B. Human and Computer Involvement in Computational Inventions

1. Requirements for Inventorship

All patent applications require one or more named inventors who must be "individuals," a legal entity such as a corporation cannot be an inventor.[100] Inventors own their patents as a form of personal property that they may transfer by "assignment" of their rights to another entity.[101] A patent grants its owner "the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States."[102] If a patent has multiple owners, each owner may independently exploit the patent without the consent of the others (absent a conflicting contractual obligation).[103] This makes the issue of whether a computer can be an inventor one of practical as well as theoretical interest because inventors have ownership rights in their patents, and failure to list an inventor can result in a patent being held invalid or unenforceable.[104]

For a person to be an inventor, the person must contribute to an invention's "conception."[105] Conception refers to, "the formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention as it is thereafter to be applied in practice."[106] It is "the complete perfor-

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[100] *See* 35 U.S.C. § 100(f) (1952) "The term 'inventor' means the individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention." *See id*. The same issues surrounding computer inventorship may not exist outside of the U.S. where applications do not require a named inventor. *See* MPEP, *supra* note 43, § 2137.01 ("The requirement that the applicant for a patent in an application filed before September 16, 2012 be the inventor(s) . . . and that the inventor . . . be identified in applications filed on or after September 16, 2012, are characteristics of U.S. patent law not generally shared by other countries."). For example, a patent application at the European Patent Office may be filed by "any body equivalent to a legal person by virtue of the law governing it." Convention on the Grant of European Patents art. 58, Oct. 5, 1973, 1065 U.N.T.S. 199. Under the U.S. Patent Act, only individuals can invent, not corporations. *See* 35 U.S.C. §§ 115–116.

[101] *See* MPEP, *supra* note 43, § 300. About ninety-three percent of patents are assigned to organizations (rather than individuals). *See Patenting by Organizations (Utility Patents)*, USPTO, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/topo_13.htm#PartA1_1b [https://perma.cc/VF56-GFVT] (last modified Jan. 25, 2016). For example, it is common for scientific and technical workers to preemptively assign their patent rights to employers as a condition of employment. Most, but not all, inventions can be placed under an obligation of assignment in employment contracts. For example, in California, employees are permitted to retain ownership of inventions that are developed entirely on their own time without using their employer's equipment, supplies, facilities, or trade secret information except for inventions that either: related, at the time of conception or reduction to practice of the invention, to the employer's business; actual or demonstrably anticipated research or development of the employer; or resulted from any work performed by the employee for the employer. CAL. LAB. CODE § 2872(a) (West 1979).

[102] 35 U.S.C. § 154.

[103] *See* MPEP, *supra* note 43, § 2137.

[104] *See, e.g.*, Advanced Magnetic Closures, Inc. v. Rome Fastener Corp., 607 F.3d 817, 829 (Fed. Cir. 2010).

[105] MPEP, *supra* note 43, § 2137.01(II).

[106] Townsend v. Smith, 36 F.2d 292, 295 (C.C.P.A. 1929).

mance of the mental part of the inventive act."[107] After conception, someone with ordinary skill in the invention's subject matter (e.g., a chemist if the invention is a new chemical compound) should be able to "reduce the invention to practice."[108] That is to say, they should be able to make and use an invention from a description without extensive experimentation or additional inventive skill.[109] Individuals who simply reduce an invention to practice, by describing an already conceived invention in writing or by building a working model from a description for example, do not qualify as inventors.[110]

2. The Role of Computers in Inventive Activity

The requirement that an inventor participate in the conception of an invention creates barriers to inventorship for computers as well as people. Although computers are commonly involved in the inventive process, in most cases, computers are essentially working as sophisticated (or not-so-sophisticated) tools. One example occurs when a computer is functioning as a calculator or storing information. In these instances, a computer may assist a human inventor to reduce an invention to practice, but the computer is not participating in the invention's *conception*. Even when computers play a more substantive role in the inventive process, such as by analyzing data in an auto-

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[107] *Id.*

[108] Reduction to practice refers to either actual reduction—where it can be demonstrated the claimed invention works for its intended purpose (for example, with a working model)—or to constructive reduction—where an invention is described in writing in such a way that it teaches a person of ordinary skill in the subject matter to make and use the invention (as in a patent application). *See In re* Hardee, 223 U.S.P.Q. (BNA) 1122, 1123 (Com'r Pat. & Trademarks Apr. 3, 1984); *see also* Bd. of Educ. *ex rel.* Bd. of Trs. of Fla. State Univ. v. Am. Bioscience, Inc., 333 F.3d 1330, 1340 (Fed. Cir. 2003) ("Invention requires conception."). With regard to the inventorship of chemical compounds, an inventor must have a conception of the specific compounds being claimed. *See Am. Bioscience*, 333 F.3d at 1340 ("[G]eneral knowledge regarding the anticipated biological properties of groups of complex chemical compounds is insufficient to confer inventorship status with respect to specifically claimed compounds."); *see also Ex parte* Smernoff, 215 U.S.P.Q 545, 547 (Pat. & Tr. Office Bd.App. Aug. 17,1982) ("[O]ne who suggests an idea of a result to be accomplished, rather than the means of accomplishing it, is not a coinventor."). Actual reduction to practice "requires that the claimed invention work for its intended purpose." Brunswick Corp. v. United States, 34 Fed. Cl. 532, 584 (1995) (quotations omitted) (quoting Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1376 (Fed. Cir. 1986). Constructive reduction to practice "occurs upon the filing of a patent application on the claimed invention." *Id*. The written description requirement is "to ensure that the inventor had possession, as of the filing date of the application relied on, of the specific subject matter later claimed by him." *Application of* Edwards, 568 F.2d 1349, 1351 (C.C.P.A. 1978).

[109] "[C]onception is established when the invention is made sufficiently clear to enable one skilled in the art to reduce it to practice without the exercise of extensive experimentation or the exercise of inventive skill." Hiatt v. Ziegler & Kilgour , 179 U.S.P.Q. 757, 763 (Bd. Pat. Interferences Apr. 3, 1973). Conception has been defined as a disclosure of an idea that allows a person skilled in the art to reduce the idea to a practical form without "exercise of the inventive faculty." Gunter v. Stream, 573 F.2d 77, 79 (C.C.P.A. 1978).

[110] *See* De Solms v. Schoenwald, 15 U.S.P.Q. 2d 1507, 1510 (Bd.Pat.App.& Interferences. Feb. 22, 1990).

mated fashion, retrieving stored knowledge, or by recognizing patterns of information, the computer still may fail to contribute to conception. Computer involvement might be conceptualized on a spectrum: on one end, a computer is simply a tool assisting a human inventor; on the other end, the computer independently meets the requirements for inventorship. AI capable of acting autonomously such as the Creativity Machine and the Invention Machine fall on the latter end of the spectrum.

3. The Role of Humans in Inventive Activity

Just as computers can be involved in the inventive process without contributing to conception, so can humans. For now, at least, computers do not entirely undertake tasks on their own accord. Computers require some amount of human input to generate creative output.

For example, before the Creativity Machine composed music, Dr. Thaler exposed it to existing music and instructed it to create something new.[111] Yet, simply providing a computer with a task and starting materials would not make a human an inventor.[112] Imagine Friend *A* tells Friend *B*, who is an engineer, that *A* would like *B* to develop an iPhone battery with twice the standard battery life and *A* gives *B* some publically available battery schematics. If *B* then succeeds in developing such a battery, *A* would not qualify as an inventor of the battery by virtue of having instructed *B* to create a result.[113] This scenario essentially occurred in the case of the Creativity Machine's toothbrush invention: Dr. Thaler provided the Creativity Machine information on existing toothbrush designs along with data on each brush's effectiveness.[114] Solely from this information, the Creativity Machine produced the first ever crossed-bristle design.[115] This does not make Dr. Thaler an inventor. In the case of the Creativity Machine, the creative act is the result of random or chaotic perturbations in the machine's existing connections that produce new results which, in turn, are judged by the machine for value.[116]

Humans are also necessarily involved in the creative process because computers do not arise from a void; in other words, humans have to create computers.[117] Once again, that should not prevent computer inventorship. No

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[111] Thaler, Telephone Interview, *supra* note 38.

[112] *Ex parte* Smernoff, 215 U.S.P.Q. at 547 ("[O]ne who suggests an idea of a result to be accomplished, rather than the means of accomplishing it, is not a coinventor.").

[113] *See id.*

[114] Thaler, Telephone Interview, *supra* note 38.

[115] *Id.*

[116] *See* Thaler, *Creativity Machine® Paradigm*, *supra* note 29, at 449.

[117] This will be the case until computers start designing other computers or engaging in reflection. Reflection is a software concept that refers to a computer program that can examine itself and modify its own behavior (and even its own code). J. Malenfant et al., *A Tutorial on Behavioral Reflection and Its Implementation*, *in* PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE REFLECTION 1, 1–

one would exist without their parents contributing to their conception (pun intended), but that does not make parents inventors on their child's patents. If a computer scientist creates an AI to autonomously develop useful information and the AI creates a patentable result in an area not foreseen by the inventor, there would be no reason for the scientist to qualify as an inventor on the AI's result. An inventor must have formed a "definite and permanent idea of the complete and operative invention" to establish conception.[118] The scientist might have a claim to inventorship if he developed the AI to solve a particular problem, and it was foreseeable that the AI would produce a particular result.[119]

4. Combining Human and Computer Creativity

A computer may not be a sole inventor; the inventive process can be a collaborative process between human and machine. If the process of developing the Creativity Machine's Patent had been a back-and-forth process with both the AI and Dr. Thaler contributing to conception, then both might qualify as inventors.[120] By means of illustration, suppose a human engineer provides a machine with basic information and a task. The engineer might learn from the machine's initial output, then alter the information that he or she provides to the machine to improve its subsequent output. After several iterations, the machine might produce a final output that the human engineer might directly alter to create a patentable result. In such a case, both the engineer and the machine might have played a role in conception. Leaving AI aside, invention is rarely occurs in a vacuum, and there are often joint inventors on patents.[121] In some of these instances, if a computer were human, it would be an inventor. Yet, computers are not human, and, as such, they face unique barriers to qualifying as inventors.

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20 (1996), *available at* http://www2.parc.com/csl/groups/sda/projects/reflection96/docs/malenfant/malenfant.pdf [https://perma.cc/7EKK-7BJT].

[118] *Townsend*, 36 F.2d at 295.

[119] *See generally* Shyamkrishna Balganesh, *Foreseeability and Copyright Incentives*, 122 HARV. L. REV. 1569 (2009) (discussing foreseeability in the patent context).

[120] What is required is some "quantum of collaboration or connection." Kimberly-Clark Corp. v. Procter & Gamble Distrib. Co., 973 F.2d 911, 917 (Fed. Cir. 1992). For joint inventorship, "there must be some element of joint behavior, such as collaboration or working under common direction, one inventor seeing a relevant report and building upon it or hearing another's suggestion at a meeting." *Id.*; *see also* Moler & Adams v. Purdy, 131 U.S.P.Q. 276, 279 (Bd. Pat. Interferences 1960) ("[I]t is not necessary that the inventive concept come to both [joint inventors] at the same time.").

[121] *See* Prerna Wardhan & Padmavati Manchikanti, *A Relook at Inventors' Rights*, 18 J. INTELL. PROP. RIGHTS 168, 169 (2013).

C. Barriers to Computer Inventorship

1. The Legal Landscape

Congress is empowered to grant patents on the basis of the Patent and Copyright Clause of the Constitution.[122] That clause enables Congress "[t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."[123] It also provides an explicit rationale for granting patent and copyright protection, namely to encourage innovation under an incentive theory.[124] The theory goes that people will be more inclined to invent things (i.e., promote the progress of science) if they can receive government-sanctioned monopolies (i.e., patents) to exploit commercial embodiments of their inventions. Having the exclusive right to sell an invention can be tremendously lucrative.[125]

The Patent Act, which here refers to United States patent law as a whole, provides at least a couple of challenges to computers qualifying as inventors under the Patent and Copyright Clause.[126] First, as previously mentioned, the Patent Act requires that inventors be "individuals."[127] This language has been in place since at least the passage of legislation in 1952 that established the basic structure of modern patent law.[128] The "individual" requirement likely was included to reflect the constitutional language that specifically gives "in-

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[122] U.S. CONST. art. I, § 8, cl. 8. This clause is also sometimes referred to as the "Patent Clause" or the "Copyright Clause."

[123] *Id.*

[124] *See* Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 129 (2004) ("The standard justification for intellectual property is ex ante . . . . It is the prospect of the intellectual property right that spurs creative incentives.").

[125] *See* JOHN STUART MILL, PRINCIPLES OF POLITICAL ECONOMY WITH SOME OF THEIR APPLICATIONS TO SOCIAL PHILOSOPHY 563 (Prometheus Books 2004) (1872) (noting that under a patent system, "the greater the usefulness, the greater the reward").

[126] Legislation pertaining to patents is found under Title 35 of the United States Code. The Patent Act may also be used to refer to specific pieces of legislation ranging from the Patent Act of 1790, the first patent law passed by the federal government, to the Patent Act of 1952. Pub. L. No. 82-593, 66 Stat. 792 (1952).

[127] *E.g.*, 35 U.S.C. § 100(f) ("The term 'inventor' means the individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."). The same issues surrounding computer inventorship may not exist outside of the U.S. where applications do not require a named inventor. *See* MPEP, *supra* note 43, § 2137.01 ("The requirement that the applicant for a patent in an application filed before September 16, 2012 be the inventor(s), . . . and that the inventor . . . be identified in applications filed on or after September 16, 2012, are characteristics of U.S. patent law not generally shared by other countries."). For example, a patent application at the European Patent Office may be filed by "any body equivalent to a legal person by virtue of the law governing it." Convention on the Grant of European Patents, *supra* note 100, at art. 58; *see also* 35 U.S.C. §§ 115–116.

[128] Pub. L. No. 82-593, 66 Stat. 792 (1952); *see also* Gregory Dolin, *Dubious Patent Reform*, 56 B.C. L. REV. 881, 889 (2015) (discussing aims of 1952 Patent Act).

ventors" the right to their discoveries as opposed to other legal entities that might assert ownership rights.[129] Such language would help to ensure that patent rights were more likely to go to individual inventors than to corporate entities where ownership was disputed.[130] Legislators were not thinking about computational inventions in 1952.[131] Second, patent law jurisprudence requires that inventions be the result of a "mental act."[132] So, because computers are not individuals and it is questionable that they engage in a mental act, it is unclear whether a computer autonomously conceiving of a patentable invention could legally be an inventor.

2. Avoiding Disclosure of Artificially Intelligent Inventors

Given that computers are functioning as inventors, and likely inventing at an escalating rate, it would seem that the Patent Office should be receiving an increasing number of applications claiming computers as inventors. That the Patent Office has not suggests that applicants are choosing not to disclose the role of AI in the inventive process.[133] That may be due to legal uncertainties about whether an AI inventor would render an invention unpatentable.[134]

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[129] In the words of the United States Court of Appeals for the Federal Circuit, "people conceive, not companies." New Idea Farm Equip. Corp. v. Sperry Corp., 916 F.2d 1561, 1566 n.4 (Fed. Cir. 1990).

[130] Now under the America Invents Act ("AIA"), a corporate entity can apply for a patent on behalf of an inventor who is under an assignment obligation. MPEP, *supra* note 43, § 325.

[131] *See* Karl F. Milde, Jr., *Can a Computer Be an "Author" or an "Inventor"?*, 51 J. PAT. OFF. SOC'Y 378, 379 (1969). As one commentator notes:

> The closest that the Patent Statute comes to requiring that a patentee be an actual person is in the use, in Section 101, of the term "whoever." Here too, it is clear from the absence of any further qualifying statements that the Congress, in considering the statute in 1952, simply overlooked the possibility that a machine could ever become an inventor.

Id.; *see also, e.g.*, A.M. Turing, *Computing Machinery and Intelligence*, 59 MIND 433, 433–51 (1950) [hereinafter Turing, *Computing Machinery and Intelligence*].

[132] Conception has been defined as "the complete performance of the mental part of the inventive art," and it is "the formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention as it is thereafter to be applied in practice." *Townsend*, 36 F.2d at 295.

[133] *See supra* note 5 and accompanying text. The discussion in note 5 infers that the Patent Office has not received applications claiming computers as inventors because they have no policy or guidance on the subject, they do not seem to have ever addressed the issue in any publication, and because computer inventorship does not seem to have been at issue in any patent litigation.

[134] *See, e.g.*, Dane E. Johnson, *Statute of Anne-imals: Should Copyright Protect Sentient Nonhuman Creators?*, 15 ANIMAL L. 15, 23 (2008) (quoting one Copyright Office employee who explained that "[as] a practical matter[,] the Copyright Office would not register [a computer's own] work if its origins were accurately represented on the copyright application. The computer program itself would be registerable if it met the normal standards for computer programs, but not the computer-generated literary work.") Despite this policy and the Copyright Office's Compendium guidelines, numerous computer-authored works have been registered. *See, e.g.*, William T. Ralston, *Copyright in Computer-Composed Music: Hal Meets Handel*, 52 J. COPYRIGHT SOC'Y OF THE U.S.A. 281, 283 (2004) (noting

Without a legal inventor, new inventions would not be eligible for patent protection and would enter the public domain after being disclosed.[135]

There is another reason why computers might not be acknowledged: a person can qualify as an inventor simply by being the first individual to recognize and appreciate an existing invention.[136] That is to say, someone can discover rather than create an invention. Uncertainty (and accident) is often part of the inventive process.[137] In such cases, an individual need only understand the importance of an invention to qualify as its inventor.[138] For the purposes of this Article, assuming that a computer cannot be an inventor, individuals who subsequently "discover" computational inventions by mentally recognizing and appreciating their significance would likely qualify as inventors. So, it may be the case that computational inventions are only patentable when an individual subsequently discovers them.

II. IN SUPPORT OF COMPUTER INVENTORS

This Part examines the law regarding non-human authorship of copyrightable material.[139] It discusses the history of the Copyright Office's Human Authorship Requirement.[140] This Part also scrutinizes case law interpreting the Patent and Copyright Clause.[141] On the basis of this analysis and principles of dynamic statutory interpretation, this Part argues that computers should qualify as legal inventors.[142] This would incentivize the development of creative ma-

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one computer-authored volume of poetry registered to a computer author, "Racter," but still not explicitly disclosed to be a computer). In 1993, Scott French programmed a computer to write in the style of a famous author, and the resulting work was registered as an "original and computer aided text." Tal Vigderson, Comment, *Hamlet II: The Sequel? The Rights of Authors vs. Computer-Generated "Read-Alike" Works*, 28 LOY. L.A. L. REV. 401, 402–03 (1994). The novel was apparently terrible. *See* Patricia Holt, *Sunday Review*, S.F. CHRON., Aug. 15, 1993, B4 ("[t]he result is a mitigated disaster").

[135] *See* MPEP, *supra* note 43, § 2137.

[136] Conception requires contemporaneous recognition and appreciation of the invention. *See* Invitrogen Corp. v. Clontech Labs., Inc., 429 F.3d 1052, 1064 (Fed. Cir. 2005) (noting that the inventor must have actually made the invention and understood the invention to have the features that comprise the inventive subject matter at issue); *see also, e.g.*, Silvestri v. Grant, 496 F.2d 593, 597 (C.C.P.A. 1974) ("[A]n accidental and unappreciated duplication of an invention does not defeat the patent right of one who, though later in time, was the first to recognize that which constitutes the inventive subject matter.").

[137] For instance, Alexander Fleming discovered penicillin in a mold that had contaminated his samples of Staphylococcus. Howard Markel, *The Real Story Behind Penicillin*, PBS (Sep. 27, 2013), http://www.pbs.org/newshour/rundown/the-real-story-behind-the-worlds-first-antibiotic/ [https://perma.cc/V6SM-2QJL].

[138] *See Silvestri*, 496 F.2d at 597.

[139] *See infra* notes 139–239 and accompanying text.

[140] COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES, *supra* note 14, § 306.

[141] U.S. CONST. art. I, § 8, cl. 8.

[142] *See generally* Eskridge, *Dynamic Statutory Interpretation*, *supra* note 16 (discussing canons of statutory interpretation).

chines consistent with the purpose and intent of the Founders and Congress. The requirement that inventors be individuals was designed to prevent corporate ownership, and, therefore, computer inventorship should not be prohibited on this basis.[143] Also, there should be no requirement for a mental act because patent law is concerned with the nature of an invention itself rather than the subjective mental process by which an invention may have been achieved.[144] This Part concludes by addressing objections to computer inventorship including arguments that computational inventions would develop in the absence of patent protection at non-monopoly prices.[145]

A. Nonhuman Authors of Copyrightable Material

The Patent Act does not directly address the issue of a computer inventor. The Patent Office has never issued guidance addressing the subject, and there appears to be no case law on the issue of whether a computer could be an inventor. That is the case despite the fact that the Patent Office appears to have already granted patents for inventions by computers but, as previously discussed, did so unknowingly.

There is, however, guidance available from the related issue of nonhuman authorship of copyrightable works.[146] Nonhuman authorship is not governed by statute, but there is interesting case law on the subject. Also, since at least 1984 the Copyright Office has conditioned copyright registration on human authorship.[147] In its 2014 compendium, the Copyright Office published an updated "Human Authorship Requirement" which states that:

> To qualify as a work of "authorship" a work must be created by a human being. . . . The Office will not register works produced by nature, animals, or plants. . . . Similarly, the Office will not register

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[143] *See infra* notes 206–208 and accompanying text.

[144] *See, e.g.*, *The "Flash of Genius" Standard of Patentable Invention*, *supra* note 18, at 86.

[145] *See* notes 189–239 and accompanying text.

[146] The issue of computer authorship (and inventorship) has been considered "since the 1960s when people began thinking about the impact of computers on copyright." Arthur R. Miller, *Copyright Protection for Computer Programs, Databases, and Computer-Generated Works: Is Anything New Since CONTU?*, 106 HARV. L. REV. 977, 1043 (1993). Most of the literature related to computer generated works has focused on copyright rather than patent protection. "In the secondary literature on copyright, rivers of ink are spilt on" whether computers can be considered authors. MELVILLE B. NIMMER & DAVID NIMMER, NIMMER ON COPYRIGHT § 5.01[A] (LexisNexis 2015).

[147] COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES, *supra* note 14, § 202.02(b). The *Compendium of U.S. Copyright Office Practices* elaborates on the "human authorship" requirement by stating: "The term 'authorship' implies that, for a work to be copyrightable, it must owe its origin to a human being. Materials produced solely by nature, by plants, or by animals are not copyrightable." *Id.* It further elaborates on the phrase "[w]orks not originated by a human author" by stating: "In order to be entitled to copyright registration, a work must be the product of human authorship. Works produced by mechanical processes or random selection without any contribution by a human author are not registrable." *Id.* § 503.03(a).

claiming he owned their copyright.[176] Other parties then reposted the photographs without his permission and over his objections, asserting that he could not copyright the images without having taken them directly.[177] On December 22, 2014, the Copyright Office published its Human Authorship Requirement, which specifically lists the example of a photograph taken by a monkey as something not protectable.[178]

In September 2015, People for the Ethical Treatment of Animals ("PETA") filed a copyright infringement suit against Mr. Slater on behalf of Naruto, the monkey it purports took the Monkey Selfies, asserting that Naruto was entitled to copyright ownership.[179] On January 28, 2016, U.S. District Judge William H. Orrick III dismissed PETA's lawsuit against Slater.[180] Judge Orrick reasoned that the issue of the ability for animals to obtain a copyright is "an issue for Congress and the President."[181] The case is currently under appeal in the Ninth Circuit.[182]

B. Computers Should Qualify as Legal Inventors

1. Arguments Supporting Computer Inventors

Preventing patents on computational inventions by prohibiting computer inventors, or allowing such patents only by permitting humans who have discovered the work of creative machines to be inventors, is not an optimal system. In the latter case, AI may be functioning more or less independently, and it is only sometimes the case that substantial insight is needed to identify and understand a computational invention. Imagine that Person *C* instructs their AI to develop an iPhone battery with twice the standard battery life and gives it some publically available battery schematics. The AI could produce results in the form of a report titled "Design for Improved iPhone Battery"—complete with schematics and potentially even pre-formatted as a patent application. It seems inefficient and unfair to reward *C* for recognizing the AI's invention when *C* has not contributed significantly to the innovative process.

Photographer David Slater Claims That Because He Thought Monkeys Might Take Pictures, Copyright Is His, TECHDIRT (July 15, 2011), https://www.techdirt.com/articles/20110714/16440915097/photographer-david-slater-claims-that-because-he-thought-monkeys-might-take-pictures-copyright-is-his.shtml [https://perma.cc/MA7S-PFJ9].

[176] *See Naruto*, 2016 WL 362231, at *1.

[177] *See* Masnick, *supra* note 175.

[178] COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES, *supra* note 14, § 313.2.

[179] *See Naruto*, 2016 WL 362231, at *1.

[180] *Id*.

[181] *See id.*; Beth Winegarner, *'Monkey Selfie' Judge Says Animals Can't Sue Over Copyright*, LAW 360 (Jan. 6, 2016), https://www.cooley.com/files/'MonkeySelfie'JudgeSaysAnimalsCan'tSueOverCopyright.pdf [https://perma.cc/2CUG-2JDT].

[182] *See generally* Opening Brief of Plaintiff-Appellant, Naruto v. Slater, No. 3:15-cv-04324 (9th Cir. July 28, 2016) (arguing for the appeal of the district court's decision).

Such a system might also create logistical problems. If *C* had created an improved iPhone battery as a human inventor, *C* would be its inventor regardless of whether anyone subsequently understood or recognized the invention. If *C* instructed *C*'s AI to develop an improved iPhone battery, the first person to notice and appreciate the AI's result could become its inventor (and prevent *C* from being an inventor). One could imagine this creating a host of problems: the first person to recognize a patentable result might be an intern at a large research corporation or a visitor in someone's home. A large number of individuals might also concurrently recognize a result if access to an AI is widespread.

More ambitiously, treating computational inventions as patentable and recognizing creative computers as inventors would be consistent with the Constitutional rationale for patent protection.[183] It would encourage innovation under an incentive theory. Patents on computational inventions would have substantial value independent of the value of creative computers; allowing computers to be listed as inventors would reward human creative activity upstream from the computer's inventive act. Although AI would not be motivated to invent by the prospect of a patent, it would motivate computer scientists to develop creative machines. Financial incentives may be particularly important for the development of creative computers because producing such software is resource intensive.[184] Though the impetus to develop creative AI might still exist if computational inventions were considered patentable but computers could not be inventors, the incentives would be weaker owing to the logistical, fairness, and efficiency problems such a situation would create.

There are other benefits to patents beyond providing an *ex ante* innovation incentive. Permitting computer inventors and patents on computational inventions might also promote disclosure and commercialization.[185] Without the ability to obtain patent protection, owners of creative computers might choose to protect patentable inventions as trade secrets without any public dis-

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[183] *See* U.S. CONST. art. I, § 8, cl. 8. Among those addressing the patentability implications of computational invention, Ralph Clifford has argued that works generated autonomously by computers should remain in the public domain unless AI develops a consciousness that allows it to respond to the Copyright Act's incentives. *See* Clifford, *supra* note 4, at 1702–03; *see also* Liza Vertinsky & Todd M. Rice, *Thinking About Thinking Machines: Implications of Machine Inventors for Patent Law*, 8 B.U. J. SCI. & TECH. L. 574, 581 (2002). Colin R. Davies has argued more recently that a computer should be given legal recognition as an individual under UK law to allow proper attribution of authorship and to allow respective claims to be negotiated through contract. *See generally* Colin R. Davies, *An Evolutionary Step in Intellectual Property Rights—Artificial Intelligence and Intellectual Property*, 27 COMPUT. L. & SEC. REV. 601 (2011).

[184] *See, e.g.*, Ferrucci et al., *supra* note 82, at 59 (stating that Watson's creation required "three years of intense research and development by a core team of about 20 researchers").

[185] *See, e.g.*, *Innovation's Golden Goose*, THE ECONOMIST, Dec. 12, 2002, at 3 (discussing the increase in innovation after the Bayh-Dole Act of 1980 because the legislation providing inventors an incentive to disclose and commercialize their ideas).

closure.[186] Likewise, businesses might be unable to develop patentable inventions into commercial products without patent protection.[187] In the pharmaceutical and biotechnology industries, for example, the vast majority of expense in commercializing a new product is incurred after the product is invented during the clinical testing process required to obtain regulatory approval for marketing.[188]

2. Arguments Against Computer Inventors

Those arguments reflect the dominant narrative justifying the grant of intellectual property protection.[189] That account, however, has been criticized, particularly by academics.[190] Patents result in significant social costs by establishing monopolies.[191] Patents also can stifle entry by new ventures by creating barriers to subsequent research.[192] Whether the benefit of patents as an innovation incentive outweighs their anti-competitive costs, or for that matter, whether patents even have a net positive effect on innovation, likely varies between industries, areas of scientific research, and inventive entities.[193]

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[186] *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 736 (2002) ("[E]xclusive patent rights are given in exchange for disclosing the invention to the public.").

[187] Commercialization theory holds that patents are important in providing incentives for investment in increasing the value of a patented technology. *See* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 276–77 (1977).

[188] *See* TUFTS CTR. FOR THE STUDY OF DRUG DEV., *Briefing: Cost of Developing a New Drug* (Nov. 18, 2014), http://csdd.tufts.edu/files/uploads/Tufts_CSDD_briefing_on_RD_cost_study_-_Nov_18,_2014..pdf (estimating that pre-human expenditures are 30.8% of costs per approved compound, and estimating average pre-tax industry cost per new prescription drug approval [inclusive of failures and capital costs] is $2.55 billion). The cost of new prescription drug approval is hotly contested. *See, e.g.*, Roger Collier, *Drug Development Cost Estimates Hard to Swallow*, 180 CANADIAN MED. ASS'N J. 279, 279 (2009).

[189] *See* Jeanne C. Fromer, *Expressive Incentive in Intellectual Property*, 98 VA. L. REV. 1745, 1746 (2012).

[190] *See generally, e.g.*, Frederick M. Abbott, *The Doha Declaration on the TRIPS Agreement and Public Health: Lighting a Dark Corner at the WTO*, 5 J. INT'L ECON L. 469 (2002) (discussing problems with a pure incentive theory for patents in the medicines context).

[191] *See* Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEX. L. REV. 303, 314–15 (2013) (discussing the deadweight loss of monopoly).

[192] *See* Lisa Larrimore Ouellette, *Access to Bio-Knowledge: From Gene Patents to Biomedical Materials*, 2010 STAN. TECH. L. REV. 48, 3 at n. 1 (considering effects of patents on entry to the biomedical products market); Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 133 (1999); *see also* Bhaven Sampat & Heidi L. Williams, How Do Patents Affect Follow-on Innovation? Evidence from the Human Genome 15 (Oct. 13, 2015) (unpublished manuscript), *available at* http://economics.mit.edu/files/10782 [https://perma.cc/5K7N-89C4] (discussing patents to entry created by patents).

[193] As discussed above, the need for patent incentives is particularly compelling in the pharmaceutical context where large investments in clinical research over several years are typically needed to commercialize products that often are inexpensive for competitors to replicate. *See* Benjamin N. Roin, *Unpatentable Drugs and the Standards of Patentability*, 87 TEX. L. REV. 503, 545–47 (2009).

For instance, commentators such as Judge Richard Posner have argued that patents may not be needed to incentivize R&D in the software industry.[194] Software innovation is often relatively inexpensive, incremental, quickly superseded, produced without patent incentives, protected by other forms of intellectual property, and associated with a significant first mover advantage.[195] Likewise, patents may be unnecessary to spur innovation in university settings where inventors are motivated to publish their results for prestige and the prospect of academic advancement.[196]

Computational inventions may develop due to non-patent incentives. Software developers have all sorts of non-economic motivations to build creative computers: for example, to enhance their reputations, satisfy scientific curiosity, or collaborate with peers.[197] Business ventures might find the value of computational inventions exceeds the cost of developing creative computers even in the absence of patent protection. Of course, computational invention patents may not be an all-or-nothing proposition; they may further encourage activities that would have otherwise occurred on a smaller scale over a longer timeframe. If patents are not needed to incentivize the development of creative computers, it may be justifiable to treat computational inventions as unpatentable and failing to recognize computer inventors. Yet, whether patents produce a net benefit as an empirical matter is difficult to determine *a priori*. Even though individuals and businesses do not always behave as rational economic actors, in the aggregate, it is likely that providing additional financial incentives to spur the development of creative computers will produce a net benefit.[198]

Patents for computational inventions might also be opposed on the grounds that they would chill future human innovation, reward human inven-

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[194] *See* WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 312–13 (2003).

[195] *See id.*; *see also* Eric Goldman, *The Problems with Software Patents*, FORBES (Nov. 28, 2012), http://www.forbes.com/sites/ericgoldman/2012/11/28/the-problems-with-software-patents/#234ba3d66545 [https://web.archive.org/web/20160412114510/http://www.forbes.com/sites/ericgoldman/2012/11/28/the-problems-with-software-patents/#41a0c38b2a70] (discussing in a three-part series why patents may be unnecessary for software, challenges to fixing the problems, and exploring possible fixes).

[196] *See* Mark A. Lemley, *Are Universities Patent Trolls?*, 18 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 611, 621 (2008).

[197] *See* YOCHAI BENKLER, THE WEALTH OF NETWORKS 65 (2006). Further, behavior law and economics posits that actual people do not act in accordance with standard economic principles because they have limited rationality, willpower, and self-interest. *See* Christine Jolls, Cass R. Sunstein, & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1476 (1998).

[198] *See, e.g.*, GARY S. BECKER, THE ECONOMIC APPROACH TO HUMAN BEHAVIOR 14 (1978) ("[A]ll human behavior can be viewed as involving participants who [1] maximize their utility [2] from a stable set of preferences and [3] accumulate an optimal amount of information and other inputs in a variety of markets.").

tors who failed to contribute to the inventive process, and result in further consolidation of intellectual property in the hands of big business (assuming that businesses such as IBM will be the most likely to own creative computers).[199]

Other non-utilitarian patent policies do not appear to support computer inventorship. For example, courts have justified granting patent monopolies on the basis of Labor Theory, which holds that a person has a natural right to the fruits of their work.[200] Labor Theory may support giving a patent to someone who has worked for years to invent a new device so that they can profit from their invention, but it does not apply to computers because computers cannot own property. All computer work is appropriated. Similarly, Personality Theory, which holds that innovation is performed to fulfill a human need, would not apply to AI.[201] Creative computers invent because they are instructed to invent, and a machine would not be offended by the manner in which its inventions were used. AI might even be a concerning recipient for inventorship under Social Planning Theory, which holds that patent rights should be utilized to promote cultural goals.[202] An AI could develop immoral new technologies.[203] Submissions, however, are no longer rejected by the Patent Office for being "deceitful" or "immoral," and, to the extent this is a concern, there would be opportunities for a person to judge the morality of an application before it is granted.[204]

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[199] *See generally* Jamie Carter, *The Most Powerful Supercomputers in the World—and What They Do*, TECHRADAR (Dec. 13, 2014), http://www.techradar.com/us/news/computing/the-most-powerful-supercomputers-in-the-world-and-what-they-do-1276865 [https://perma.cc/AZ94-H3B2] (noting that most advanced computer systems are owned by governments and large businesses).

[200] *See* William Fisher, *Theories of Intellectual Property*, *in* NEW ESSAYS IN THE LEGAL AND POLITICAL THEORY OF PROPERTY 173–74 (Stephen Munzer ed., 2001).

[201] Tom G. Palmer, *Are Patents and Copyrights Morally Justified? The Philosophy of Property Rights and Ideal Objects*, 13 HARV. J.L. & PUB. POL'Y 817, 835–36 (1990).

[202] Mohammad Amin Naser, *Computer Software: Copyrights v. Patents*, 8 LOY. L. & TECH. ANN. 37, 41–42 (2009).

[203] Beneficial utility was once required for patent grant such that "deceitful" or "immoral" inventions would not qualify. In 1999, The United States Court of Appeals for the Federal Circuit in *Juicy Whip, Inc. v. Orange Bang, Inc.*, stated:

> [Y]ears ago courts invalidated patents on gambling devices on the ground that they were immoral, . . . but that is no longer the law . . . . "Congress never intended that the patent laws should displace the police powers of the States, meaning by that term those powers by which the health, good order, peace and general welfare of the community are promoted". . . . [W]e find no basis in section 101 to hold that inventions can be ruled unpatentable for lack of utility simply because they have the capacity to fool some members of the public.

185 F.3d 1364, 1367–68 (Fed. Cir. 1999) (quoting Webber v. Virginia, 103 U.S. 344, 347–48 (1880))

[204] *See id. See generally* Cynthia M. Ho, *Splicing Morality and Patent Law: Issues Arising from Mixing Mice and Men*, 2 WASH. U. J.L. & POL'Y 247, 247–85 (2000) (discussing Social Planning theory).

Ultimately, despite concerns, computer inventorship remains a desirable outcome. The financial motivation it will provide to build creative computers is likely to result in a net increase in the number of patentable inventions produced. Particularly, while quantitative evidence is lacking about the effects of computational invention patents, courts and policy makers should be guided first and foremost by the explicit constitutional rationale for granting patents.[205] Further, allowing patents on computational inventions as well as computer inventors would do away with what is essentially a legal fiction—the idea that only a human can be the inventor of the autonomous output of a creative computer—resulting in fairer and more effective incentives.

C. It Does Not Matter Whether Computers Think

1. The Questionable Mental Act Requirement

The judicial doctrine that invention involves a mental act should not prevent computer inventorship. The Patent Act does not mention a mental act, and courts have discussed mental activity largely from the standpoint of determining when an invention is actually made not whether it is inventive. In any case, whether or not creative computers "think" or have something analogous to consciousness should be irrelevant with regards to inventorship criteria.[206]

To begin, the precise nature of a "mental act requirement" is unclear. Courts associating inventive activity with cognition have not been using terms precisely or meaningfully in the context of computational inventions. It is unclear whether computers would have to engage in a process that results in creative output—which they do—or whether, and to what extent, they would need to mimic human thought. If the latter, it is unclear what the purpose of such a requirement would be except to exclude nonhumans (for which a convoluted test is unnecessary). Dr. Thaler has argued eloquently that the Creativity Machine closely imitates the architecture of the human brain.[207] Should that mean that the Creativity Machine's inventions should receive patents while Watson's do not? There is a slippery slope in determining what constitutes a "thinking" computer system even leaving aside deficits in our understanding of the structure and function of the human brain. Perhaps the Creativity Machine still is not engaging in mental activity—would a computer scientist have to design a completely digitized version of the human brain? Even if designing a completely digitized version of the human brain was possible, it might not be the

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[205] *See* United States v. Line Material Co., 333 U.S. 287, 316 (1948) (Douglas, J., concurring) (noting "the reward to inventors is wholly secondary" to the reward to society); *see also* THE FEDERALIST NO. 43 (James Madison) (stating that social benefit arises from patents to inventors).

[206] Though, it is surely a fascinating topic deserving of its own treatise.

[207] Thaler, *Synaptic Perturbation and Consciousness*, *supra* note 29.

most effective way to structure a creative computer.[208] On top of that, it would be difficult or impossible for the Patent Office and the courts to distinguish between different computers' architectures.

2. The Turing Test and a Functionalist Approach

The problem of speaking precisely about thought with regards to computers was identified by Alan Turing, one of the founders of computer science, who in 1950 considered the question, "Can machines think?"[209] He found the question to be ambiguous, and the term "think" to be unscientific in its colloquial usage.[210] Turing decided the better question to address was whether an individual could tell the difference between responses from a computer and an individual; rather than asking whether machines "think," he asked whether machines could perform in the same manner as thinking entities.[211] Dr. Turing referred to his test as the "Imitation Game" though it has come to be known as the "Turing test."[212]

Although the Turing test has been the subject of criticism by some computer scientists, Turing's analysis from more than sixty years ago demonstrates that a mental act requirement would be ambiguous, challenging to administer, and of uncertain utility.[213] Incidentally, it is noteworthy that the Patent Office administers a sort of Turing test, which creative computers have successfully passed. The Patent Office receives descriptions of inventions then judges whether they are nonobvious—which is a measure of creativity and ingenuity.[214] In the case of the Invention Machine's Patent, it was already noted that "January 25, 2005 looms large in the history of computer science as the day that genetic programming passed its first real Turing test: The examiner had no idea that he was looking at the intellectual property of a computer."[215] In an-

[208] This is analogous to one of the criticisms of the Turing test. Namely, that mimicking human responses may not be the best test of intelligence given that not all human responses are intelligent. *See* Editorial, *Artificial Stupidity*, THE ECONOMIST, Aug. 1, 1992, at 14.

[209] Turing, *Computing Machinery and Intelligence*, *supra* note 131, at 433. "Nobody so far has been able to give a precise, verifiable definition of what general intelligence or thinking is. The only definition I know that, though limited, can be practically used is Alan Turing's. With his test, Turing provided an operational definition of a specific form of thinking—human intelligence." Tomaso Poggio, "*Turing+" Questions*, *in* WHAT TO THINK ABOUT MACHINES THAT THINK 48 (John Brockman ed., 2015).

[210] *See* Turing, *Computing Machinery and Intelligence*, *supra* note 131, at 433.

[211] *See id.* at 433–34.

[212] *See id.* at 433.

[213] *See, e.g.*, Jose Hernandez-Orallo, *Beyond the Turing Test*, 9 J. LOGIC LANGUAGE & INFO. 447, 447 (2000).

[214] *See* Koza et al., *Evolving Inventions*, *supra* note 49, at 59. The Patent Office "receives written descriptions of inventions and then judges whether they are nonobvious," which is a measure of creativity and ingenuity. *See id.*

[215] Keats, *John Koza Has Built an Invention Machine*, *supra* note 57.

other sense, GP had already also passed the test by independently recreating previously patented inventions: because the original human invention received a patent, the AI's invention should have received a patent as well, leaving aside that the original patent would be prior art not relied upon by the GP.[216]

3. The Invention Matters, Not the Inventor's Mental Process

The primary reason a mental act requirement should not prevent computer inventorship is that the patent system should be indifferent to the means by which invention comes about.

Congress came to this conclusion in 1952 when it abolished the Flash of Genius doctrine.[217] That doctrine had been used by the Federal Courts as a test for patentability for over a decade.[218] It held that in order to be patentable, a new device, "however useful it may be, must reveal the flash of creative genius, not merely the skill of the calling."[219] The doctrine was interpreted to mean that an invention must come into the mind of an inventor in a "flash of genius" rather than as a "result of long toil and experimentation."[220] As a commentator at the time noted, "the standard of patentable invention represented by [the Flash of Genius doctrine] is apparently based upon the nature of the mental processes of the patentee-inventor by which he achieved the advancement in the art claimed in his patent, rather than solely upon the objective nature of the advancement itself."[221]

The Flash of Genius test was an unhelpful doctrine because it was vague, difficult for lower courts to interpret, involved judges making subjective decisions about a patentee's state of mind, and made it substantially more difficult

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[216] *See id.*

[217] *See* 35 U.S.C. § 103 (2012).

[218] *See, e.g.*, Hamilton Standard Propeller Co. v. Fay-Egan Mfg. Co., 101 F.2d 614, 617 (6th Cir. 1939) ("The patentee did not display any flash of genius, inspiration or imagination . . . ."). The doctrine was formalized by the Supreme Court in 1941 in *Cuno Engineering Corp. v. Automatic Devices Corp.* 314 U.S. 84, 91 (1941). It was reaffirmed by the Court in 1950 in *Great Atlantic & Pacific Tea Co. v. Supermarket Equipment Corp.*, 340 U.S. 147, 154 (1950) (Douglas, J., concurring).

[219] *Cuno Eng'g Corp.*, 314 U.S. at 91.

[220] The Supreme Court later claimed the "Flash of Creative Genius" language was just a rhetorical embellishment and that requirement concerned the device not the manner of invention. Graham v. John Deere Co. of Kan. City, 383 U.S. 1, 15 n.7, 16 n.8 (1966). That was not, however, how the test was interpreted. *See* P.J. Federico, *Origins of Section 103*, 5 APLA Q.J. 87, 97 n.5 (1977) (noting the test led to a higher standard of invention in the lower courts). When Congress abolished the test, Congress noted it should be immaterial whether invention was made "from long toil and experimentation or from a flash of genius." 35 U.S.C. § 103. Further, the Court stated in 1966 in *Graham* that "[t]he second sentence states that patentability as to this requirement is not to be negatived by the manner in which the invention was made, that is, it is immaterial whether it resulted from long toil and experimentation or from a flash of genius." *Graham*, 383 U.S. at 16 n.8.

[221] *The "Flash of Genius" Standard of Patentable Invention*, *supra* note 18, at 87.

to obtain a patent.[222] The test was part of a general hostility toward patents exhibited by mid-twentieth century courts, a hostility that caused United States Supreme Court Justice Robert Jackson to note in a dissent that "the only patent that is valid is one which this Court has not been able to get its hands on."[223]

Criticism of this state of affairs led President Roosevelt to establish a National Patent Planning Commission to study the patent system and to make recommendations for its improvement.[224] In 1943, the Commission reported with regard to the Flash of Genius doctrine that "patentability shall be determined objectively by the nature of the contribution to the advancement of the art, and not subjectively by the nature of the process by which the invention may have been accomplished."[225] Adopting this recommendation, the Patent Act of 1952 legislatively disavowed the Flash of Genius test.[226] In the same manner, patentability of computational inventions should be based on the inventiveness of a computer's output rather than on a clumsy anthropomorphism because, like Turing, patent law should be interested in a functionalist solution.

4. A Biological Requirement Would Be a Poor Test

Incidentally, even a requirement for biological intelligence might be a bad way to distinguish between computer and human inventors. Although functioning biological computers do not yet exist, all of the necessary building blocks have been created.[227] In 2013, a team of Stanford University engineers created

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[222] *See* DePaul College of Law, *Patent Law—"Flash of Genius" Test for Invention Rejected*, 5 DEPAUL L. REV. 144, 146 (1955); Stephen G. Kalinchak, *Obviousness and the Doctrine of Equivalents in Patent Law: Striving for Objective Criteria*, 43 CATH. U. L. REV. 577, 586 (1994).

[223] Jungersen v. Ostby & Barton Co., 335 U.S. 560, 572 (1949) (Jackson, J., dissenting).

[224] *See* William Jarratt, *U.S. National Patent Planning Commission*, 153 NATURE 12, 14 (1944).

[225] *The "Flash of Genius" Standard of Patentable Invention*, *supra* note 18, at 85 (internal quotation marks omitted).

[226] *See* 35 U.S.C. § 103 (2012). Further, in *Graham*, the Supreme Court noted that "[i]t . . . seems apparent that Congress intended by the last sentence of § 103 to abolish the test it believed this Court announced in the controversial phrase 'flash of creative genius,' used in *Cuno Engineering*." *Graham*, 383 U.S. at 15.

[227] *See* Sebastian Anthony, *Stanford Creates Biological Transistors, the Final Step Towards Computers Inside Living Cells*, EXTREMETECH (Mar. 29, 2013), http://www.extremetech.com/extreme/152074-stanford-creates-biological-transistors-the-final-step-towards-computers-inside-living-cells [https://perma.cc/ENX4-WZKA] (noting that, in addition to biological transistors, a method for data storage and a means of connecting transcriptors with memory would be necessary to create a biological computer and stating that "[f]ortunately, as we've covered a few times before, numerous research groups have successfully stored data in DNA—and Stanford has already developed an ingenious method of using the M13 virus to transmit strands of DNA between cells"); *see also* Monica E. Ortiz & Drew Endy, *Engineered Cell-Cell Communication via DNA Messaging*, J. BIOLOGICAL ENGINEERING (Dec. 1, 2012), https://jbioleng.biomedcentral.com/articles/10.1186/1754-1611-6-16 [https://perma.cc/6BWZ-GUUP]; Katherine Deria, *Biological Supercomputer Can Solve Complex Problems Using Less* Energy, TECH TIMES (Feb. 27, 2016), http://www.techtimes.com/articles/137017/20160227/biological-supercomputer-can-solve-complex-problems-using- less-energy.htm [https://perma.cc/A75T-3TVV] (describing a new biological supercomputer model powered by a biochemical that facilitates energy transfer among cells).

a biological version of an electrical transistor. Mechanical computers use numerous silicon transistors to control the flow of electrons along a circuit to create binary code.[228] The Stanford group created a biological version with the same functionality by using enzymes to control the flow of RNA proteins along a strand of DNA.[229] Envisioning a not-too-distant future in which computers can be entirely biological, there seems to be no principled reason why a biological, but not a mechanical version, of Watson should qualify as an inventor. In the event that policymakers decide computers should not be inventors, a rule explicitly barring nonhuman inventorship would be a better way to achieve that result.

D. Computer Inventors Are Permitted Under a Dynamic Interpretation of Current Law

Whether a computer can be an inventor in a constitutional sense is a question of first impression. If creative computers should be inventors, as this Article has argued, then a dynamic interpretation of the law should allow computer inventorship.[230] Such an approach would be consistent with the Founders' intent in enacting the Patent and Copyright Clause, and it would interpret the Patent Act to further that purpose.[231] Nor would such an interpretation run afoul of the chief objection to dynamic statutory interpretation, namely that it interferes with reliance and predictability and the ability of citizens "to be able to read the statute books and know their rights and duties."[232] That is because a dynamic interpretation would not upset an existing policy; permitting computer inventors would allow additional patent applications rather than retroactively invalidate previously granted patents, and there is naturally less reliance and predictability in patent law than in many other fields given that it is a highly dynamic subject area that struggles to adapt to constantly changing technologies.[233]

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[228] *See* Anthony, *supra* note 227.

[229] *See id.*

[230] *See* William N. Eskridge, Jr. & Philip P. Frickey, *Statutory Interpretation as Practical Reasoning*, 42 STAN. L. REV. 321, 324 (1990).

[231] *See* HENRY M. HART, JR. & ALBERT M. SACKS, THE LEGAL PROCESS: BASIC PROBLEMS IN THE MAKING AND APPLICATION OF LAW 1124 (1994); *see also* Abbe R. Gluck, *The States as Laboratories of Statutory Interpretation: Methodological Consensus and the New Modified Textualism*, 119 YALE L.J. 1750, 1764 (2010) (noting that purposivists subscribe to dynamic methods of statutory interpretation).

[232] *See* Eskridge, Jr. & Frickey, *supra* note 230, at 340.

[233] *See* William C. Rooklidge & W. Gerard von Hoffmann, III, *Reduction to Practice, Experimental Use, and the "On Sale" and "Public Use" Bars to Patentability*, 63 ST. JOHN'S L. REV. 1, 49–50 (1988).

Other areas of patent law have been the subject of dynamic interpretation.[234] For example, in the landmark 1980 case of *Diamond v. Chakrabarty*, the Supreme Court was charged with deciding whether genetically modified organisms could be patented.[235] It held that a categorical rule denying patent protection for "inventions in areas not contemplated by Congress . . . would frustrate the purposes of the patent law."[236] The court noted that Congress chose expansive language to protect a broad range of patentable subject matter.[237]

Under that reasoning, computer inventorship should not be prohibited based on statutory text designed to favor individuals over corporations. It would be particularly unwise to prohibit computer inventors on the basis of literal interpretations of texts written when computational inventions were unforeseeable. If computer inventorship is to be prohibited, it should only be on the basis of sound public policy. Drawing another analogy from the copyright context, just as the terms "Writings" and "Authors" have been construed flexibly in interpreting the Patent and Copyright Clause, so too should the term "Inventors" be afforded the flexibility needed to effectuate constitutional purposes.[238] Computational inventions may even be especially deserving of protection because computational creativity may be the only means of achieving certain discoveries that require the use of tremendous amounts of data or that deviate from conventional design wisdom.[239]

III. IMPLICATIONS OF COMPUTER INVENTORSHIP

This Part finds that a computer's owner should be the default assignee of any invention because this is most consistent with the rules governing owner-

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[234] The Supreme Court has called the section of the U.S. Code relating to patentable subject matter a "dynamic provision designed to encompass new and unforeseen inventions." J.E.M. AG Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc., 534 U. S. 124, 135 (2001). The Court noted in *Bilski v. Kappos* that "it was once forcefully argued that until recent times, 'well- established principles of patent law probably would have prevented the issuance of a valid patent on almost any conceivable computer program.'" 561 U.S. 593, 605 (2010) (quoting Diamond v. Diehr, 450 U.S 175, 195 (1981) (Stevens, J., dissenting)). The Court, however, went on to state that "this fact does not mean that unforeseen innovations such as computer programs are always unpatentable." *Id.* (citing *Diehr*, 450 U.S at 192–93 (Stevens, J., dissenting)).

[235] *See* Diamond v. Chakrabarty, 447 U. S. 303, 317 (1980).

[236] *Id*. at 315.

[237] *See id*. at 316.

[238] In 1973, the Supreme Court in *Goldstein v. California* noted that the terms "Writings" and "Authors," have "not been construed in their narrow literal sense but, rather, with the reach necessary to reflect the broad scope of constitutional principles." 412 U.S. 546, 561 (1973).

[239] *See* Jason D. Lohn, *Evolvable Systems for Space Application*, NASA (Nov. 24, 2003), http://www.genetic-programming.com/c2003jasonlohn20031124talk.pdf [https://perma.cc/BWC7-UPJK]; Adam Frank, *The Infinite Monkey Theorem Comes to Life*, NPR (Dec. 10, 2013), http://www.npr.org/blogs/13.7/2013/12/10/249726951/the-infinite-monkey-theorem-comes-to-life [https://perma.cc/PT5R-53GS].