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# EVERYTHING IS OBVIOUS

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**Abstract:** For more than 60 years, "obviousness" has set the bar for patentability. Under this standard, if a hypothetical *person skilled in the art* would find an invention obvious in light of existing relevant information, then the invention cannot be patented. The skilled person is defined as a non-innovative worker with a limited knowledge-base. The more creative and informed the skilled person, the more likely an invention will be considered obvious. The standard has evolved since its introduction, and it is now on the verge of an evolutionary leap. Inventive machines are increasingly being used in research, and once the use of such machines becomes standard, the person skilled in the art should be a person using an inventive machine, or just an inventive machine. Unlike the skilled person, the inventive machine is capable of innovation and considering the entire universe of prior art. As inventive machines continue to improve, this will increasingly raise the bar to patentability, eventually rendering innovative activities obvious. The end of obviousness means the end of patents, at least as they are now.

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## I. INTRODUCTION

For at least two decades, machines have been autonomously generating patentable inventions.[1] Autonomously here refers to the machine, rather than a person, meeting traditional inventorship criteria. In other words, if the "inventive machine" were a natural person, it would qualify as a patent inventor. In fact, the Patent Office has granted patents for inventions autonomously generated by computers at least as early as 1998.[2] In earlier articles, I examined instances of autonomous machine invention in detail and argued that such machines ought to be legally recognized as patent inventors to incentivize innovation and promote fairness.[3] The owners of such machines would be the owners of their inventions. In those works, as here, terms such as "computers" and "machines" are used interchangeably to refer to computer programs or software rather than to physical devices or hardware.[4]

This Article focuses on a related phenomenon: what happens when inventive machines become a *standard* part of the inventive process? This is not a thought experiment.[5] For instance, the weight of expert opinion holds that artificial general intelligence, which is a computer able to successfully perform any intellectual task a person could, will develop in the next twenty-five years.[6] Some thought leaders, such as Ray Kurzweil, Google's Director

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[1] *See* Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*. 1079 B. C. Law Rev. 1083–1091 (2016) [hereinafter, "I Think"] (describing instances of "computational invention").

[2] *Id.* at 1085.

[3] *Id.* at 1083–1091; Ryan Abbott, *Hal the Inventor: Big Data and Its Use by Artificial Intelligence*, *in* BIG DATA IS NOT A MONOLITH (Cassidy R. Sugimoto, Hamid R. Ekbia & Michael Mattioli eds., 2016) [hereinafter Hal the Inventor] (discussing computational invention in a book chapter first posted online February 19, 2015).

[4] Except perhaps in exceptional cases where software does not function on a general-purpose machine, and where specialized hardware is required for the software's function.

[5] The growing prevalence and sophistication of artificial intelligence is accelerating the use of inventive machines in research and development. *See*, Ryan Abbott and Bret Bogenschneider, *Should Robots Pay Taxes? Tax Policy in the Age of Automation* HARV. L. & POL'Y REV. (forthcoming), https://ssrn.com/abstract=2932483 (discussing the trend toward automation) [hereinafter *Should Robots Pay Taxes?*]. The McKinsey Global Institute "estimate[s] tech giants spent $20 billion to $30 billion on AI in 2016, with 90 percent of this spent on R&D and deployment, and 10 percent on AI acquisitions. VC and PE financing, grants, and seed investments also grew rapidly, albeit from a small base, to a combined total of $6 billion to $9 billion." Jacques Bughin, et al., *How artificial intelligence can deliver real value to companies*, MCKINSEY GLOBAL INSTITUTE (June 2017), at 4–5, https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/how-artificial-intelligence-can-deliver-real-value-to-companies. This is a three-fold increase in AI investment since 2013. *Id.*

[6] Vincent C Müller and Nick Bostrom, *Future progress in artificial intelligence: A Survey of Expert Opinion*, *in* FUNDAMENTAL ISSUES OF ARTIFICIAL INTELLIGENCE (Vincent C. Müller (ed, 2016).

of Engineering, predict computers will have human levels of intelligence in about a decade.[7]

The impact of the widespread use of inventive machines will be tremendous, not just on innovation, but also on patent law. Right now, patentability is determined based on what a hypothetical, non-inventive, skilled person would find obvious. The skilled person represents the average worker in the scientific field of an invention.[8] Once the average worker uses inventive machines, or inventive machines replace the average worker, then inventive activity will be normal instead of exceptional.

If the skilled person standard fails to evolve to reflect the fact that the average worker is inventive, this will result in too lenient a standard for patentability. Patents have significant anti-competitive costs, and allowing the average worker to routinely patent their outputs would cause social harm. As the Supreme Court has articulated, "[g]ranting patent protection to advances that would occur in the ordinary course without real innovation retards progress and may… deprive prior inventions of their value or utility."[9]

The skilled standard must keep pace with real world conditions. In fact, the standard needs updating even before inventive machines are normal. Already, computers are widely facilitating research and assisting with invention. For instance, computers may perform literature searches, data analysis, and pattern recognition.[10] This makes current workers more knowledgeable and creative than they would be without the use of such technologies. The Federal Circuit has provided a list of non-exhaustive factors to consider in determining the level of ordinary skill: (1) "type[s] of problems encountered in the art;" (2) "prior art solutions to those problems;" (3) "rapidity with which innovations are made;" (4) "sophistication of the technology;" and (5) "educational level of active workers in the field."[11] <u>This test should be modified to include, (6) "technologies used by active workers."</u>

This change will take into account the fact that machines are already augmenting the capabilities of workers, in essence making more obvious and expanding the scope of prior art. Once inventive machines become the standard means of research in a field, the test would also encompass the

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[7] Peter Rejcek, *Can Futurists Predict the Year of the Singularity,* SINGULARITY HUB (March 31, 2017) SINGULARITY HUB, https://singularityhub.com/2017/03/31/can-futurists-predict-the-year-of-the-singularity/ (predicting artificial general intelligence in 2029).

[8] *See* Section IID *infra.*

[9] *KSR International Co. v. Teleflex Inc.,* 550 U.S. 398 (2007) [hereinafter KSR].

[10] Such contributions when made by other persons do not generally rise to the level of inventorship, but they assist with reduction to practice.

[11] *In re GPAC,* 57 F.3d 1573, 1579 (Fed. Cir. 1995).

routine use of inventive machines by skilled persons. Taken a step further, once inventive machines become the standard means of research in a field, the skilled person should be an inventive machine. Specifically, the skilled person should be an inventive machine when the standard approach to research in a field or with respect to a particular problem is to use an inventive machine.

To obtain the necessary information to implement this test, the Patent Office should establish a new requirement for applicants to disclose when a machine contributes to the conception of an invention, which is the standard for qualifying as an inventor. Applicants are already required to disclose all human inventors, and failure to do so can render a patent invalid or unenforceable.[12] Similarly, applicants should need to disclose whether a machine has done the work of a human inventor. This information could be aggregated to determine whether most invention in a field is performed by people or machines. This information would also be useful for determining appropriate inventorship, and more broadly for formulating innovation policies.

Whether the future standard is that of a skilled person using an inventive machine or just an inventive machine, the result will be the same: the average worker will be capable of inventive activity. Conceptualizing the skilled person as using an inventive machine might be administratively simpler, but replacing the skilled person with the inventive machine would be preferable because it emphasizes that it is the *machine* which is engaging in inventive activity, rather than the human worker.

Application of the inventive machine standard in the obviousness inquiry should focus on reproducibility. With the skilled person standard, decision makers, in hindsight, need to reason about what another person would have found obvious. This results in inconsistent and unpredictable nonobviousness determinations.[13] In practice, the skilled person standard bears unfortunate similarities to Justice Stewart's famously unworkable definition of obscene material—"I know it when I see it."[14] By contrast, whether machines could reproduce the subject matter of a patent application is far more objective. A more determinate test would allow the Patent Office

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

[13] *See* FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY (2003), ch. 4, at 6-15, http://www.ftc.gov/os/2003/10/innovationrptsummary.pdf (critiquing Section 103 decisions).

[14] Jacobellis v. Ohio, 378 U.S. 184, 197 (1964). This was later recognized as a failed standard. Miller v. California, 413 U.S. 15, 47-48 (1973) (Brennan, J., dissenting).

to apply a single standard consistently, and it would result in fewer judicially invalidated patents.

An inventive machine standard will dynamically raise the current benchmark for patentability. Inventive machines will be significantly more intelligent than skilled persons, and also capable of considering more prior art. An inventive machine standard would not prohibit patents, but it would make obtaining them substantially more difficult. Either a person or computer would need to have an unusual insight that inventive machines could not easily recreate, developers would need to create increasingly intelligent computers that could outperform standard machines, or computers would need access to specialized, non-public sources of data. The nonobviousness bar will continue to rise as machines inevitably become increasingly sophisticated. Taken to its logical extreme, and given there is no limit to how intelligent computers would become, it may be that every invention will one day be obvious to commonly used computers. That would mean no more patents would be issued without some radical change to current patentability criteria.

This Article is structured in four parts. Part II considers the current test for obviousness and its historical evolution. It finds that obviousness is evaluated through the lens of the skilled person, who reflects the characteristics of the average worker in a field.[15] The level of creativity and knowledge imputed to the skilled person is critical for the obviousness analysis.[16] The more capable the skilled person, the more they will find obvious, and this will result in fewer issued patents.[17]

Part III considers the use of artificial intelligence in R&D, and proposes a novel framework for conceptualizing the transition from human to machine inventors. Already, inventive machines are competing with human inventors, and human inventors are augmenting their abilities with inventive machines. In time, inventive machines or people using inventive machines will become the standard in a field, and eventually, machines will be responsible for most or all innovation. As this occurs, the skilled person standard must evolve if it

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[15] *Ruiz,* 234 F.3d at 666*, see, also, Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714*,* 718 (Fed. Cir. 1991) ("The importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry."). The MPEP provides guidance on the level of ordinary skill in the art. MPEP § 2141.03.

[16] Dystar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co., 464 F.3d 1356, 1370 (Fed. Cir. 2006) ("If the level of skill is low, for example that of a mere dyer, as Dystar has suggested, then it may be rational to assume that such an artisan would not think to combine references absent explicit direction in a prior art reference.").

[17] A & P Tea Co. v. Supermarket Equipment Corp. 340 U.S. 147 (1950).

is to continue to reflect real-world conditions. Failure to do this would "stifle, rather than promote, the progress of the useful arts."[18]

Part III then proposes a framework for implementing the proposed standard. A decision maker would need to 1) determine the extent to which inventive machines are used in a field, 2) characterize the inventive machine(s) that best represents the average worker if inventive machines are the standard, and 3) determine whether the machine(s) would find an invention obvious. The decision maker is a patent examiner in the first instance,[19] and potentially a judge or jury in the event the validity of a patent is at issue in trial.[20] In both instances, this new test would involve new challenges.

Finally, Part IV provides an example of how the proposed obviousness standard would work in practice. It then goes on to consider some of the implications of the new standard. Once the average worker is inventive, there may no longer be a need for patents to function as innovation incentives. To the extent patents accomplish other goals such as promoting commercialization and disclosure of information or validating moral rights, other mechanisms may be found to accomplish these goals with fewer costs.

Although this Article focuses on U.S. Patent Law, a similar framework exists in nearly every country. Member States of the World Trade Organization (WTO) are required to grant patents for inventions that "are new, involve an inventive step and are capable of industrial application."[21] Although U.S. law uses the term "nonobvious" rather than "inventive step," the criteria are substantively similar.[22] For instance, the European Patent

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[18] KSR, *supra* note 9.

[19] At the Patent Office, applications are initially considered by a patent examiner, examiner decisions can be appealed to the Patent Trial and Appeal Board (PTAB). https://www.uspto.gov/patents-application-process/patent-trial-and-appeal-board-0. Also, the PTAB can adjudicate issues of patentability in certain proceedings such as inter parties review. *Id.*

[20] Determinations of patent validity can involve mixed questions of law and fact. Generally, in civil litigation, legal questions are determined by judges while factual questions are for a jury. *See, e.g.*, Structural Rubber Products Co. v. Park Rubber Co., 749 F.2d 707, 719-720 (Fed. Cir. 1984) ("Litigants have the right to have a case tried in a manner which ensures that factual questions are determined by the jury and the decisions on legal issues are made by the court"). There are some exceptions to this rule. *See, e.g.*, General Electro Music Corp. v. Samik Music Corp., 19 F.3d 1405, 1408 (Fed. Cir. 1994) ("issues of fact underlying the issue of inequitable conduct are not jury questions, the issue being entirely equitable in nature").

[21] Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 27, Apr. 15, 1994, 33 I.L.M. 1197, 1208. *See*, Ryan B Abbott, et al., *The Price Of Medicines In Jordan: The Cost Of Trade-Based Intellectual Property*, 9 J. OF GEN. MED. 75, 76.

[22] Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 27, Apr. 15, 1994, 33 I.L.M. 1197, 1208 n. 5. Although, there are some substantive differences in the way these criteria are implemented, and TRIPS provides nations with various flexibilities for compliance. *See*

Office's criteria for inventive step differs in only minor respects from the U.S. criteria for obviousness, and also uses the theoretical device of the skilled person.[23]

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*generally* Ryan Abbott, *Balancing Access and Innovation in India's Shifting IP Regime, Remarks*, 35 WHITTIER L. REV. 341, 344 (2014) [hereinafter Balancing Access].

[23] "An invention is considered as involving an inventive step if, having regard to the state of the art, it is not obvious to a person skilled in the Art." Art 56 E.P.C. For guidance on the "skilled person" in European patent law, see, *Guidelines for Examinations,* European Patent Office http://www.epo.org/law-practice/legal-texts/html/guidelines/e/g_vii_3.htm (last visited on 16 October 2017).

## II. OBVIOUSNESS

Part II investigates the current obviousness standard, its historical origins, and how the standard has changed over time. It finds that obviousness depends on the creativity of the skilled person, as well as the prior art they consider. These factors in turn vary according to the complexity of an invention and its field of art.

### *A. Public Policy*

Patents are granted for inventions that are new, nonobvious, and useful.[24] Of these three criteria, obviousness is the primary hurdle for most patent applications.[25] Patents are not intended to be granted for incremental inventions.[26] Only inventions which represent a significant advance over existing technology should receive protection.[27] That is because patents have significant costs. They limit competition, and they can inhibit future innovation by restricting the use of patented technologies in research and development.[28] To the extent that patents are justified, it is because they are thought to have more benefits than costs. Patents function as innovation incentives, they can promote the dissemination of information, encourage commercialization of technology, and they can validate moral rights.[29]

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[24] 35 U.S.C. §§ 101-02, 112 (2000). In the European system, these criteria are referred to as novelty, inventive step, and industrial applicability. Art. 52 EPC. Inventions must also comprise patentable subject matter and be adequately disclosed. 35 U.S.C. §§ 101-02, 112 (2000).

[25] DONALD CHISUM, CHISUM ON PATENTS § 5.02[6] (2007); NONOBVIOUSNESS—THE ULTIMATE CONDITION OF PATENTABILITY 2:101 (J. Witherspoon ed., 1980). Obviousness is the most commonly litigated issue of patent validity. John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q. J. 185, 208-09 (1998).

[26] The nonobviousness requirement is contained in Section 103 of the Patent Act. "A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 [novelty], if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains." 35 U.S.C. § 103(a) (2000).

[27] 107 U.S. 192, 200 (1882) (noting that, "[t]o grant to a single party monopoly of every slight advance made, except where the exercise of invention, somewhat above ordinary mechanical or engineering skill is distinctly shown, is unjust in principle and injurious in its consequences.")

[28] *See* I Think *supra* note 1 at 1105–6 (discussing the costs and benefits of the patent system).

[29] *Id.* Congress' power to grant patents is constitutional, and based on incentive theory: "To promote the progress of science … by securing for limited times to … inventors the exclusive right to their respective … discoveries." U.S. CONST. art. I, § 8, cl. 8. *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."); *see also* 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

Although other patentability criteria contribute to this function, the nonobviousness requirement is the primary test for distinguishing between significant innovations and trivial advances.[30] Of course, it is one thing to express a desire to only protect meaningful scientific advances, and another to come up with a workable rule that applies across every area of technology.

*B. Early Attempts*

The modern obviousness standard has been the culmination of hundreds of years of struggle by the Patent Office, courts, and Congress to separate the wheat from the chaff.[31] As Thomas Jefferson, the first administrator of the patent system and one of its chief architects, wrote, "I know well the difficulty of drawing a line between the things which are worth to the public the embarrassment of an exclusive patent, and those which are not... I saw with what slow progress a system of general rules could be matured."[32]

The earliest patent laws focused on novelty and utility, although Jefferson did at one point suggest an "obviousness" requirement.[33] The Patent Act of 1790 was the first patent statute, and it required patentable inventions to be "sufficiently useful and important."[34] Three years later, a more comprehensive patent law was passed—the Patent Act of 1793. The new act did not require an invention to be "important," but required it to be "new and useful".[35] The 1836 Patent Act reinstated the requirement that an

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arises from patents to inventors). The Supreme Court has endorsed an economic inducement rationale in which patents should only be granted for inventions which would "not be disclosed or devised but for the inducement of a patent." This is the inducement theory articulated in *Graham v. John Deere Co.* 383 U.S. at 10-11, 148 U.S.P.Q. (BNA) at 464; *see also* Michael and Duffy Abramowicz, John F., *The Inducement Standard of Patentability*. 120 YALE L.J. 1590 (2010).

[30] 35 U.S.C. §§ 101-02, 112 (2000).

[31] For that matter, the struggle dates back to the very first patent law, the Venetian Act of 1474, which stated that only "new and ingenious" inventions would be protected. *See* Giulio Mandich, *Venetian Patents* (1450-1550), 30 J. PAT. OFF. SOC'Y 166, 176-77 (1948); Samuel Oddi, *Beyond Obviousness: Invention Protection in the Twenty-First Century*, 38 AM. U. L. REV. 1097, 1102-03 (1989); F.D. Prager, *A History of Intellectual Property from 1545 to 1787,* 26J. PAT. OFF. SOC'Y 711, 715 (1944).

[32] VI WRITINGS OF THOMAS JEFFERSON, LETTER TO ISAAC MCPHERSON (Washington ed. 1813) [hereinafter LETTER TO ISAAC MCPHERSON], at 180-181.

[33] In 1791, Jefferson proposed amending the 1790 Patent Act to prohibit patents on an invention if it, "is so unimportant and obvious that it ought not be the subject of an exclusive right." 5 THE WRITINGS OF THOMAS JEFFERSON, 1788-1792, 279.

[34] Act of April 10, 1790, ch. 7, 1 Stat. 109.

[35] *Patent Act of 1793, Ch. 11, 1 Stat. 318-323 (February 21, 1793)*. It also prohibited patents on certain minor improvements: "simply changing the form or the proportions of any machine, or compositions of matter, in any degree, shall not be deemed a discovery." *Id.* On this basis, Jefferson,

invention be "sufficiently used and important".[36]

In 1851, the Supreme Court adopted the progenitor of the skilled person and the obviousness test—an "invention" standard.[37] *Hotchkiss v. Greenwood* concerned a patent for substituting clay or porcelain for a known door knob material such as metal or wood.[38] The Court invalidated the patent, holding that "the improvement is the work of a skillful mechanic, not that of the inventor."[39] The Court also articulated a new legal standard for patentability: "Unless more ingenuity and skill . . . were required . . . than were possessed by an ordinary mechanic acquainted with the business, there was an absence of that degree of skill and ingenuity which constitute essential elements of every invention."[40]

However, the Court did not give specific guidance on what makes something inventive or the required level of inventiveness. In subsequent years, the Court made several efforts to address these deficiencies, but with limited success. As the Court stated in 1891, "The truth is the word [invention] cannot be defined in such manner as to afford any substantial aid in determining whether any particular device involves an exercise of inventive faculty or not."[41] Or as one commentator noted, "it was almost

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who was credited with drafting most of this statute, argued that, "[a] change of material should not give title to a patent. As the making a ploughshare of cast, rather than of wrought, iron; a comb of iron, instead of horn or of ivory. . . ." LETTER TO ISAAC MCPHERSON *supra* note 32.

[36] Patent Act of 1836, Ch. 357, 5 Stat. 117 (July 4, 1836).

[37] *See, e.g.*, *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966) ("We conclude that the section [§ 103] was intended merely as a codification of judicial precedents embracing the *Hotchkiss* condition, with congressional directions that inquiries into the obviousness of the subject matter sought to be patented are a prerequisite to patentability."); s*ee also* S. REP. NO. 82-1979, at 6 (1952); H.R. REP. NO. 82-1923, at 7 (1952) ("Section 103 . . . provides a condition which exists in the law and has existed for more than 100 years."). Obviousness had been at issue in earlier cases, although not necessarily in such terms. For instance, in Earle v. Sawyer, Justice Story rejected an argument by the defendant that the invention at issue was obvious, and that something more than novelty and utility was required for a patent. 8 F. Cas. 254, 255 (C.C.D. Mass. 1825). He argued a court was not required to engage in a "mode of reasoning upon the metaphysical nature, or the abstract definition of an invention." *Id.* Justice Story further noted that English law permits the introducer of a foreign technology to receive a patent, and such an act could not require intellectual labor. *Id.* at 256. In *Evans v Eaton*, the Supreme court held that a patent invention must involve a change in the "principle of the machine" rather than a "mere change in the form or proportions." 20 U.S. 356 (1822). Writing for the Court, Justice Story noted the patent was invalid because it was "substantially the same in principle" as a prior invention. *Id.* at 362. Although, such a rationale for invalidating a patent is be closer a novelty rejection. §35 U.S.C. 102.

[38] 52 U.S. 248, 265 (1850).

[39] *Id.* at 267.

[40] *Id.*

[41] McClain v. Ortmayer, 141 U.S. 419, 427 (1891). Another court noted that "invention" is "as fugitive, impalpable, wayward, and vague a phantom as exists in the paraphernalia of legal concepts." Harries v. Air King Prods. Co., 183 F.2d 158, 162 (2d Cir. 1950).

impossible for one to say with any degree of certainty that a particular patent was indeed valid."[42]

Around 1930, the Supreme Court, possibly influenced by a national anti-monopoly sentiment, began implementing stricter criteria for determining the level of invention.[43] This culminated in the widely disparaged "Flash of Genius" test articulated in *Cuno Engineering v. Automatic Devices Corp* (1941).[44] Namely, that in order to receive a patent, "the new device must reveal the flash of creative genius, not merely the skill of the calling."[45] This test was interpreted to mean that an invention must come into the mind of an inventor as a result of "inventive genius"[46] rather than as a "result of long toil and experimentation."[47] The Court reasoned that, "strict application of the test is necessary lest in the constant demand for new appliances the heavy hand of tribute be laid on each slight technological advance in the art."[48]

The Flash of Genius test was criticized for being vague, difficult to implement, and for involving subjective decisions about an inventor's state of mind.[49] It certainly made it substantially more difficult to obtain a

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[42] Gay Chin, *The Statutory Standard of Invention: Section 103 of the 1952 Patent Act*, 3 PAT. TRADEMARK & COPY. J. RES. & ED. 317, 318 (1959).

[43] *See, e.g.*, Edward B. Gregg, *Tracing the Concept of "Patentable Invention*", 13 VILL. L. REV. 98 (1967).

[44] *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 Eng'g 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).

[45] 314 U.S. 84 (1941).

[46] Reckendorfer v. Faber, 92 U.S. 347, 357 (1875).

[47] 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). In *A & P Tea Co. v. Supermarket Equipment Corp*. 340 U.S. 147 (1950), another case cited for the proposition that the Court had adopted stricter patentability criteria, the majority did not consider the question of inventiveness, but in his concurring opinion Justice Douglas reiterated the concept of "inventive genius." *Id*. "It is not enough that an article is new and useful. The Constitution never sanctioned the patenting of gadgets. Patents serve a higher end-the advancement of science. An invention need not be as startling as an atomic bomb to be patentable. But it has to be of such quality and distinction that that masters of the scientific field in which it falls will recognize it as an advance." *Id*.

[48] 314 U.S. 84, 92 (1941).

[49] 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

patent.[50] Extensive criticism of perceived judicial hostility toward patents resulted in President Roosevelt's creating a National Patent Planning Commission to make recommendations for improving the patent system. The Commission's report recommended that Congress adopt a more objective and certain standard of obviousness.[51] A decade later, Congress did.[52]

### *C. The Nonobviousness Inquiry*

The Patent Act of 1952 established the modern patentability framework.[53] Among other changes to substantive patent law,[54] "[T]he central thrust of the 1952 Act removed 'unmeasurable' inquiries into 'inventiveness' and instead supplied the nonobviousness requirement of Section 103."[55] Section 103 states:

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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." *The "Flash of Genius" Standard of Patentable Invention*, *supra*, at 87. *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); *see also*, Comment, The Standard of Patentability. Judicial Interpretation of Section 103 of the Patent Act Source: 63 Colum. L. Rev. 306 [hereinafter The Standard of Patentability].

[50] Supreme Court Justice Robert Jackson noted in a dissent that, "the only patent that is valid is one which this Court has not been able to get its hands on." Jungersen v. Ostby & Barton Co., 335 U.S. 560, 572 (1949) (Jackson, J., dissenting).

[51] *See* William Jarratt, *U.S. National Patent Planning Commission*, 153 NATURE 12 (1944); *see also Report of the National Patent Planning Commission*, H.R. DOC. NO. 239, at 6, 10 (1943) ("One of the greatest technical weaknesses of the patent system is the lack of a definitive yardstick as to what is invention. The most serious weakness of the present patent system is the lack of a uniform test or standard for determining whether the particular contribution of an inventor merits the award of the patent grant... It is proposed that Congress shall declare a national standard whereby patentability of an invention shall be determined by the objective test as to its advancement of the arts and sciences.")

[52] Though, Congress may not have realized what it was doing. *See* George M. Sirilla, *35 U.S.C. 103: From Hotchkiss to Hand to Rich, the Obvious Patent Law Hall-of-Famers,* 32 J. Marshall L. Rev. 437 (1999), at 509–514 (discussing the legislative history of the Patent Act of 1952 and the lack of congressional awareness of, and intent for, Section 103).

[53] *See* The Standard of Patentability *supra* note 49 **Error! Bookmark not defined.**at 309. It also introduced the judicial doctrine of contributory infringement in 35 U.S.C. Section 271. "[P]robably no other title incorporates the thinking of so many qualified technical men throughout the country as does this revision." L. J. Harris, *Some Aspects of the Underlying Legislative Intent of the Patent Act of 1952*, 23 GEO. WASH. L. REV. 658, 661 (1955).

[54] The major changes or innovations in the title consist of incorporating a requirement for invention in § 103 and the judicial doctrine of contributory infringement in § 271." H.R. REP. No. 1923, 82d Cong., 2d Sess. 5 (1952); S. REP. No. 1979, 82d Cong., 2d Sess. 4 (1952).

[55] 717 F.3d 1269, 1295 (Fed. Cir. 2013) (Rader J., dissenting in part, concurring in part) (citing P.J. Federidco's Commentary on the New Patent Act, reprinted in 75 J. PAT. & TRADEMARK OFFICE

*A patent may not be obtained ... if the difference 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. Patentability shall not be negatived by the manner in which the invention was made.* [56]

Section 103 legislatively disavowed the Flash of Genius test, codified the sprawling judicial doctrine on "invention" into a single statutory test, and restructured the standard of obviousness in relation to a person having ordinary skill in the art.[57] However, while Section 103 may be more objective and definite than the earlier standard, the meanings of "obvious" and "a person having ordinary skill" were not defined, and in practice proved "often difficult to apply."[58]

The Supreme Court first interpreted the statutory nonobviousness requirement in a trilogy of cases: *Graham v. John Deere* (1966) and its companion cases, *Calmar v. Cook Chemical* (1965) and *United States v. Adams* (1966).[59] In these cases, the Court articulated a framework for evaluating obviousness as a question of law based on the following underlying factual inquiries: (1) the scope and content of the prior art; (2) the level of ordinary skill in the prior art; (3) the differences between the claimed invention and the prior art; and (4) objective evidence of nonobviousness.[60] This framework remains applicable today. Of note, the

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SOC'Y 161, 177 (1993)); *see also* Dann v. Johnston, 425 U.S. 219, 225-26 (1976) (describing the shift from "an exercise of the inventive faculty" established in case law to a statutory test. "[I]t was only in 1952 that Congress, in the interest of uniformity and definiteness, articulated the requirement in a statute, framing it as a requirement of 'nonobviousness'" (internal quotation marks and footnote omitted)). The official "Revision Notes" state § 103 is meant to be the basis for "holding ...patents invalid by the courts[] on the ground of lack of invention." S. Rep. No. 82-1979, at 18."

[56] 35 U.S.C. §103, as amended by the America Invents act. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284, 286 (2011) (codified at 35 U.S.C.§ 103).

[57] *See* GEO. WASH. U. L. REV. 393-407 (Jan. 1960). See, also, Gay Chin, *The Statutory Standard of Invention: Section 103 of the 1952 Patent Act*, 3 PAT. TRADEMARK & COPY. J. RES. & ED. 317, 318 (1959). 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.

[58] Uniroyal Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 1050,5 U.S.P.Q. (BNA) 1434, 1438 (Fed. Cir. 1988) (noting the obviousness standard is easy to expound and often difficult to apply).

[59] 383 U.S. 1 (1966), 380 U.S. 949 (1965), and 383 U.S. 39, 51-52 (1966), respectively.

[60] *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966). With regards to the fourth

*Graham* analysis does not explain how to evaluate the ultimate legal question of nonobviousness, beyond identifying underlying factual considerations.[61]

In 1984, the newly established United States Court of Appeals for the Federal Circuit, the only appellate-level court with jurisdiction to hear patent case appeals, devised the "teaching, suggestion and motivation" (TSM) test for obviousness.[62] Strictly applied, this test only permits an obviousness rejection when prior art explicitly teaches, suggests or motivates a combination of existing elements into a new invention.[63] The TSM test protects against hindsight bias because it requires an objective finding in the prior art. In retrospect, it is easy for an invention to appear obvious by piecing together bits of prior art using the invention as a blueprint.[64]

In *KSR v. Teleflex* (2006), the Supreme Court upheld the *Graham* analysis but rejected the Federal Circuit's exclusive reliance on the TSM test. The Court instead endorsed a flexible approach to obviousness in light of "[t]he diversity of inventive pursuits and of modern technology."[65] Rather than approving of a single definitive test, the Court identified a non-exhaustive list of rationales to support a finding of obviousness.[66] This

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category, considerations such as *commercial success* and *long felt but unsolved needs* can serve as evidence of non-obviousness in certain circumstances. *Id*.

[61] *See* Joseph Miller, *Nonobviousness: Looking Back and Looking Ahead, in* INTELLECTUAL PROPERTY AND INFORMATION WEALTH: ISSUES AND PRACTICES IN THE DIGITAL AGE, VOLUME 2: PATENTS AND TRADE SECRETS 9 (Peter K. Yu ed., 2007). ("[T]he Court did *not* indicate . . . *how* one was to go about determining obviousness (or not).").

[62] Court Jurisdiction, UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, http://www.cafc.uscourts.gov/the-court/court-jurisdiction (last accessed on 16 October 2017).

[63] 732 F.2d 1572 (Fed. Cir. 1984).

[64] *See, e.g.*, Ryko Mfg. Co. v. Nu-Star, Inc., 950 F.2d 714,718 (Fed. Cir. 1991).

[65] KSR, *supra* note 9 "[An obviousness] analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a [PHOSITA] would employ." *Id*. at 418.

[66] These post-KSR rationales include: ["(A) Combining prior art elements according to known methods to yield predictable results; (B) Simple substitution of one known element for another to obtain predictable results; (C) Use of known technique to improve similar devices (methods, or products) in the same way; (D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (E) "Obvious to try" – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; (F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; (G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention."] *2141 Examination Guidelines for Determining Obviousness Under 35 U.S.C. 103 [R-07.2015]*, UNITED STATES PATENT AND TRADEMARK OFFICE, https://www.uspto.gov/web/offices/pac/mpep/s2141.html [hereinafter

remains the approach to obviousness today.

### *D. Finding PHOSITA*

Determining the level of ordinary skill is critical to assessing obviousness.[67] The more sophisticated the skilled person, the more likely a new invention is to appear obvious.[68] Thus, it matters a great deal whether the skilled person is a "moron in a hurry"[69] or the combined "masters of the scientific field in which an [invention] falls".[70]

The skilled person has never been precisely defined, although there is judicial guidance.[71] In *KSR*, the Supreme Court described the skilled person as "a person of ordinary creativity, not an automaton."[72] The Federal Circuit has explained the skilled person is a hypothetical person, like the reasonable person in tort law,[73] who is presumed to have known the relevant art at the time of the invention.[74] The skilled person is not a judge, amateur, person skilled in remote arts, or a set of "geniuses in the art at hand."[75] The skilled person is "one who thinks along the line of conventional wisdom in the art and is not one who undertakes to innovate."[76]

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Examination Guidelines].

[67] *Ruiz*, 234 F.3d at 666, *see, also, Ryko Mfg. Co. v. Nu-Star, Inc.*, 950 F.2d 714, 718, 21 USPQ2d 1053, 1057 (Fed. Cir. 1991) ("The importance of resolving the level of ordinary skill in the art lies in the necessity of maintaining objectivity in the obviousness inquiry."). The MPEP provides guidance on the level of ordinary skill in the art. MPEP § 2141.03. *See*, John Duffy & Robert Merges, *The Story of Graham v. John Deere: Patent Law's Evolving Standard of Creativity*, *in* INTELLECTUAL PROPERTY STORIES 110 (Jane C. Ginsburg & Rochelle Cooper Dreyfuss eds., 2006) (noting that determining the appropriate level of ordinary skill for the nonobviousness standard "is one of the most important policy issues in all of patent law"). The skilled person is relevant to many areas of patent law including claim construction, best mode, definiteness, enablement, and the doctrine of equivalents. *See* Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1186–7 (2002).

[68] *Supra* note 16.

[69] Morning Star Cooperative Society Ltd v Express Newspapers Ltd [1979] FSR. 113 (first using the term "moron in a hurry" as a standard for trademark confusion).

[70] A & P Tea Co. v. Supermarket Equipment Corp. 340 U.S. 147 (1950).

[71] *See* James B. Gambrell & John H. Dodge, II, *Ordinary Skill in the Art — An Enemy of the Inventor or a Friend of the People?*, *in* NONOBVIOUSNESS—THE ULTIMATE CONDITION OF PATENTABILITY at 5:302 (J. Witherspoon ed., 1980) ("[T]he Supreme Court in particular, but other courts as well, has done precious little to define the person of ordinary skill in the art.").

[72] KSR, *supra* note 9 at 1397.

[73] *See, e.g.*, Panduit Corp. v. Dennison Mfg. Co., 810 F.2d 1561, 1566 (Fed. Cir. 1987) ("[T]he decision maker confronts a ghost, i.e., 'a person having ordinary skill in the art,' not unlike the 'reasonable man' and other ghosts in the law.").

[74] Examination Guidelines *supra* note 66.

[75] 713 F.2d 693 (Fed. Cir. 1983).

[76] Standard Oil Co. v. American Cyanamide Co., 774 F.2d 448, 454 (Fed. Cir. 1985).

The Federal Circuit has provided a list of non-exhaustive factors to consider in determining the level of ordinary skill: (1) "type[s] of problems encountered in the art;" (2) "prior art solutions to those problems;" (3) "rapidity with which innovations are made;" (4) "sophistication of the technology;" and (5) "educational level of active workers in the field."[77] In any particular case, one or more factors may predominate, and not every factor may be relevant.[78] The skilled person standard thus varies according to the invention in question, its field of art, and researchers in the field.[79] In the case of a simple invention in a field where most innovation is created by laypersons, for instance, a device to keep flies away from horses, the skilled person may be someone with little education or practical experience.[80] By contrast, where an invention is in a complex field with highly educated

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[77] *In re GPAC,* 57 F.3d 1573, 1579 (Fed. Cir. 1995).

[78] *Id.*; *Custom Accessories, Inc. v. Jeffrey-Allan Indust., Inc.,* 807 F.2d 955, 962 (Fed. Cir. 1986). Previously, this list of factors included the "educational level of the inventor." *Environmental Designs, Ltd. V. Union Oil Co.,* 713 F.2d 693, 696 (Fed. Cir. 1983) [hereinafter Environmental]. That was until the Federal Circuit announced that, "courts never have judged patentability by what the real inventor/applicant/patentee could or would do. Real inventors, as a class, vary in the capacities from ignorant geniuses to Nobel laureates; the courts have always applied a standard based on an imaginary work of their own devising whom they have equated with the inventor." *Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1454 (Fed. Cir. 1984) ("[H]ypothetical person is not the inventor, but an imaginary being possessing 'ordinary skill in the art' created by Congress to provide a standard of patentability.").

[79] *See, e.g*., *supra* note 16 ("If the level of skill is low, for example that of a mere dyer, as Daystar has suggested, then it may be rational to assume that such an artisan would not think to combine references absent explicit direction in a prior art reference... [if] the level of skill is that of a dying process designer, then one can assume comfortably that such an artisan will draw ideas from chemistry and systems engineering-without being told to do so."). *Daiichi Sankyo Co. v. Apotex, Inc*. concerned a patent for treating ear infections by applying an antibiotic to the ear.[79] The Federal Circuit overturned a finding by the district court that the skilled person "would have a medical degree, experience treating patients with ear infections, and knowledge of the pharmacology and use of antibiotics. This person would be . . . a pediatrician or general practitioner—those doctors who are often the 'first line of defense' in treating ear infections and who, by virtue of their medical training, possess basic pharmacological knowledge." 501 F.3d 1254, 1257 (Fed. Cir. 2007). Rather, a person of ordinary skill in the art was, "a person engaged in developing new pharmaceuticals, formulations and treatment methods, or a specialist in ear treatments such as an otologist, otolaryngologist, or otorhinolaryngologist who also has training in pharmaceutical formulations." *Id.*; *Penda Corp. v. United States*, 29 Fed. Cl. 533, 573 (1993) (noting that "education" includes practical experience as well as formal education). For instance, in *Bose Corp. v. JBL, Inc*., the District Court found that keeping "up with current literature and trade magazines to keep abreast of new developments," could be the equivalent of "a bachelor of science degree in electrical engineering, physics, mechanical engineering, or possibly acoustics." Bose Corp. v. JBL Inc., 112 F. Supp.2d 138 (D. Mass. 2000). As one might expect, the skilled person standard is often an issue in infringement litigation.

[80] *See Graham v. Gun-Munro,* No. C-99-04064 CRB, 2001 U.S. Dist. LEXIS 7110, *19 (N.D. Cal. May 22, 2001) (holding in a case regarding fly wraps for the legs of horses that the skilled person had some formal education but no special training in the field of art).

workers such as chemical engineering or pharmaceutical research, the skilled person may be quite sophisticated.[81]

### *E. Analogous Prior Art*

Determining what constitutes prior art is also central to the obviousness inquiry.[82] On some level, virtually all inventions involve a combination of known elements.[83] The more prior art can be considered, the more likely an invention is to appear obvious. To be considered for the purposes of obviousness, prior art must fall within the definition for anticipatory references under Section 102, and must additionally qualify as "analogous art."[84]

Section 102 contains the requirement for novelty in an invention, and it explicitly defines prior art.[85] An extraordinarily broad amount of information qualifies as prior art, including any printed publication made available to the public prior to filing a patent application.[86] Courts have long held that inventors are charged with constructive knowledge of *all* prior art.[87] While no real inventor could have such knowledge,[88] the social benefits of this rule are thought to outweigh its costs.[89] Granting patents on existing inventions

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[81] *See Imperial Chem. Indus., PLC v. Danbury Pharmacal, Inc.*, 777 F. Supp. 330, 371 (D. Del. 1991) (holding the skilled person is an organic chemist with a PhD); *see also* 713 F.2d 693 (Fed. Cir. 1983) (noting the respective chemical expert witnesses of the parties with extensive backgrounds in sulfur chemistry were skilled persons).

[82] This is the second inquiry of the *Graham* analysis described earlier.

[83] *See, e.g.*, Ryko Mfg. Co. v. Nu-Star, Inc., 950 F.2d 714,718 (Fed. Cir. 1991).

[84] *In re Bigio*, 381 F.3d 1320, 1325, 72 USPQ2d 1209, 1212 (Fed. Cir. 2004).

[85] 35 U.S.C. 102.

[86] 35 U.S.C. 102(a); *see* MPEP § 2152 for a detailed discussion of what constitutes prior art. Almost anything in writing is prior art. "A U.S. patent on the lost wax casting technique was invalidated on the basis of Benvento Cellini's 16th Century autobiography which makes mention of a similar technique." See Michael Ebert, *Superperson and the Prior Art*, 67 J.PAT. & TRADEMARK OFF. SOCY 657 (1985).

[87] In *Mast, Foos, & Co. v. Stover Manufacturing Co.*, the Court applied a presumption that the skilled person is charged with constructive knowledge of all prior art: "Having *all* these various devices before him, and *whatever* the facts may have been, he is chargeable with a knowledge of all preexisting devices." 177 U.S. 485, 493 (1900) (further, "we must presume the patentee was fully informed of everything which preceded him, whether such were the actual fact or not.")

[88] *See, e.g., In re Wood*, 599 F.2d 1032, 1036, 202 USPQ 171, 174 (CCPA 1979) ("[A]n inventor could not possibly be aware of every teaching in every art.").

[89] *See* Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 147 (1989) (reciting that Thomas Jefferson, the "driving force behind early federal patent policy," believed that "a grant of patent rights in an idea already disclosed to the public [i]s akin to an *ex post facto* law, 'obstruct[ing] others in the use of what they possessed before'" (quoting Letter from Thomas Jefferson to Isaac McPherson (Aug. 13, 1813), *in* 13 THE WRITINGS OF THOMAS JEFFERSON 326, 327 (Andrew A. Lipscomb & Albert Ellery Bergh eds., 1903)); Graham v. John Deere Co., 383 U.S. 1, 5–6 (1966)

could prevent the public from using something it already had access to, and remove knowledge from the public domain.[90]

For the purposes of obviousness, prior art under Section 102 must also qualify as analogous. That is to say, *the prior art must be in the field of an applicant's endeavor, or reasonably pertinent to the problem with which the applicant was concerned*.[91] A real inventor would be expected to focus on this type of information. The "analogous art" rule better reflects practical conditions, and it ameliorates the harshness of the definition of prior art for novelty given that prior art references may be combined for purposes of obviousness but not novelty.[92] Consequently, for the purposes of obviousness, the skilled person is presumed to have knowledge of all prior art within the field of an invention, as well as prior art reasonably pertinent to the problem the invention solves. Restricting the universe of prior art to analogous art lowers the bar to patentability.[93]

The analogous art requirement was most famously conceptualized in the case of *In re Winslow*, in which the court explained a decision maker was to "picture the inventor as working in his shop with the prior art references,

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(stating that granting patents on non-novel inventions would remove knowledge from the public domain).

[90] *Id.*

[91] *See, e.g.,* Wyers v. Master Lock Co., 616 F.3d 1231, 1237 (Fed. Cir. 2010) ("Two criteria are relevant in determining whether prior art is analogous: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved." (internal quotation marks omitted)). "Under the correct analysis, any need or problem known in the field of endeavor at the time of the invention and addressed by the patent [or application at issue] can provide a reason for combining the elements in the manner claimed." KSR *supra* note 9, at 420. Prior art in other fields may sometimes be considered as well. *Id.* at 417 ("[w]hen a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one"). The general question is whether it would have been "reasonable" for the skilled person to consider a piece of prior art to solve their problem. *In re Clay*, 966 F.2d 656 (Fed. Cir. 1992). To be "reasonably pertinent", prior art must "logically [] have commended itself to an inventor's attention in considering his problem." *Id.*

[92] *See, In re Wood*. 599 F.2d 1032, 1036 (C.C.P.A. 1979) ("The rationale behind this rule precluding rejections based on combination of teachings of references from nonanalogous arts is the realization that an inventor could not possibly be aware of every teaching in every art."). (The rule "attempt[s] to more closely approximate the reality of the circumstances surrounding the making of an invention by only presuming knowledge by the inventor of prior art in the field of his endeavor and in analogous arts."). *Id.*

[93] *See* Margo A. Bagley, *Internet Business Model Patents: Obvious by Analogy*, 7 MICH. TELECOMM. & TECH. L. REV. 253, 270 (2001) (arguing that prior to the analogous arts test references were rarely excluded as prior art); *see also* Jacob S. Sherkow, *Negativing Invention*, 2011 BYU L. Rev. 1091, 1094–95 (2011) (noting that once a relevant piece of prior art is classified as analogous, an obviousness finding is often inevitable).

which he is presumed to know, hanging on the walls around him."[94] Or as Judge Learned Hand remarked, "the inventor must accept the position of a mythically omniscient worker in his chosen field. As the arts proliferate with prodigious fecundity, his lot is an increasingly hard one."[95]

[94] *Application of* Winslow, 365 F.2d 1017, 1020 (C.C.P.A. 1966).
[95] 185 F.2d 350 (2d Cir. 1950).

## III. MACHINE INTELLIGENCE IN THE INVENTIVE PROCESS

### A. *Automating and Augmenting Research*

Artificial intelligence, which is to say a computer able to perform tasks normally requiring human intelligence, is playing an increasingly important role in innovation.[96] For instance, IBM's flagship AI system, "Watson," is being used to conduct research in drug discovery, as well as clinically to analyze the genes of cancer patients and develop treatment plans.[97] In drug discovery, Watson has already identified novel drug targets and new indications for existing drugs.[98] In doing so, Watson may be generating patentable inventions either autonomously or collaboratively with human researchers.[99] In clinical practice, Watson is also automating a once human function.[100] In fact, Watson can interpret a patient's entire genome and prepare a clinically actionable report in 10 minutes, a task which otherwise requires around 160 hours of work by a team of experts.[101] A recent study by IBM found that Watson's report outperformed the standard practice.[102]

Watson is largely structured as an "expert system," although Watson is not a single program or computer—the brand incorporates a variety of technologies.[103] Here, Watson will be considered a single software program in the interests of simplicity. Expert systems are one way of designing AI that solve problems in a specific domain of knowledge using logical rules derived

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[96] *See, e.g.*, Outlook on Artificial Intelligence in the Enterprise, DATASCIENCEASSN.ORG, http://www.datascienceassn.org/sites/default/files/Outlook%20on%20Artificial%20Intelligence%20in%20the%20Enterprise%202016.pdf (a survey of 235 business executives conducted by the National Business Research Institute (NBRI) which found that *38% of enterprises were using AI technologies in 2016, and 62% will use AI technologies by 2018*.) (hereinafter Outlook on AI) (last visited October 16, 2004).

[97] IBM Watson Health, *Accelerate Scientific Breakthroughs*, https://www.ibm.com/watson/health/life-sciences/drug-discovery/; IBM Watson Health, *IBM Watson for Genomics helps doctors give patients new hope*, https://www.ibm.com/watson/health/oncology-and-genomics/genomics/

[98] *Id.*

[99] *See generally* Hal the Inventor *supra* note 3 (discussing the "hypothetical" example of an AI system being used in drug discovery to identify new drug targets and indications for existing drugs).

[100] Kazimierz O. Wrzeszczynski, et al., *Comparing sequencing assays and human-machine analyses in actionable genomics for glioblastoma*, http://ng.neurology.org/content/3/4/e164.

[101] *Id.*

[102] *Id.*

[103] *See* Richard Waters, *Artificial intelligence: Can Watson save IBM?* FINANCIAL TIMES (JANUARY 5, 2016), https://www.ft.com/content/dced8150-b300-11e5-8358-9a82b43f6b2f; *see also* Will Knight, *IBM's Watson is Everywhere- But What Is it?* MIT TECHNOLOGY REVIEW (October 27, 2016) https://www.technologyreview.com/s/602744/ibms-watson-is-everywhere-but-what-is-it/.

from the knowledge of experts. These were a major focus of AI research in the 1980s.[104] Expert system based chess playing programs HiTech and Deep Thought defeated chess masters in 1989, paving the way for another famous IBM computer, Deep Blue, to defeat world chess champion Garry Kasparov in 1997.[105] But Deep Blue had limited utility—it was solely designed to play chess. The machine was permanently retired after defeating Kasparov.[106]

Google's leading AI system, DeepMind, is an example of another sort of inventive machine. DeepMind uses an artificial neural network, which essentially consists of many highly interconnected processing elements working together to solve specific problems.[107] The design of neural networks is inspired by the way the human brain processes information.[108] Like the human brain, neural networks can learn by example and from practice.[109] Examples for neural networks come in the form of data, so more data means improved performance.[110] This has led to data being described as the new oil of the 21st century, and the fuel for machine learning.[111] Developers may not be able to understand exactly how a neutral network processes data or generates a particular output.[112]

In 2016, DeepMind developed an algorithm known as AlphaGo which beat a world champion of the traditional Chinese board game, Go.[113] This feat

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[104] STUART J. RUSSELL & PETER NORVIG, ARTIFICIAL INTELLIGENCE: A MODERN APPROACH 22–23 (2nd ed. 2003).

[105] Deep Blue, http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/words/.

[106] *Id*.

[107] KEVIN GURNEY, AN INTRODUCTION TO NEURAL NETWORKS, 1–4 (1997). The first neural network was built in 1951. *Supra* note 104.

[108] Rather, Deep Mind uses deep learning on a convolutional neural network with a form of model-free reinforcement learning known as Q-learning. V. Mnih, et al., *Human-level control through deep reinforcement learning*, NATURE. 518 (7540): 529–33. Deep learning is based on learning data representations from processing and interpreting large data sets, as opposed to task-specific algorithms. *Id*. A convolutional neural network is a particular type of artificial neural network structure. *Id*. Q-learning is a particular model of reinforcement learning, which involves software taking an action which is interpreted for a particular result that feeds back to the software to influence future action. *Id*.

[109] *Supra* note 107.

[110] PEDRO DOMINGOS, THE MASTER ALGORITHM: HOW THE QUEST FOR THE ULTIMATE LEARNING MACHINE WILL REMAKE OUR WORLD (2015), at xi.

[111] *See, e.g*., Michael Palmer, *Data is the New Oil* (November 3, 2006), http://ana.blogs.com/maestros/2006/11/data_is_the_new.html. Humby was first credited with the data as oil metaphor. https://www.quora.com/Who-should-get-credit-for-the-quote-data-is-the-new-oil.

[112] *Supra* note 108.

[113] D. Silver, *et al.*, *Mastering the game of Go with deep neural networks and tree search Nature* 529, 484–489 (2016) (hereinafter Silver). In 2015, Deep Mind attained "human-level performance in video games" playing a series of class Atari 2600 games. V. Mnih, et al., *Human-level control through deep reinforcement learning*, NATURE 518, 529–533 (2015).

was widely lauded in the artificial intelligence community because Go is exponentially more complicated than chess.[114] Current computers cannot "solve" Go solely by using "brute force" computation to determine the optimal move to any potential configuration in advance.[115] There are more possible board configurations in Go than there are atoms in the universe.[116] Rather than being pre-programmed with a number of optimal Go moves, DeepMind used a general-purpose algorithm to interpret the game's patterns.[117] DeepMind is now working to beat human players at the popular video game StarCraft II.[118]

AI like DeepMind is proving itself and training by playing games, but similar techniques can be applied to other challenges requiring recognition of complex patterns, long-term planning, and decision-making.[119] DeepMind is already being applied to solve practical problems. For instance, it has helped decrease cooling costs at company datacenters.[120] DeepMind is working to develop an algorithm to distinguish between healthy and cancerous tissues, and to evaluate eye scans to identify early signs of diseases leading to blindness.[121] The results of this research may well be patentable.

Ultimately, the developers of DeepMind hope to create Artificial General Intelligence (AGI).[122] Existing, "narrow" or specific AI (SAI) systems focus on discrete problems or work in specific domains. For instance, "Watson for Genomics" can analyze a genome and provide a treatment plan, and "Chef Watson" can develop new food recipes by combining existing ingredients. However, Watson for Genomics cannot respond to open-ended

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[114] Silver, *id*.
[115] *Id.*; *cf*, Cade Metz, *One Genius' Lonely Crusade to Teach a Computer Common Sense* https://www.wired.com/2016/03/doug-lenat-artificial-intelligence-common-sense-engine/ (arguing that brute force computation was part of AlphaGo's functionality) (hereinafter Lonely Crusade).
[116] $10^{170}$, or thereabouts. Silver, *id*.
[117] D. Silver, *et al.*, Mastering the game of Go with deep neural networks and tree search *Nature* 529, 484–489 (2016).
[118] Tom Simonite, *Google's AI Declares Galactic War On Starcraft* (August 9, 2017), https://www.wired.com/story/googles-ai-declares-galactic-war-on-starcraft-/Compared with Go, StarCraft is vastly more complex. It involves high levels of strategic thinking and acting with imperfect information. *Id*.
[119] Game playing has long been a proving ground for AI, as far back as what may have been the very first AI program in 1951. *See* Jack Copeland, *A Brief History of Computing*, http://www.alanturing.net/turing_archive/pages/Reference%20Articles/BriefHistofComp.html. That program played checkers, and was competitive with amateurs. *Id*.
[120] *Supra* note 118.
[121] Chris Baraniuk, *Google's DeepMind to peek at NHS eye scans for disease analysis* BBC (6 July 2016); Chris Baraniuk, *Google DeepMind targets NHS head and neck cancer treatment* BBC (31 August 2016).
[122] Solving Intelligence through Research, https://deepmind.com/research/

patient queries about their symptoms, and Chef Watson cannot design a self-driving car. New capabilities could be added to Watson to do these things, but Watson can only solve problems it has been programmed to solve.[123] By contrast, AGI would be able to successfully perform any intellectual task a person could.

AGI could even be set to the task of self-improvement, resulting in a continuously improving system that surpasses human intelligence—what philosopher Nick Bostrom has termed Artificial SuperIntelligence (ASI).[124] Such an outcome has been referred to as the intelligence explosion or the technological singularity.[125] ASI could then innovate in all areas of technology, resulting in progress at an incomprehensible rate. As the mathematician Irving John Good wrote in 1965, "the first ultraintelligent machine is the last invention that man need ever make."[126]

Experts are divided on when, and if, AGI will be developed. Many industry leaders predict based on historical trends that AGI will occur within the next couple of decades.[127] Others believe the magnitude of the challenge has been underestimated, and that AGI may not be developed in this century.[128] In 2013, hundreds of AI experts were surveyed on their predictions for AGI development.[129] On average, participants predicted a 10% likelihood that AGI would exist by 2022, a 50% likelihood it would exist by 2040, and a 90% likelihood it would exist by 2075.[130] In another similar survey, 42% of participants predicted AGI would exist by 2030, and

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[123] *See, e.g.*, Lonely Crusade *supra* note 115.
[124] *See generally* NICK BOSTROM, SUPERINTELLIGENCE: PATHS, DANGERS, STRATEGIES (2017).
[125] *See generally* RAY KURZWEIL, THE SINGULARITY IS NEAR (2005).
[126] I. Good, *Speculations Concerning the First Ultraintelligent Machine,* 6 Advances in Computers (1965) ("Let an ultraintelligent machine be defined as a machine that can far surpass all the intellectual activities of any man however clever. Since the design of machines is one of these intellectual activities, an ultraintelligent machine could design even better machines; there would then unquestionably be an 'intelligence explosion,' and the intelligence of man would be left far behind. Thus the first ultraintelligent machine is the last invention that man need ever make.")
[127] Pawel Sysiak, *When Will The First Machine Become Superintelligent?*, https://medium.com/ai-revolution/when-will-the-first-machine-become-superintelligent-ae5a6f128503.
[128] *Id*. In fairness, history also reflects some overly optimistic predictions. In 1970, Marvin Minsky, one of the most famous AI thoughts leaders, was quoted in Life Magazine as stating, "In from three to eight years we will have a machine with the general intelligence of an average human being." 1970 November 20, LIFE, Meet Shaky, the first electronic person: The fascinating and fearsome reality of a machine with a mind of its own by Brad Darrach, Start Page 58B, Quote Page 58D, 66, and 68, Time Inc., New York.
[129] *Supra* note 6.
[130] *Id*. Participants were asked to provide an optimistic year for AGI's development (10% likelihood), a realistic year (50% likelihood), and a pessimistic year (90% likelihood). The median responses were 2022 as an optimistic year, 2040 as a realistic year, and 2075 as a pessimistic year. *Id*.

another 25% predicted AGI by 2050.[131] In addition, 10% of participants reported they believed ASI would develop within 2 years of AGI, and 75% predicted this would occur within 30 years.[132] The weight of expert opinion thus holds artificial general intelligence and superintelligence will exist this century. In the meantime, specific artificial intelligence is getting ever better at outcompeting people at specific tasks—including invention.

### *B. Timeline to the Creative Singularity*

We are amid a transition from human to machine inventors. The following five-phase framework illustrates this transition, and divides the history and future of inventive AI into several stages.

| Evolution of Machine Invention | | | |
|---|---|---|---|
| Phase | Inventors | Skilled Standard | Timeframe |
| I | Human | Person | Past |
| II | Human > SAI | Augmented Person | Present |
| III | Human ~ SAI | Aug Person ~ SAI | Short Term |
| IV | SAI ~ AGI > Human | Augmented AGI | Medium Term |
| V | ASI | ASI | Long Term |
| SAI = Specific Artificial Intelligence; AGI = Artificial General Intelligence; ASI = Artificial Superintelligence; ~ = competing; > = outcompeting | | | |

Until relatively recently, all invention was created by people. If a company wanted to solve an industrial problem, it asked a research scientist, or a team of research scientists, to solve the problem. That is no longer the only option. In some industries, and for some problems, AI can autonomously solve problems. In 2006, for instance, NASA recruited an autonomously inventive machine to design an antenna that flew on NASA's Space Technology 5 (ST5) mission.[133]

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[131] A survey conducted at an annual AGI Conference reported 42% believed AGI would exist by 2030, 25% by 2050, 20% by 2100, 10% after 2010, and 2% never. *See* JAMES BARRAT, OUR FINAL INVENTION: ARTIFICIAL INTELLIGENCE AND THE END OF THE HUMAN ERA at 152. For instance, Demis Hassabis, the founder of DeepMind, believes AGI is still decades away. *Supra* note 119.
[132] *Supra* note 6.
[133] Gregory S. Hornby, *Automated Antenna Design with Evolutionary Algorithms*, http://alglobus.net/NASAwork/papers/Space2006Antenna.pdf.

Phase I ended when the first patent was granted for an invention created by an autonomous machine—likely 1998 or earlier.[134] It may be difficult to determine precisely when the first patent was issued for an autonomous machine invention as there is no obligation to report the role of machines in patent applications. Still, any number of patents have been issued to inventions autonomously generated by machines.[135] In 1998, a patent was issued for an invention autonomously developed by a neural network-based system known as the Creativity Machine.[136]

Patents may have been granted on earlier machine inventions. For instance, an article published in 1983 describes experiments with an AI program known as Eurisko, in which the program, "invent[ed] new kinds of three-dimensional microelectronic devices… novel designs and design rules have emerged."[137] Eurisko was an early, expert AI system for autonomously discovering new information.[138] It was programmed to operate according to a series of rules known as heuristics, but it was able to discover new heuristics and use these to modify its own programming.[139] To design new microchips, Eurisko was programmed with knowledge of basic microchips along with simple rules and evaluation criteria.[140] It would then combine existing chip structures together to create new designs, or mutate existing entities.[141] The new structure would then be evaluated for interest and either retained or

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[134] Phase I might also be distinguished by the first time a machine invented anything independently of receiving a patent. However, using the first granted patent application is a better benchmark. It is an external measure of a certain threshold of creativity, and it represents the first time a computer automated the role of a patent inventor. Granted, there is a degree of subjectivity in a patent examiner determining whether an invention is new, nonobvious and useful. What is nonobvious to one examiner may be obvious to another. *See*, *e.g*., Iain M. Cockburn, Samuel Kortum, and Scott Stern, *Are All Patent Examiners Equal? The Impact of Characteristics on Patent Statistics and Litigation Outcomes*, in PATENTS IN THE KNOWLEDGE-BASED ECONOMY, (Cohen, Wesley and Steven Merrill (eds. 2003) (describing significant inter-examiner variation).

[135] *See generally* I Think, *supra* note 1**Error! Bookmark not defined.**, at 1083–91 (describing patents issued for "computational invention").

[136] I Think, *supra* note 1 at 1083–6.

[137] Douglas B. Lenat and William R. Sutherland, *Heuristic Search for New Microcircuit Structures: An Application of Artificial Intelligence*, AI MAGAZINE, VOL 3(3), 1982, at 17.

[138] Eurisko was created by Douglas Lenat as the predecessor to the Automated Mathematician (AM). *See, generally,* Douglas B. Lenat and John Seely Brown, *Why AM and EURISKO Appear to Work*, ARTIFICIAL INTELLIGENCE MAGAZINE, 269–294. AM was an "automatic programming system" that could modify its own computer code. It relied on pre-programed rules known as heuristics. *Id.* Eurisko was a subsequent iteration of the machine designed to additionally develop new heuristics and incorporate those into its function. *Id.*

[139] *Supra* note 137.

[140] *Id.*

[141] *Id.*

discarded.[142] Several references suggest a patent was granted for one of Eurisko's chip designs in the mid-1980s.[143] Although, upon investigation, it appears that while Stanford University did file a patent for the chip design in 1980, the University abandoned the filing for unknown reasons in 1984.[144] Also, as with other known instances of patent applications claiming the output of inventive machines, the patent application was filed on behalf of natural persons.[145] In this case, the individuals who built a physical chip based on Eurisko's design.[146]

In the present, Phase II, machines and people are competing and cooperating at inventive activity. However, in all technological fields, human researchers are the norm and thus best represent the skilled person standard. While AI systems are inventing, it is unclear to what extent this is occurring. Inventive machine owners may not be disclosing the extent of such machines in the inventive process due to concerns about patent eligibility or because companies generally restrict information about their organizational methods to maintain a competitive advantage.[147] This phase will reward early adopters of inventive machines which are able to outperform human inventors at solving specific problems, and whose output can exceed the skilled person standard.

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[142] *Id.*

[143] *See, e.g.*, FORSYTH AND NAYLOR, THE HITCHHIKER'S GUIDE TO ARTIFICIAL INTELLIGENCE. IBM PC Basic Version, 2167 (1986); *see also* MARGARET A. BODEN, THE CREATIVE MIND: MYTHS AND MECHANISMS, 2nd Ed (2004) 228.

[144] U.S. provisional patent application SN 144,960, April 29, 1980. Email communications with Katherine Ku, Director of Stanford Office of Technology Licensing, January 17, 2018 (on file with author). Douglas Lenat, CEO of Cycorp, Inc., who wrote Eurisko and performed the above-mentioned research, reported that this work was done "before the modern rage about patenting things…" and that in his opinion Eurisko had independently created a number of patentable inventions. *See* Telephone Interview with Douglas Lenat, CEO, Cycorp, Inc. (Jan. 12, 2018). He further reported that after Eurisko came up with the chip design that Professor James Gibbons at Stanford successfully built a chip based on the machine's design. *Id.* Dr. Lenat is now continuing to develop an expert-system based AI that can use logical deduction and inference reasoning based on "common sense knowledge" as opposed to a system like Watson that recognizes patterns in very large datasets. *Id.* He also states that his current company has developed numerous patentable inventions, but that it has not filed for patent protection because he believes that, at least with regards to software, the downside of patents providing competitors with a roadmap to copying patented technology exceeds the value of a limited term patent. *Id.*

[145] *See I Think*, 1083–1091 (describing instances of "computational invention").

[146] Email communications with Katherine Ku, Director of Stanford Office of Technology Licensing, January 17, 2018 (on file with author).

[147] Lonely Crusade, *supra* note 115.

While there may now only be a modest amount of autonomous[148] machine invention, human inventors are being widely augmented by creative computers. For example, a person may design a new battery using a computer to perform calculations, search for information, or run simulations on new designs. The computer does not meet inventorship criteria, but it does augment the capabilities of a researcher in the same way that human assistants can help reduce an invention to practice. Depending on the industry researchers work in and the problems they are trying to solve, researchers may rarely be unaided by computers. The more sophisticated the computer, the more it is able to augment the worker's skills.

Phase III, in the near future, will involve increased competition and cooperation between people and machines. In certain industries, and for certain problems, inventive machines will become the norm. For example, in the pharmaceutical industry, Watson is now identifying novel drug targets and new indications for existing drugs. Soon, it may be the case that inventive machines are the primary means by which *new uses* for existing drugs are researched. That is a predictable outcome, given the advantage machines have over people at recognizing patterns in very large datasets. However, it may be that people still perform the majority of research related to *new drug targets*. Where the standard varies within a broad field like drug discovery, this variation can be addressed by defining fields and problems narrowly, for instance according to the subclasses currently used by the Patent Office.[149]

Perhaps 25 years from now—based on expert opinion—the introduction of AGI will usher in Phase IV. Recall that AGI refers to artificial intelligence that can be applied generally, as opposed to narrowly in specific fields of art, and that it has intelligence comparable to a person. AGI will compete with human inventors in every field, which makes AGI a natural substitute for the skilled person. Even with this new standard, human inventors may continue to invent—just not as much. An inventor may be a creative genius whose

[148] As the term is used here, autonomous machines are given goals to complete by users, but determine for themselves the means of completing those goals. *See,* Ryan Abbott, *The Reasonable Computer: Disrupting the Paradigm of Tort Liability,* GEO. WASH. L. REV (forthcoming) https://ssrn.com/abstract=2877380. For example, a user could ask a computer to design a new battery with certain characteristics, and the computer could produce such a design without further human input. In this case, the machine would be autonomously inventive, and competing with human inventors.

[149] *See generally Overview of the U.S. Patent Classification System (USPC)* https://www.uspto.gov/sites/default/files/patents/resources/classification/overview.pdf. "Some subclasses are harmonized with classifications in other classification systems, for example, the International Patent Classification (IPC) or the European Classification (ECLA) systems." *Id.* at 1–10.

abilities exceed the human average, or a person of ordinary intelligence who has a groundbreaking insight.

Just as SAI outperforms people in certain fields, it will likely be the case that SAI outperforms AGI in certain circumstances. An example of this could be when screening a million compounds for pesticide function lends itself to a "brute force" computational approach. For this reason, SAI could continue to represent the level of ordinary skill in fields in which SAI is the standard, while AGI could replace the skilled person in all other fields. However, the two systems will likely be compatible. A general AI system wanting to play Go could incorporate AlphaGo into its own programming, design its own algorithm like AlphaGo, or even instruct a second computer operating AlphaGo.

AGI will continually improve, transforming into ASI. Ultimately, in Phase V, when AGI succeeds in developing artificial superintelligence, it will mean the end of obviousness. Everything will be obvious to a sufficiently intelligent machine.

### *C. Inventive and Skilled Machines*

For purposes of patent law, an *inventive machine* should be one which generates patentable output while meeting traditional inventorship criteria.[150] Because obviousness focuses on the quality of a patent application's inventive content, it should be irrelevant whether the content comes from a person or machine, or a particular type of machine. A machine which autonomously generates patentable output, or which does so collaboratively with human inventors where the machine meets joint inventorship criteria, is inventive.

Under the present framework, inventive machines would not be the equivalent of skilled machines, just as human inventors are not skilled persons. In fact, it should not be possible to extrapolate about the characteristics of a skilled entity from information about inventive entities. Granted, the Federal Circuit once included the "educational level of the inventor" in its early factor-based test for the skilled person.[151] However, that was only until it occurred to the Federal Circuit that, "courts never have judged patentability by what the real inventor/applicant/patentee could or would do. Real inventors, as a class, vary in the capacities from ignorant geniuses to Nobel laureates; the courts have always applied a standard based

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[150] *See* I Think, *supra* note 1 (arguing computers which independently meet human inventorship criteria should be recognized as inventors).
[151] *See, e.g.*, Environmental *supra* note 78.

on an imaginary work of their own devising whom they have equated with the inventor."[152]

What then conceptually is a skilled machine? A machine that anthropomorphizes to the various descriptions courts have given for the skilled person? Such a test might focus on the way a machine is designed or how it functions. For instance, a skilled machine might be a conventional computer as opposed to a machine like Deep Mind that functions unpredictably. However, basing a rule on how a computer functions might not work for the same reason the Flash of Genius test failed. Even leaving aside the significant logistical problem of attempting to figure out how a computer is structured or how it generates particular output, patent law should be concerned with whether a machine is generating inventive output, not what is going on inside the machine.[153] If a conventional computer and a neural network were both able to generate the same inventive output, there would be no reason to favor one over the other.

Alternately, the test could focus on a machine's capacity for creativity. For example, Microsoft Excel plays a role in a significant amount of inventive activity, but it is not innovative. It applies a known body of knowledge to solve problems with known solutions in a predictable fashion (e.g., multiplying values together). However, while Excel may sometimes solve problems that a person could not easily solve without the use of technology, it lacks the ability to engage in almost any inventive activity.[154] Excel is not the equivalent of a skilled machine—it is an automaton incapable of ordinary creativity.

Watson in clinical practice may be a better analogy for a skilled worker. Watson is analyzing a patient's genome and providing treatment recommendations.[155] Yet as with Excel, this activity is not innovative. The problem Watson is solving may be more complex than multiplying a series of numbers, but it has a known solution. Watson is identifying *known* genetic mutations from a patient's genome. Watson is then suggesting *known* treatments based on existing medical literature. Watson is not innovating because it is being applied to solve problems with known solutions, adhering to conventional wisdom.

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[152] *Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1454 (Fed. Cir. 1984) ("[H]ypothetical person is not the inventor, but an imaginary being possessing 'ordinary skill in the art' created by Congress to provide a standard of patentability.").
[153] *See* I Think, *supra* note 1(arguing against a subjective standard for computational invention).
[154] Some behaviors like correcting a rogue formula may have a functionally creative aspect.
[155] *Supra* note 100.

Unlike Excel, however, Watson *can* be inventive. For instance, Watson could be given unpublished clinical data on patent genetics and actual drug responses, and tasked with determining whether a drug works for a genetic mutation in a way that has not yet been recognized. Traditionally, such discoveries have been patentable. Watson is *situationally inventive* depending on the problem it is solving.

It may be difficult to identify an actual computer program now which has a "skilled" level of creativity. To the extent a computer is creative, in the right circumstances, any degree of creativity might result in inventive output. To be sure, this is similar to the skilled person. A person of ordinary skill, or almost anyone, may have an inventive insight. Characteristics can be imputed to a skilled person, but it is not possible the way the test is applied to identify an actual skilled person or to definitively say what she would have found obvious. The skilled person test is simply a theoretical device for a decision maker.

Assuming a useful characterization of a skilled machine, to determine that a skilled machine now represents the average worker in a field, decision makers would need information about the extent to which such machines are used. Obtaining this information may not be practical. Patent applicants could be asked generally about the use and prevalence of computer software in their fields, but it would be unreasonable to expect applicants to already have, or to obtain, accurate information about general industry conditions. The Patent Office, or another government agency, could attempt to proactively research the use of computers in different fields, but this might be costly. The Patent Office lacks expertise is this activity, and its findings would inevitably lag behind rapidly changing conditions. Ultimately, there may not be a reliable and low-cost source of information about skilled machines right now.

### *D. Inventive is the New Skilled*

Having inventive machines replace the skilled person may better correspond with real world conditions. Right now, there are inherent limits to the number and capabilities of human workers. The cost to train and recruit new researchers is significant, and there are a limited number of people with the ability to perform this work. By contrast, inventive machines are software programs which may be non-rivalrous.[156] Once Watson outperforms the average industry researcher, IBM may be able to simply copy Watson and

[156] ANDREAS KEMPER, VALUATION OF NETWORK EFFECTS IN SOFTWARE MARKETS (2010) at 37.

have it replace most of an existing workforce. Copies of Watson could replace individual workers, or a single Watson could do the work of a large team of researchers.

Indeed, as mentioned earlier in a non-inventive setting, Watson can interpret a patient's entire genome and prepare a clinically actionable report in 10 minutes, as opposed to a team of human experts which take around 160 hours.[157] Once Watson is proven to produce better patient outcomes than the human team, it may be unethical to have people underperform a task which Watson can automate. When that occurs, Watson should not only replace the human team at its current facility—it should replace every comparable human team. Watson could similarly automate in an inventive capacity.

Thus, inventive machines change the skilled paradigm because once they become the average worker, the average worker becomes inventive. This should then raise the bar for obviousness, so that these machines will no longer qualify as inventive. At this point, such machines may be *skilled machines*—machines which represent the average worker and are no longer capable of routine invention.[158]

Regardless of the terminology, as machines continue to improve, this will continue to raise the nonobviousness bar. To generate patentable output, it may be necessary to use an advanced machine that can outperform standard machines, or a person or machine will need to have an unusual insight that standard machines cannot easily recreate. Inventiveness might also depend on the data supplied to a machine, such that only certain data would result in inventive output. Taken to its logical extreme, and given there is no limit to how sophisticated computers can become, it may be that everything will one day be obvious to commonly used computers.

It is possible to generate reasonably low-cost and accurate information about the use of inventive machines. The Patent Office should institute a requirement for patent applicants to disclose the role of computers in the inventive process.[159] This disclosure could be structured along the lines of current inventorship disclosure. Right now, there is an obligation on

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[157] *Supra* note 100.

[158] *See* Enzo Biochem, Inc. v. Calgene, Inc., 188 F.3d 1362, 1374 n.10 (Fed. Cir. 1999) ("In view of the rapid advances in science, we recognize that what may be unpredictable at one point in time may become predictable at a later time.")

[159] It may also be beneficial for applicants to disclose the use of computers when they have been part of the inventive process but where their contributions have not risen to the level of inventorship. Ideally, a detailed disclosure should be provided: applicants should need to disclose the specific software used and the task it performed. In most cases, this would be as simple as noting a program like Excel was used to perform calculations. However, while this information would have value for policy making, it might involve a significant burden to patent applicants.

applicants to disclose all patent inventors.[160] Failure to do so can invalidate a patent or render it unenforceable.[161] Similarly, applicants should have to disclose when a machine autonomously meets inventorship criteria.

These disclosures would only apply to an individual invention. However, the Patent Office could aggregate responses to see whether most inventors in a field (e.g., a class or subclass) are human or machine. These disclosures would have a minimal burden on applicants compared to existing disclosure requirements and the numerous procedural requirements of a patent application. In addition to helping the Patent Office with determinations of nonobviousness, these disclosures would provide valuable information for purposes of attributing inventorship.[162] It might also be used to develop appropriate innovation policies in other areas.[163]

### *E. Skilled People Use Machines*

The current standard neglects to take into account the modern importance of machines in innovation. Instead of now replacing the skilled person with the skilled machine, it would be less of a conceptual change, and administratively easier, to characterize the skilled person as an average worker facilitated with technology. Recall the factor test for the skilled person includes: (1) "type[s] of problems encountered in the art;" (2) "prior art solutions to those problems;" (3) "rapidity with which innovations are made;" (4) "sophistication of the technology;" and (5) "educational level of active workers in the field." This test could be amended to include, (6) "technologies used by active workers." This would take into account the fact that human researchers are augmented with computers in a way that is not currently captured by the test.

Moving forward in time, once the use of inventive machines is standard, instead of a skilled person being an inventive machine, the skilled person standard could incorporate the fact that *technologies used by active workers* includes inventive machines. In future research, the standard practice may be for a worker to ask an inventive machine to solve a problem. This could be conceptualized as the inventive machine doing the work, or the person doing the work using an inventive machine.

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[160] 37 CFR 1.56. *Duty to disclose information material to patentability* https://www.uspto.gov/web/offices/pac/mpep/s2001.html.

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

[162] *See* I Think, *supra* note 1 (advocating for acknowledging machines as inventors)

[163] *See* Should Robots Pay Taxes?, *supra* note 5 (arguing the need to monitor automation for adjusting tax incentives).

Granted, in some instances, using an inventive machine may require significant skill, for instance, if the machine were only able to generate a certain output by virtue of being supplied with certain data. Determining which data to provide a machine, and obtaining that data, may be a technical challenge. Also, it may be the case that significant skill is required to formulate the precise problem to put to a machine. In such instances, a person might have a claim to inventorship independent of the machine, or a claim to joint inventorship. This is analogous to collaborative human invention where one person directs another to solve a problem. Depending on details of their interaction, and who "conceived" of the invention, one person or the other may qualify as an inventor, or they may qualify as joint inventors.[164] Generally, however, directing another party to solve a problem does not qualify for inventorship.[165]

Whether the future standard becomes that of an inventive machine or a skilled person using an inventive machine, the result will be the same: the average worker will be capable of inventive activity. Replacing the skilled person with the inventive machine may be preferable doctrinally because it emphasizes that it is the machine which is engaging in inventive activity, rather than the human worker.

The changing use of machines also suggests a change to the scope of prior art. The analogous art test was implemented because it is unrealistic to expect inventors to be familiar with anything more than the prior art in their field, and the prior art relevant to the problem they are trying to solve.[166] However, a machine is capable of accessing a virtually unlimited amount of prior art. Advances in medicine, physics, or even culinary science may be relevant to solving a problem in electrical engineering. Machine augmentation suggests that the analogous arts test should be modified, or abolished, once inventive machines are common, and that there should be no difference in prior art for purposes of novelty and obviousness.[167] The scope

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[164] "[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).

[165] *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").

[166] In 1966, in *Graham*, the Court recognized that "the ambit of applicable art in given fields of science has widened by disciplines unheard of a half century ago. . . . [T]hose persons granted the benefit of a patent monopoly [must] be charged with an awareness of these changed conditions." Graham v. John Deere Co., 383 U.S. 1, 19 (1966).

[167] *See* Part IIE, *supra*.

of analogous prior art has consistently expanded in patent law jurisprudence, and this would complete that expansion.[168]

### *F. The Evolving Standard*

The skilled person standard should be amended as follows:

1) The test should now incorporate the fact that skilled persons are already augmented by machines. This could be done by adding "technologies used by active workers" to the Federal Circuit's factor test for the skilled person.
2) Once inventive machines become the standard means of research in a field, *the skilled person should be an inventive machine when the standard approach to research in a field or with respect to a particular problem is to use an inventive machine*.
3) When and if artificial general intelligence is developed, it should become the skilled person in all areas, taking into account that artificial general intelligence may also be augmented by specific artificial intelligence.

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[168] *See, e.g.*, George. J. Meyer Mfg. Co. v. San Marino Elec. Corp., 422 F.2d 1285, 1288 (9th Cir. 1970) (discussing the expansion of analogous art); Innovative Scuba Concepts, Inc., v. Feder Indus., Inc., 819 F. Supp. 1487, 1503 (D. Colo. 1993) (discussing the expansion of analogous art).

## IV. A POST-SKILLED WORLD

### *A. Application*

*Mobil Oil Corp. v. Amoco Chemicals Corp.*, (D. Del. 1991), concerned complex technology involving compounds known as Zeolites used in various industrial applications.[169] Mobil had developed new compositions known as ZSM-5 zeolites and a process for using these zeolites as catalysts in petroleum refining to help produce certain valuable compounds. The company received patent protection for these zeolites and for the catalytic process.[170] Mobil subsequently sued Amoco, which was using zeolites as catalysts in its own refining operations, alleging patent infringement. Amoco counterclaimed seeking a declaration of non-infringement, invalidity, and unenforceability with respect to the two patents at issue. The case involved complex scientific issues. The three-week trial transcript exceeds 3,300 pages, and more than 800 exhibits were admitted into evidence.

One of the issues in the case was the level of ordinary skill. An expert for Mobil testified the skilled person would have "a bachelor's degree in chemistry or engineering and two to three years of experience."[171] An expert for Amoco argued the skilled person would have a doctorate in chemistry and several years of experience.[172] The District Court ultimately decided that the skilled person, "should be someone with at least a Masters degree in chemistry or chemical engineering or its equivalent, [and] two or three years of experience working in the field."[173]

If a similar invention and subsequent fact pattern happened today, to apply the obviousness standard proposed in this Article, a decision maker would need to 1) determine the extent to which inventive technologies are used in the field, 2) characterize the inventive machine(s) that best represents the average worker if inventive machines are the standard, and 3) determine whether the machine(s) would find an invention obvious. The decision maker is a patent examiner in the first instance,[174] and potentially a judge or jury in the event the validity of a patent is at issue in trial.[175] For the first step, determining the extent to which inventive technologies are used in a field, evidence from disclosures to the Patent Office could be used. That may be

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[169] 779 F. Supp. 1429, 1442-1443 (D. Del. 1991).
[170] *Id.*
[171] *Id.*
[172] *Id.*
[173] *Id.*
[174] *Supra* note 19.
[175] *Supra* note 20.

the best source of information for patent examiners, but evidence may also be available in the litigation context.

Assume that today most petroleum researchers are human, and that if machines are autonomously inventive in this field it is happening on a small scale. The court would apply the skilled person standard. However, the court would now consider, "technologies used by active workers." For instance, experts might testify that the average industry researcher has access to a computer like Watson. They further testify that while Watson cannot autonomously develop a new catalyst, it can significantly assist an inventor. The computer provides a researcher with a database containing detailed information about every catalyst used not only in petroleum research, but in all fields of scientific inquiry. Once a human researcher creates a catalyst design, Watson can also test it for fitness together with a predetermined series of variations on any proposed design.[176]

The question for the court will thus be whether the hypothetical person with at least a Masters degree in chemistry or chemical engineering or its equivalent, two or three years of experience working in the field, *and using Watson*, would find the invention obvious. It may be obvious, for instance, if experts convincingly testify that the particular catalyst at issue was very closely related to an existing catalyst used outside of the petroleum industry in ammonia synthesis, that any variation was minor, and that a computer could do all the work of determining if it was fit for purpose. It might thus have been an obvious design to investigate, and it did not require undue experimentation in order to prove its effectiveness.

Now imagine the same invention and fact pattern occurring approximately 10 years into the future, at which point DeepMind, together with Watson and a competing host of AI systems, have been set to the task of developing new compounds to be used as catalysts in petroleum refining. Experts testify that the standard practice is for a person to provide data to a computer like DeepMind, specify desired criteria (e.g., activity, stability, perhaps even designing around existing patents), and ask the computer to develop a new catalyst. From this interaction, the computer will produce a new design. As most research in this field is now performed by inventive machines, a machine would be the standard for judging obviousness.

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[176] *See* Daiichi Sankyo Co. v. Matrix Labs., Ltd., 619 F.3d 1346, 1352 (Fed. Cir. 2010) (finding that, a "chemist of ordinary skill would have been motivated to select and then modify a prior art compound (e.g., a lead compound) to arrive at a claimed compound with a reasonable expectation that the new compound would have similar or improved properties compared with the old.").

The decision maker would then need to characterize the inventive machine(s). It could be a hypothetical machine based on general capabilities of inventive machines, or a specific computer. Using the standard of a hypothetical machine would be similar to using the skilled person test, but this test could be difficult to implement. A decision maker would need to reason what the machine would have found obvious, perhaps with expert guidance. It is already challenging for a person to predict what a hypothetical person would find obvious; it would be even more difficult to do so with a machine. Computers may excel at tasks people find difficult (like multiplying a thousand different numbers together), but even supercomputers struggle with visual intuition which is mastered by most toddlers.

In contrast, using a specific computer should result in a more objective test. This computer might be the most commonly used computer in a field. For instance, if DeepMind and Watson are the two most commonly used AI systems for research on petroleum catalysts, and DeepMind accounts for 35% of the market while Watson accounts for 20%, then DeepMind could represent the inventive machine. However, this potentially creates a problem for the machine selected to represent the standard. If DeepMind is the standard, then it would be more likely that DeepMind's own inventions would appear obvious as opposed to the inventions of another machine. This might give an unfair advantage to non-market leaders, simply because of their size. A patentability disadvantage may be the price of industry dominance, but it may also rarely be the case that what is obvious to one machine will be nonobvious to the industry standard. Where that occurs, it may be because the nonobvious machine exceeds the standard.

Alternatively, to avoid unfairness, the test could be based on more than one specific computer. For instance, both DeepMind and Watson could be selected to represent the standard. This test could be implemented in two different ways. In the first case, if a patent application would be obvious to DeepMind <u>or</u> Watson, then the application would fail. In the second case, the application would have to be obvious to both DeepMind <u>and</u> Watson to fail. The first option would result in fewer patents being granted, with those patents presumably going mainly to disruptive inventive machines with limited market penetration, or to inventions made using specialized non-public data. The second option would permit patents where a machine is able to outperform its competitors in some material respect. The second option could continue to reward advances in inventive machines, and therefore seems preferable.

It may be that relatively few AI systems, such as DeepMind and Watson, end up dominating the research market in a field. Alternately, many different machines may each occupy a small share of the market. There is no need to limit the test to two computers. To avoid discriminating on the basis of size, all inventive machines being routinely used in a field or to solve a particular problem might be considered. However, allowing any machine to be considered could allow an underperforming machine to lower the standard, and too many machines might result in an unmanageable standard. An arbitrary cutoff may be applied based on some percentage of market share. That might still give some advantage to very small entities, but it would be a minor disparity.

After characterizing the inventive machine(s), a decision maker would need to determine whether the inventive machine(s) would find an invention obvious. This could broadly be accomplished in one of two ways, either with abstract knowledge of what the machines would find obvious, perhaps through expert testimony, or through querying the machines. The former would be the more practical option.[177] For example, a petroleum researcher experienced with DeepMind might be an expert, or a computer science expert in DeepMind and neural networks. This inquiry would focus on reproducibility.

Finally, a decision maker will have to go through a similar process if the same invention and fact pattern occurs 25 years from now, at which point artificial general intelligence has theoretically taken over in all fields of research. AGI should have the ability to respond directly to queries about whether it finds an invention obvious. Once AGI has taken over from the average researcher in all inventive fields, it may be widely enough available that the Patent Office could arrange to use it for obviousness queries. In the litigation context, it may be available from opposing parties. If courts cannot somehow access AGI, they may still have to rely on expert evidence.

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[177] Alternately, the machine could be asked to solve the problem at question and given the relevant prior art. If the machine generates the substance of the patent, the invention would be considered obvious. However, this would require a decision maker to have access to the inventive machine. At the application stage, the Patent Office would need to contract with, say, Google to use DeepMind in such a fashion. For that matter, the Patent Office might use DeepMind not only to decide whether inventions are obvious, but to automate the entire patent examination process. At trial, if Google is party to a lawsuit, an opposing party might subpoena use of the computer. However, if Google is not a party, it might be unreasonable to impose on Google for access to DeepMind.

### *B. Reproducibility*

Focusing on reproducibility offers some clear advantages over the skilled person standard. The current standard results in inconsistent and unpredictable outcomes.[178] Courts have "provided almost no guidance concerning what degree of ingenuity is necessary to meet the standard or how a decision maker is supposed to evaluate whether the difference between the invention and prior art meet this degree."[179] This leaves decision makers in the unenviable position of trying to subjectively establish what another person would have found obvious. Worse, this determination is to be made in hindsight with the benefit of a patent application. On top of that, judges and juries lack scientific expertise.[180] In practice, decision makers may arrive at a conclusion the same way that Justice Stewart identified obscene material, and then reason backward to justify their findings.[181]

This is problematic because patents play a critical role in the development and commercialization of products, and patent holders and potential infringers should have a reasonable degree of certainty about whether patents are valid. A more determinate standard would make it more likely the Patent Office would apply a single standard consistently, and result in fewer judicially invalidated patents. To the extent machine reproducibility is a more objective standard, this would seem to address many of the problems inherent in the current standard.

On the other hand, reproducibility comes with its own baggage. Decision-makers have difficulty imagining what another person would find

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[178] *See supra* note 13.

[179] Gregory Mandel, *The Non-Obvious Problem: How the Indeterminate Nonobviousness Standard Produces Excessive Patent Grants*, U. C. DAVIS, L. REV. 57 (2008) at 64.

[180] As Judge Learned Hand wrote, "I cannot stop without calling attention to the extraordinary condition of the law which makes it possible for a man without any knowledge of even the rudiments of chemistry to pass upon such questions as these. The inordinate expense of time is the least of the resulting evils, for only a trained chemist is really capable of passing upon such facts . . . How long we shall continue to blunder along without the aid of unpartisan and authoritative scientific assistance in the administration of justice, no one knows; but all fair persons not conventionalized by provincial legal habits of mind ought, I should think, unite to effect some such advance." 189 F. 95, 115 (S.D.N.Y. 1911). *See also*, Safety Car Heating & Lighting Co. v. Gen. Elec. Co., 155 F.2d 937, 939 (1946) ("Courts, made up of laymen as they must be, are likely either to underrate, or to overrate, the difficulties in making new and profitable discoveries in fields with which they cannot be familiar."); *see also* Doug Lichtman & Mark A. Lemley, *Rethinking Patent Law's Presumption of Validity*, 60 STAN. L. REV. 45, 123 ("District Court judges are poorly equipped to read patent documents and construe technical patent claims. Lay juries have no skill when it comes to evaluating competing testimony about the originality of a technical accomplishment.")

[181] Namely, the "I know it when I see it" standard. Jacobellis v. Ohio, 378 U.S. 184, 197 (1964). This was later recognized as a failed standard. Miller v. California, 413 U.S. 15, 47-48 (1973) (Brennan, J., dissenting).

obvious, and it would probably be even more difficult to imagine in the abstract what a machine could reproduce. More evidence might need to be supplied in patent prosecution and during litigation, perhaps in the format of analyses performed by inventive machines, to demonstrate whether particular output was reproducible. This might also result in greater administrative burden.

In some instances, reproducibility may be dependent on access to data. A large health insurer might be able to use Watson to find new uses for existing drugs by giving Watson access to proprietary information on its millions of members. Or, the insurer might license its data to drug discovery companies using Watson for this purpose. Without that information, another inventive computer might not able to recreate Watson's analysis.

This too is analogous to the way data is used now in patent applications: obviousness is viewed in light of the prior art, which does not include non-public data relied upon in a patent application. The rationale here is that this rule incentivizes research to produce and analyze new data. Yet as machines become increasingly advanced, it is likely that the importance of proprietary data will decrease. More advanced machines may be able to do more with less.

Finally, reproducibility would require limits. For instance, a computer which generates semi-random output might eventually recreate the inventive concept of a patent application if it were given unlimited resources. However, it would be unreasonable to base a test on what a computer would reproduce given, say, 7.5 million years.[182] The precise limits that should be put on reproducibility might depend on the field in question, and what best reflected the actual use of inventive machines in research. For instance, when asked to design a new catalyst in the petroleum industry, Watson might be given access to all prior art and publically available data, and then given a day to generate output.

### *C. Incentives Without Patents?*

Today, there are strong incentives to develop inventive machines. Inventions by these machines have value independent of intellectual property protection, but they should also be eligible for patent protection. People may apply as inventors for recognizing the inventive nature of a machine's

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[182] This brings to mind a super intelligent artificial intelligence system, "Deep Thought," which famously, and fictionally, took 7.5 million years to arrive at the "Answer to the Ultimate Question of Life, the Universe, and Everything." DOUGLAS ADAMS, THE HITCHHIKER'S GUIDE TO THE GALAXY (1980). The answer was 42. *Id.*

output,[183] or more ambitiously, inventive machines may be recognized as inventors, resulting in stronger and fairer incentives.

Once inventive machines set the baseline for patentability, standard inventive machines, as well as people, would generally be unable to obtain patents. It is widely thought that setting a nonobviousness standard too high would reduce the incentives for innovators to invent and disclose. Yet once inventive machines are normal, there should be less need for patent incentives. Once the average worker is inventive, inventions will "occur in the ordinary course…"[184] Machine inventions will be self-sustaining. In addition, the heightened bar might result in a technological arms race to create ever more intelligent computers capable of outdoing the standard. That would be a desirable outcome in terms of incentivizing innovation.

Even after the widespread use of inventive machines, patents may still be desirable. For instance, patents may be needed in the biotechnology and pharmaceutical industries to commercialize new technologies. The biopharma industry claims that new drug approvals cost around 2.2 billion dollars and take an average of 8 years.[185] This cost is largely due to resource intensive clinical trials required to prove safety and efficacy. Once a drug is approved, it is often relatively easy for another company to recreate the approved drug. Patents thus incentivize the necessary levels of investment to commercialize a product given that patent holders can charge monopoly prices for their approved products during the term of a patent.

Yet patents are not the only means of promoting product commercialization. Newly approved drugs and biologics, for example, receive a period of market exclusivity during which time no other party can sell a generic or biosimilar version of the product. Newly approved biologics, for instance, receive a 12-year exclusivity period in the United States. Because of the length of time it takes to get a new biologic approved, the market exclusivity period may exceed the term of any patent an originator company has on its product. A heightened bar to patentability may lead to

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[183] 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.").

[184] KSR, *supra* note 9.

[185] DiMasi JA, Grabowski HG, Hansen RA. Innovation in the pharmaceutical industry: new estimates of R&D costs. 47 J. OF HEALTH ECON. 20–33 (2016).

greater reliance on alternative forms of intellectual property protection such as market exclusivity, or prizes, grants, and tax incentives.[186]

With regards to disclosure, without the ability to receive patent protection, owners of inventive machines may choose not to disclose their discoveries and rely on trade secret protection. However, with an accelerated rate of technological progress, IP holders would run a significant risk that their inventions would be independently recreated by inventive machines.

Depending on the type of innovation, industry, and competitive landscape, business ventures may be successful without patents, and patent protection is not sought for all potentially patentable inventions.[187] For instance, patents are often considered a critical part of biotechnology corporate strategy, but often ignored in the software industry.[188] On the whole, a relatively small percentage of firms patent, even among firms conducting R&D.[189] Most companies do not consider patents crucial to business success.[190] Other types of intellectual property such as trademark, copyright, and trade secret protection, combined with "alternative" mechanisms such as first mover advantage and design complexity may protect innovation in the absence of patents.[191]

### *D. Alternatives to the Proposed Standard*

Courts may maintain the current skilled person standard, and decline to consider the use of machines in obviousness determinations. However, this

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[186] *See generally* Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents-Prizes Debate*, 92 TEX. L. REV. 303 (2013) (describing various non-traditional intellectual property incentives).

[187] Bronwyn Hall, et al., *The Use of Alternatives to Patents and Limits to Incentives*, Intellectual Property Office (2012), http://webarchive.nationalarchives.gov.uk/20140603121456/http://www.ipo.gov.uk/ipresearch-patalternative.pdf at 2; s*ee also*, Rochelle Cooper Dreyfuss, Does IP Need IP? Accommodating Intellectual Production Outside the Intellectual Property Paradigm, 31 CARDOZO L. REV. 1437, 1437, 1439 (2010); *see also* David Fagundes, Talk Derby to Me: Intellectual Property Norms Governing Roller Derby Pseudonyms, 90 TEX. L. REV. 1094, 1146 (2012) (describing norm based protections that function effectively in the absence of traditional IP). Patent holders are only successful in about a quarter of cases that are litigated to a final disposition and appealed. Paul M. Janicke & LiLan Ren, Who Wins Patent Infringement Cases?, 34 AIPLA Q.J. 1, 8 (2006). Fewer than two percent of patents are ever litigated, and only about 0.1% go to trial. Mark A. Lemley & Carl Shapiro, Probabilistic Patents, 19 J. ECON. PERSP. 75, 79–83 (2005). In cases where the validity of a patent is challenged, about half of the time the patent is invalidated. John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q. J. 185, 208-09 (1998).

[188] *Id.*

[189] *Id.*

[190] *Id.*

[191] *Id.*

means that as research is augmented and then automated by machines, the average worker will routinely generate patentable output. The dangers of such a standard for patentability are well recognized.[192] A low obviousness requirement can "stifle, rather than promote, the progress of the useful arts."[193]

There are already concerns that the current bar to patentability is too low, and that a patent "anticommons" with excessive private property is resulting in "potential economic value . . . disappear[ing] into the 'black hole' of resource underutilization."[194] It is expensive for firms interested in making new products to determine whether patents cover a particular innovation, to evaluate those patents, contact patent owners, and negotiate licenses.[195] In many cases, patent owners may not wish to license their patents, even if they are non-practicing entities that do not manufacture products themselves.[196] Firms that want to make a product may thus be unable to find and license all the rights they need to avoid infringing. Adding to this morass, most patents turn out to be invalid or not infringed in litigation.[197] Excessive patenting can thus slow innovation, destroy markets, and even cost lives.[198] Failing to raise the bar to patentability once the use of inventive machines is widespread would significantly exacerbate this anticommons effect.

Instead of updating the skilled person standard, courts might determine that inventive machines are incapable of inventive activity, much as the U.S. Copyright Office has determined that non-human authors cannot generate

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[192] See, e.g., ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT 32-35, 75, 119-23, 145-49 (2004) (criticizing the Patent Office for granting patents on obvious inventions); NATIONAL RESEARCH COUNCIL, A PATENT SYSTEM FOR THE 21ST CENTURY 87-95 (2004) (criticizing lenient nonobviousness standards); Matthew Sag & Kurt Rohde, *Patent Reform and Differential Impact*, 8 MINN. J. L. SCI. & TECH. 1, 2 (2007) ("[a]cademics, business leaders, and government officials have all expressed concern that too many patents are issued for [obvious] inventions" (internal quotations omitted)).
[193] KSR *supra* note 9.
[194] James M. Buchanan & Yong J. Yoon, *Symmetric Tragedies: Commons and Anticommons,* 43 J. L. & COM 1–13; DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT (2009) (arguing for a heightened bar to patentability).
[195] *See generally* Mark A. Lemley, *Ignoring Patents,* MICH. ST. L. REV. 19, 25–26 (2008) (describing various costs associate with innovation in patent heavy industries).
[196] *See* David L. Schwartz & Jay P. Kesan, *Analysing the Role of Non-Practicing Entities in the Patent System,* 99 Cornell L. Rev 425.
[197] *See* Mark A. Lemley, & Carl Shapiro *Probabilistic Patents,* J. ECON. PRESP. 19(2) 75-98 (2005).
[198] *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets,* 111HARV. L. REV. 621 (1998); *see also* MICHAEL HELLER, THE GRIDLOCK ECONOMY: HOW TOO MUCH OWNERSHIP WRECKS MARKETS, STOPS INNOVATION AND COSTS LIVES (2008); *see also* Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698 (1998).

copyrightable output.[199] In this case, otherwise patentable inventions might not be eligible for patent protection, unless provision were made for the inventor to be the first person to recognize the machine output as patentable. However, this would not be a desirable outcome. As I have argued elsewhere, providing intellectual property protection for computer-generated inventions would incentivize the development of inventive machines, which would ultimately result in additional invention.[200] This is most consistent with the constitutional rationale for patent protection, "[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."[201]

### *E. A Changing Innovation Landscape*

Inventive machines may result in further consolidation of wealth and intellectual property in the hands of large corporations like Google and IBM. Large enterprises may be the most likely developers of inventive machines due to their high development costs.[202] A counterbalance to additional wealth disparity could be broad societal gains. The public would stand to gain access to a tremendous amount of innovation—innovation which might be significantly delayed or never come about without inventive machines. In fact, concerns about industry consolidation are another basis for revising the obviousness inquiry. The widespread use of inventive machines may be inevitable, but raising the bar to patentability would make it so that inventions which would naturally occur would be less likely to receive protection. Finally, to the extent market abuses such as price gouging and supply shortages are a concern, protections are built into patent law to protect

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[199] This has been a policy of the Copyright Office since at least 1984. *See* U.S. COPYRIGHT OFFICE, COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES § 306 (3d ed. 2014). 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).

[200] *See generally* I Think, *supra* note 1.

[201] U.S. CONST. art. I, § 8, cl. 8.

[202] *See* 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-powerfulsupercomputers-in-the-world-and-what-they-do-1276865 (noting that most advanced computer systems are owned by governments and large businesses).

consumers against such problems.[203] For example, the government could exercise its march in rights or issue compulsory licenses.[204]

Inventive machines may ultimately automate knowledge work and render human researchers redundant. While past technological advances have resulted in increased rather than decreased employment, the technological advances of the near future may be different.[205] There will be fewer limits to what machines will be able to do, and greater access to machines. Automation should generate innovation with net societal gains, but it may also contribute to unemployment, financial disparities, and decreased social mobility.[206] It is important that policy makers act to ensure that automation benefits everyone, for instance by investing in retraining and social benefits for workers rendered technologically unemployed.[207] Ultimately, patent law alone will not determine whether automation occurs. Even without the ability to receive patent protection, once inventive machines are significantly more efficient than human researchers, they will replace people.

### *F. Concluding Thoughts*

*Prediction is very difficult, especially about the future*.[208]

In the past, patent law has reacted slowly to technological change. For instance, it was not until 2013 that the Supreme Court decided human genes should be unpatentable.[209] By then, the Patent Office had been granting patents on human genes for decades,[210] and more than 50,000 gene-related patents had been issued.[211]

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[203] *See* Balancing Access, *supra* note 22 (discussing patent law protections against practices including "evergreening").
[204] *See Id.* (explaining India's issuance of a compulsory license).
[205] *See* Should Robots Pay Taxes? *supra* note 5, Part II.
[206] *Id.*
[207] *Id.*
[208] ARTHUR K. ELLIS, TEACHING AND LEARNING ELEMENTARY SOCIAL STUDIES 56, (1970) (quoting physicist Niels Bohr).
[209] Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107 (2013).
[210] *See*, *e.g*., U.S. patent 4,447,538 (filed Feb. 5, 1982) (a patent issued in 1984 which claims the human *Chorionic Somatomammotropin* gene).
[211] Robert Cook-Deegan & Christopher Heaney, Patetns in Genomics and Human Genetics, 11 Annu Rev Genomics Hum Genet. 383 (2010) ("In April 2009, the U.S. Patent and Trademark Office (USPTO) granted the 50,000th U.S. patent that entered the DNA Patent Database at Georgetown University. That database includes patents that make claims mentioning terms specific to nucleic acids (e.g., DNA, RNA, nucleotide, plasmid, etc.").

Eminent technologists now predict that artificial intelligence is going to revolutionize the way innovation occurs in the next ten to twenty years. This timeline would be consistent with the exponential advances in computer science that have already occurred. As innovation evolves, so too must patent law.