, machine, manufacture, composition of matter, or material," it follows that it is no ground for holding a claim is directed to nonstatutory subject matter to say it includes or is directed to an algorithm. This is why the proscription against patenting has been limited to mathematical algorithms. . . . [FN168]

However, even after its rejection of the overall Freeman-Walter test, the Federal Circuit court has indicated that the presence of patentable subject matter in a claimed invention turns on functional operations and results that distinguish the invention from a discovery of abstract knowledge. [FN169] The analyses of the structural implications of mathematical algorithms that courts formerly used as part of their evaluations of the second step of the Freeman-Walter test may continue to be helpful in current inquiries regarding

patentable subject matter. Types of inventions that were considered to have sufficiently important structural interactions to establish patentable subject matter under the second step of the Freeman-Walter test will probably also be *395 seen as having sufficiently functional and structurally implemented features to constitute applications with useful, concrete and tangible results. [FN170] With these sorts of results, the inventions will be patentable subject matter under current standards. [FN171]

For example, the Federal Circuit court's analysis of the second step of the Freeman-Walter test in Arrhythmia Research Technology, Inc. v. Corazonix Corp. [FN172] provides a good illustration of how similar analyses may proceed under current standards. Portions of the patent at issue in that case covered a method for analyzing electrocardiographic signals to provide information about certain human heart conditions and a computer apparatus for implementing the method. [FN173]

Addressing the claimed method, the court assumed that the method involved a mathematical algorithm. [FN174] The court went on to apply the second step of the Freeman-Walter test and found a sufficient application of the mathematical algorithm to establish patentable subject matter in the overall method. [FN175] The court explained that the claimed invention entailed "'converting', 'applying', 'determining', and 'comparing' . . . steps that transform[ed] one physical, electrical signal into another." [FN176] The resulting signal defined an output that "[was] not an abstract number, but [was] a signal related to the patient's heart activity." [FN177] In short, the court held that a new type of information processing used to produce data with practical significance was patentable subject matter. [FN178]

The court also found statutory subject matter in the claimed apparatus because the mathematical features of the claimed apparatus design were used to program the computer involved in a new way. [FN179] The apparatus claims "define[d] 'a combination of interrelated means' for performing specified functions. . . . The computer-performed *396 operations transform[ed] a particular input signal to a different output signal, in accordance with the internal structure of the computer as configured by electronic instructions." [FN180]

These two portions of the court's analysis indicate how a new, intangible information-processing method may be used to create patentable subject matter under current standards. First, as with the method successfully claimed in Arrhythmia, an analytic method will be patentable subject matter if the method is used to evaluate data or information with physical significance or relevance, giving the result a further physical significance and practical utility. [FN181] Second, a new analytic approach can be used to direct and organize the programming of a computer. [FN182] Used this way, the new method of information processing defines a new sequence or structure of analytic steps performed by the computer and, with this new manner of operation, a potentially patentable new machine design.

This analysis clarifies how a single information-processing advance may produce two types of patentable subject matter: a patentable process for using the new advance to produce physically significant data-processing results and a patentable device in the form of a general purpose computer specially configured to process data in accordance with the new advance but not necessarily applied to any particular physical task.

The analysis in Arrhythmia suggests a general framework for recognizing patentable subject matter in intangible inventions. Patentable subject matter should be found where intangible rules or relationships are used to analyze physically significant information (with or without a computer) or to define equivalent information-processing steps undertaken by a computer or other information-processing device. Applied across a variety of application domains, these two types of intangible but patentable advances may include a

wide range of computer-processing and information-processing applications. The breadth of patentable information-processing advances that this standard encompasses suggests there may be a correspondingly broad role for patents in promoting computer software innovations and in controlling subsequent computer applications.

*397 These and other impacts of the approach used in Arrhythmia will be revisited in later portions of this Article describing a proposed standard for identifying patentable subject matter in intangible inventions. [FN183] Ultimately, the proper test for patentable subject matter in intangible inventions must include an articulated principle for balancing the patent controls given to inventors as rewards for applying intangible information-processing algorithms to specific tasks and the public's interest in unrestricted access to information-processing algorithms that can be used beneficially in many applied contexts.

2. Scientific discoveries

Scientific discoveries are unpatentable. [FN184] This is true even for scientific discoveries of fundamental importance such as Einstein's famous discovery that energy and mass adhere to the relationship described by the formula E=MC2. [FN185] Scientific discoveries such as this may be descriptions of widely encountered natural phenomena or relationships between such phenomena, but they are not useful, practically significant knowledge of themselves. [FN186] Whatever their descriptive importance, these discoveries lack the immediate practical benefit to society required of a patentable invention.

Of course, the addition of practical implementation details to newly discovered scientific knowledge can produce a patentable invention. [FN187] Courts have long recognized that "[w]hile a scientific truth, or the mathematical expression of it, is not [a] patentable invention, a novel and useful structure created with the aid of knowledge of scientific truth may be." [FN188]

The difficulty in distinguishing raw, unpatentable scientific discoveries from further patentable applications of those discoveries is similar to the problem surrounding the patenting of information-processing inventions. For both scientific discoveries and information-processing methods, it is difficult to define in general terms the types of practical elements that will bring a new discovery *398 out of the abstract realm into the domain of a practical application. These minimum application elements are the focus of later discussions in this Article. [FN189]

3. Naturally occurring items

Plants, animals and processes occurring in nature are not patentable even when they are newly discovered and brought to public attention. [FN190] The reason for this is that the discovery of these preexisting items does not involve the development and specification of any artificial, human-created construct of the sort that the patent system is designed to encourage and reward. [FN191] In short, a person who goes into a natural setting and brings to public knowledge a preexisting plant or animal has made the wrong sort of discovery for patenting. Such a person has provided the public with a better description of a preexisting item, but the person has not constructed a new item of the sort that courts will treat as an "invention." [FN192] Absent such an invention, there is nothing to patent. The practical effect of this rule is that no person can use the patent system to control the propagation or replication of naturally occurring plants, animals, and processes, even ones that are recently discovered.

However, the patent system does support controls over newly developed uses of plants or animals. [FN193] Such a new use may be developed in conjunction with the discovery of a plant or animal in nature. If a person develops a new use for a previously unknown plant or animal, this new use may be patentable as an invented process. [FN194] If *399 a patent issues for the new process, the patent will control the use of the plant or animal in the specified way, but will not limit other uses of the plant or animal. [FN195] Similar protection may be obtained for newly developed uses of plants or animals where the plants or animals involved have been publicly known for some time. [FN196] This type of patent protection will be available so long as the new use is not merely an obvious extension or modification of the previously known uses of the plant or animal. [FN197]

In addition, the patent system will protect certain modified forms of previously known animals or plants. [FN198] At least two types of modifications of preexisting plants and animals have qualified for patent protections. One sort of patentable material is produced by the purification or isolation of naturally occurring materials to produce forms of those materials that did not occur in nature. [FN199] The presence of new functionality in newly isolated or purified materials is often sufficient evidence that the materials are patentable subject matter. [FN200]

A second type of modification of naturally occurring materials that can produce patentable subject matter involves the use of preexisting animals or plants to produce genetically modified versions. [FN201] The plants or animals that result from these genetic engineering processes did not previously exist in nature and are therefore patentable subject matter, at least where they can be shown to be useful. [FN202] Here, the newly engineered animal or plant is an original life form with genetic differences from its predecessors. These changes in genetic composition and interior features constitute the structural differences needed to make these genetically engineered plants and animals patentable subject matter. [FN203]

*400 Cases resolving questions about the patentability of modified forms of naturally occurring items tend to focus on the extent of physical differences between the modified items and their naturally occurring counterparts and the functional significance of those differences. [FN204] Because they emphasize physical differences as means to distinguish patentable, modified life forms from unpatentable, naturally occurring items, the analyses in these cases provide few insights into how courts should evaluate the intangible features that are needed to establish patentable subject matter in intangible inventions.

4. Mental steps

Analytic processes or other information-processing methods are unpatentable if they involve no more than a series of mental steps or information-processing steps that could be implemented through mental processes. [FN205] Federal courts have accepted this rule--commonly referred to as the "mental steps doctrine"--for many years. [FN206] The scope of the mental steps doctrine was considered in detail in In re Prater. [FN207] In Prater, the Court of Customs and Patent Appeals (C.C.P.A.) described the mental steps doctrine as a narrow rule that only precludes patents which interfere with the free use of mental processes. [FN208] Seen this way, the mental steps doctrine only affects the patentability of information-processing sequences standing alone. That is, the mental steps doctrine applies only if patent protection is sought for an information-processing sequence such that a mental process incorporating the same information-processing sequence would fall within the patent and be restricted. [FN209]

Several explanations have been offered for the mental steps doctrine. One concern addressed by the mental steps doctrine is that mental activities and associated human communication, *401 understanding, and creativity should not be limited by patent constraints. [FN210] The mental steps doctrine ensures that mental steps, standing alone, cannot infringe a patent because patents purporting to cover such processes are void and unenforceable. [FN211] This view of the mental steps doctrine suggests that the doctrine may apply to some patents purporting to cover information-processing methods that could be implemented by either mental steps or computer processing since these patents could conceivably restrict mental processes. However, the best means to avoid a conflict between these sorts of patents on information- processing advances and free pursuit of mental activity may be to adopt patent infringement standards that treat all mental activities as noninfringing per se. [FN212] This approach would retain patent limitations on computer applications and other electronic implementations of patented information-processing inventions, but would leave mental steps of all types free from patent limitations. This adjustment of infringement standards is a preferable means of protecting mental processes from patent interference in comparison with the more drastic method of excluding information processes from patentable subject matter generally through a broad application of the mental steps doctrine.

A second view is that discoveries of disembodied processes such as mental steps are unpatentable because sequences of mental steps (and equivalent information processing accomplished in machines rather than mental processes) lack the physical manipulations or results that are required in a patentable invention. [FN213] For example, in *402 Ex parte Read, [FN214] the Patent Office Board of Patent Appeals relied on the mental steps doctrine in rejecting a patent covering a method of determining the speed or distance traveled by an aircraft. [FN215] The Board concluded that a patentable method was not present because the claims at issue failed to describe "any true manipulative steps, except the moving of one scale relative to the other." [FN216] The act of reading an instrument was seen as "purely a mental act that can not be regarded as a true manipulative step." [FN217]

The continued validity of this rationale for the mental steps doctrine is doubtful in light of recent judicial decisions holding that physical manipulations or results are not required in patentable inventions. [FN218] A process such as the one at issue in Read, which is essentially an information-processing method once the process's inconsequential physical elements are stripped away and ignored, will constitute patentable subject matter under present standards because the information being processed corresponds to a particular external object being measured or analyzed. For example, in State Street Bank & Trust Co., [FN219] the Federal Circuit court found patentable subject matter in a disembodied process involving the manipulation of information about the dollar amounts of deposits in financial accounts. [FN220] Even though the means involved in this manipulation of information (computer processing through circuits and signals having unspecified physical structures) [FN221] and the immediate ends (computer records with unspecified structures) were intangible, [FN222] patentable subject matter was present because the invention involved practical, useful results--i.e., accounting results useful in the control of funds. [FN223] *403 In light of this type of holding, the impact of the mental steps doctrine may be limited to abstract analyses of information having no direct linkage to a particular practical application. The presence or absence of physical manipulations or results no longer seems indicative of patentable subject matter.

A third explanation of the mental steps doctrine may have greater current validity. Rejections of patents involving mental steps may reflect concerns

over the imprecision or irreproducibility of discretionary components of claimed inventions. [FN224] Under this view, processes involving certain mental steps are unpatentable because, although they produce practical results, they do so through partially specified exercises of individual judgment or decision making. [FN225] "A patent may not properly issue for a method dependent upon the aesthetic, emotional, or normative reactions of a human actor." [FN226] When applied this way to render unpatentable certain discoveries which turn on imperfectly reproducible discretion or judgment, the mental steps doctrine serves to ensure that patent restrictions generally attach only to inventions involving transferable, widely replicable utility.

As will be discussed at a later point in this Article, replicable utility is probably an essential feature of patentable subject matter generally. [FN227] If the mental steps doctrine is viewed as an indirect means to limit patented inventions to advances involving regularly operative, objectively defined features and replicable utility, then this doctrine points towards a valuable and important threshold feature of patentable subject matter in both intangible inventions and other types of advances.

5. Printed matter

Expressive content recorded in printed matter--and, by analogy, expressive content preserved in any other recording material--generally is not patentable. [FN228] Printed matter that does no more than *404 record text is not patentable because, although it may record new, useful information or otherwise convey useful or desirable contents, the printed matter does not serve a functional role except as an information recording medium. [FN229] This role is not innovative even though the recorded contents may change. [FN230] While specific words or means of communication used in new printed matter may gain some protection against copying under copyright laws, [FN231] the process of printing information to record or convey it involves no new functional structures and activities and, hence, no patentable invention. In short, where new content is recorded in printed matter, no patentable invention is created because the novelty and utility of the newly created printed matter rest in features other than the structure or functional attributes of the entity created. [FN232]

*405 This general rule regarding the unpatentability of printed matter is subject to an important exception covering functionally significant printed materials. [FN233] This exception recognizes that some printed or recorded materials contain both functionally significant structures and recorded information. [FN234] The involvement of functionally significant structures in these materials makes them patentable subject matter. [FN235] As one leading commentator explains:

> "[P]rinted matter" by itself does not constitute a "manufacture" and is not within the statutory classes of patentable subject matter. As an exception to this rule, printed matter may constitute an element of a patentable claim if the claim involves a new and useful feature of physical structure or a new and useful relation between the printed matter and the physical structure. The courts admit that the line between the rule and the exception is frequently difficult to draw. [FN236]

In considering what sorts of functional features will lift printed matter innovations into the category of patentable advances, courts focused on a number of relationships between the physical features of printed works and the functional features of those works. [FN237] The rule that has emerged from these judicial analyses is that if the shape or form of printed material or the location of matter printed on it has functional implications in enhancing or limiting the use of the material, then a sufficient functional structure for patenting is present in the printed matter. [FN238]

The roots of this rule extend back many years. For example, in Benjamin Menu Card Co. v. Rand, McNally & Co., [FN239] decided in 1894, a district court considered the patentability of a "combined *406 menu and meal check" which was developed to prevent fraud by railroad employees in dining car operations. [FN240] Prior to the development of the new checks, the practice was to sell meal tickets for dining car meals in book form with a check for the waiter, one for the cook and one for the conductor. [FN241] The three copies would be turned into the company to prevent an employee from reselling a ticket and pocketing the proceeds. [FN242] However, employees could still accomplish fraudulent sales if all three types of employees worked in collusion. [FN243] The newly developed menu scheme required further participation by the customer in the fraud since the detachment of the checks "mutilated" the menu and made it "useless for another guest." [FN244]

The district court in this case held that the combined menu and meal ticket was patentable despite the fact that this invention involved a specialized form of printed matter. [FN245] The court found a sufficient functional structure in these materials due to the functional implications of the mutilation of the materials in their intended use. [FN246] The presence of printed matter on the menus and meal tickets, in addition to their functionally significant structure, did not detract from the patentability of the combination. As the court noted, "[t]he fact that the structure may be of cardboard with printed matter upon it does not exclude the device from patentability . . . ." [FN247]

A similar analysis was applied in Cincinnati Traction Co. v. Pope. [FN248] The patent at issue in this case covered a new type of transfer ticket for street railways. [FN249] The new ticket was designed to reduce a particular type of fraudulent practice plaguing the railways. [FN250] Prior to the adoption of the new ticket, conductors issued a transfer to a morning passenger and punched an afternoon time, thereby allowing *407 the customer to use the transfer instead of paying a return fare. [FN251] The new ticket contained a detachable coupon. [FN252] A "morning" transfer was issued with the coupon detached; an "afternoon" transfer was issued with the coupon attached. [FN253] The Court of Appeals for the Sixth Circuit found this ticket design to be patentable subject matter because of the functional implications of the ticket's distinctive physical structure. [FN254] The court explained its reasoning as follows:

> The device of the patent clearly involves physical structure. The claims themselves are, in a proper sense, limited to such structure. . . . [T]he alleged patentable novelty does not reside in the arrangement of the printed text, nor does such text constitute merely a printed agreement . . . . The specifications do not confine the construction to either the style, or printed arrangement or language of the legends. [FN255]

In In re Lowry, [FN256] the Court of Appeals for the Federal Circuit considered the impact of the printed matter doctrine on an intangible data-recording invention. [FN257] The patent application involved in this case covered a novel data structure for storing, using, and managing information in a computer memory. [FN258] The United States Patent and Trademark Office (PTO) sought to reject this patent application, in part because the application covered patterns of data storage in a computer memory. [FN259] The PTO argued that such data storage innovations were equivalent to unpatentable recordings of information in printed matter. [FN260] Consequently, in the PTO's view, the claimed data storage patterns should be treated as unpatentable information recordings rather than functionally significant innovations. [FN261]

Rejecting this analogy, the Court of Appeals for the Federal Circuit found the printed matter doctrine inapplicable because the claimed data structure had functional implications in improving the *408 operation of computers in

which the structure was used. [FN262] The court explained its conclusion as follows:

[T]he data structures [claimed by Lowry are not] analogous to printed matter. Lowry's [data structures] do not represent merely underlying data in a database. [These structures] contain both information used by application programs and information regarding their physical interrelationships within a memory. Lowry's claims dictate how application programs manage information. Thus, Lowry's claims define functional characteristics of the memory.

Contrary to the PTO's assertion, Lowry does not claim merely the information content of a memory. Lowry's data structures, while including data resident in a database, depend only functionally on information content. While the information content affects the exact sequence of bits stored in accordance with Lowry's data structures, the claims require specific electronic structural elements which impart a physical organization on the information stored in memory. . . .

Indeed, Lowry does not seek to patent the [claimed] data model in the abstract. Nor does he seek to patent the content of information resident in a database. Rather, [his] data structures impose a physical organization on the data.

In Lowry's invention, the stored data adopt no physical "structure" per se. Rather, the stored data exist as a collection of bits having information about relationships between the [data elements]. Yet this is the essence of electronic structure. In Bernhart, this court's predecessor noted:

There is one further rationale used by both the board and the examiner, namely, that the provision of new signals to be stored by the computer does not make it a new machine, i.e . it is structurally the same, no matter how new, useful and unobvious the result. . . . To this question we say that if a machine is programmed in a *409 certain new and unobvious way, it is physically different from the machine without that program; its memory elements are differently arranged. The fact that these physical changes are invisible to the eye should not tempt us to conclude that the machine has not been changed.

More than mere abstraction, the data structures are specific electrical or magnetic structural elements in a memory. According to Lowry, the data structures provide tangible benefits: data stored in accordance with the claimed data structures are more easily accessed, stored, and erased. Lowry further notes that, unlike prior art data structures, [his] data structures simultaneously represent complex data accurately and enable powerful nested operations. [FN263]

Lowry is important because the court's analysis indicates how an intangible invention can possess sufficient structure and linkage to an outside physical context to be patentable. [FN264] The court recognized that the invention held patentable in Lowry was a specification of intangible data formats. [FN265] However, the court saw that the arrangement of those formats implied a functional consequence in the improved operation of computers programmed to handle data in the new formats. [FN266] This operational impact was sufficient to establish that the data formats were functionally significant electronic structures, rather than just recordings of information. [FN267]

Lowry adopts the view that an intangible invention comprises patentable subject matter where the invention includes information formats, relationships, or sequences of relationships which are functionally significant of themselves regardless of the particular information content that is stored or processed with those formats, relationships, or sequences of relationships. [FN268] Put another way, the features of the intangible invention produce functional advantages *410 which disappear if the same data is recorded in a different format. This indicates that the claimed format

has a functional significance that can be separated from its data recording contents.

Taken out of the computer context of Lowry, a separately identifiable functionality that exists independent of the value of the information being processed may be an essential attribute of all patentable information-processing inventions. The mere fact that an intangible process addresses information about an important subject matter does not produce a patentable invention unless the process achieves some new efficiency or effectiveness in handling that information. [FN269] This new efficiency or effectiveness separates useful information-processing techniques from mere data recording methods.

In sum, the court's analysis in Lowry and the patent case law on printed matter generally suggest that to be patentable an information- processing procedure should achieve an element of practical benefit or utility above and beyond the utility of the input information used in the procedure. [FN270] The presence of identifiable, incremental utility in a specific physical context where the procedure is used indicates that an intangible invention has the proper utility for patenting. [FN271] This rule, drawn from the concerns and case law surrounding the printed matter doctrine, will form an important part of the standard for patentable subject matter in intangible inventions developed later in this Article.

E. The PTO's Examination Guidelines

Although they are primarily directed to computer-related inventions, the PTO's Examination Guidelines for Computer-Related Inventions [FN272] (Guidelines) outline the PTO's views concerning the minimum features of patentable subject matter generally. [FN273] Portions of the Guidelines describe the characteristics that distinguish computer-related processes constituting patentable subject matter from *411 unpatentable computer implementations of unapplied information-processing sequences. [FN274] In describing these distinguishing characteristics in the context of computer-related processes, the PTO reveals what it considers to be the generally applicable tests for patentable subject matter under present case law. The PTO's evaluation of the minimum features of patentable subject matter in computer-related processes is as follows:

> A [patent] claim that requires one or more acts to be performed defines a process. However, not all processes are statutory under ¤ 101. To be statutory, a claimed computer-related process must either: (1) [r]esult in a physical transformation outside the computer for which a practical application in the technological arts is either disclosed in the specification or would have been known to a skilled artisan . . . or (2) be limited by the language in the claim to [a] practical application within the technological arts . . . . The claimed practical application must be a further limitation upon the claimed subject matter if the process is confined to the internal operations of the computer. If a physical transformation occurs outside the computer, it is not necessary to claim the practical application. A disclosure that permits a skilled artisan to *412 practice the claimed invention, i.e., to put it to a practical use, is sufficient. On the other hand, it is necessary to claim the practical application if there is no physical transformation or if the process merely manipulates concepts or converts one set of numbers into another. [FN275]

The patentable subject matter standards that the PTO is applying to computer-related processes can be derived from this discussion. These standards treat a physical transformation achieved under information-processing control as sufficient but not necessary to establish patentable subject matter. [FN276] The standards also specify that some information-processing based advances lacking physical transformations may constitute

patentable subject matter if the advances entail practical applications in the technological arts and the patent rights sought in connection with the advances are limited in the corresponding patent claims to specified practical applications. [FN277] This last requirement means that resulting patents will only restrict the information-processing methods described in the patents when used in the applications specified in the patent claims or in closely equivalent applications. [FN278] Unfortunately, the Guidelines do not describe the minimum features of a practical application of computer-implemented information-processing methods, nor do they specify what will bring an application within the "technological arts."

The PTO's standards concerning physically manipulative inventions based on new information-processing methods are consistent with prior court opinions that have considered physically transformative features to be evidence of patentable subject matter. [FN279] *413 However, the Guidelines are seriously deficient in their failure to provide more detailed standards for determining when patentable subject matter is present in computer-related advances lacking manipulations or transformations of physical items. Aside from noting the need for a stated application in the technological arts, [FN280] the Guidelines provide little useful instruction to examiners about how to assess patentable subject matter in the important types of information- processing advances that are the focus of this Article. Hence, these Guidelines, like the case law on which they are based, fail to state clear principles or criteria for distinguishing patentable and unpatentable advances in information processing. The remainder of this Article is aimed at defining these needed principles and criteria, beginning with an evaluation of the characteristics of technological knowledge and knowledge-transfer mechanisms and then shaping proposed patentable subject matter standards for furthering the development and dissemination of technological knowledge.

III. The Essential Features of Technology in an Information Age

Like many judicial analyses before them, the PTO's Guidelines adopt a patentable subject matter test which turns in part on whether a discovery concerns an application within the technological arts. [FN281] Under this test, the scope of technology and the technological arts stake out the outer boundaries of patentable subject matter. [FN282] To understand these boundaries, then, it is necessary to understand the scope of technology and the means--that is, the arts--used to apply technology to useful designs and tasks.

*414 This section examines the distinctive features of technology and the technological arts as they relate to the patent system. The section begins with a review of features which a variety of commentators have seen as distinguishing technological knowledge from other types of knowledge. The section also examines the inadequacies of some particular definitions of technology and offers suggestions for avoiding similar deficiencies in our standards for patentable subject matter.

A. Distinctive Features of the Technological Arts

1. Practical content

Technological knowledge is distinguishable from other types of information or knowledge in that technological knowledge is directed at furthering practical activities. Technology concerns "bodies of skills, knowledge, and procedures for making, using, and doing useful things." [FN283] An element of technological knowledge will typically involve specifications for a

device, material, or procedure that can be used to complete part or all of a practical task. In accomplishing this task, the device, material, or procedure will have a corresponding functionality that can be invoked again and again in a predictable fashion. [FN284] Users of the item or practice will be able to adopt it as a useful implement or tool with predictable functional characteristics, without necessarily appreciating the technological knowledge that went into the development or production of the implement or tool.

While a new physical tool such as a new type of hammer is a good example of technological innovation and design, [FN285] it is important not to read too much into such examples. As efforts to improve information-processing techniques have increased, broader *415 notions of technological innovation have emerged. [FN286] These broader visions of technology treat certain information-processing techniques as useful "tools" much like their physical counterparts. [FN287] Technological advances now encompass not only new designs for physical items like new wrenches and drills, but also new designs for intangible yet predictably useful information-processing methods. This broader notion of technological design is a response to the recognition that a wide range of useful discoveries--including many new methods for computer processing of useful information--can have the same sorts of reusable, useful characteristics present in new physical tool designs. Hence, when considering new physical tools as examples of technological design, it is helpful to remember the reusability and usefulness of these tools and to forget the specific physical characteristics of the tools that account for these features.

2. Artificial structure

A second important characteristic of technology is that it entails an artificial structure imposed by human effort on an item or process to increase the usefulness of that item or process. A wide range of specific items-- including materials, machines, and processes--can be artificially assembled, shaped, or arranged to create the necessary structure. Sometimes the combinations of elements that are ordered in accordance with technological knowledge may be quite complex. However, complexity is not the key, artificial--that is, human created--content is. Some artificial device elements or processing steps applied to achieve a practical effect or advantage must be present in every technological design. [FN288] Activities based on technological knowledge involve the "application of scientific and other knowledge to practical tasks by ordered systems that involve people and organizations, living things and machines." [FN289]

Entirely new items or processes need not be present in a technological advance. Several types of artificial structures can be added to or imposed upon preexisting materials, devices, or practices *416 to achieve practical results. [FN290] Functionally important new structures can be created by arranging new combinations of old elements, establishing new relationships between previously combined elements, or creating new sequences of relationships between previously related elements. Sometimes new technological designs involve innovations in several of these types of artificial structures. For example, a new radio circuit design might involve assembling some previously used radio parts in new locations on a circuit board (thereby establishing new relationships between previously combined elements), and might also include some electronic components previously used in other electronic devices but not previously used in radio designs (thereby producing a new combination of old elements).

Artificially created structures of these sorts distinguish technological products from their component parts. [FN291] Technological innovation

involves the accumulation of knowledge about these artificially created structures, including how to implement the structures and their functional capabilities and limitations. [FN292]

Patent laws encourage inventors to develop and disclose artificial structures for useful items or practices by withholding patent rewards until functionally complete versions of these structures are understood by the inventors and clearly described in patent applications. [FN293] Short of this level of understanding and disclosure, the type of partial design information that a patent applicant is able to give to the public is not the sort of useful knowledge that merits a patent reward. Consequently, disclosure demands of the patent laws encourage inventors both to finish their development of complete artificial structures for new inventions and to describe those structures thoroughly in related patent applications. [FN294]

*417 3. Knowledge indexing or organization

A third distinguishing characteristic of technological knowledge is that it is typically described and organized in relation to particular practical problems or applications. [FN295] A given technological discovery usually produces its full societal value, not from a single application in a single instantiation of a device or procedure, but rather from the discovery's repeated application as problems that the discovery can address are encountered. [FN296] This repeated application of technological discoveries can be best accomplished through the organization, usage, retrieval, and indexing of technological knowledge, not in terms of the means by which the technology works, but rather in terms of the context in which it works. [FN297]

I refer to this as a method of "indexing" technological information because the essential point is that a given type of technological information must be known to relate to a given practical problem in order for that knowledge to be applied regularly to solve the problem and for the full measure of societal benefit to be gained from the knowledge. Put another way, technological knowledge that is overlooked when a problem that the knowledge could solve is presented is little different than the absence of such knowledge. Technological knowledge is valuable for what it can do. Hence, the value of that knowledge turns on both its immediate usefulness when applied and the frequency with which it is applied. Effectively indexing technological knowledge to ensure that it is located and applied when related problems are encountered can be highly *418 important in increasing the total societal gain from a technological discovery. With such indexing and application, the practical value of an element of technological knowledge can often be realized again and again.

B. Avoiding Overly Narrow Definitions of the Technological Arts

Several commentators have advocated narrow definitions of technology and the technological arts. [FN298] This section describes these narrow views of technology and argues that many of the limitations or restrictions contained in these definitions are unwise. These limitations and restrictions are criticized to explain why similar limitations and restrictions should not be incorporated in patentable subject matter standards.

1. Limiting technology to systematically applied science and engineering

One commonly articulated view limits technology to systematically applied science and engineering. For example, Jacob Bigelow, in an 1831 text, [FN299] described technology as involving "the principles, processes, and nomenclatures of the more conspicuous arts, particularly those which involve applications of science." [FN300] The Patent Office used a similar

definition of technology in a 1996 publication, defining it as "the 'application of science and engineering to the development of machines and procedures in order to enhance or improve human conditions, or at least to improve human efficiency in some respect." ' [FN301] Both of these definitions imply that technological discoveries result from the systematic, rational application of preexisting scientific or engineering principles to the solution of practical problems.

While technological knowledge certainly encompasses practical knowledge derived from the application of well-understood scientific *419 or engineering principles to practical problems, it is not limited to knowledge that is gained in this manner. The view that technology is the product of the systematic application of scientific or engineering principles is overly restrictive in that it fails to address situations in which luck or nonsystematic engineering know-how leads to useful technological advances. These advances are not products of preexisting endeavors or knowledge since the principles underlying the advances are not fully understood when the advances are made. Nonetheless, these sorts of partially understood, but practically useful advances are undeniably technological in nature. As summarized by one commentator:

> Although some of the theoretical tools for engineering design derive from science, many do not and some are even problematic to the scientific community. In particular, the set of idealized artifacts, technical skills and pragmatic considerations indigenous to engineering practice have little place in scientific endeavors. Technology is much more than applied scientific knowledge, but is itself a distinct form of knowledge. [FN302]

Because a wider range of practical products and procedures are brought to consumers, society has benefited from the development of engineering and practical design disciplines which do not depend on or wait for the prior development of underlying scientific or engineering understanding. The functional attributes and advantages of a technological advance may be specified by an inventor and used to benefit society without the inventor having gained an understanding of the advance's inner workings in scientific terms. "[I]t would be ridiculous to suppose that invention has to wait humbly, cap in hand, for science to open the door before it can proceed. Technology is purposive and it tends . . . to be positivist. The criterion is simply, does it work?" [FN303]

*420 2. Limiting technology to systematic physical manipulations

Additional commentators have asserted that physical manipulations or transformations of the states of items are the distinguishing features of technological advances. [FN304] According to Robert E. McGinn, technology involves "material product-making or object-transforming activity." [FN305] V. Gordon Childe has advocated a similar definition, observing that "[t]echnology should mean the study of those activities, directed to the satisfaction of human needs, which produce alterations in the material world." [FN306] Under this sort of definition, technological knowledge concerns the

> production or transformation of artifacts; interaction with the external environment; systematic manipulation of physical forces; and the presence of design. Technological activities expend resources and knowledge in order to fabricate or modify products, or to develop procedural systems for so doing . . . . [T]echnology presents a form of rational and systematic knowledge, oriented towards efficiency and capable of being assessed through objective criteria. [FN307]

The difficulty with this view of technology is that it ignores many present fields of design in which highly useful innovations--particularly innovations

in computer-based information handling--are intangible. Like their physical counterparts, the innovations emerging from these new design fields achieve practical utility in a predictable way such that numerous users can employ the innovations as tools. Repeatable data handling steps in these innovations have predictable and reliable utility like the utility found in physical tools. Given this important functional similarity allowing data-processing advances to be used as tools like their physical counterparts, standards which require physical characteristics in technological advances would artificially separate intangible information-processing tools from earlier physical implements and processes.

*421 While discoveries involving new or improved physical items and physical process steps have been and will continue to be important types of technological innovations, in our present era information-processing improvements are often the focus of complex, costly design and popularization efforts that are similar to the comparable efforts used to develop and distribute physical advances. [FN308] Advances in information processing can be implemented with as much or more utility and public advantage as earlier physical advances. Given that these information-processing advances have the critical features of earlier physical technology--utility, repeatably delivered to solve practical problems--intangible information-processing improvements should be considered to be technological advances on a par with earlier physical advances.

To ignore this equivalency and exclude intangible advances from our notions of technology is to tie our definitions of technology to outdated expectations about the future. Once, most new, practical tools were physical in nature, involving either physical inner workings or physical results. It was reasonable in this environment to expect that future developments would be along the same lines and to define technological development of artificial, useful tools as a purely physical domain of discovery and design.

However, the advent of widespread computer usage and the corresponding proliferation of computer-mediated information processing has changed the essential nature of innovation in our time. In many practical engineering contexts, new information is the design goal, and new intangible processes to produce the new information are the design result. [FN309] Both the means and ends of this type of design are intangible. If we are to free our notions of technology from the boundaries of past patterns of technological knowledge and innovation, we must avoid notions of technology that require physical contents or transformations. Technology, as an inherently changing, expanding domain of knowledge and practice, should not be so historically--and, one is tempted to say, physically--bound.

*422 3. Limiting technology to physical accommodations

Additional commentators have argued that technological advances are limited to innovations that have a specific physical relationship to the surroundings in which the innovations are used. For example, according to John R. Thomas, "technology may be characterized as knowledge that is applied towards material enterprise, guided by an orientation to the external environment and the necessity of design." [FN310] Technology analyst Paul W. DeVore agrees, noting that "[t]hinking in technology is problem specific and environmentally specific, concerned with efficiency and the relationship of elements in the behavior of a total system." [FN311] To DeVore, acclimation of a practical activity to a physical environment is a characteristic trait of technology: "[T]echnological knowledge is knowledge generated through activities involved in creating adaptive systems as opposed to knowledge used to create ideological and/or social systems." [FN312]

While recognizing that many technological advances involve useful physical links between the advances and their surroundings, these definitions emphasizing the need for a physical "fit" between a technological advance and an external environment seem to mix and muddle two thoughts.

First, these definitions may be based on the restrictive view that technology includes only physically useful structures that interact favorably with external environments. This is but a narrower version of the physical transformation based definition of technology previously addressed in this Article. [FN313] Under the narrower physical accommodation standard, a technological innovation must not only involve physical elements or produce physical transformations, but those elements or transformations must interact with some further physical features of a surrounding environment to achieve useful results. [FN314] This sort of additional requirement of a physical interaction with a surrounding environment takes us further and further away from recognizing purely intangible advances as technological *423 innovations. If an information-processing advance can provide desirable results to users without manipulating or interacting with a physical context, there seems little reason to interpret the information-processing advance as a nontechnological discovery merely because it lacks external physical impacts. Both intangible and tangible advances can sometimes provide users with dependable, reusable utility. If this kind of utility is present, both the intangible and tangible advances should be considered technological regardless of the presence of incidental features, such as physical components affecting external environments.

Demanding physical interactions with external environments as essential features of technological advances would exclude a broad range of useful but intangible discoveries from our notions of technological advances. For example, a variety of seismic data analysis schemes that use sophisticated mathematical evaluations of seismic signals to produce valuable insights into the presence and scope of underground oil deposits would be viewed as nontechnological under this standard. [FN315] No physical steps or implements are involved in these evaluations, and the analytic techniques in question do not require any physical interactions with the geologic conditions they characterize. [FN316] The exclusion of these techniques from the range of technological advances seems particularly artificial in that these information-processing advances substitute for more physical means of oil exploration--such as the drilling of test wells--which can produce similar information through physical interactions that would make the physical methods unquestionably technological.

Definitions of technology focusing on the role of technological innovations in aiding our interactions with physical environments may relate to a second, more valuable distinction between technological innovations and other creative works. As will be discussed at a later point in this Article, [FN317] technological advances generally operate in regular, predictable ways to produce predictable results. Innovations that produce practically significant results by manipulating, measuring, or interpreting physical surroundings are good examples of advances with the types of predictable operating outcomes and utility *424 that are characteristic of technological innovations. Hence, physically manipulative advances are good examples of technological advances, but do not exhaust the range of those advances. Innovations for coping with physical environments are not the only advances with predictable operating features, [FN318] but they do provide us with means to study and understand the types of predictable features that are generally present in technological advances.

In particular, innovations for achieving physical accommodations or coping with physical environments provide good examples of the sorts of predictable utility that generally distinguish technological advances from other,

essentially aesthetic creations. [FN319] Nontechnological expressive advances (e.g., a new CD recording of a singer's performance) will tend to have subjective, relatively unpredictable utility, while technological advances (e.g., a new CD recording of computer software that is capable of regulating a communications network or measuring physical features of the network) will have predictable operating features producing predictable utility. The types of relationships between intangible information-processing advances and physical surroundings or environments which produce predictable utility and warrant treatment of the advances as technological innovations will be examined at a later point in this Article. [FN320]

IV. Reconstructing Patentability Standards for an Era of Intangible Inventions

Patentable subject matter standards are difficult to define because future innovations are hard to predict. Modes of technological innovation are peculiarly fluid and unpredictable. [FN321] Patents are concerned with presently unknown discoveries that are substantially different than present technology. [FN322] Types of devices and processes *425 which can be thoroughly described either because they presently exist or because they involve small, predictably successful variations from items that presently exist are, by definition, not patentable under our present standards. [FN323] Only the new and nonobvious discovery--i.e., the sort of discovery that is difficult to predict and describe in advance--will qualify for a patent. [FN324]

Perhaps because of the inherent difficulty of including as yet unknown technologies in a forward-looking definition of patentable subject matter, the patentable subject matter standards imposed by courts and recommended by commentators frequently have been *426 overly tied to old technologies. [FN325] These standards have incorporated patentable subject matter boundaries based on what technology has been, rather than what it may be. Patents and patentable subject matter standards should be primarily concerned with the latter--the development of as yet unknown technological domains and design approaches. Patentable subject matter standards that describe the types of innovations to be influenced by patent incentives should avoid limitations that place useful items or processes based on fundamentally new types of design or operating principles outside of the patent system. Definitions of patentable subject matter that are overly tied to historical modes of innovation may exclude and fail to encourage new dimensions of advances reflecting the latest design approaches and technological insights. [FN326]

Concern over possible legal blindness to evolving types of innovation in useful devices and practices suggests two desirable features of patentable subject matter standards. First, these standards should be broadly inclusive and forward-looking in the types of innovations that they recognize as patentable subject matter. As innovation moves into new domains of engineering--such as new designs for communication technology or bioengineering--notions of patentable subject matter should be general enough to attach patent incentives even though the modes and results of the new design processes are very different than those involved in earlier engineering of physical implements and physical processes.

Second, while being sufficiently general to include new modes of technological design, patentable subject matter tests must still be articulated in terms of objective standards that courts, the PTO, patent applicants, and potential patent infringers can apply consistently. The *427 need for forward-looking yet objective standards suggests that patentable subject matter tests should be framed in terms of objective descriptions of

design discoveries which are capable of furthering the social utility enhancing goals of the patent system. Patentable subject matter should include innovations that are capable of being described to the public and popularized as useful artifacts, regardless of the technological means used to implement the innovations. This approach focuses on the knowledge accumulation and communication circumstances needed for the patent system to operate successfully, while divorcing patentable subject matter standards from ties to any particular technology or set of technologies.

The remainder of this section will attempt to develop patentable subject matter standards that meet these two criteria of forward-looking generality and objective content. It will begin with an assessment of the patent system's impact on agency processes in which innovators serve as problem-solving agents of product and process users. Based on this agency framework, the analysis proceeds to specify the circumstances in which patent rights and incentives can promote the development and dissemination of useful innovations. Finally, these circumstances are used to define the essential features of patentable subject matter in standards that can be used as legal tests for patentable subject matter in both tangible and intangible inventions.

A. An Agency Framework for Patentability Standards

While courts typically analyze patent rights as specialized forms of property rights that attach to intellectual designs for useful objects and processes, [FN327] the functional impacts of patent rights are perhaps better understood if those rights are considered as parts of broader agency processes. In general, an agency process is one in which one party (the agent) undertakes actions on behalf of, and for the benefit of, another (the principal). [FN328] An agency framework is useful in *428 interpreting inventive processes and related patent incentives because inventors are, at bottom, agents of invention users. Inventors typically do not innovate for themselves; rather, they serve as agents of other product and process users. [FN329]

Agency processes are considered here as a variety of multiparty social conduct, not just as the focus of a set of substantive legal standards sometimes referred to as "agency law." [FN330] The agency processes studied here are varieties of behavior, while agency law is one of several bodies of law that assist the participants in certain agency processes in defining associated duties and liabilities.

Typically, agency law applies only where one individual has consented to serve another through direct agreement with the benefited party. [FN331] Agency law supplies default terms fleshing out the legal consequences of this sort of agreement. [FN332] For example, one important consequence of a party's agreement to serve as the agent of another is that the agent takes on fiduciary duties with respect to the benefited party in carrying out agency tasks. [FN333]

Agency processes in the behavioral sense can be created and bolstered through a variety of legal measures other than agency laws. Contract terms are often more important than agency laws in defining the duties of agents and related rights to compensation upon the completion of actions by agents. [FN334] Agency laws provide gap fillers where contractual definitions of agents' and principals' legal relationships are incomplete. [FN335] In addition, agency laws also define the potential liabilities of principals and agents to outsiders injured by activities conducted through agency processes. [FN336] In this respect, *429 agency laws describe the legal responsibilities of agents and principals to individuals threatened by agency conduct who are not identifiable at the time agency contracts are formed or who, although identifiable, are simply not part of the negotiations leading to those

contracts and are unable to protect their interests through corresponding contract terms. [FN337]

This Article argues that patent laws should be seen as a further type of legal standard encouraging and facilitating desirable forms of agency behavior. The agency conduct promoted by patent standards involves inventive exploration and development activities undertaken by innovators on behalf of invention users. [FN338] Patent laws establish agency relationships between invention users with functional needs and innovators willing to fill those needs. By properly defining patentable subject matters and thereby targeting patent incentives, the formation and completion of innovative agency relationships between innovators and innovation users can be encouraged. The public will benefit from these relationships through increased access to the new and useful inventions the relationships will produce.

This Article aims to evaluate the functional characteristics of agency relationships used to accomplish technological innovation and to assess how patent rights can encourage the formation and successful completion of those agency relationships.

The needs of potential product and process users define the scope of innovative agency processes. These needs define the functional parameters that successful innovations must meet. These parameters, in turn, define the nature of a successful product or process development effort by an innovative agent.

Innovative processes are agency processes because they generally involve actions by inventors acting as agents on behalf of potential product or process users to satisfy these users' needs. By embarking on their inventive efforts, innovators undertake to act as agents of product and process users in clarifying the practical needs of those users and in filling those needs through newly designed inventions. Innovators successfully carry out their agency roles by developing and delivering to users products or practices with greater functionality--or at least different functionality--than previously available substitutes.

*430 Patent laws create a framework that enables the formation and efficient execution of these sorts of innovative agency arrangements. By doing so, patent laws help potential users of products and processes to gain the assistance of innovative agents to solve practical problems that would otherwise stymie the users. At the same time, patent laws create incentives that encourage innovators to act as innovative agents for broad classes of potential invention users, and to apply inventive resources in proportion to the total benefits that targeted inventions are expected to achieve for broad classes of persons. Because they are in effect working for broad classes of parties, inventors can justify expenditures of development resources that would not be warranted if the inventors were acting only for themselves. With this multi-user perspective on the proper costs of research, innovator-agents working for user groups can produce a wider range of innovations than if the innovators were working for themselves or a single principal.

Patent laws can encourage the formation of innovative agency relationships through several means. As will be described in more detail below, patent rights encourage innovators to assist product and process users in translating these users' functional desires into more soluble product and process design problems. [FN339] In this respect, patent incentives encourage innovators to help define the desired functional features of successful innovations and, correspondingly, the criteria of successful design efforts by innovative agents. Second, patent rights encourage innovators to value various design alternatives in terms of the utility that those designs achieve for entire classes of users, thereby establishing an incentive scheme which ties the interests of innovator-agents to the interests of classes of user-principals. [FN340] Finally, minimum content

requirements for patent applications encourage innovators to continue their design and development efforts until their innovations operate with clear utility and to describe the innovations in published patents with sufficient completeness and clarity that readers of the patents can both evaluate and replicate the innovations. [FN341] This level of invention description in publicly available patents aids potential users--or companies serving those users--in monitoring the utility and merit of inventions.

*431 To secure these benefits of innovative agency processes, patent laws should attach to innovative efforts--and patentable subject matter should be recognized--where the promise of patent rights to innovators will encourage the formation and completion of innovative agency relationships. This section describes the patentable subject matter tests suggested by this approach. The analysis here proceeds in three steps. First, the essential elements of successful agency relationships are described. Second, the potential impacts of patent rights in furthering the creation of innovative agency relationships are explored in detail. Third, the types of innovations which can be furthered through patent-influenced agency relationships are examined. A test for patentable subject matter is then proposed which recognizes such subject matter in all innovations that are susceptible to creation and popularization though agency processes.

B. Requirements for Effective Agency Processes

To better understand the role of patent rights in promoting innovation through agency processes, it is first important to understand the essential components of agency relationships generally. Based on an understanding of these components, we can then consider the impacts that patent rights and incentives may have in creating and strengthening innovative agency relationships.

An agency relationship typically possesses three essential features: (1) standards defining the actions which a principal desires an agent to undertake, (2) means to encourage the agent to undertake those actions, [FN342] and (3) means to monitor steps undertaken by the agent to determine if the desired actions have been completed. [FN343] Typically, these elements are interrelated. For example, statements of desired actions by agents and criteria for granting rewards to agents are often linked. [FN344] An agent is often promised rewards that are contingent upon the completion of the tasks desired by the agent's principal, thereby giving the agent a personal stake in the completion of the tasks targeted by the principal. [FN345] Similarly, monitoring of agent activities and the delivery of agent rewards are often linked. [FN346] *432 That is, a principal will often monitor an agent's activities to determine if the tasks desired by the principal have been undertaken and if the rewards promised for completion of those tasks should be delivered. [FN347]

Agency relationships are present in many day-to-day activities. For example, a simple agency relationship is formed when a child agrees to mow a neighbor's lawn. The child might come to the neighbor's door and offer to mow the lawn in exchange for a payment of $10, with payment to be made when the task is completed. If the neighbor agrees, an agency relationship is formed, as well as a related payment contract. The payment contract--much like the patent rights of interest here--supports the agency relationship, but is only a part of a broader picture.

This mowing arrangement has all of the essential features of an agency relationship just described. The child (the agent) agrees to act on behalf of the neighbor (the principal) to undertake a task that the latter wishes to complete. The scope of the desired actions is simple and well defined--the mowing of the lawn. The means of encouraging the agent to undertake these actions and to tie his or her efforts to the interests of the principal are

that the promised payment is held back until the agent's tasks are successfully completed--i.e., until the child successfully completes the mowing. Finally, the means of monitoring the completion of the agency tasks is also simple--the neighbor can simply inspect his or her lawn and withhold payment to the child until the mowing is complete. This scenario provides a simple but complete example of how agency processes and supporting legal arrangements (in this case, a compensation contract) arise frequently in day-to-day activities.

While principals sometimes provide agents with detailed specifications of desired actions, this is not always the case. In settings where agents have greater expertise than the principals they serve, the principals may only have broad, ill-defined goals which the agents must interpret and flesh out. [FN348] In these settings, agents must use their expertise to both define and satisfy the goals of their principals. [FN349]

*433 For example, in a doctor-patient relationship, a doctor is the agent of his or her patient for purposes of improving or maintaining the health of the patient. This general goal defines the scope of the agency relationship between a doctor and patient. However, in acting as the agent of a patient, a doctor must often clarify further detailed goals of the doctor-patient relationship. A doctor does this by determining what sorts of treatment a patient needs. Once these needs are determined, steps carrying out the indicated treatment become detailed goals of the doctor-patient relationship. In assisting with a patient's treatment, a doctor shifts from goal defining to goal satisfying. In both activities the doctor is an agent of the patient-principal.

Similarly, the agency relationships between product and process user-principals and innovator-agents may involve substantial discretion on the part of the innovators in defining the design goals of the agency relationship and the means of achieving them. Businesses or individuals reveal broadly defined functional needs--perhaps by buying products that presently fill those needs or by undertaking activities that imply the needs in a publicly disclosed way. However, these parties may not specify or care how those functional needs are filled. These partially defined, but publicly revealed needs define the goals of innovative agency relationships. Innovators, acting as agents of the parties with the needs, seek to clarify the detailed characteristics of those needs and to create new means to fill the needs. In these settings, the needs of innovation-users define the broad contours of successful innovations and successful invention development efforts by innovator-agents. However, in specifying the details of design problems as well as in producing solutions, innovator-agents have substantial control over the end products of innovation and the means for producing those products through innovative agency relationships.

C. Features of Patent Law Furthering Innovative Agency Processes

1. Defining agency goals

Potential invention users and inventors each define portions of the goals of innovative agency relationships. Patent rights can play an important role in aligning the perspective of users and inventors in the goal-setting process. In their efforts to clarify user needs and to identify available technologies for filling those needs, innovators can be strongly motivated by potential patent rights to keep in mind the *434 needs and desires of potential invention users. By defining contingent property interests with values that vary in accordance with the values of the new functionality provided to invention users, patent rights encourage inventors to evaluate the functional needs of invention users and to translate these needs into

invention design projects. [FN350] The promise of patent rewards that are scaled in value to user benefits achieved through new innovations cause innovators to keep the interests of invention users in mind in defining both the procedures and ends of innovation projects.

Potential invention users define the essential functional characteristics of new inventions. [FN351] They do so through ongoing behaviors or activities which describe or imply functional tasks that the users wish to accomplish and deem valuable. [FN352] Existing business or individual activities that indicate the need to complete some functional task may serve as direct evidence of desired functionality. Desired functionality can also be determined indirectly from the features of existing devices or processes that can be improved or replaced by other devices or processes based on different technologies. [FN353] For example, a procedure for assembling a particular device by hand may reflect certain essential assembly steps. These essential steps will define the functional characteristics which any machine assembling the same item must also possess. In essence, the prior hand-assembly version of this process--coupled with the economic value of the assembly process and the implied willingness of companies using the process to pay for a better way of accomplishing the same item assembly at a lower cost--implicitly signals to innovators the scope and potential value of a process improvement task that may warrant inventive efforts. [FN354]

An innovator may become aware of a desire for innovation in this type of device assembly through several means. First, an innovator may be a company or industry insider and be aware of some frequently repeated task that is susceptible to machine automation if a *435 suitable device can be developed. [FN355] Second, an innovator or her company may have been involved in the design of similar devices and maintain ongoing contacts with the industry where these earlier devices are used. [FN356] These ongoing contacts may indicate the need for improvements or additional devices to serve the same customer base. Third, the innovator may be an expert concerning a particular technology and seek to identify new uses for the technology. [FN357] A systematic search for user needs that the technology might satisfy may identify potential applications for the technology if the innovator has sufficient insight to see relationships between the functional characteristics of the technology and the functional needs of individuals or businesses.

Through whatever means the needs of potential invention users are communicated, an innovator who is aware of needs for a new type of invention may still have to define the key features that are desired in the invention before any meaningful inventive work can be done. For example, in the device assembly context previously described, an inventor might need to study the process used for hand assembly of the device to identify the essential subassembly steps as well as the key characteristics of the component parts and assembled products. These characteristics of the component parts and assembled products define the outside parameters within which the innovator's invention must work. That is, a successful invention in this context must take the same input components and produce the same results.

The innovator may also gain additional insights by evaluating the practices of the persons currently undertaking the hand assembly process. These practices constitute one set of complete and successful assembly steps that might be replicated in machine-operating steps. [FN358] Furthermore, past hand assembly practices may reveal stages in the assembly process involving fragile component features or critical alignment situations. The same features and situations may need to be taken into account in designing a machine that will complete the same assembly task. [FN359] Overall, these sorts of factual assessments of past versions of the assembly process help to define the desirable *436 characteristics of a machine that will perform the

needed assembly task. [FN360] From the better understanding of the desired machine she gains, the innovator can go on to define the specific invention design goals that the innovator-agent will need to meet to produce a successful invention.

The invention design criteria produced in this way are developed by the innovator with the benefit of his or her particular technological expertise and perspective. Indeed, innovators with different technical backgrounds may approach the same user need differently, focusing on different subcomponents of the functionality needed or on different means of providing that functionality. Based on these different perspectives, multiple innovators may work in a single application area yet produce very different inventions. These different inventions may fill a particular type of user need through different technologies or different operating methods.

2. Aligning interests

a. alignment concerning design functionality

Patent laws help to ensure that innovators are attentive to the functional needs of invention users and that the innovators invest the analytic effort necessary to translate these user needs into technological design goals within the particular technological specialties of the innovators. [FN361] Patent laws achieve this by promising rewards to innovators that are approximately equal in value to the value of the increased functionality that the innovators' discoveries provide to users. [FN362]

*437 The opportunity to gain rewards scaled in this way to the value of an invention to users derives directly from a patent holder's ability to control the making, use, and sale of a patented invention. [FN363] Using the example described above, if a new machine design is able to cut assembly costs from $1.00 per unit to $.20 per unit, a rational business person would pay a royalty of up to $.80 per unit (assuming no other costs were involved) to use the new machine. So long as the user's cost in adopting the machine is less than $.80 per unit, the manufacturer is better off with the machine than without it. Hence, the patent holder will be able to charge a royalty and gain a reward for the invention that is approximately equal to the user's gains from the invention. Of course, actual royalties will probably be somewhat less than the full value gained by invention users due to transaction costs and the need to give users an incentive, in the form of some retained portion of the gain, to shift from using previous alternatives to using the new invention. However, even taking these additional factors into account, available patent royalties and rewards should closely track the user value realized through a new invention, thereby giving inventors substantial reasons to pursue this type of value in shaping innovative efforts.

Under this method of valuing inventions, the more incremental value over past practices that an invention provides, the more a patent holder can expect to charge for use of the invention. This link between the value provided to users and patent value effectively aligns the economic interests of innovators to those of invention users. Since innovators will understand from the outset of their inventive efforts that users of their inventions will pay royalties [FN364] which depend on the *438 incremental value users receive from those inventions, inventors' notions about the desirable features of new designs--including both performance characteristics and operating costs--will conform to the perspectives and economic interests of potential invention users. [FN365]

b. alignment concerning design approaches

The alignment of the interests of invention creators and users through the promise of patent rights influences not only the invention designs that innovators produce, but also the design approaches that are given serious attention by innovators. [FN366] Few innovators will waste time on design approaches that either achieve less desirable results than preexisting substitutes or that achieve better results than those substitutes but at a significantly greater cost. Rather, the emphasis in defining invention design goals and related interim design steps and problems to be solved is on minimizing the costs of implementing and operating inventions and maximizing the value of invention functionality. [FN367] Innovators often contribute substantially to the diagnosis of the key features of a successful product or process design and in doing so play key roles in defining the remaining design tasks desired of them as innovative agents. [FN368] However, in identifying *439 design targets within the context of promised patent rights, the innovators assume the perspective and interests of their user-principals. Hence, the design criteria that emerge are the same sorts that the user-principals would articulate if they had the technological expertise of the innovators involved.

c. alignment concerning design procedures

In addition to influencing the substance of innovative designs, patent rights also affect the nature of the innovative procedures undertaken to realize those designs. The direction and scope of invention design efforts are beneficially tied to the interests of invention users through the contingent promise of patent rights. [FN369] Because the interests of innovators and invention users are aligned, an innovator will tend to seek an optimal balance of inventive effort costs and related improvements in invention functionality. [FN370] In this regard, the incentives to innovators afforded by patent rights avoid wasteful innovation efforts and produce innovations with greater net gains to society after innovation costs are taken into account. [FN371]

Patent rights give innovators a stake in producing useful innovations at the lowest possible cost. [FN372] The innovator's potential gain from a patented invention does not equal the full amount of patent royalties the innovator charges for access to the new invention, or the full amount of profits from sales of the patented item or service, but rather equals the net gain after innovation costs are subtracted from these royalties or profits. [FN373] Because their opportunities to gain *440 decrease as innovation costs increase, innovators are encouraged to avoid unnecessary innovation costs. [FN374] In addition, as their work progresses, innovators have a personal financial stake in maintaining a reasonable balance between the resources allocated to additional innovative efforts and the increased invention functionality and value that are likely to result from the further efforts. [FN375]

In maintaining this balance between resource allocation and likely results, an innovator typically will not consider just the value that an invention under development will achieve for a particular user, but rather will tend to take into account the full extent of increased value the invention will realize for all users of the invention. [FN376] This means that an innovator will be able to justify and complete innovation efforts that are of benefit to a group of users, but that would not be worthwhile for the innovator, or any single user, to undertake based on the increased functional value the targeted innovation is expected to achieve for any particular user. In this respect, innovators are not only effective agents of invention users, but

they are also efficient cost spreaders, allocating the cost of innovation efforts across multiple invention users and royalty-charging opportunities.

By causing innovators to adopt the perspective of an entire group of invention users, patent incentives achieve two important benefits at the group level. First, these incentives ensure that inventive resources are applied at efficient levels by measuring the cost-effectiveness of using additional resources to develop each aspect of the innovation in light of its functional gains to the entire group of invention users. If an additional inventive effort would be likely to produce net benefits to the overall set of users of a patentable invention, that effort will be *441 encouraged by patent rights. However, inventive efforts that seem unlikely to produce a net gain for users, even taking into account the interests of the full user group, will not be encouraged. Even with the payment opportunities implied by patent rights, an innovator will not realize any profit from these excessive and inefficient development efforts.

In addition, giving innovators (and their financial backers) incentives to invest in inventive efforts at the resource levels justified by benefits to the full set of users of the inventions will lead to substantially funded and quickly conducted development efforts to produce new products and services as new technical advances imply the potential success of these development efforts. Because inventive programs are conducted at levels justified by the potential benefits to all users of the resulting products rather than at the lesser resource levels justified by the possible benefits to a few users, successful inventive programs tend to be pursued more aggressively and quickly than if only the needs of a few users were driving these programs. The increased pace of innovation in these programs opens up new design methods and reveals new technological information more rapidly than if patents were absent. In addition, the quick pursuit and disclosure of innovations that are developed to gain patent rewards may cut off some duplicative efforts that would otherwise have been undertaken by multiple innovators working for multiple users. Avoiding this wasteful duplication of effort can produce significant societal benefits by leaving the resources not spent on these duplicative efforts to be applied to more productive activities.

3. Enhancing agent monitoring

In order to monitor the progress of innovative agents, potential users of innovations need information about the innovations produced by the agents. With this information, potential users can determine if the innovators have produced successful advances and can decide when innovators should be compensated for their successful design efforts. For innovative agency processes leading to patentable inventions, this type of monitoring of agent progress occurs at the stage when inventions are disclosed to the public through the issuance of a patent. By using invention descriptions in issued patents or further accounts of patented inventions in journal or newsletter articles derived from patent disclosures, potential users can monitor the *442 inventions involved and determine which, if any, of the patented inventions the users would like to acquire or use.

The willingness of potential users to pay for access to new products or processes depends on the demonstrated and communicated utility of the new products or processes. [FN377] Put simply, potential users will pay for access to innovative new products and processes if and only if those products and processes possess substantial utility and that utility is communicated to the users in a way that they can understand and evaluate in relation to the users' practical problems.

The invention disclosures that inventors must make to gain patent rights aid in the completion of innovative agency relationships by ensuring that invention users have the types of information needed to monitor patented advances. To gain a patent, an inventor must discover, describe, and disclose a working design for an invention with identifiable utility. [FN378] The disclosure of an invention in an issued patent ensures that the invention is brought to public attention at a stage of complete development in an operative state, and through a thorough description which will aid potential users of the invention in evaluating it. Once inventions reach this stage of completion and description, potential users can at least make a preliminary determination of whether the inventions will be useful to them and how much they are willing to pay in royalties or purchase prices to adopt the inventions. Where an acquisition of a patented invention is felt to be desirable based on this preliminary assessment, more detailed information about the invention and how to acquire the right to use it will be available from the patent holder.

By aiding invention monitoring, patents help to ensure that successful inventions of innovator-agents are actually transferred to user-principals. Enhanced monitoring of new inventions through issued patents and other distributed information derived from those patents also expands the number of users of inventions, thereby increasing the likelihood that innovator-agents will be compensated in close relation to the full scope of enhanced utility achieved by the innovators' efforts.

*443 D. Advances Susceptible to Innovation by Agents

Because agency processes are only effective where (1) principals' needs are communicated to agents, (2) agents are given incentives to meet those needs, and (3) principals can monitor agents' actions to determine if desired performance is rendered by the agents, [FN379] agency processes are likely to further innovations in useful items and processes only where all of these features of agency relationships can be implemented. Hence, the furtherance of innovation through agency processes turns on the presence of circumstances where these critical features of agency processes can operate.

Once the circumstances in which innovative agency processes can operate are present, a second concern needs to be addressed. When, within these circumstances, will patent rights be helpful influences on innovative agency processes? Ideally, patent rights should be adjusted to assist in the formulation and carrying out of innovative agency processes in the broadest range of settings where those processes can produce valuable innovations.

In general, innovative agents will be effective in filling the functional needs of innovation users where (1) the needs of users are stable and at least partially defined at the beginning of an innovative agency relationship, (2) innovators develop new products or procedures with functional features and useful results that can be evaluated by user-principals, and (3) the features and utility of those inventions are fully described so that the descriptions can be communicated to potential users for evaluation. The remainder of this section describes why these circumstances are needed to support innovative agency relationships. The next section of this Article considers how patent rights may operate in these circumstances to aid in the formation and completion of agency relationships promoting innovation.

1. Defined and stable user needs

In order for the needs of user-principals to signal an innovation opportunity and to foster corresponding innovative agency relationships, those needs must be at least partially described by users or be discernable from user practices and stable enough to be communicated to potential

innovators. In an innovative agency *444 relationship, the agent involved will expect a reward if he or she provides a desired functionality to innovation users by developing and disclosing a useful invention. [FN380] If the needs of innovation users at the future point when innovative efforts are projected to be completed cannot be predicted with some reasonable certainty, innovators will have few hopes for invention-related rewards and, hence, few incentives to begin invention efforts. The unpredictability of future user needs will create an uninviting moving target for potential innovations. At some point of uncertainty about the future needs of users, innovators will simply not begin innovative projects for fear that the end results will not match the needs of potential users when the projects are completed. In these circumstances, innovation by agents will be stymied because of agents' fears that their innovative efforts will be wasted. [FN381]

The need for stability in manifest user needs suggests two other features of innovative agency relationships. First, these relationships may be of little advantage in settings where items valued by users turn on highly personal tastes that are subject to substantial variations from person to person and time to time. In such settings, the features of a successful innovation--that is, a creation which meets the personal criteria of users for a pleasing product or work--will be so obscure or so fluid that innovators will be unlikely to foresee any predictable reward for embarking on efforts to satisfy the aesthetic desires of potential principals. [FN382]

Second, innovative agency relationships will tend to vary in number and scope with the future viability of potential invention users. *445 Even where the present needs of a group of users are well defined, if there are reasons to question the future viability of the users, there will be little incentive for innovative agents to pursue solutions to the problems of these users. Here, the source of uncertainty lies not in the initial definition of the users' needs, but rather in the potential inability of the users to compensate a successful innovator in the future. Absent a substantial likelihood of such compensation upon successful completion of an innovative agency relationship through the production and disclosure of a useful invention, agency relationships for the pursuit of innovation simply will not be formed.

2. Useful, repeatable results

Successful innovative agency relationships generally will be aimed at producing new products or procedures that have useful, repeatable applications. This is the case because the functional benefits of the products of an innovative agency relationship must be transferable to user-principals at the conclusion of the relationship. [FN383] Without this transferability, there will be no reason for users to pay for access to the products of the agency relationship and, consequently, no reward or payment to the agent for his or her work.

Innovations will need to have several characteristics to be transferable in this way. First, transferable innovations will generally not involve discretionary steps or practices which require the application of rarely held expert judgment or skill. [FN384] If such judgment or skill were required, a new product or procedure would be valuable only where that judgment or skill could also be obtained. The advance itself might be seen as having little or no independent value. [FN385]

*446 Second, innovations that are the products of innovative agency relationships must be developed to the point that they operate in a regular fashion to perform particular functions time and again. [FN386] This sort of regular performance is needed in order for useful and reliable functionality to be transferred to users of the innovation. Absent regular operations and

results, a purported innovation may be under- or over-valued by potential users and under- or over-utilized in the activities of those users. Regularity of operation of a new innovation not only promotes accurate assessments of its desirability by various potential users, but also helps to ensure that users who adopt the innovation are not forced to waste resources in accommodating the unpredictable failures of the innovation. [FN387]

3. Specifically and completely described innovations

Since the ultimate goal of an innovative agency relationship is the transfer of a new, useful product or practice from an innovative-agent to one or more user-principals, the successful completion of such a relationship depends in part on the acquisition and transfer to users of certain information about a new invention. In particular, the key operative features of an invention and the results achieved by the innovation must be understood and described to potential users with sufficient particularity and detail to permit the effective evaluation and use of the innovation. This descriptive requirement implies several further features that innovations must have to be produced effectively through agency relationships.

First, the innovations must be capable of specific description. [FN388] This implies that devices and procedures that require substantial discretionary choices for successful operation may not be sufficient. Such devices and procedures cannot be completely described because the exercise of expert judgment required to operate them cannot be broken down into fully described components. [FN389] Absent a description of the basis for the exercise of discretion in connection with the device *447 or procedure, a potential user will be unable to predict the means and success of operating a new device or practice and correspondingly will be unable to assess the cost-effectiveness of this new invention relative to preexisting substitutes.

Second, where an invention is capable of being described completely--that is, where the invention is comprised of specific, well-understood components or steps--the eventual transfer of this invention to users will be furthered by the inventor's prompt completion of a full description coupled with the public disclosure of that description. [FN390] The disclosure of a full invention description is a means to promote the efficient and complete evaluation of the invention by potential users. [FN391] Patent law requirements that compel patent applicants to make these types of disclosures promote invention evaluations in several ways. Potential users seeking to evaluate a new advance can begin their evaluations by reviewing the innovator's complete description of the invention. [FN392] This ensures the consideration and reuse of the innovator's analyses by multiple parties rather than requiring each potential invention user to engage in wasteful reevaluations of the same invention features already addressed by the innovator. Moreover, this ensures that potential invention users gain the full insights provided by an innovator's expertise concerning the means of constructing and operating an innovation. Often, the result will be better informed assessments of new inventions than would occur if the users (or someone acting on their behalf) started their assessments of the inventions from scratch.

The requirement of a reasonably complete description of a new invention as a basis for granting a patent does not imply that an inventor must describe all of the scientific principles or internal operating features involved in that invention. [FN393] Indeed, many useful inventions are marketed to consumers before the internal operations of the inventions are fully understood. [FN394] What is necessary is that the *448 critical input, output, and operational requirements associated with a new invention be described with reasonable completeness and certainty. [FN395] A potential

user needs to evaluate these features of a new invention to assess whether adoption of the new invention is likely to advance the user's activities. Thus, the notion of a complete description must be assessed from the standpoint of the types of information that a potential user of the invention would need in order to assess the functional advantages of an invention. This includes the characteristics of inputs and outputs of the invention and further details (such as implementation steps) which will bear on the costs and other operational impacts of using the invention. [FN396]

V. Patentable Subject Matter Tests Promoting Innovation Through Agency Processes

A. Where Contracts Are Enough: Agency Innovation in One-to-One Relationships

The types of innovative agency process which have been described in this Article can be encouraged and rewarded on a small scale without patent rights or incentives. The innovation targets, incentives, monitoring arrangements, and rewards that are needed to form innovative agency relationships on a small scale can be established through contractual arrangements. [FN397]

To take a simple example, consider a small shoe-making business that wishes to improve its machines for attaching soles to shoes. The business can hire an engineer and establish an agency agreement that covers this design process. To provide a framework for an innovative agency relationship, the contract with the engineer would need to: (1) specify the type of design desired, (2) establish a compensation scheme under which at least some of the engineer's compensation is contingent on producing a successful design, and (3) define a means *449 for assessing whether the engineer has produced a successful design such that the contingent compensation should be paid to the agent.

This sort of one-to-one innovative agency relationship is present in a variety of settings. For example, a company that encourages its employees to provide the company with innovative ideas through an employee suggestion program and rewards the employees who submit valuable ideas establishes innovative agency relationships through employment contract terms. Similarly, a company that engages a consultant or employee to produce a new or improved design for a product or practice uses the consulting or employment contract involved to establish an innovative agency relationship.

In such contract-based agency settings, the rewards and restrictions of patent law are not necessary to encourage the types of agent behavior that will produce successful innovations. The terms of the contracts involved in these settings can define the essential agency features, including: (1) the desired work products of the innovator-agent, (2) the contingent compensation which will align the interests of the agent with his or her principal, and (3) the mechanisms for evaluating the results of the agency process and for providing compensation upon the delivery of successful results. [FN398]

B. Beyond Contracts: The Need for Patent Incentives to Overcome Contractual Breakdowns in Large User Groups

Many innovative efforts involve situations where mechanisms for the formation of agency relationships through contractual processes will not be adequate to produce the full range of potentially desirable agency relationships. These situations are present where numerous users share a particular need, yet lack effective means to contract for the assistance of innovator-agents to meet that need. [FN399] Sufficient contracting mechanisms may be lacking in these circumstances for several reasons.

*450 First, the transaction costs of joint contracting may preclude multiple innovation users from successfully identifying each other and banding together to negotiate and administer the necessary contracts.

Second, even if these parties could join together, they might be unable to agree on a means to share the associated development costs in light of their differences in planned use and perceived value of the jointly sought innovation. Third, efforts among competitors to band together and contract jointly for innovation services might raise antitrust concerns and associated deterrents to effective action.

Finally, and most significantly, even if multiple innovation users appreciate their joint interests in particular innovations, each of them might hold back from participation in the joint funding of development efforts in the hope that other members of the user group would support the full costs of the development efforts. [FN400] Were this to occur in the absence of patent limitations, the nonpaying users could adopt advances at no development cost and achieve a corresponding competitive advantage. In short, hopes of being a "freerider" concerning the development of a new innovation would cause each of the potentially interested parties to resist contributing resources to the development efforts, with the result that the formation of innovation development contracts involving multiple innovation users would be impaired or stopped entirely. [FN401]

For these reasons, contractual formation of innovative agency relationships may be particularly ineffective where needs and opportunities for applying a particular innovation are widely shared. To generate desirable innovation agency arrangements in these circumstances, alternative legal standards constituting "default rules" or contractual substitutes should be recognized to create the agency incentives which contractual processes are unlikely to produce. Patent rights can serve as contract substitutes to encourage innovation by agents on behalf of large, uncoordinated groups of innovation users.

C. Patentable Subject Matter Tests Promoting Innovative Agency Relationships

Patent rights can encourage innovators to act as if they are contractually engaged agents of innovation users despite the absence *451 of an effective means to form contracts between the innovators and users. To ensure that the broadest possible range of innovative agency relationships is furthered, patent rights should be recognized in all settings where innovative agency arrangements can be useful, but are unlikely to be formed through contractual processes.

Patentable subject matter tests can be thought of as descriptions of the range of subject matters towards which patents will serve as substitutes for contracts in encouraging the formation of innovative agency relationships. [FN402] Hence, a given type of innovation should be deemed patentable subject matter where there is a clear opportunity for developing that innovation through agency processes and a lack of effective means for contracting to create the agency processes.

Noncontractual, patent-based incentives will be likely to encourage the formation of desirable agency relationships for innovation where two conditions are present. First, these incentives will be valuable where a particular innovation has features that make the innovation susceptible to development and implementation within an agency process. This will be the case where an advance has the features already identified in this Article as making an innovation a good candidate for development by agents--namely, an ability of the innovation to meet a predefined user need through repeatable operations delivering predictable utility. Second, due to the potential costs of applying the patent system, patent incentives should be reserved for those circumstances where private contracting is unlikely to be effective in forming desirable agency arrangements. This suggests that patent rights should generally be reserved for innovations that address widely shared user

needs in settings where group contracting to secure innovative efforts is likely to be ineffective.

Taken together, these criteria suggest that patentable subject matter should have the following features:

1) An innovation filling a user need with identifiable value;

2) The innovation fills a need that is shared by more than a few potential users;

3) The innovation meets the need though regular operations that produce consistent results; and

4) The innovation and the results it achieves can be described *452 clearly and distinctly, permitting effective evaluation of the innovation. [FN403]

This proposed standard for patentable subject matter is not tied to particular physical features or technological domains. Rather, it extends the patent system to all types of innovations--tangible and intangible--that are likely to be furthered through innovative agency processes.

Each of the four components of the proposed standard serves a different purpose in limiting the scope of the patent system. The first component ensures that patent incentives and restrictions are only created where innovative agents have clear targets for innovative efforts and have related means for measuring the scope of reasonable innovative efforts in light of the aggregate benefits an innovation will be likely to achieve. The second component of the proposed standard ensures that the conduct restrictions and administrative costs imposed by the patent system are only invoked where contractual processes for engaging agency innovation are unlikely to be successful. The third component of the proposed standard limits patent rights to situations where innovators have produced innovations that have consistent results providing repeatable value to users such that potential users can evaluate the innovations in terms of that value. Finally, the last component of the proposed standard adds a descriptive requirement to the third component, restricting patent rights to situations where *453 innovators can translate their development and understanding of useful advances into clear descriptions of those advances that facilitate the evaluation and use of the advances by parties other than the inventors.

VI. Applying Patentable Subject Matter Tests to Intangible Inventions

Under the proposed standard, patentable subject matter is freed from the bounds of physical designs to encompass a broader range of regularly operative, demonstrably valuable innovations regardless of their lack of physical details. The key feature of patentable subject matter under the approach advocated here is transferable utility from an artificial (i.e., nonnatural) device, composition, or practice. The necessary utility may derive from a physical transformation of something to achieve a useful result, but need not involve such a physical transformation. Rather, in our information- based age, artificially constructed, useful tools comprising patentable subject matter will increasingly involve intangible, but regularly operative and useful information-processing techniques. [FN404]

At least three questions deserve further attention before physical content limits on patentable subject matter are abandoned completely. First, what will such an abandonment of physical limits mean for the administration of patent law? Second, what remaining relationship must an intangible advance have to physical surroundings in order to possess the type of consistently achievable, transferable utility that will qualify the advance as patentable subject matter? Third, will patent restrictions on the use of intangible information- processing inventions produce undesirable limitations on the use of related mental processes?

A. Impact on Patent System Administration

By limiting patentable subject matter to physical advances, earlier patentable subject matter tests may have simplified certain key administrative tasks in the patent system in ways that will be lost if intangible advances can be patented along with physical innovations. One commentator summarized the possible advantages of a physical invention limitation on patentable subject matter as follows:

*454 The requirement of physical instantiation is not an illogical one. It ties the relatively abstract proprietary interests created by the patent law to the corporeal things that form the traditional objects of property. The identifiable boundaries that result better enable individuals to complete transactions, form markets and determine the sorts of conduct that will be judged permissible. The stricture that processes generate embodied results also places appropriate limits upon infringement liability, for the courts may far more readily observe the market impact of manipulated objects than trace the effect of more rarefied teachings. In all these matters the patent law reflected the precepts of the copyright law, which offers protection only to works fixed in a tangible medium of expression. [FN405]

This sort of argument suggests that there is something inherently precise and understandable about a physically instantiated device or process that is necessarily lacking in a purely intangible advance such as a new information-processing sequence. However, it is unclear that this is the case. There are several reasons why physically instantiated inventions may be no easier to describe in patents and to recognize in potentially infringing activities than intangible inventions.

First, the above argument implies that being able to refer to a physical unit of a patented item or the physical results of a patented process lends clarity to the description of a patented invention. Yet, these physical features are typically not what is protected by a patent on a physically instantiated invention. [FN406] Because a patent typically does not protect the complete device or process but rather some functionally critical subset of it, the descriptive benefits of having a physical example of the implementation of a patented invention may be modest.

Typically, a patent claim addressing a physically instantiated invention protects a defined set of features or elements of the particular invention implementation described in the patent. [FN407] That is, *455 the patent describes at least one working example or "embodiment" of the invention, but the patent claim--the only legally operative portion of the patent--protects a narrow set of features of the described item or process. The item or process that is described in the specification portion of a patent must include the elements which are sought to be protected in the patent claim, but the item or process described in the patent specification will usually not be coextensive with the claimed invention. [FN408] To understand the claimed invention, a reader of the patent must not focus too much on the physical details of the invention implementation example described in the patent, but rather must dissect that example and consider only the specific elements adding up to the claimed and protected invention. [FN409] Thus, even when a physical embodiment of a claimed invention is described in a patent, the claimed invention is a conceptual entity that is not tangibly present in a pure form even in the described embodiment, but which can only be conjured up from that embodiment.

In this respect, claimed inventions--even those with physically instantiated implementations--are always intangible because they are conceptual entities rarely constructed by themselves as separate objects, but rather existing only as conceptual counterparts to real items and processes. Thus, any notion that invention descriptions and related infringement assessments are simplified by some form of side-by-side comparison of

physical inventions described in patents with assertedly infringing devices or processes misconceives the nature of patent claims and patented inventions. Patent claims always address intangible subject matters to a degree because they describe abstractions of the items and processes from which the claims are derived. [FN410]

Second, there is no reason to expect that patent claims derived from physical items and processes will be any less complex than claims derived from intangible inventions such as information-processing advances. Physical elements in a physical invention can have details, interrelationships, and changing interactions that are numerous and highly complex. Because of their complexity, these *456 sorts of physical invention elements can be difficult to describe in patent claims. Many chemical and biological advances in particular are notoriously detailed and difficult to describe in patent claims. [FN411] While information-processing arrangements may also be complex, there is no obvious reason why they are inherently more complex or less capable of description as a class than the elements of physical inventions. Hence, arguments that allowing patents for intangible inventions will somehow dilute the specificity of patent claims and impair the consistent enforcement of patent rights seem misplaced.

Even if intangible inventions do involve a higher degree of ambiguity and descriptive complexity than their physically instantiated counterparts, patent law's confrontation and acceptance of this greater complexity is probably a price that must be paid to ensure that patent incentives attach to and encourage information-processing innovations in the same ways that these rights have promoted advances in physical technologies. To leave what is arguably the most active and important field of technological advance today outside the patent system because useful information-processing innovations lack physical steps is literally to elevate physical form over policy substance. Valuable information-processing advances will be delayed or left undeveloped through this unwise restriction of the patent system.

B. The Continuing Significance of Physical Contexts

While the proposed patentable subject matter standards described in this Article reject any requirement of physical features in patentable inventions, the proposed standard may still impose a hidden test for physical invention features. This hidden test may be implied from the requirement that a patentable invention operate in a consistent way to provide valuable results to users. Depending on the way that valuable results are measured, this need for invention utility may imply a need for some beneficial interaction between a patentable invention and a physical environment. Such a version of the utility test would reinject physical element considerations into patentable subject matter standards. However, the test would not be a physical component test but rather a physical context test. That is, the key to showing *457 sufficient value in an invention to establish patentable subject matter would lie in establishing that the invention interacts with a physical environment or situation in a valuable way.

Courts that have considered the patentability of computer-based inventions have identified a number of ways that an information-processing advance may achieve sufficient practical utility to constitute patentable subject matter. [FN412] While some of the types of utility found to be sufficient involved physical manipulations or results produced by physical elements of an information-processing based device or process, some information-processing based inventions have been held to be patentable subject matter without this sort of physical instantiation. [FN413] Decisions that have gone beyond physical instantiations and examined inventions lacking physical contents have identified several types of sufficiently useful relationships between intangible inventions and physical surroundings. [FN414] The presence of

these sorts of relationships to physical environments were treated as sufficient evidence of utility in the inventions involved to make those inventions patentable subject matter. [FN415] In short, these relationships between information-processing advances and the outside world distinguish intangible but patentable inventions from mere intellectual discoveries.

Courts have identified at least three ways that software-based inventions can produce sufficient practical utility for patenting: manipulating physical devices to produce desirable physical results, [FN416] manipulating physical means of operation to produce desirable but intangible results, [FN417] and measuring or interpreting surrounding physical environments to produce useful but intangible results. [FN418] While primarily developed in the context of computer-based inventions, these tests for practical utility and related physical interactions describe minimum standards for utility that should be *458 incorporated in patentable subject matter standards applied to all types of inventions.

These utility mechanism tests differ subtly from utility standards already present in patent laws. Existing utility tests focus on the need for some degree of beneficial utility in an invention [FN419] whereas the utility standards described here for assessing the patentability of information-processing inventions would require that beneficial utility be achieved through certain mechanisms. Specifically, the utility mechanism test described here for application as part of patentable subject matter standards would only be satisfied where positive utility is achieved through information processing used for the manipulation, measurement, or interpretation of a physical environment. This requirement of particular mechanisms for achieving utility is an important component of patentable subject matter standards in that the requirement distinguishes purely intellectual and unapplied information- processing discoveries from useful and patentable information-processing advances.

1. Physical manipulation of invention results

Software-based inventions sometimes produce useful results by controlling the operation of physical device or process elements that are separate from the computer running the software. [FN420] This type of invention is present where an invention includes a combination of software, a general-purpose computer programmed in accordance with the software, and further device or process components that are controlled by the computer. [FN421] Such an invention is simply a computer-controlled machine or process, having many of the same characteristics as an equivalent process or machine that is operated through human manipulation or some other purely mechanical control mechanism.

Treating these software-controlled devices and processes as patentable subject matter merely recognizes that under patent laws, software-controlled devices and processes should be given parity with human-controlled devices and processes. [FN422] That is to say that *459 software-controlled devices and processes should be treated for patent law purposes like their predecessors lacking software-based controls. If the human-operated version of a software- controlled machine or process is patentable subject matter absent its software controls, then the addition of a software-directed control element (or the substitution of such a control element for some prior control feature) should not change the patentability of the machine or process. [FN423] The machine or process should be deemed to comprise patentable subject matter in both its computer-based and non-computer forms.

The Supreme Court recognized the need for patent law parity between computer-controlled and human-controlled devices and processes in Diamond v. Diehr. [FN424] Diehr involved an information-processing innovation implemented in a computer-controlled rubber molding process. [FN425] The

Court found that the inclusion of a computer control feature did not change the essential characteristics of the invention at stake. [FN426] Both before and after this change, the design was one for a rubber molding process. [FN427] Such a process involved a sufficient sequence of changes in physical structures--i.e., the changes in both the rubber mold positions being controlled and in the rubber materials being molded--to make the process a technological design which could qualify for patent rewards. [FN428]

Inventions like the one in Diehr--where the claimed invention included both information-processing controls and at least some of the physical things being controlled--should continue to be seen as having sufficient mechanisms for achieving practical utility to make these advances patentable subject matter under the proposed standard. Means of physical interaction with the external world are present in components of these inventions, thereby implementing the type of physically significant utility mechanism needed to make these inventions patentable subject matter.

*460 2. Physical manipulation of operative means

A different way that a software advance can produce new physical structures in a device is by causing a general-purpose computer to operate in particular sequences of electronic states as dictated by the instructions in the software. [FN429] A general-purpose computer programmed to perform useful information processing constitutes patentable subject matter because the software-computer combination specifies a series of computer state transformations used to produce a useful result. Rather than achieving utility by manipulating physical results or ends of information processing, this type of innovation produces utility by manipulating physical means of information processing--that is, by manipulating the electronic states assumed by the computer performing the processing.

This type of advance constitutes patentable subject matter because it involves a means for improved operation of a preexisting physical tool--a computer--in order to achieve increased efficiency or effectiveness. A patentable, technological application is present due to the involvement of the physical tool being manipulated regardless of whether that tool is being applied to produce physical results. [FN430] Innovations involving new programming of computers entail new *461 physical device and process designs in which the coupling of particular software directions with existing computer circuits achieves a better computer design or a better means of operating a preexisting computer. Whether claimed as a new device or a new process, these software-based improvements in the components and operating features of a physical tool like a computer possess the practical, physically situated utility needed to make the computer-based advance patentable subject matter.

3. Measuring or interpreting data or signals corresponding to physical surroundings

Another way in which a software-based invention can produce useful results is by processing data or signals that correspond to external physical surroundings. Such an invention is present where software is used to control a computer that is part of a measurement or analysis system and the system is defined in terms of information-processing steps without describing the particular software code statements or the physical computer processing states that are necessary to implement the system. This type of system for information processing does not involve physical transformations in either its operative means or ends. It is a completely intangible invention consisting of practically useful information-processing sequences.

Such an invention is a pure information-processing advance in the sense that it involves a process or device for transforming one type of information (i.e., data reflecting measurements about a physical condition) into another type of information (i.e., interpretive results). The fact that this invention is used to analyze a particular physical context establishes a sufficient relationship to the physical context and related practical needs to make the invention a technological advance that can qualify for patent rewards and incentives. This type of advance constitutes patentable subject matter because the advance helps to analyze or interpret a physical condition or characteristic. [FN431]

*462 The Court of Appeals for the Federal Circuit confirmed the patentability of this type of software-based invention in State Street Bank & Trust Co. [FN432] In that case, the court considered the patentability of a computer-based process for keeping track of pooled investments of mutual funds. [FN433] The court held that, while the computer system at issue was not defined in terms of specific computer states or steps of operation, this lack of physical details in the claimed invention did not preclude the invention from being patentable subject matter. [FN434] In the court's view, patentable subject matter was present because the system analyzed information about a physically significant characteristic (i.e., funds in an investment account), used clearly specified information-processing steps to do so, and produced a useful result concerning the physical characteristic under study (i.e., an analysis of each investor's fractional interest in the pooled funds). [FN435] This linkage of information processing to the analysis of a specified physical property established a sufficient mechanism of utility to qualify the invention as patentable subject matter. [FN436]

4. Information-processing methods producing consistently useful results, but lacking any particular physical instantiation

The previous three categories of information-processing advances each involve some useful relationship between information processing and a specified physical environment. The information processing in each example is used to manipulate or interpret elements of the physical context of the invention. However, as described in this Article, patentable subject matter need not be limited to these sorts of physically grounded processes. A physical relationship (either physically transformative or physically interpretive) is sufficient to define patentable subject matter, but not necessary.

Under the patentable subject matter standard proposed in this Article, the essential feature of a patentable invention is not a physical characteristic or relationship but rather a design process. A patentable *463 invention is any repeatedly useful discovery that is capable of encouragement and dissemination through agency processes. The invention must perform in a regular, defined manner to achieve regular, defined utility. These features, while present in physically transformative or physically interpretive inventions, can also be found in other, intangible inventions. These further intangible inventions, capable of being developed by innovator- agents and transferred to user-principals like tangible inventions, should qualify for patent protections along with their tangible counterparts.

The characteristics purely intangible inventions need to qualify as patentable subject matter under the proposed standard can best be understood by considering these characteristics in the reverse of the order in which they arise in the use of an invention--that is, results first and then the means for achieving those results. The results achieved by an intangible invention will be information that users wish to obtain, generate, record, or retrieve because of the practical significance of the information in their

businesses or personal activities. [FN437] Typically, the information-processing steps involved in the invention will need to be useful to multiple parties, thereby justifying patent incentives as means to overcome the limitations of contracting between innovative agents and potential invention users. An information-processing advance will need to be describable in terms of well- defined, consistently successful information-processing steps that do not turn on discretionary choices by users of the advance. [FN438] To ensure that the utility of the invention is predictable and measurable, the steps involved in the invention should produce the same results each time the process is used in a particular setting with a particular set of inputs.

This combination of consistent operating means and ends should be treated as patentable subject matter regardless of whether the means for accomplishing the innovative information processing involve physical subcomponents or the ends of the information processing involve physical results. Furthermore, there should be no need for *464 such an invention to interpret or analyze an external physical context. Rather, it should be enough that the invention takes information that the user already values for some reason and then processes that information in a regular, repeatable fashion to produce new or altered information with increased utility over that of the original information. Patent protections for these types of information-processing tools should serve the same incentive functions for intangible information-processing advances that patents have long served for physically situated inventions. Such protections should encourage the development and public disclosure of new and valuable information-processing advances.

C. Potential Restrictions on Mental Processes

Patents for purely intangible information-processing inventions of the sort just described may be undesirable because they reach so far as to restrict information processing in mental processes. Where an information-processing sequence is protected by a patent and the same sequence of information processing is undertaken by an individual as part of a mental analysis, will these mental steps infringe the patent involved? Would present patent laws grant a patent holder control over such mental processes? If so, would this type of control be consistent with constitutional restrictions on patents imposed by either the Patent Clause [FN439] or the First Amendment? [FN440]

Patent controls over mental processes seem unwise for several reasons. Aside from the practical patent enforcement problems that would arise in detecting and acting against "infringing" mental activities, patent restrictions on mental steps and analyses are probably inconsistent with First Amendment standards protecting free thought and expression. [FN441] These standards encourage intellectual competition *465 among individuals and groups to develop and disseminate innovative information processing in the form of alternative analyses, interpretations, and descriptions of our surroundings and activities. [FN442] Greater diversity of mental steps in support of analytic and descriptive ends generally enhances society's understanding of various activities. Because of the societal benefits flowing from these results, legal scholars generally disfavor restrictions on mental processes that will curtail the reuse in personal analyses of useful information- processing methods. [FN443]

However, this sort of freedom of thought and analysis is not the only consideration in deciding how the patent system should encourage innovation concerning intangible information-processing methods. In these settings, there is a countervailing public policy in favor of providing temporary restrictions on new information-processing use as an inducement and reward for the development of the new methods. In short, the typical incentive logic of the patent system still applies. The ultimate question is whether

this logic should, in the narrow area of practically useful information processing, trump the normal countervailing logic of freedom of thought and expression underlying aspects of First Amendment doctrine.

The conflict between patent incentives and intellectual freedom protections arises because certain types of mental analyses are not just mental or intellectual exercises, but rather information analyses with substantial, transferable utility. These sorts of innovations can be tools for individuals or businesses much like physical tools such as phones or screwdrivers. As such, use of these intangible, but consistently operative and useful information-processing tools may be restrictable under patent laws enacted under the Patent Clause of the Constitution in ways that would be unconstitutional if applied to less practically useful intellectual or political ideas and analyses. Such a view might *466 be premised on the notion that the type of temporary restriction on information-processing techniques imposed under patent laws encourages the development of new techniques in the long run and, hence, enhances information processing alternatives in a way that does not conflict with the First Amendment.

The development of new constitutional doctrines to address this problem is beyond the scope of this Article. However, there may be little need to develop such doctrines. Patents that are drafted broadly enough to limit information-processing sequences in mental processes will probably be rare. Most of the information-processing sequences that are likely to be submitted for patent protection will entail sufficiently complex or extensive information processing that they are unlikely to be undertaken through purely mental processes. Rather, the methods sought to be protected will typically be information-processing methods that are peculiarly--indeed, perhaps exclusively--suited for computer implementation. Precluding mental use of new information processes by enforcing patent protections will not be a significant problem because individual use of most patented information-handling processes will either be impossible or seldom undertaken.

Even if some patented information-processing methods are used in mental processes, there is a simple means to prevent patent rights from limiting these mental processes. This problem can be avoided by adjusting patent infringement standards to treat the use of a patented method in purely mental activities as a specially protected, liability-free activity. This approach will carve out and protect a sphere of mental "fair use" of intangible information-processing innovations. This type of adjustment of infringement standards is preferable to leaving intangible advances outside of patentable subject matter generally. Recognizing patent rights for innovative information-processing inventions generally and then holding mental use of those processes to be noninfringing retains patent rights and incentives for all information-processing designs aimed at computer-based applications and other electronically implemented information processing.

Since most new information-processing methods will be developed for computer implementations that will still be governed by patent controls and rewards, the gap in patent rights created by the above adjustment in infringement standards will not substantially *467 lessen incentives for the development of innovative information-processing methods. Only the few--if any--incidental personal uses of the new methods in mental analyses will be able to proceed without patent controls and inventor rewards. Such a small omission from the overall scheme of patent controls and rewards will probably have little negative effect. The fact that most computer-based uses of the patented information-processing inventions will be protected will create sufficient economic incentives for beneficial information-processing innovations.

VII. Conclusion

As information-processing advances assume central roles in our understanding and control of useful activities and physical phenomena, patent rewards should encourage intangible, information-processing inventions in the same way that patent rights have previously encouraged tangible inventions. Tests for patentable subject matter that tie opportunities for patent rewards to the presence of physically transformative or interpretive inventions have placed outdated physical bounds on the incentives that the patent system was intended to create. The nature of the "useful arts" has changed to include intangible information-processing innovations. The patent system must change as well to embrace and encourage new modes of design and engineering that emphasize intangible procedures or practices with practical utility.

This Article has proposed new standards for patentable subject matter that will encourage innovations in intangible inventions. These new standards recognize that inventions are often products of agency processes in which an inventor acts as the agent of a group of principals comprised of the potential users of the inventor's discoveries. The new patentability standards described here encourage innovators to extend this agency framework to intangible inventions.

Useful innovations that are susceptible to development by innovative agents and transferable to user-principals constitute patentable subject matter under the new standards. The standards reflect the view that where innovation through agency processes is likely to be effective, patentable subject matter should be found to ensure that the incentives of the patent system will attach. Such an approach ensures that patent incentives are coextensive with the scope of potentially beneficial agency relationships supporting innovation.

*468 The patentable subject matter standards developed in this Article do not require physical invention features in patentable inventions but rather turn on the presence of more basic invention characteristics that facilitate innovation through agency methods. Physically transformative or physically interpretive devices and processes will typically have the features required to be patentable subject matter under the new standards, but will not be the only inventions with these features. Hence, the new tests for patentable subject matter are consistent with older tests emphasizing physically transformative or interpretive features, but are not limited to the physically situated inventions covered by those older tests.

Ultimately, the range of patents and patent incentives that will result from these new patentable subject matter tests will depend on additional factors. The recognition that an intangible invention constitutes patentable subject matter only means that the innovation may qualify for patent protections and rewards. To gain these, the innovation must still be novel, a substantial, nonobvious advance over prior knowledge in the same field, and the subject of a timely patent application. Relatively few intangible advances may meet all of these standards. In particular, the requirement of a substantial, nonobvious advance over prior knowledge about tangible or intangible methods for undertaking similar tasks may be hard to meet. A great many intangible inventions may be no more than abstractions of previously existing tangible methods for undertaking similar tasks. As such, the intangible inventions may be obvious and unpatentable. All that the new, physically-unbound patentability standards proposed here will do is ensure that these further tests regarding patentability will be addressed for intangible inventions and that innovators producing substantial intangible advances will have an opportunity to gain patent rewards on the same terms that those rewards are granted to developers of tangible inventions.

The possibility that even a few widely used intangible innovations will be developed and disclosed to the public due to the promise of patent rewards provides a sound basis for extending the patent system to these innovations.

The increasing importance of innovations in intangible information-processing methodologies heightens the significance of encouraging the best and fastest innovations in this area through the same types of patent incentives that have previously enhanced physical innovations. Patentable subject matter standards *469 for intangible inventions are a substantial step forward, equal in importance to the many useful intangible advances the new standards will encourage and the associated societal benefits those advances will bring.

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[FN1]. See, e.g., Mackay Radio & Tel. Co. v. Radio Corp. of America, 306 U.S. 86, 94 (1939) ("[A] scientific truth, or the mathematical expression of it, is not [a] patentable invention...."). See generally Donald S. Chisum, Chisum on Patents: A Treatise on the Law of Patentability, Validity and Infringement ¤ 1.03(2) (2001) (stating that one may not obtain a patent for the discovery of a mere principle or abstract idea, however important).

[FN2]. See Gottschalk v. Benson, 409 U.S. 63, 67 (1972). Many intangible discoveries--including those concerning some of our most fundamental scientific concepts--serve as instrumental tools in that they aid further intellectual inquiries and practical engineering efforts. Patent restrictions on the use of these discoveries are withheld in part to ensure that these further intellectual inquiries and engineering efforts are not hindered. As Judge Jerome Frank noted:

> It is indeed something of a paradox, but, nevertheless, doubtless wise, that our patent law gives no reward to the discoverers of scientific principles, while it protects the discoveries and inventions of lesser minds, who find new, original and useful applications of such principles. No Prometheus is welcome in the Patent Office.... If the statutory provision authorizing the issuance of a patent for a "composition of matter" were interpreted to validate [patent claims for scientific principles], then that statutory provision might well be unconstitutional, since it would authorize the creation of monopolies which "would discourage arts and manufactures." Schering Corp. v. Gilbert, 153 F.2d 428, 435 (2d Cir. 1946) (Frank, J., dissenting).

[FN3]. See 35 U.S.C. ¤ 101 (1994) (providing for patents concerning "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof").

[FN4]. See 35 U.S.C. ¤154(a)(2) (1994).

[FN5]. Adjustments in patentable subject matter standards frequently follow changes in technological knowledge. These adjustments are needed to maintain patent incentives as inducements for design efforts and disclosures in new technological realms. See AT&T Corp. v. Excel Communications, Inc., 172 F.3d 1352, 1356 (Fed. Cir. 1999) (describing how "sea-changes" in computer technology required courts to revise and expand notions of patentable computer programs in order to ensure that patent rewards provided incentives for software development; these legal changes reflect "the ability of

[patent] law to adapt to new and innovative concepts, while remaining true to basic principles").

[FN6]. The rise in the number of patent applications concerning innovative software and business methods reflects a shift from earlier efforts to improve physical tools and processes for business and individual use to a new focus on improved control over these physical tools and processes. This improved control is often achieved through new information-processing methods implemented in computer-based control or analysis systems. See U.S. Patent and Trademark Office, Automated Financial or Management Data Processing Methods (Business Methods) [hereinafter Automated Data Processing Methods], at http:// www.uspto.gov/web/menu/busmethp/index.html (last visited July 26, 2000) (describing the nature and evolution of patents on useful business devices and methods).

[FN7]. See, e.g., AT&T Corp., 172 F.3d at 1353 (discussing patent application for a new electronic record-keeping format for information on long distance calls); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1370 (Fed. Cir. 1998) (discussing patent application for a new data-processing system used in investment management).

[FN8]. See, e.g., AT&T Corp., 172 F.3d at 1358-60 (recognizing the patentability of advances that produce physically significant data-processing results without necessarily producing physical results).

[FN9]. See, e.g., id. at 1355-57; State St. Bank & Trust Co., 149 F.3d at 1373-75; In re Lowry, 32 F.3d 1579, 1583-84 (Fed. Cir. 1994); Arrhythmia Research Tech., Inc. v. Corazonix Corp., 958 F.2d 1053, 1055-59 (Fed. Cir. 1992).

[FN10]. See, e.g., AT&T Corp., 172 F.3d at 1355-57; State St. Bank & Trust Co., 149 F.3d at 1368; Lowry, 32 F.3d at 1584; Arrhythmia, 958 F.2d at 1055-59.

[FN11]. As new technological knowledge makes new types of useful devices and processes possible, patent standards need to evolve to ensure that patent rewards will serve as incentives for innovation in applying the new technological knowledge. To ensure that the promise of patent rewards encourages the application of newly discovered technologies, we cannot tie the boundaries of patentable subject matter to our present understanding of technology. Rather, these boundaries must encourage practically useful designs of diverse types such that new types of technological applications are presumed to fall within the range of potential patent rewards as developers first discover and apply new technological knowledge. This implies that patentable subject matter should never be limited to today's technologies, but rather should extend to presently unknown, but practically useful technologies as those technologies are used to produce useful applications. See In re Bergy, 596 F.2d 952, 973 (C.C.P.A. 1979) ("To insist on ... Congressional foresight in construing [patentable subject matter standards] would be the very antithesis of the Constitutional and Congressional purpose of stimulating the creation of new technologies--by their nature unforeseeable--and their progressive development."), aff'd sub nom. Diamond v. Chakrabarty, 447 U.S. 303 (1980).

[FN12]. The rise of software development as a major business activity and target of business spending reflects this new emphasis. "With revenues of more than $200 billion and a growth rate of some 13% a year, software is one

of the world's largest and fastest-growing industries." The Software Industry: The Birth of a New Species, The Economist, May 25, 1996, at 4 [hereinafter The Software Industry].

These figures focus on companies that produce software products. See id. at 3-5. Expenditures on software development are also large within companies which use software to achieve operational improvements rather than as the basis of marketable products. For example, AT&T, not a major seller of software itself, spent approximately $1.8 billion on software development in 1994. This represented sixty percent of the company's total research and development budget. See U.S. Patent and Trademark Office, Public Hearing on Use of the Patent System to Protect Software-Related Inventions [hereinafter Public Hearing] (Jan. 26-27, 1994) (statement of William Ryan, AT&T attorney), available at http://www.uspto.gov/web/offices/com/hearings/index.html (last visited Oct. 24, 2001).

[FN13]. See generally The Software Industry, supra note 12, at 5-6 (discussing the role of software and the emergence of the Internet in U.S. businesses).

[FN14]. See id. at 7-8.

[FN15]. See Keith E. Witek, Comment, Developing a Comprehensive Software Claim Drafting Strategy for U.S. Software Patents, 11 Berkeley Tech. L.J. 363, 366-67 (1996); see also Richard H. Stern, Scope-of-Protection Problems with Patents and Copyrights on Methods of Doing Business, 10 Fordham Intell. Prop. Media & Ent. L.J. 105, 130-31 (1999) (discussing problems raised by patent protections for computer-implemented inventions).

[FN16]. Patent attorneys and agents who assist clients in protecting intangible information-processing advances have attempted to anticipate developing judicial standards for patentable information-processing advances and to draft patent claims accordingly. However, judicial standards in this area have shifted so quickly and substantially that many practitioners have doubtless had problems in keeping up with the broadest boundaries of patentable subject matter. See, e.g., Witek, supra note 15, at 369-89 (discussing how patent practitioners were hampered by evolving judicial standards over the last thirty years). At one time, the most common technique for protecting information-processing advances was to claim protection for these advances in combination with further devices or device features so that the inventions sought to be patented were not purely intangible ones. See id. at 371-72 (describing the advantages under past case law of including the physical details of a software advance's operative surroundings in patent claims seeking protection for the advance). More recently, patent practitioners have recognized the desirability and effectiveness of broader patent claims addressing purely intangible advances such as innovative software or information-processing designs. See, e.g., Thomas A. Fairhall, Maximizing the Effectiveness of Software Patents: Drafting and Prosecution Strategies, in A.L.I.-A.B.A. Course of Study: Computer Software: Protection and Commercial Exploitation 95, 104-14 (1998) (emphasizing the desirability of several formats of patent claims that are capable of protecting innovative software features without including physical invention features that would limit software protections to particular physical contexts).

[FN17]. Recent changes in patentable subject matter standards for intangible inventions have been recognized by the PTO as potential sources of

uncertainty for patent examiners leading to inefficient examination proceedings and erroneous patent issuance decisions. As a consequence, the PTO has issued special patent examination guidelines concerning computer-related inventions, including new software designs based on intangible information-processing advances. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478 (Feb. 28, 1996).

The PTO has also recognized that expanded patentable subject matter standards have produced increased numbers of applications for business method patents and that the PTO's examiners may have difficulty in properly reviewing these applications. Many of the business methods addressed in these applications are based on intangible methods for handling financial or management information. To ensure proper attention to these sorts of applications, the PTO established special procedures for the review of patent applications covering business methods. The PTO also instituted special ongoing oversight of the agency's handling of such applications. See Automated Data Processing Methods, supra note 6.

[FN18]. Absent patent protections, the risk of appropriation of intangible innovations by competitors may cause potential innovators (and potential investors who might back the innovators) to divert their resources towards more promising ventures. The importance of patent protections in channeling resources into the development of innovative software designs, rather than into other commercially significant activities, was described by one software industry lawyer as follows:

Going into the next century, the key inventions will be in information processing. [Restricting patents] for software-related inventions will shift investment away from this area.

The purpose of research and development in any technology is to gain an advantage over your competitor. But if your competitor can legitimately copy the fruits from your R&D and can create a product that can compete head-on with your product while you are still trying to build a market for the product, then you've lost.

The long term value of R&D in the marketplace is in the new functions implemented by software. If such new functions are protected, investment flows to the industry. If not, investment will dry up.

Public Hearing, supra note 12, at 78 (Jan. 26-27, 1994) (statement of Victor Siber, Senior Corporate Counsel, IBM Corporation).

[FN19]. Patents on intangible innovations are means to clarify the transferable value of those innovations and, by extension, the value of the efforts of experts that produce such innovations. Recognition of patent rights in software and other intangible innovations may have broad impacts in shifting our notions of business value and power:

In today's global highly competitive marketplace, some believe that we are witnessing a fundamental shift in business history. They are, we say, progressing from managerial capitalism to intellectual capitalism. They believe that the importance of intellectual capital will ultimately cause a dramatic shift in the wealth of the world from material resources to those who control ideas and information, that is intellectual property.

A fundamental feature of the patent system is that it establishes a basis for this intellectual effort to be regarded as an asset and to be traded in the marketplace. Thus, an effective patent system which promotes creativity by providing a beneficial and stimulating environment for inventors is essential for the information age.

Public Hearing, supra note 12, at 26 (Feb. 10-11, 1994) (statement of Ron Reiling, Digital Equipment Corporation).

[FN20]. Assessments of the validity and scope of a company's patents on key software or other information-processing innovations may be a central feature of valuing that company for either purchase or investment purposes. Noting the importance of software patents in encouraging investment in software innovators, one observer explained the potential impact of software patents on investment decisions this way: "[I]nvestors seeking to sponsor a start-up organization or a new enterprise within a larger company would like to have some certitude about what it is that they can hope to have some protection for and... how their investments can be protected." Public Hearing, supra note 12, at 7 (Jan. 26-27, 1994) (statement of William Ryan, AT&T attorney); see also id. at 9-10 (Jan. 26-27, 1994) (statement of Richard LeFaivre, Vice-President of Advanced Technology, Apple Computer) (noting that Apple Computer and other large software producers regularly consider the patent potential of alternative development projects before embarking on those projects; projects lacking potential patent protections are disfavored because of the risks that innovative products resulting from the projects will be appropriated by competitors).

[FN21]. Accurate assessments of the validity and scope of issued patents are important in several features of corporate planning. If companies cannot accurately predict whether their contemplated actions will fall within the patents and control of other parties, they risk inadvertently backing themselves into activities that are only discovered to be infringing conduct when a patent holder threatens litigation. Where infringement of an unexpected patent is encountered once an intangible practice is already in use in ongoing activities, the results may include (1) unanticipated financial liability for patent infringement; (2) lost chances to adopt different business activities that do not require the infringing practice; (3) lost opportunities to "design around" the patented features of the practice to produce noninfringing substitutes; and (4) lost chances to negotiate licenses to undertake the patented practice free from the threat of patent enforcement litigation. See generally Donald S. Chisum & Michael A. Jacobs, Understanding Intellectual Property Law ¤ 2F (1992) (discussing patent law standards concerning infringement and remedies, including compensatory damages).

[FN22]. Patentable subject matter standards concerning intangible discoveries--particularly intangible information-processing discoveries embedded in innovative software--have bedeviled federal courts for several decades. For a summary of some of the sources and patterns of judicial confusion in this area, see id. ¤ 2C[1][f].

[FN23]. Subsequent defendants in patent enforcement litigation are free to challenge the validity of a patent that was unsuccessfully challenged by an initial litigant. See id. ¤ 2F[4][a]. However, an initial judicial interpretation of a disputed patent may (perhaps correctly) be seen by subsequent defendants as an accurate prediction of the probable interpretation of additional federal courts should the validity and scope of the patent be relitigated. Hence, the interpretation of an initial court will have a strong practical effect in defining the scope of patent rights in later licensing and litigation settlement negotiations. See id. ¤ 2F[4][a][i-iii].

[FN24]. See Chisum, supra note 1, ¤ 1.01.

[FN25]. For a complete description of the standards that an invention must meet in order to qualify for a patent, see id. ¤¤ 1.01-6.04.

[FN26]. The analytic framework adopted in this Article--and in most appellate court opinions addressing patentable subject matter standards-- assumes, arguendo, that all other invention features needed for patenting are present, leaving the disputed issue of patentable subject matter to determine whether a patent should issue. In this sense, the patentable subject matter standards described in this Article identify features of intangible inventions that are necessary but not sufficient to warrant a patent.

[FN27]. See 35 U.S.C. ¤ 102(a) (1994).

[FN28]. See id. ¤ 103.

[FN29]. See id. ¤ 102(b).

[FN30]. See, e.g., Amazon.com, Inc. v. Barnesandnoble.com, Inc., 239 F.3d 1343, 1365-66 (Fed. Cir. 2001) (recognizing that a "one-click" online purchasing method probably constituted patentable subject matter, but expressing doubts about the validity of a patent on the method due to evidence that the method was a mere obvious variation of methods already disclosed in the same field).

[FN31]. Jared Earl Grusd, Internet Business Methods: What Role Does and Should Patent Law Play?, 4 Va. J.L. & Tech. 9, P 8 (1999), at http://www.vjolt.net/vol4/v4i2a9-grusd.html.

[FN32]. See, e.g., Public Hearing, supra note 12, at 27 (Jan. 26-27, 1994) (statement of Kaye Caldwell, President, Software Entrepreneurs Forum); see also id. at 73 (Jan. 26-27, 1994) (statement of Richard Stallman, Free Software Foundation) (describing problems with PTO examiners' evaluations of the obviousness of software advances).

[FN33]. See Shawn McDonald, Patenting Floppy Disks, or How the Federal Circuit's Acquiescence Has Filled the Void Left by Legislative Inaction, 3 Va. J.L. & Tech. 9 (1998), at http://vjolt.student.virginia.edu/graphics/vol3/home_ art9.html (describing some of the difficulties in identifying and evaluating the novel features of newly developed software).

[FN34]. The PTO has recognized that the nonobviousness of business method advances may be hard for patent examiners to assess. To combat errors in this area, the PTO has issued special guidance to its examiners regarding nonobviousness evaluations for intangible business method advances. See U.S. Patent and Trademark Office, Formulating and Communicating Rejections Under 35 U.S.C. 103 for Applications Directed to Computer-Implemented Business Method Inventions, at http://www.uspto.gov/web/menu/busmethp/busmeth103rej.htm (last modified Feb. 7, 2001).

[FN35]. See John M. Carson & Eric M. Nelson, Legal Victory for Electronic Commerce Companies: State Street Bank & Trust v. Signature Financial Group Signals Fall of Last Barrier to Internet Software Patents, 21 T. Jefferson L. Rev. 193, 206 (1999).

[FN36]. The PTO believes that accurate reviews of intangible business methods patents can be achieved through increased recruiting of patent examiners with business backgrounds, improved training of examiners regarding innovative

business methods, and expanded prior art searching. See Automated Data Processing Methods, supra note 6.

[FN37]. At present, even under the broadly inclusive patentability standards being applied by federal courts, relatively few applications for business method patents are being submitted to the PTO. See id. In fiscal year 1999, the total number of business method patent applications was 2658. See id. This represented only about one percent of all patent applications in this period. See id. With this total, business method patents represented a relatively small fraction of the total number of patent applications addressing communication and information-processing technologies. Other types of inventions in this field with more patent applications than business methods during fiscal year 1999 included the following: Digital and Multiplex Communications Technology (7131 applications), Display Data Processing (3898 applications), Telecommunications (3480 applications), Networked Computer Data Processing (3190 applications), Databases and Word Processors (3068 applications), and Dynamic Information Storage (2905 applications). See id.

[FN38]. See discussion infra Part IV.

[FN39]. See discussion infra Part II.A.

[FN40]. See discussion infra Part II.B.2.

[FN41]. See discussion infra Part II.C.

[FN42]. See discussion infra Part II.D.

[FN43]. U.S. Const. art. I, ¤ 8.

[FN44]. See In re Shao Wen Yuan, 188 F.2d 377, 380 (C.C.P.A. 1951) ("It is interesting to note that this particular grant is the only one of the several powers conferred upon the Congress which is accompanied by a specific statement of the reason for it.").

[FN45]. See U.S. Const. art. I, ¤ 8. See generally Robert I. Coulter, The Field of the Statutory Useful Arts, Part II, 34 J. Pat. & Trademark Off. Soc'y 487, 491 (1952) (discussing statutory use of "useful arts"); Karl B. Lutz, Patents and Science: A Clarification of the Patent Clause of the U. S. Constitution, 18 Geo. Wash. L. Rev. 50, 51 (1949) (discussing interpretation of "useful arts").

[FN46]. See Lutz, supra note 45, at 51; Arthur H. Seidel, The Constitution and a Standard of Patentability, 48 J. Pat. & Trademark Off. Soc'y 5, 11-12 (1966).

[FN47]. See In re Bergy, 596 F.2d 952, 958-59 (C.C.P.A. 1979) (describing the intent of the drafters of the Constitution to promote science through copyright protections and to promote the useful arts through patent protections), aff'd sub nom. Diamond v. Chakrabarty, 447 U.S. 303 (1980).

[FN48]. 383 U.S. 1 (1966).

[FN49]. Id. at 5-6.

[FN50]. Id. at 6 (emphasis in original).

[FN51]. See Alan L. Durham, "Useful Arts" in the Information Age, 1999 BYU L. Rev. 1419, 1426-27.

[FN52]. See Paulik v. Rizkalla, 760 F.2d 1270, 1276 (Fed. Cir. 1985) ("The exclusive right, constitutionally derived, was for the national purpose of advancing the useful arts--the process today called technological innovation."); In re Waldbaum, 457 F.2d 997, 1003 (C.C.P.A. 1972) ("The phrase 'technological arts,' as we have used it, is synonymous with the phrase 'useful arts' as it appears in Article I, Section 8 of the Constitution."); In re Musgrave, 431 F.2d 882, 893 (C.C.P.A. 1970).

[FN53]. See, e.g., Carl Mitcham, Thinking Through Technology: The Path Between Engineering and Philosophy 154-60 (1994).

[FN54]. See Musgrave, 431 F.2d at 895-96 (Baldwin, J., concurring).

[FN55]. John R. Thomas, The Post-Industrial Patent System, 10 Fordham Intell. Prop. Media & Ent. L.J. 3, 34-35 (1999); see also Mitcham, supra note 53, at 154-60 (emphasizing the need for a conceptual framework for discussing technology).

[FN56]. See discussion infra Part III.

[FN57]. See discussion infra Parts III-IV.

[FN58]. See, e.g., Coulter, supra note 45, at 496; Durham, supra note 51, at 1424; Stern, supra note 15, at 127-28 n.98.

[FN59]. See Durham, supra note 51, at 1424-25.

[FN60]. See id. at 1426-28.

[FN61]. See discussion infra Part III.

[FN62]. Durham, supra note 51, at 1454.

[FN63]. See Coulter, supra note 45, at 495-96, 499-500.

[FN64]. See Timothy R. Holbrook, The More Things Change, the More They Stay the Same: Implications of Pfaff v. Wells Electronics, Inc. and the Quest for Predictability in the On-Sale Bar, 15 Berkeley Tech. L.J. 933, 935 (2000). See generally Emerson: Quotes, available at http://www.transcendentalists.com/emerson_quotes.htm (last visited Oct. 22, 2001) ("If a man write a better book, preach a better sermon, or make a better mouse-trap than his neighbor, tho' he build his house in the woods, the world will make a beaten path to his door."). This quote is believed to originate from either Ralph Waldo Emerson or Elbert Hubbard. It is not found in any of Emerson's writings.

[FN65]. See, e.g., State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1375-77 (Fed. Cir. 1998), cert. denied, 525 U.S. 1093 (1999) (recognizing that the patent system extends to nonindustrial innovations such as new business methods concerning financial records).

[FN66]. See Coulter, supra note 45, at 496; see also Durham, supra note 51, at 1429-37 (discussing a historical interpretation of the useful arts).

[FN67]. Coulter, supra note 45, at 496.

[FN68]. See Graham v. John Deere Co., 383 U.S. 1, 6 (1966); see also Coulter, supra note 45, at 499-500 (arguing that useful arts should not be confined to a purely historical meaning).

[FN69]. Coulter, supra note 45, at 496; see also Stern, supra note 15, at 128 n.98 ("The best modern synonym for the term 'useful arts'... is 'bodies of knowledge relating to the trades that artisans ply." ').

[FN70]. See Coulter, supra note 45, at 494, 496-97.

[FN71]. See id. at 494, 496.

[FN72]. See id. at 496.

[FN73]. See id.

[FN74]. See id. at 496-97.

[FN75]. Durham, supra note 51, at 1440 (quoting Coulter, supra note 45, at 498).

[FN76]. See id. at 1445-52.

[FN77]. See id. at 1473 n.277 (quoting Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948)).

[FN78]. See id. at 1521-22.

[FN79]. See discussion infra Part IV.

[FN80]. See Durham, supra note 51, at 1448.

[FN81]. See id. at 1473.

[FN82]. See discussion infra Part IV.

[FN83]. 35 U.S.C. ¤ 101 (1994).

[FN84]. Id.

[FN85]. See generally Chisum, supra note 1, ¤¤ 1.01-6.04 (discussing patent law standards governing the granting of utility patents for useful inventions).

[FN86]. See id.

[FN87]. See Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 483 (1974) ("[N]o patent is available for a discovery, however useful, novel, and nonobvious, unless it falls within one of the express categories of patentable subject matter of 35 U.S.C. ¤ 101....").

[FN88]. See id. at 476-83; see also Robert A. Kreiss, Patent Protection for Computer Programs and Mathematical Algorithms: The Constitutional Limitations on Patentable Subject Matter, 29 N.M. L. Rev. 31, 33-35 (1999) (noting that courts have no coherent methodology for determining if computer-related and

algorithm-related inventions are patentable subject matter); Thomas, supra note 55, at 5 (noting that the scope of the statutory term "process" appears coextensive with almost any possible endeavor).

[FN89]. See Diamond v. Chakrabarty, 447 U.S. 303, 308-09 (1980); In re Alappat, 33 F.3d 1526, 1542 (Fed. Cir. 1994) (en banc).

[FN90]. See Thomas, supra note 55, at 4.

[FN91]. See Chakrabarty, 447 U.S. at 309-10.

[FN92]. Id.

[FN93]. Id. at 312-13.

[FN94]. See, e.g., Diamond v. Diehr, 450 U.S. 175, 183 (1981); Gottschalk v. Benson, 409 U.S. 63, 67 (1972).

[FN95]. See Diehr, 450 U.S. at 183; Benson, 409 U.S. at 67.

[FN96]. See State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1375-77 (Fed. Cir. 1998); see also AT&T Corp. v. Excel Communications, Inc., 172 F.3d 1352, 1353 (Fed.Cir. 1999); In re Bergy, 596 F.2d 952, 952 (C.C.P.A. 1979).

[FN97]. See Chakrabarty, 447 U.S. at 309-10; Parker v. Flook, 437 U.S. 584, 588 n.9 (1978).

[FN98]. Chakrabarty, 447 U.S. at 309 (quoting S. Rep. No. 1979, at 5 (1952)).

[FN99]. The Court of Appeals for the Federal Circuit has exclusive jurisdiction to hear appeals from federal district courts on patent matters. See 28 U.S.C. ¤ 1295(a) (2000). Hence, the views of the Federal Circuit on the scope of patentable subject matter effectively establish nationwide tests subject only to revision by a contrary Supreme Court decision or a statutory change by Congress.

[FN100]. See State St. Bank & Trust Co., 149 F.3d at 1375; In re Alappat, 33 F.3d 1526, 1540-45 (Fed. Cir. 1994) (en banc); Arrhythmia Research Tech., Inc. v. Corazonix Corp., 958 F.2d 1053, 1058-61 (Fed. Cir. 1992).

[FN101]. 149 F.3d 1368 (Fed. Cir. 1998).

[FN102]. Id. at 1375 (footnote omitted).

[FN103]. 33 F.3d 1526 (Fed. Cir. 1994) (en banc).

[FN104]. See id. at 1544.

[FN105]. Suzanne R. Swanson, The Patentability of Business Methods, Mathematical Algorithms and Computer-Related Inventions After the Decision by the Court of Appeals for the Federal Circuit in State Street, 8 Fed. Cir. B.J. 153, 158 (1999).

[FN106]. See 35 U.S.C. ¤ 101 (1994).

[FN107]. See discussion infra Part V.

[FN108]. See In re Bergy, 596 F.2d 952, 965 (C.C.P.A. 1979).

[FN109]. See id.

[FN110]. See id.

[FN111]. See Thomas, supra note 55, at 10.

[FN112]. "Perhaps realizing the expansive grasp of proprietization made possible by the patent system, the courts developed sundry doctrines to cabin its reach." Id.

[FN113]. The patent-limiting doctrines discussed here are by no means the only such doctrines that courts have identified. One court offered the following list of advances that are unpatentable: "principles, laws of nature, mental processes, intellectual concepts, ideas, natural phenomena, mathematical formulae, methods of calculation, fundamental truths, original causes, motives, [and] the Pythagorean theorem." Bergy, 596 F.2d at 965.

[FN114]. In the view of the Federal Circuit court,
> [t]he definition of "algorithm" is not universally agreed. One working definition is that "[a]n algorithm is an unambiguous specification of a conditional sequence of steps or operations for solving a class of problems." Allen Newell, Response: The Models Are Broken, The Models Are Broken, 47 U. Pitt. L. Rev. 1023, 1024 (1986). The same author notes that the label "mathematical algorithm" is a source of confusion: "The first confusion is using involvement with numbers as the hallmark for distinguishing mathematics from nonmathematics, as an aid to determining what is an algorithm.... [M]athematics deals with both nonnumerical things and numerical things.... [T]here are both numerical and nonnumerical algorithms.... Therefore, any attempt to find a helpful or cutting distinction between mathematics and nonmathematics, as between numerical or nonnumerical, is doomed."

In re Schrader, 22 F.3d 290, 293 n.5 (Fed. Cir. 1994).

[FN115]. See Gottschalk v. Benson, 409 U.S. 63, 67 (1972).

[FN116]. See id.

[FN117]. See Rubber-Tip Pencil Co. v. Howard, 87 U.S. 498, 507 (1874).

[FN118]. The relationship involved concerns the ability of the input information to be transformed into a specified type of results or outputs by analyzing the input information in accordance with the algorithm. In essence, this is an idea about the equivalency, with the addition of some analytic effort, of the input and output information.

[FN119]. "Though they may be represented by written formulae, symbols, equations, or 'algorithms,' mathematical exercises remain disembodied. They may not, therefore, cross the threshold of [patentable subject matter]." In re Sarkar, 588 F.2d 1330, 1333 (C.C.P.A. 1978).

[FN120]. See id.

[FN121]. See id. at 1336.

[FN122]. See Benson, 409 U.S. at 67-68.

[FN123]. Id. at 67.

[FN124]. See id.

[FN125]. Chisum, supra note 1, ¤ 1.01 (citations omitted).

[FN126]. See Chisum & Jacobs, supra note 21, ¤ 2C[1][f][v].

[FN127]. See, e.g., Amazon.com, Inc. v. Barnesandnoble.com, Inc., 239 F.3d 1343, 1347-48 (Fed. Cir. 2001) (describing a new method for online purchasing in which a new information-processing algorithm enabled a single computer-mouse click to be used to purchase an item).

[FN128]. See In re Iwahashi, 888 F.2d 1370, 1374 (Fed. Cir. 1989); see also Chisum & Jacobs, supra note 21, ¤ 2C[1][f][iv] (discussing the Freeman-Walter test).

[FN129]. See Iwahashi, 888 F.2d at 1374.

[FN130]. 409 U.S. 63 (1972).

[FN131]. See id. at 71.

[FN132]. See Chisum & Jacobs, supra note 21, ¤ 2C[1][f][ii] (describing the uncertainty created by the Supreme Court's analysis in Benson).

[FN133]. See id. ¤ 2C[1][f][iv] (describing the origins of the Freeman-Walter test).

[FN134]. See id.; 1 David Bender, Computer Law 3A-14.7 (2001).

[FN135]. See Bender, supra note 134, at 3A-15; Chisum & Jacobs, supra note 21, ¤ 2C[1][f][iv].

[FN136]. See Chisum & Jacobs, supra note 21, ¤ 2C[1][f][v].

[FN137]. See Arrhythmia Research Tech., Inc. v. Corazonix Corp., 958 F.2d 1053, 1058 (Fed. Cir. 1992).

In its 1981 Guidelines addressing software patentability standards, the United States Patent and Trademark Office described the Freeman-Walter test as follows:

[E]ach method or apparatus claim must be analyzed to determine whether a mathematical algorithm is either "directly" or "indirectly" recited. If the claim at issue fails to directly recite a mathematical algorithm, reference must be made to the specification in order to determine whether claim language indirectly recites mathematical calculations, formulas, or equations.

If a given claim directly or indirectly recites a mathematical algorithm, the second step of the analysis must be applied. Under this step, a determination must be made as to whether the claim as a whole, including all its steps or apparatus elements, merely recites a mathematical algorithm, or method of calculation. If so the claim does not recite statutory subject matter under 35 U.S.C. ¤ 101.

Rick D. Nydegger, Traversing the Section 112, Paragraph Six Field of Land Mines: Does In re Donaldson Adequately Defuse the Problems (Part I), 76 J.

Pat. & Trademark Off. Soc'y 947, 965-66 (1994) (quoting U.S. Patent and Trademark Office, Patentable Subject Matter--Mathematical Algorithms or Computer Programs, Manual of Patent Examining Procedure ¤ 2110 (4th ed. 1979, rev. 1981)).

[FN138]. See Arrhythmia, 958 F.2d at 1058-59.

[FN139]. See id.

[FN140]. See id.

[FN141]. In In re Walter, 618 F.2d 758 (C.C.P.A. 1980), the court described the application of the second Freeman-Walter step as follows:

> Once a mathematical algorithm has been found, the claim as a whole must be further analyzed. If it appears that the mathematical algorithm is implemented in a specific manner to define structural relationships between the physical elements of the claim (in apparatus claims) or to refine or limit claim steps (in process claims), the claim being otherwise statutory, the claim passes muster under ¤ 101. If, however, the mathematical algorithm is merely presented and solved by the claimed invention, as was the case in Benson and Flook, and is not applied in any manner to physical elements or process steps, no amount of post-solution activity will render the claim statutory; nor is it saved by a preamble merely reciting the field of use of the mathematical algorithm.

Id. at 767 (citations omitted).

[FN142]. See id.

[FN143]. See Arrhythmia, 958 F.2d at 1058-59.

[FN144]. See id.

[FN145]. See Walter, 618 F.2d at 767.

[FN146]. See id.

[FN147]. See id.

[FN148]. See discussion infra at notes 164-68.

[FN149]. See, e.g., In re Alappat, 33 F.3d 1526, 1544-45 (Fed. Cir. 1994) (en banc) (holding that a new device constitutes patentable subject matter if the device is a specific machine that produces a "useful, concrete, and tangible result").

[FN150]. Compare In re Meyer, 688 F.2d 789, 794 (C.C.P.A. 1982) (treating "mathematical algorithms" as a subset of mental processes or mental process equivalents for purposes of applying the Freeman-Walter test), with In re Toma, 575 F.2d 872, 877 (C.C.P.A. 1982) (treating "mathematical algorithms" as only those sequences based on a formula or equation), and In re Freeman, 573 F.2d 1237, 1246 (C.C.P.A. 1978) (same).

[FN151]. See, e.g., Freeman, 573 F.2d at 1245-46.

[FN152]. Varying views on the scope of "mathematical algorithms" within the meaning of the Freeman-Walter test often dictated the outcome of patent litigation. For example, this type of difference in threshold standards and

resulting differences in software evaluations was present in Toma. The patent at issue in this case involved a sequence of information processing to accomplish natural language translation. See Toma, 575 F.2d at 874. The patent office found that this invention met the first prong of the Freeman-Walter test because a form of information-processing algorithm was involved. See id. at 876. However, on appeal, the Court of Customs and Patent Appeals (C.C.P.A.) held that the first prong of the Freeman-Walter test was not satisfied because there was no algorithm involved in the invention. See id. at 876-77. In applying this test, the C.C.P.A. was searching for a mathematical algorithm--that is, a formula or equation--per se. Finding none in the claimed invention, the court simply concluded that problems sought to be addressed by the Freeman-Walter test were not present in the patent under scrutiny. See id. Consequently, the court concluded that patentable subject matter was present. See id. at 877-78.

[FN153]. See, e.g., Pamela Samuelson, Benson Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions, 39 Emory L.J. 1025, 1075-76 (1990) (discussing judicial application of the first prong of the Freeman-Walter test).

[FN154]. See Meyer, 688 F.2d at 795 n.2 (noting that the second step of the Freeman-Walter test was subject to "misinterpretation").

[FN155]. See, e.g., Walter, 618 F.2d at 765.

[FN156]. See id. at 767 (applying the second prong of the Freeman-Walter test, the court determined that patentable subject matter is present if a "mathematical algorithm is implemented in a specific manner to define structural relationships between the physical elements of the claim (in apparatus claims) or to refine or limit claim steps (in process claims)").

[FN157]. See id.

[FN158]. See In re Abele, 684 F.2d 902, 906-07 (C.C.P.A. 1982) (describing sources of uncertainty in applying the second prong of the Freeman- Walter test).

[FN159]. See, e.g., In re Richman, 563 F.2d 1026 (C.C.P.A. 1977); In re de Castelet, 562 F.2d 1236 (C.C.P.A. 1977).

[FN160]. See Walter, 618 F.2d at 767.

[FN161]. In In re Meyer, 688 F.2d 789 (C.C.P.A. 1982), the court concluded that certain physical features of an invention should be ignored in determining if a mathematical algorithm used as part of the invention had a sufficiently functional role in dictating the structure of the invention to make the overall invention patentable subject matter. The court observed that: (1) "mere antecedent data gathering steps do not render the claims statutory"; (2) "mere reference to apparatus does not render a claim statutory"; and (3) "reading out the results of calculations does not render the claim statutory." Id. at 796 n.4 (citations omitted).

[FN162]. See, e.g., Parker v. Flook, 437 U.S. 584 (1978) (analyzing data output steps); Walter, 618 F.2d at 767 (analyzing field of use restrictions); Richman, 563 F.2d at 1026 (analyzing data gathering steps).

[FN163]. See, e.g., Gottschalk v. Benson, 409 U.S. 63 (1972) (finding patent claims to a method for reformatting numerical representations to preempt further use of the information-processing algorithm involved; invention held not to be patentable subject matter); In re Toma, 575 F.2d 872 (C.C.P.A. 1978) (finding patent claims to a method of natural language translation not to preempt further use of the algorithm involved; invention held to be patentable subject matter).

[FN164]. State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368 (Fed. Cir. 1998).

[FN165]. Diamond v. Diehr, 450 U.S. 175 (1981).

[FN166]. Diamond v. Chakrabarty, 447 U.S. 303 (1980).

[FN167]. Alappat, 33 F.3d at 1543.

[FN168]. State St. Bank & Trust Co., 149 F.3d at 1374-75 (quoting Iwahashi, 888 F.2d at 1374.).

[FN169]. See State St. Bank & Trust Co., 149 F.3d at 1375.

[FN170]. See Arrhythmia, 958 F.2d at 1058-60.

[FN171]. See Alappat, 33 F.3d at 1545.

[FN172]. 958 F.2d 1053 (Fed. Cir. 1992).

[FN173]. See id. at 1059-61.

[FN174]. See id. at 1058-59.

[FN175]. See id.

[FN176]. Id. at 1059.

[FN177]. Id.

[FN178]. See id. at 1060.

[FN179]. See id. at 1053-54.

[FN180]. Id. at 1060 (citation omitted).

[FN181]. See id. at 1059.

[FN182]. See id. at 1057.

[FN183]. See discussion infra Part IV.

[FN184]. See Benson, 409 U.S. at 67.

[FN185]. See Chakrabarty, 447 U.S. at 309.

[FN186]. See Benson, 409 U.S. at 67-68.

[FN187]. See id. at 69-70.

[FN188]. Mackay Radio & Tel. Co. v. Radio Corp. of Am., 306 U.S. 86, 94 (1939).

[FN189]. See discussion infra Part V.B.

[FN190]. See, e.g., Sarkar, 588 F.2d at 1333 ("Though every set of steps, of whatever nature, may properly be labeled a 'process,' ¤ 101... limits the patent system to invented processes.").

[FN191]. "Even though a phenomenon of nature or mathematical formula may be well known, an inventive application of the [process] may be patented. Conversely, the discovery of such a phenomenon cannot support a patent [without]... some other inventive concept in its application." Id. at 1335-36 (quoting Parker, 437 U.S. at 594.).

[FN192]. "Sets of steps conducted entirely by nature are not subject to patenting; they are not invented by man." Sarkar, 588 F.2d at 1333.

[FN193]. See, e.g., In re Mancy, 499 F.2d 1289, 1294 (C.C.P.A. 1974) (noting that a method of using natural materials may be patentable even though the natural starting material is unprotectable).

[FN194]. See id. (holding that the process of using a new antibiotic cultivated from a newly found bacterium is clearly within 35 U.S.C. ¤ 101 and, thus, is patentable).

[FN195]. See id.

[FN196]. See 35 U.S.C. ¤ 101(b) (1994) (defining patentable subject matter as including a "new use of a known process, machine, manufacture, composition of matter, or material").

[FN197]. See Mancy, 499 F.2d at 1290-94.

[FN198]. See Brenner v. Manson, 383 U.S. 519, 531-32 (1966).

[FN199]. See, e.g., Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200 (Fed. Cir. 1991) (upholding a patent for a purified and isolated DNA sequence).

[FN200]. See Brenner, 383 U.S. at 531-32.

[FN201]. See, e.g., Diamond v. Chakrabarty, 447 U.S. 303 (1980) (holding that live, human-made micro-organisms are patentable subject matter and can be "manufactured").

[FN202]. See id. at 308-10.

[FN203]. See id. at 310 ("[T]he patentee has produced a new bacterium with markedly different characteristics from any found in nature and one having the potential for significant utility.").

[FN204]. See id.

[FN205]. See In re Prater, 415 F.2d 1393, 1402 n.22 (C.C.P.A. 1969).

[FN206]. See id.

[FN207]. 415 F.2d 1378, 1387-89 (C.C.P.A. 1968), modified on reh'g, 415 F.2d 1393 (C.C.P.A. 1969) (tracing the development of the doctrine).

[FN208]. Specifically, the court held that the doctrine only precludes patents for those processes that can be performed in the human mind without the aid or involvement of further equipment. See id. at 1389.

[FN209]. See id.

[FN210]. See Meyer, 688 F.2d at 796 (rejecting a patent on a computer system on the ground that the patent sought protection for "a mathematical algorithm representing a mental process that has not been applied to physical elements or process steps"); see also Samuelson, supra note 153, at 1118 (noting that the holding in Meyer demonstrated that "the CCPA would not accept a patent for an innovation which was 'concerned with replacing, in part, the thinking processes of a neurologist with a computer" ').

[FN211]. See Meyer, 688 F.2d at 794-95.

[FN212]. The scope and implications of this sort of adjustment of infringement standards are addressed at a later point in this Article. See discussion infra Part VI.C.

[FN213]. "Sets of steps occurring only in the mind have not been made subject to patenting because mental processes are but disembodied thoughts, whereas inventions which Congress is constitutionally empowered to make patentable are tangible embodiments of ideas in the useful, or technological, arts." Sarkar, 588 F.2d at 1333.

[FN214]. 123 U.S.P.Q. (BNA) 446 (Pat. Off. Bd. App. 1943).

[FN215]. See id. at 447.

[FN216]. Id.

[FN217]. Id.

[FN218]. See, e.g., AT&T Corp. v. Excel Communications, Inc., 172 F.3d 1352, 1353 (Fed. Cir. 1999) (holding that patentable subject matter was present in a new electronic record-keeping system for information on long distance calls); State St. Bank & Trust Co., 149 F.3d at 1369 (holding that patentable subject matter was present in a new data-processing system used in investment management).

[FN219]. 149 F.3d 1368 (Fed. Cir. 1998).

[FN220]. See id. at 1370.

[FN221]. See id. at 1373.

[FN222]. See id.

[FN223]. See id. at 1373, 1375.

[FN224]. See In re Musgrave, 431 F.2d 882, 890 (C.C.P.A. 1970).

[FN225]. See id.

[FN226]. Chisum, supra note 1, ¤ 1.03.

[FN227]. See discussion infra Part V.C.

[FN228]. See, e.g., In re Rice, 132 F.2d 140 (C.C.P.A. 1942) (holding that a pictorial method of writing sheet music was not patentable); In re Russell, 48 F.2d 668 (C.C.P.A. 1931) (holding that a method of arranging directories in a phonetic order was not patentable); Boggs v. Robertson, 13 U.S.P.Q. 214 (D.C. Cir. 1931) (holding that printed matter that merely reduced an abstract idea to written form was not patentable). See generally Morton C. Jacobs, Note, The Patentability of Printed Matter: Critique and Proposal, 18 Geo. Wash. L. Rev. 475 (1950) (discussing standards for identifying the patentable and non-patentable aspects of printed matter).

[FN229]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478 (Feb. 28, 1996); see also Samuelson, supra note 153, at 1036-37 (arguing that a basis exists in patent law for denying patents for these types of computer program algorithms and related computer program inventions).

[FN230]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7484; Samuelson, supra note 153, at 1035-36.

[FN231]. See Samuelson, supra note 153, at 1037 n.36.
> Underlying the "printed matter" rule may be a perception that printed matter is among the set of things that are "writings" protectible [sic] by copyright law, not inventions in the "useful arts," and that copyright law strikes the appropriate balance between protection of expression and nonprotection of ideas for written texts. This balance would be disrupted if patents were available based on the content of the "printed matter." When "printed matter" has been patented, it has generally been in situations in which it has been integrated into some machine or physical structure which then supports the patent.

Id.

[FN232]. See Chisum, supra note 1, ¤ 1.02. The fact that a book or other writing is about a technological subject does not make the book a technological advance. As Pamela Samuelson has noted:
> One reason for the "printed matter" rule may be a perception that although printing itself is a manufacturing process and part of the technological arts, the printed matter itself--and its contents, in particular--are not "in the technological arts," even when about the technological arts. A book describing how to organize one's work force in a rubber curing plant most effectively might be the product of a manufacturing process (i.e., the book) and it might be about a manufacturing process, but the content of the work would still not be the kind of manufacture or process traditionally considered to be patentable.

Samuelson, supra note 153, at 1037 n.36.

[FN233]. See Jacobs, supra note 228, at 477.

[FN234]. See id. at 478.

[FN235]. See Samuelson, supra note 153, at 1048, n.70.

[FN236]. Chisum, supra note 1, ¤ 1.02(4) (citations omitted).

[FN237]. See id.

[FN238]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7478-80.

[FN239]. 210 F. 285 (N.D. Ill. 1894).

[FN240]. Id. at 286.

[FN241]. See id.

[FN242]. See id.

[FN243]. See id.

[FN244]. Id.

[FN245]. See id. at 288.

[FN246]. See id.

[FN247]. Id. at 286.

[FN248]. 210 F. 443 (6th Cir. 1913).

[FN249]. See id. at 444.

[FN250]. See id.

[FN251]. See id.

[FN252]. See id.

[FN253]. Id. at 448.

[FN254]. Id. at 450.

[FN255]. Id. at 446-47.

[FN256]. 32 F.3d 1579 (Fed. Cir. 1994).

[FN257]. See id. at 1580.

[FN258]. See id.

[FN259]. See id. at 1582-83.

[FN260]. See id.

[FN261]. See id.

[FN262]. See id. at 1583-84.

[FN263]. Id. at 1583-84 (citation omitted) (quoting In re Bernhart, 417 F.2d 1395, 1400 (C.C.P.A. 1969)).

[FN264]. See id.

[FN265]. See id.

[FN266]. See id.

[FN267]. See id.

[FN268]. See id.

[FN269]. See id.

[FN270]. See id.; see, e.g., In re Gulack, 703 F.2d 1381, 1386 (Fed. Cir. 1983); Bernhart, 417 F.2d at 1400.

[FN271]. See Lowry, 32 F.3d at 1584.

[FN272]. Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478 (Feb. 28, 1996).

[FN273]. See id. at 7481-82.

[FN274]. See id. at 7483-85. The guidelines also deal with patentable devices incorporating computers. See id. at 7482-83. However, these devices, by virtue of the physical structure supplied by their computer and non-computer contents, are inherently tangible inventions. Hence, they do not raise the same sorts of issues about the patentability of intangible inventions which are the focus of this Article.

Computer-based processes, by contrast, do raise these issues. Such processes may be little more than disembodied information-processing sequences. Where these sequences are described in terms of computer operations that do not achieve a practical, useful result, the sequences are nothing more than disembodied information-processing ideas and patentable subject matter should not be found. See id. at 7485-86.

The physical and functional features that must be present in a computer-based process to transform it from an unpatentable processing idea into a patentable invention provide useful examples of the types of features that may distinguish abstract, unapplied subject matter from patentable applications generally. See id. at 7483. Thus, the PTO's guidelines addressing the invention features that are necessary for patenting computer-based processes provide insights into the broader problem of the minimum content of patentable inventions.

[FN275]. Id. at 7483.

[FN276]. See id.

[FN277]. See id. at 7484-85.

[FN278]. See id. at 7484.

[FN279]. It is clear that a process which produces a physical change or "transformation" in an item is sufficient to constitute patentable subject matter. As the Supreme Court observed as early as 1877:

A process is a mode of treatment of certain materials to produce a given result. It is an act, or a series of acts, performed upon the subject-matter

to be transformed and reduced to a different state or thing. If new and useful, it is just as patentable as is a piece of machinery.
Cochrane v. Deener, 94 U.S. 780, 788 (1876) (quoted with approval in Diamond v. Diehr, 450 U.S. 175, 183 (1981)).

While the presence of a physical transformation as the result of the completion of a process is sufficient to make the process patentable subject matter, it is doubtful that such a transformation is necessary. Lower federal courts have held that it is not. See, e.g., AT&T Corp. v. Excel Communications, Inc., 172 F.3d 1352, 1358-59 (Fed. Cir. 1999) (finding patentable subject matter in a new electronic record-keeping format for information on long-distance calls); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1373 (Fed. Cir. 1998) (finding patentable subject matter in a new data-processing system used in investment management).

[FN280]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7483.

[FN281]. See id. at 7479.

[FN282]. See id.

[FN283]. 15 International Encyclopedia of the Social Sciences 576 (David L. Sills ed., 1968).

[FN284]. Under a broadly inclusive view, technology may involve all things that are undertaken in accordance with a "technical operation," where a technical operation includes "every operation carried out in accordance with a certain method in order to attain a particular end." Jacques Ellul, The Technological Society 19 (John Wilkinson trans., Alfred A. Knopf ed., 1964).

[FN285]. See id. at 3-10; see also Mitcham, supra note 53, at 161-63 (discussing various objects as forms of technology).

[FN286]. See Ellul, supra note 284, at 3-10.

[FN287]. See id.

[FN288]. See Mitcham, supra note 53, at 168-69.

[FN289]. Arnold Pacey, The Culture of Technology 6 (1983) (emphasis in original omitted).

[FN290]. See id.

[FN291]. See id. at 6-7.

[FN292]. See id.

[FN293]. An inventor must gain at least a working understanding of an invention to be able to provide a sufficient description of the invention in a patent application. The description of an invention in the specifications and drawings within a patent application must provide sufficient information about the invention "to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same...." 35 U.S.C. ¤ 112 (1994).

[FN294]. Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478, 7486 (Feb. 28, 1996).

[FN295]. See Mitcham, supra note 53, at 198.

[FN296]. Technological knowledge is frequently valuable in industrial settings where repeated activities are common and the advantages of a technological solution to a practical problem can be realized systematically over and over again. However, technological processes and tools are not limited to industrial contexts. Rather, they are present in diverse settings where parties undertake recurrent activities. See McGraw-Hill Concise Encyclopedia of Science and Technology 1954 (Sybil P. Parker ed., 4th ed. 1994) (stating that technology involves "systematic knowledge and action, usually of industrial processes but applicable to any recurrent activity").

[FN297]. See Daniel Bell, The Winding Passage: Essays and Sociological Journeys 1960-1980, at 20 (1980) ("Technology is the instrumental ordering of human experience within a logic of efficient means."); John Kenneth Galbraith, The New Industrial State 12 (2d ed., rev. 1971) ("Technology means the systematic application of scientific or other organized knowledge to practical tasks.").

[FN298]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478, 7478 (Feb. 28, 1996); Jacob Bigelow, Elements of Technology, at v (2d ed. 1831).

[FN299]. See Bigelow, supra note 298.

[FN300]. Id. at v.

[FN301]. Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478, 7488 (Feb. 28, 1996) (quoting Computer Dictionary 384 (Microsoft Press, 2d ed. 1994)).

[FN302]. Thomas, supra note 55, at 38.

[FN303]. Donald Cardwell, The Norton History of Technology 492-93 (Roy Porter ed., 1995); see also Durham, supra note 51, at 1445 n.133 (noting that American patent laws embrace this view of technology, permitting patents for inventions that are functionally complete, but that have internal operations which are not fully understood by their inventors; such discoveries are patentable because an "[i]nvention without understanding is still a contribution to the 'useful arts" ').

[FN304]. See, e.g., V. Gordon Childe, Early Forms of Society, in 1 A History of Technology 38 (Charles Singer et al. eds., 1954); Robert E. McGinn, What is Technology?, in 1 Research in Philosophy & Technology: An Annual Compilation of Research 179, 179-81 (Paul T. Durbin ed., 1978).

[FN305]. McGinn, supra note 304, at 181.

[FN306]. Childe, supra note 304, at 38.

[FN307]. Thomas, supra note 55, at 53.

[FN308]. See id.

[FN309]. See id. at 41-45.

[FN310]. Id. at 46.

[FN311]. Paul W. DeVore, Technology: An Introduction 226 (1980).

[FN312]. Id. at 225.

[FN313]. See discussion supra Part III.B.2.

[FN314]. See, e.g., Thomas, supra note 55, at 46 (stating that technology is "knowledge that is applied towards material enterprise, guided by an orientation to the external environment and the necessity of design").

[FN315]. See id.

[FN316]. See id.

[FN317]. See discussion infra Part IV.D.1.

[FN318]. See id.

[FN319]. See id.

[FN320]. See discussion infra Part VI.B.

[FN321]. See id.; see also Thomas, supra note 55, at 10 (stressing the resulting "constantly shifting contours" of the patent system).

[FN322]. In order to be patentable, an advance must be more than just an obvious extension of current technological knowledge in the field of the advance. This standard is currently embodied in Section 103 of the Patent Act which provides:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. ¤ 103 (1994); see also Graham v. John Deere Co., 383 U.S. 1, 17 (1966) ("Under ¤ 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined.").

[FN323]. Designs for items or processes that are available to the public through prior disclosures are unpatentable because the designs are not novel. See 35 U.S.C. ¤ 102(a) (1994). Designs for items or processes that are new but that are no more than small, obvious variations from the designs of existing items or processes are not patentable because they do not meet the patent statute's requirement of nonobviousness. See id. ¤ 103.

[FN324]. The scope of differences between a new invention and prior art--and, hence, the likelihood that the differences will be viewed as nonobvious and the invention deemed patentable--depends on two types of differences:

The first is the difference between the claims and the prior art purely in terms of structure or methodology. For product claims, how does the claimed product differ in physical structure from the products in the prior art? For process claims, how does the claimed process differ in terms of operative steps from the processes in the prior art? 'Differences' in this sense are ascertained by interpretation of the teachings of the prior art and of the claims of the patent or application.

The second is the difference between the claims and the prior art in terms of functions and advantages (comparative utility). What functions, advantages and results does the claimed product or process have that the prior art products or processes do not in fact have?

Chisum, supra note 1, ¤ 5.03(5)(a) (citation omitted). Where a new invention is unexpectedly superior in some functional attribute to comparable items or processes previously known in the prior art, the new invention will typically be seen as nonobvious and patentable if all other patent law standards are met. See, e.g., In re Chupp, 816 F.2d 643, 646-47 (Fed. Cir. 1987).

[FN325]. See Swanson, supra note 105, at 158-64.

[FN326]. A number of courts have recognized the need for broadly inclusive, technologically diverse standards for identifying patentable subject matter. For example, in In re Bergy, the Court of Customs and Patent Appeals observed that "[t]o insist on specific Congressional foresight in construing ¤ 101 would be the very antithesis of the Constitutional and Congressional purpose of stimulating the creation of new technologies--by their nature unforeseeable--and their progressive development." 596 F.2d 952, 973 (C.C.P.A. 1979), aff'd sub nom. Diamond v. Chakrabarty, 447 U.S. 303 (1980). In reaching this conclusion, "the court unanimously agreed that statutory subject matter under ¤ 101 was broadly drawn to encompass unforeseeable future developments, such as a new field of technology." Swanson, supra note 105, at 157-58.

[FN327]. See, e.g., United States v. Am. Bell Tel. Co., 167 U.S. 224, 238-39 (1896) (comparing patents for lands with patents for inventions); Chisum & Jacobs, supra note 21, ¤ 2C[1] (describing judicial views on the scope of patentable subject matter).

[FN328]. An agency process is present whenever one party is called upon to undertake activities on behalf of another. For a complete treatment of the features of agency processes, see Kenneth J. Arrow, The Economics of Agency, in Principals and Agents: The Structure of Business 37 (John W. Pratt & Richard J. Zeckhauser eds., 1985).

[FN329]. See 3 Jeremy Bentham, Manual of Political Economy, in The Works of Jeremy Bentham 31, 71 (1962) (describing the role of patents in encouraging inventors to pursue and deliver innovations desired by the public).

[FN330]. See generally Restatement (Second) of Agency (1958) (discussing agency law).

[FN331]. See id. ¤ 1 (describing agency law standards that apply to "the fiduciary relation which results from the manifestation of consent by one person to another that the other shall act on his behalf and subject to his control, and consent by the other so to act").

[FN332]. See id. ¤ 1 cmt. b.

[FN333]. See id.

[FN334]. See id. ¤ 1 cmt. c; see also id. ¤¤ 376-77, 432, 441 (distinguishing the roles of principals and agents).

[FN335]. See id. ¤¤ 377-98, 432-62.

[FN336]. See id. ¤ 1 cmt. b; see also id. ¤¤ 212-67 (discussing the liability of principals to third parties).

[FN337]. See id.

[FN338]. See discussion infra Part IV.C.

[FN339]. See discussion infra Part IV.C.2.a.

[FN340]. See discussion infra Part IV.C.2.b.

[FN341]. See 35 U.S.C. ¤ 112 (1994).

[FN342]. See Restatement, supra note 330, ¤ 14.

[FN343]. See Arrow, supra note 328, at 37-38.

[FN344]. See id. at 37-38.

[FN345]. See id. at 43-44.

[FN346]. See id. at 45-46.

[FN347]. See id. at 45.

[FN348]. See Leonard Lakin & Martin Schiff, The Law of Agency 103-10 (1984).

[FN349]. See id.; Restatement, supra note 330, ¤¤ 33-35, 379, 383.

[FN350]. See David A. Burge, Patent and Trademark: Tactics and Practice 31-33 (3d ed. 1999).

[FN351]. See William B. Bennett, The American Patent System: An Economic Interpretation 1-5 (1943).

[FN352]. See id.

[FN353]. See Burge, supra note 350, at 32-33.

[FN354]. See id. at 27-46.

[FN355]. See generally id. at 32-33 (discussing sources of inventions).

[FN356]. See id.

[FN357]. See id.

[FN358]. See id.

[FN359]. See id.

[FN360]. See id.

[FN361]. See Guide to Invention and Innovation Evaluation 73-74 (Gerald G. Udell et al. eds., 1977) [hereinafter Invention and Innovation Evaluation]. See generally Chad King, Abort, Retry, Fail: Protection for Software-Related Inventions in the Wake of State Street Bank & Trust Co. v. Signature Financial Group, Inc., 85 Cornell L. Rev., 1118, 1163-64 (2000) (observing that "[f]unctionality is the domain of patent law; unless Congress legislates a sui generis protection scheme, patent law provides the only comprehensive protection for the functional aspects of [various technology specialties]").

[FN362]. See 35 U.S.C. ¤ 154(d) (1994); Seth A. Cohen, To Innovate or Not to Innovate, That Is the Question: The Functions, Failures, and Foibles of the Reward Function Theory of Patent Law in Relation to Computer Software Platforms, 5 Mich. Telecomm. & Tech. L. Rev. 1, 3 (1998), available at http://www.mttlr.org/volfive/cohen-art.html (stating that "the reward function utilizes legal devices to create incentives for technological innovation and disclosure by means of granting rewards which are otherwise unrecognizable by the innovator").

[FN363]. See 35 U.S.C. ¤ 154(a)(1) (1994).

[FN364]. The analysis in this section assumes that an innovator realizes gains from a patent by charging a royalty for use of the patented invention. Equivalent gains may be realized by charging elevated prices for sales of a patented invention. The analysis of how much the sales price of a patented invention can be elevated over the price of nonpatented substitutes is equivalent to the patent royalty analysis presented in the main text. Sales prices for a patented item can be elevated by an amount less than or equal to the value of the increased utility achieved by the patented version of the item, above and beyond the utility achieved by nonpatented alternatives to the patented product. Since the considerations governing sales price increases for patented products are directly parallel to those governing royalties for use of the same products, additional discussion of patent-influenced sales prices is not presented in the main text.

[FN365]. See 3 Roger M. Milgrim, Milgrim on Licensing ¤ 18.06 (2001); see also Joby A. Hughes & Kate L. Birenbaum, Insuring Intellectual Property Risks: Creative Solutions on the Cutting Edge, in Protecting Your Intellectual Property Assets 1999, at 203 (1999) (stating that "patent value can be established quantitatively based on the incremental value associated with higher sales and increased price as compared to other models that do not have the [patented] feature"); Lauren Johnston Stiroh & Richard T. Rapp, Modern Methods for the Valuation of Intellectual Property, in PLI's Fourth Annual Institute for Intellectual Property Law 821 (4th ed. 1998) (stating that "[o]nly inventions that fulfill a need that producers or consumers are willing to pay to fulfill can be valuable").

[FN366]. See Stiroh & Rapp, supra note 365, at 8-9. See generally Roger L. Beck, Patents and Over-Investment in Process Inventions: Reply, 45 S. Econ. J. 289 (1978) (discussing the appropriate reward for partially and completely redundant inventions).

[FN367]. See Nuala Swords-Isherwood, The Process of Innovation: A Study of Companies in Canada, the United States and the United Kingdom 9-15 (1984).

[FN368]. See id.

[FN369]. See Robert P. Merges, Uncertainty and the Standard of Patentability, 7 High Tech. L.J. 1, 20-21 (1992) (stating that the decision to invent "can be thought of as an investment decision like any other. The inventor faces the choice of attempting to invent, or of investing her money elsewhere. In this conception, patents are held out as a potential reward to induce the inventor to decide to proceed with research.").

[FN370]. See Invention and Innovation Evaluation, supra note 361, at 73-74.

[FN371]. See id. at 29.

[FN372]. See Kerry Schott, Industrial Innovation in the United Kingdom, Canada and the United States 46-52 (1981).

[FN373]. See Douglas Gary Lichtman, The Economics of Innovation: Protecting Unpatentable Goods, 81 Minn. L. Rev. 693, 710 (1997) (stating that "[a]n innovation is good for society whenever its societal value (the sum of consumer and producer surplus) exceeds its development costs.... Goods that satisfy this criterion will be produced whenever an original innovator believes that his own personal reward (producer surplus) will exceed those same development costs.").

[FN374]. See id.; Invention and Innovation Evaluation, supra note 361, at 35-36.

[FN375]. See Lichtman, supra note 373, at 710; Invention and Innovation Evaluation, supra note 361, at 31-44.

[FN376]. See Swords-Isherwood, supra note 367, at 12-13; Lichtman, supra note 373, at 702 n.32 (stating that an innovator working on only one invention, who is unsure of success or failure:

> will invest in a new idea only if the rewards from success sufficiently outweigh both the costs of success and the risks (and accompanying costs) of failure. A system that paid only development costs (the costs of success) would pay nothing toward this risk premium and therefore would not sufficiently reward the innovator.).

[FN377]. See Brenner v. Manson, 383 U.S. 519, 528-29 (1966) (holding that "practical utility... is an essential element in establishing a prima facie case for the patentability of [a] process"). Id. at 520.

[FN378]. See id. at 528-36.

[FN379]. See Arrow, supra note328, at 37.

[FN380]. See id.

[FN381]. See id.

[FN382]. This may not be universally true. There may be, for example, detailed combinations of aesthetic elements--such as those combined in a written work or a graphic image--that are predictably pleasing, perhaps because they match or closely mimic previously pleasing patterns. The creation of these detailed patterns of aesthetic elements for the benefit of persons other than their originators may be encouraged by intellectual

property laws providing protections and rewards for the resulting creative works. For example, this type of encouragement for new expressive works aimed at satisfying aesthetic tastes is provided under copyright laws. See 17 U.S.C. ¤¤ 101-1332; Chisum & Jacobs, supra note 21, ¤ 4A. The protections and incentives that copyright laws create generally reward persons who correctly predict the aesthetic interests of readers, viewers, or listeners and who create expressive works that match those interests.

[FN383]. See generally Arrow, supra note 328, at 37 (discussing the role each party plays in an agency relationship).

[FN384]. See Chisum, supra note 1, ¤ 1.03 (noting that innovations that depend on the aesthetic, emotional, or normative reactions of a human actor should not be considered to be useful inventions for purposes of patent law).

[FN385]. Even if it were used in conjunction with the requisite judgment or skill, the advance would have a degree of value that is difficult to measure separately and that would vary in accordance with the care and effectiveness of the person exercising the judgment or skill. This would significantly impair the ability of potential users to monitor and evaluate the projected value of a new innovation and to provide corresponding payments to innovators for developing such an innovation. The degree of value attributable to a new innovation--as opposed to that attributable to the judgment or skill of a given user--would always be in doubt.

[FN386]. See William H. Francis & Robert C. Collins, Patent Law 389 (4th ed. 1995) (discussing utility as a necessary feature of a patentable invention).

[FN387]. See id.

[FN388]. See 35 U.S.C. ¤ 112 (1994).

[FN389]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478, 7479 (Feb. 28, 1996); Francis & Collins, supra note 386, at 408-12.

[FN390]. See 35 U.S.C. ¤ 112; see also Francis & Collins, supra note 386, at 410-11 (discussing invention description requirements for a valid patent).

[FN391]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7479; Francis & Collins, supra note 386, at 408.

[FN392]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7487; Francis & Collins, supra note 386, at 408.

[FN393]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7486; Francis & Collins, supra note 386, at 409.

[FN394]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7486.

[FN395]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7486; Francis & Collins, supra note 386, at 408-13.

[FN396]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. at 7487.

[FN397]. See generally Chemtool, Inc. v. Lubrication Tech., Inc., 148 F.3d 742, 745 (7th Cir. 1998) (describing the necessary features of an agency relationship created by conduct or contract); Restatement, supra note 330, ¤1 (describing agency relationships created through contracts).

[FN398]. See generally Grubb & Ellis Co. v. Bradley Real Estate Trust, 909 F.2d 1050, 1054 (7th Cir. 1990) (describing an agent's role as governed by contract terms); Restatement, supra note 330, ¤ 1 (discussing the agent's role in an agency relationship).

[FN399]. These conditions will be present where parties share common activities and corresponding needs for supplies and tools to support those activities, but do not have cost-effective methods for contracting (either separately or as a group) with innovators who might fill the needs.

[FN400]. See Lichtman, supra note 373, at 710.

[FN401]. See id.

[FN402]. See 35 U.S.C. ¤ 101 (1994).

[FN403]. Portions of these tests for patentable subject matter admittedly overlap with other minimum standards that must be met by a patentable invention. In particular, the first criterion focusing on the need for an innovation to fill a user need with identifiable value imposes a test that is probably coextensive with the traditional requirement that patents should only attach to inventions with identifiable utility. See 35 U.S.C. ¤ 101; Francis & Collins, supra note 386, at 170-73. Similarly, the requirement that patentable subject matter be capable of being described completely states a test that is related to the requirement that a complete patent application must include an enabling disclosure from which a specialist in the field of the invention can understand and recreate the invention. See 35 U.S.C. ¤ 101; Francis & Collins, supra note 386, at 408-13. The appearance of these similar standards in patentable subject matter tests and other patent law tests should create no problems, so long as they are interpreted consistently. In any case, these standards are included here as part of patentable subject matter tests because satisfaction of these standards is a critical step towards the effective formation of innovative agency relationships. So long as tests are applied which limit patent rights and incentives to circumstances where innovative agency relationships can operate effectively, it matters little where in patent law doctrine these tests reside.

[FN404]. See Carson & Nelson, supra note 35, at 205-08.

[FN405]. Thomas, supra note 55, at 12-13.

[FN406]. See U.S. Patent & Trademark Office, A Guide to Filing a Utility Patent Application (last modified Mar. 7, 2001), available at http://www.uspto.gov/web/offices/pac/utility/utility.htm (providing an explanation of how to describe an invention in a patent application).

[FN407]. See id.

[FN408]. See Carson & Nelson, supra note 35, at 196-97 (providing an example of a patent claim).

[FN409]. See Examination Guidelines for Computer-Related Inventions, 61 Fed. Reg. 7478, 7479 (Feb. 28, 1996).

[FN410]. See id. at 7480.

[FN411]. See generally David J. Weitz, The Biological Deposit Requirement: A Means of Assuring Adequate Disclosure, 8 High Tech. L.J. 275, 279 (1993) (discussing the difficulty of adequately describing biological inventions in written texts).

[FN412]. See State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1375 (Fed. Cir. 1998).

[FN413]. See In re Alappat, 33 F.3d 1526, 1542-45 (Fed. Cir. 1994); In re Iwahashi, 888 F.2d 1370, 1374 (Fed. Cir. 1989).

[FN414]. See Alappat, 33 F.3d at 1544.

[FN415]. See id.

[FN416]. See Diamond v. Diehr, 450 U.S. 175, 184 (1981).

[FN417]. See Alappat, 33 F.3d at 1544.

[FN418]. See State St. Bank & Trust Co., 149 F.3d at 1373.

[FN419]. See Brenner v. Manson, 383 U.S. 519, 528-36 (1966).

[FN420]. See Diehr, 450 U.S. at 178-81 (describing a process in which a computer controlled the operation of a physical device).

[FN421]. See id.

[FN422]. See generally id. at 187 (discussing the patentability of a software-controlled process that was a substitute for an earlier human-controlled process).

[FN423]. See id. at 184 n.8.

[FN424]. See id. at 175.

[FN425]. See id. at 191-92.

[FN426]. See id. at 185.

[FN427]. See id. at 187.

[FN428]. See id. at 183-89.

[FN429]. See In re Toma, 575 F.2d 872, 874 (C.C.P.A. 1978).

[FN430]. Where a physical tool is applied to a purely intellectual or intangible task, a technological device or process is present because a physical tool is involved. Thus, for example, a means for operating an electronic device to translate text from one language to another is a patentable advance because it involves a new means for operating a physical device. See id. at 877-78. The fact that the device is applied to a

nontechnological task--the intellectual task of language translation--does not make the method of operating the electronic device unpatentable subject matter. Rather, as explained by the court in Toma, the method falls within the technological arts and therefore is patentable subject matter regardless of the nontechnological ends to which it is applied:

> [A] method for enabling a computer to translate natural languages is in the technological arts, i.e., it is a method of operating a machine. The "technological" or "useful" arts inquiry must focus on whether the claimed subject matter (a method of operating a machine to translate) is statutory, not on whether the product of the claimed subject matter (a translated text) is statutory, not on whether the prior art which the claimed subject matter purports to replace (translation by human mind) is statutory, and not on whether the claimed subject matter is presently perceived to be an improvement over the prior art, e.g., whether it "enhances" the operation of a machine.

Id. (citations omitted).

[FN431]. See, e.g., Arrhythmia Research Tech., Inc. v. Corazonix Corp., 958 F.2d 1053, 1058-60 (Fed. Cir. 1992) (holding that a method for analyzing electrocardiographic signals to determine certain characteristics of heart functions was patentable subject matter because, although the essence of the method involved complicated numerical processing, "the resultant output is not an abstract number, but is a signal related to the patient's heart activity").

[FN432]. State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368 (Fed. Cir. 1998).

[FN433]. See id. at 1370.

[FN434]. See id. at 1372-75.

[FN435]. See id. at 1374-75.

[FN436]. See id. at 1375.

[FN437]. See Chisum & Jacobs, supra note 21, ¤ 2C[2] (noting that a patentable invention must be "operable and capable of satisfying some function of benefit to humanity").

[FN438]. See generally id. ¤ 2C[1][f] (explaining that a patent application must describe an invention in terms that will enable one with ordinary skill in the art to make and use the invention without undue experimentation).

[FN439]. U.S. Const. art. I, ¤ 8, cl. 7.

[FN440]. U.S. Const. amend. I.

[FN441]. See In re Prater, 415 F.2d 1393, 1400 n.20 (C.C.P.A. 1969) (noting, but not ruling on, concern expressed by the United States Patent and Trademark Office that patent claims precluding an individual from thinking in a particular manner would violate the First Amendment); Dan L. Burk, Software as Speech, 8 Seton Hall Const. L.J. 683, 690 (1998) (arguing that the mental steps doctrine previously limited patent rights so as to avoid patent restrictions that would raise First Amendment issues but that weakening of the mental steps doctrine means that patent laws may now limit free use of mental processes in ways that will violate the First Amendment); Gary L.

Francione, Experimentation and the Marketplace Theory of the First Amendment, 136 U. Pa. L. Rev. 417, 512 (1987) (noting that patent limitations on the use of certain new items may restrict academic freedom regarding further research addressing those items but questioning whether the First Amendment will protect free pursuit of such research); Kreiss, supra note 88, at 86 (arguing that "a claimed patent on a process for improving gymnastics performances by mentally visualizing the entire routine prior to performing it should be barred from patentable subject matter on First Amendment grounds").

[FN442]. See Francione, supra note 441, at 427-30.

[FN443]. See id.
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