COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

PATENTS' NEW SALIENCE

*Janet Freilich**

The vast majority of patents do not matter. They are almost never enforced or licensed and, in consequence, are almost always ignored. This is a well-accepted feature of the patent system and has a tremendous impact on patent policy. In particular, while there are many aspects of patent law that are potentially troubling—including grants of unmerited patents, high transaction costs in obtaining necessary patent licenses, and patents' potential to block innovation and hinder economic growth—these problems may be insignificant in practice because patents are under-enforced and routinely infringed without consequence.

This Article argues that technological developments are greatly increasing the salience of patents by making patents easier and cheaper to find and enforce. These developments—including private platforms' adjudication systems and AI-driven patent analytics—profoundly impact how the patent system functions and upend the system's present dependence on under-enforcement and ignorance. Where most patents could previously be safely disregarded, formerly forgotten patents now matter.

This Article makes four contributions to the literature. First, this Article explores the technology that is rendering patents newly salient and explains how this alters basic assumptions underlying the patent system. Second, this Article demonstrates that although new technology is increasing the number of patents that can be reviewed and enforced, this transformation sometimes decreases the depth of patent analysis. Because it is difficult to draw conclusions about patent scope or validity

* Associate Professor, Fordham Law School. For insightful comments, I thank Tinu Adediran, BJ Ard, Pam Bookman, Jorge Contreras, Courtney Cox, Nestor Davidson, Tabrez Ebrahim, Joseph Kupferman, Christa Laser, Mark Lemley, Glynn Lunney, Jonathan Masur, Michael Meurer, Tim Murphy, Nicholson Price, Jason Rantanen, Sepehr Shahshahani, Jacob Victor, Maggie Wittlin, Shlomit Yanisky-Ravid, and participants at the 2021 JIPSA Conference, the 28th Annual Intellectual Property Law and Policy Conference, the University of Iowa Intellectual Property Seminar, and the 2021 Intellectual Property Scholars Conference. For excellent research assistance, I thank Mark Brodt, Vivienne Brown, AJ Harris, Delia Wu, and Lu Yan.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

without in-depth analysis, this omission means that technological review of patents may give patents unmerited influence.

Third, this Article shows a sharp divergence between public policy goals and private use of patents. For several decades, the courts and Congress have been reforming patent policy to decrease the impact of patents to alleviate concerns that patent owners hinder innovation by others. This Article demonstrates, in clear contrast to this goal, an increase in patent salience that is due exclusively to the use of private platforms and technologies. Further, the use of private platforms to find, analyze, and enforce patents creates the risk that choices made by companies and software developers will displace substantive patent law. Finally, this Article suggests policy reform, including ways to improve technology and patents and adjusted approaches to patent doctrine and theory.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

INTRODUCTION

It is quite likely that you, the reader, have infringed a patent today. There are millions of in-force U.S. patents, and many cover routine, everyday behaviors. Perhaps you used a smartphone, which are covered by thousands of patents, and liability for infringement extends not just to the phone manufacturer but also to the consumer.[1] Or you used Wi-Fi, also covered by many patents.[2] Alternatively, your infringing act may have been low-tech—playing on a swing[3] or throwing a stick,[4] for example. You were probably not aware that you took an action covered by a patent, but this is no defense to patent infringement, which is a strict liability tort and does not take intent into account.[5]

Fortunately, the vast majority of patents are never enforced so the likelihood that you will be sued for infringement is infinitesimally small.[6] The patent system relies heavily on under-enforcement: if most patents were enforced, day-to-day activities would be impossible because the transaction costs required to find and license all relevant patents would be prohibitively high.[7] Patent scholars, policy makers, and the U.S. Patent and Trademark Office ("USPTO" or "Patent Office") all recognize that many potential problems with the patent system are avoided because patentees rarely enforce patents and infringers generally ignore patents.[8]

[1] Colleen Chien, Predicting Patent Litigation, 90 Tex. L. Rev. 283, 289 (2011); Gaia Bernstein, The Rise of the End User in Patent Litigation, 55 B.C. L. Rev. 1443, 1452–53 (2014).

[2] Mark A. Lemley & Carl Shapiro, Patent Holdup and Royalty Stacking, 85 Tex. L. Rev. 1991, 2027 (2007).

[3] U.S. Patent No. 6,368,227 (filed Nov. 17, 2000).

[4] U.S. Patent No. 6,360,693 (filed Dec. 2, 1999).

[5] In re Seagate Tech., LLC, 497 F.3d 1360, 1368 (Fed. Cir. 2007).

[6] Mark A. Lemley, Rational Ignorance at the Patent Office, 95 Nw. U. L. Rev. 1495, 1497 (2001).

[7] Mark A. Lemley, Ignoring Patents, 2008 Mich. St. L. Rev. 19, 25. This is analogous to many other areas of law—torts, criminal law—where the system is characterized by pervasive under-enforcement. See Richard Abel, The Real Tort Crisis—Too *Few* Claims, 48 Ohio St. L.J. 443, 447 (1987); Richard Frase, The Decision to File Federal Criminal Charges: A Quantitative Study of Prosecutorial Discretion, 47 U. Chi. L. Rev. 246, 246 (1980).

[8] See, e.g., Jonathan M. Barnett, Property as Process: How Innovation Markets Select Innovation Regimes, 119 Yale L.J. 384, 392 (2009) (noting that criticisms of the subject-matter expansion of patents as excessive propertization are overblown because most patents are ignored); Tun-Jen Chiang, Fixing Patent Boundaries, 108 Mich. L. Rev. 523, 542 (2010)

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

This Article argues that we are at the beginning of a technological shift that is changing this pattern of under-enforcement and ignorance.[9] Because patent policy relies so heavily on ignorance and under-enforcement, the shift towards patent salience has important implications for both doctrinal and theoretical reform.[10]

This shift from ignorance and under-enforcement to salience is caused by new technologies that make patents easier to find and use. This Article illustrates the shift with three case studies: First, automated freedom-to-operate algorithms, which are computer programs that take a desired endpoint and design around any relevant patents.[11] Such a program was used, for instance, to suggest ways to avoid patents on remdesivir (VEKLURY®) in order to increase production during the COVID-19 pandemic.[12] Second, Amazon's Utility Patent Neutral Evaluation program, a company-run system to adjudicate claims of patent infringement and remove infringing products from Amazon's platform.[13] The program provides fast and cheap ($4,000) opportunities for arbitration.[14] Third, analytics software that uses machine learning and artificial intelligence to produce patent landscape reports.[15] These reports are detailed accounts of trends in patenting across a field that inform a varied set of decision makers—for example, a report on hydrogen fuel patents designed to help companies find collaborators and make investment decisions.[16]

(suggesting that the notice functions of patent claims work poorly in part because competitors ignore patents); Lemley, supra note 6, at 1510–11 (arguing that low-cost, error-prone patent examination is rational because most patents are ignored).

[9] See infra Part II.

[10] See infra Part III.

[11] See infra Section II.A.

[12] Sara Szymkuc et al., Computer-Generated "Synthetic Contingency" Plans at Times of Logistics and Supply Problems: Scenarios for Hydroxychloroquine and Remdesivir, 11 Chem. Sci. 6736, 6736 (2020).

[13] Ganda Suthivarakom, Welcome to the Era of Fake Products, N.Y. Times: Wirecutter (Feb. 11, 2020), https://www.nytimes.com/wirecutter/blog/amazon-counterfeit-fake-products/ [https://perma.cc/B3LJ-UACW].

[14] Tammy Terry & Lisa Margonis, Unpacking Amazon's Patent Infringement Evaluation Process, Law360 (Mar. 19, 2021), https://www.law360.com/articles/1366714/unpacking-amazon-s-patent-infringement-evaluation-process [https://perma.cc/TQ48-KTBY].

[15] Leonidas Aristodemou, Frank Tietze, Nikoletta Athanassopoulou & Tim Minshall, Exploring the Future of Patent Analytics: A Technology Roadmapping Approach, at Abstract (Univ. of Cambridge Ctr. for Tech. Mgmt., Working Paper No. 5, 2017).

[16] Chem. Abstracts Serv., Am. Chem. Soc'y, Hydrogen Fuel: Insights into a Growing Market 12 (2019).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

With each of these new technologies, patents that would previously never have been enforced, licensed, or likely even read now impact behavioral choices. Because automated freedom-to-operate analyses show users how to avoid all patents in a field, a patent need simply exist to cause a response, even though many such patents would not—indeed could not—be enforced.[17] In the case of Amazon's program, the low cost of the program compared to litigation incentivizes additional enforcement, as does Amazon's ability to reach beyond traditional jurisdictional limits.[18] Further, by providing an easy way to search for products, Amazon's platform makes it considerably simpler for patentees to find infringers.[19] Patent landscape analyses provide information on all patents in a field so that decisions can be made based on a great breadth of patents.[20] Patents that were formerly overlooked are now found and integrated into decision-making. Previously ignored, these patents are now impactful.

The technologically driven shift from under-enforcement to salience has created a second fundamental change in how patents are used: the greater impact of patents is accompanied by a move away from deep legal analysis. This shift is most stark with respect to patent validity. Granted patents can be found invalid, and indeed many are.[21] The mere presence of a patent therefore means little without some evaluation of its validity.[22] But not all of the case studies highlighted in this Article evaluate validity.[23] Amazon's adjudication system explicitly excludes a validity analysis—a significant difference from litigation, where validity is an issue in almost every case.[24] Some algorithms that run automated freedom-to-operate analyses and create patent landscapes do not account for the possibility of invalidity nor do they discount patents of dubious validity.[25] Rather, each patent is given equal weight in the analysis.[26]

[17] See infra Subsection II.A.1.
[18] See infra Subsection II.B.1.
[19] See infra Subsection II.B.1.
[20] See infra Subsection II.C.1.
[21] 35 U.S.C. § 282.
[22] Lemley, supra note 7, at 27.
[23] See infra Part II.
[24] Terry & Margonis, supra note 14; Lemley, supra note 6, at 1502 ("Virtually every patent infringement lawsuit includes a claim that the patent is either invalid or unenforceable due to inequitable conduct (or commonly both).").
[25] See infra Sections II.A, II.C.
[26] See infra Sections II.A, II.C.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

Though technology allows analysis of more patents, the analysis can be cursory and blurs the major quality differences between patents.

The trend toward greater patent salience and the changes in how patents are analyzed have substantial implications for patent theory and policy. One notable example is the Patent Office's "rational ignorance" approach to patent examination.[27] Examiners spend relatively little time reviewing each patent and make many mistakes, meaning that many invalid patents are granted.[28] This is justified because more careful examination would be expensive and, if most patents are ignored, these errors have little practical effect.[29] If, however, more patents impact behavioral choices, the rational ignorance approach breaks down, particularly if new technology does little or no analysis of validity.[30] This Article highlights several additional policies and doctrines that are central to the patent system—including the lack of a research exception, methods by which remedies are determined, and the potential for a patent anticommons to block follow-on research—where potentially disastrous consequences are brushed aside on the grounds that patents are ignored.[31]

Another key consequence of patents' new salience is that choices about patent impact are increasingly privatized, which creates concerns about the influence of private platforms and their divergence from public goals. First, the technological shift highlighted in this Article predominantly involves private platforms.[32] When private platforms design algorithms and choose training data for patent analysis, they inevitably make choices about how to interpret and prioritize substantive law.[33] To the extent that algorithmic output influences decisions and is not subject to judicial review, it raises the risk that private choices about enforcement mechanisms or platform design will displace substantive law.[34] While these privatization concerns have been well-aired in the context of copyright law and other fields, the concerns apply with equal force to patent law.[35] Moreover, to the extent that substantive patent law is woven

[27] Lemley, supra note 6, at 1497.
[28] Id. at 1500.
[29] See infra Section III.B.
[30] See infra Section IV.C.
[31] See infra Section IV.C.
[32] See infra Part II.
[33] See infra Section III.D.
[34] See infra Section III.D.
[35] E.g., Matthew Sag, Internet Safe Harbors and the Transformation of Copyright Law, 93 Notre Dame L. Rev. 499, 499 (2017).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

into private designs, it is often in a black box without transparency about how and when patent law is incorporated into the analysis.[36]

Further, the increasing patent impact documented herein is in striking contrast to a countervailing trend in congressional and judicial action which is towards making patents *less* impactful.[37] In recent years, Congress and the courts have increased the difficulty of obtaining and enforcing patents, meaning that third parties can more safely ignore patents—a deliberate policy intended to alleviate some of the roadblocks that patents can pose to innovation and the economy.[38] This Article argues that private actors, in making patents more salient, are moving patent law away from values espoused by public actors.[39]

Despite these challenges, technological developments in patent law are not inherently negative. Software's ability to draw information from millions of patents is exciting and may improve patents' ability to fulfill their disclosure function.[40] It is important for e-commerce platforms to have some form of patent enforcement mechanism.[41] But these technologies can be improved. This Article suggests avenues for using artificial intelligence ("AI") to expand in-depth analysis of patents and also highlights where AI is unlikely to work.[42] The Article additionally recommends strategies to alter patents to better interface with AI.[43] And, doctrinally, the Article suggests reviewing the implications of patent law doctrine and theories such as rational ignorance, research exceptions, the application of damages and other remedies, and reliance on under-enforcement—all areas that may be impacted by the new salience of patents.[44]

---

[36] See infra Section III.D. More specifically, technologies that rely on AI do not always disclose the data used to train the AI, making it difficult to predict bias in output. See, e.g., Shlomit Yanisky-Ravid & Sean K. Hallisey, "Equality and Privacy by Design": A New Model of Artificial Intelligence Data Transparency via Auditing, Certification, and Safe Harbor Regimes, 46 Fordham Urb. L.J. 428, 474 (2019) (recommending increased disclosure of data inputs in order to prevent discrimination).

[37] Paul Gugliuzza, Quick Decisions in Patent Cases, 106 Geo. L.J. 619, 622 (2018); Jonathan Masur, Patent Inflation, 121 Yale L.J. 470, 510 (2011).

[38] Gugliuzza, supra note 37, at 624.

[39] See infra Section III.C.

[40] One way in which patents incentivize innovation is by providing information about cutting-edge inventions to the public. E.g., Sean B. Seymore, The Teaching Function of Patents, 85 Notre Dame L. Rev. 621, 622 (2010).

[41] Terry & Margonis, supra note 14.

[42] See infra Section IV.A.

[43] See infra Section IV.B.

[44] See infra Section IV.C.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

The Article proceeds as follows. Part I explores why patents have historically been ignored and, for those few patents that are not, why in-depth analysis is essential to understand the enforceability of any patent. Part II provides three case studies of technologies that render patents newly salient. Part III turns to the implications of this shift towards technologically-driven patent impact (Section III.A). It further discusses the consequences of platforms that avoid in-depth patent analysis (Section III.B), the divergence between the public trend towards easier invalidation and the private trend towards easier enforcement (Section III.C), and the displacement of substantive law by private choices (Section III.D). Part IV suggests policy reform.

I. IGNORING PATENTS

Patents give their owners a quasi-property right: the ability to exclude others from making, using, or selling an invention.[45] This incentivizes innovation by allowing the patentee to charge higher prices for the invention while the patent is in force.[46] If a patent is infringed, the patentee can litigate and get a court order that requires the infringer to pay damages and/or to stop the infringing activity.[47]

That describes the theoretical setup of the patent system. In practice, patents are infringed routinely and—in the vast majority of cases—without consequence.[48] This occurs at least in part because it is cost-prohibitive both for patentees to detect infringement and enforce their rights and for potential infringers to identify relevant patents and avoid infringement.[49] Because it is impractical to prevent infringement, patents are, by and large, simply ignored.[50] Thus, the vast majority of patents are never licensed, never litigated, and perhaps never even read.[51]

Sections I.A and I.B, below, discuss why most patents are ignored, despite widespread infringement. Section I.C turns to the small minority of patents that are not ignored and explains how they are analyzed.

[45] 35 U.S.C. § 271(a).

[46] Sepehr Shahshahani, The Role of Courts in Technology Policy, 61 J.L. & Econ. 37, 40 (2018).

[47] 35 U.S.C. §§ 283–84.

[48] Janet Freilich, Patent Shopping, 10 U.C. Irvine L. Rev. 619, 631 (2020).

[49] Id. at 632.

[50] Lemley, supra note 7, at 21.

[51] Outside of examination, where they are reviewed by a patent examiner before grant. See 35 U.S.C. § 131.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

A. Widespread Infringement

As explained above, you routinely infringe dozens, perhaps hundreds, of patents every day.[52] Even if you tried to avoid patent infringement, it would probably not be possible. For instance, have you used your smartphone today? To avoid infringement, you would need to conduct a freedom-to-operate search to determine if smartphone use infringed any patents. Patents can cover many different aspects of a technology, so a smartphone user would need to look at patents on, for example, the battery, the screen, the type of plastic used to construct the case; the software used to unlock the phone,[53] support email functionality,[54] and operate the calendar;[55] and a multiplicity of other areas.[56] You would also need to check whether your apps infringed any patents—for instance, if you use a Tinder-copycat dating app that also involves swiping right on other users, you (and the app) would be infringing Tinder's swipe-right patent.[57]

[52] Supra notes 1–5 and accompanying text.

[53] Apple owns the patent on slide-to-unlock technology. U.S. Patent No. 8,046,721 (filed June 2, 2009). The patent was at issue in the extensive (and expensive) litigation between Apple and Samsung over several smartphone patents. Apple Inc. v. Samsung Elecs. Co., 809 F.3d 633, 638 (Fed. Cir. 2015). Apple was also sued by a company called Zeroclick that claimed that they (Zeroclick) owned patents that covered the slide-to-unlock technology. Ben Lovejoy, Slide-to-Unlock Patent Battles Continue – This Time Apple on the Other Side, 9to5Mac (June 15, 2020), https://9to5mac.com/2020/06/15/slide-to-unlock-patent [https://perma.cc/EQ6U-UWB7].

[54] NTP, Inc. v. Rsch. in Motion, Ltd., 418 F.3d 1282, 1287 (Fed. Cir. 2005). The dispute settled after Research in Motion (the maker of BlackBerry phones) agreed to pay over $612 million to the patentee. Rob Kelley, BlackBerry Maker, NTP Ink $612 Million Settlement, CNNMoney (Mar. 3, 2006, 7:29 PM), https://money.cnn.com/2006/03/03/technology/rimm_ntp/ [https://perma.cc/8E6W-FW8R].

[55] Lucent Techs., Inc. v. Gateway, Inc., 580 F.3d 1301, 1309, 1317, 1340 (Fed. Cir. 2009) (vacating and remanding a jury verdict finding the infringer (Microsoft) liable for $358 million in damages for its "date-picker" function in Outlook calendars).

[56] See, e.g., Joel R. Reidenberg, N. Cameron Russell, Maxim Price & Anand Mohan, Patents and Small Participants in the Smartphone Industry, 18 Stan. Tech. L. Rev. 375, 379 (2015).

[57] Camila Domonoske, The Tinder-Bumble Feud: Dating Apps Fight Over Who Owns the Swipe, NPR (Oct. 30, 2018), https://www.npr.org/2018/10/30/660006488/the-tinder-bumble-feud-dating-apps-fight-over-who-owns-the-swipe [https://perma.cc/2XXR-99RR]. Bumble explained:

> We swipe left on you. We swipe left on your multiple attempts to buy us, copy us, and, now, to intimidate us. We'll never be yours. No matter the price tag, we'll never compromise our values. We swipe left on your attempted scare tactics, and on these endless games. We swipe left on your assumption that a baseless lawsuit would intimidate us.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

Avoiding patent infringement is infeasible because there are simply too many patents covering too many aspects of day-to-day life. In fact, the task of avoiding patent infringement is so difficult that even big companies often cannot (or choose not to) do it.[58] Indeed, many companies are surprised by patent infringement complaints that arrive after a product has been launched.[59]

B. Ignorance

Many commentators have noted that the ubiquity of patents and infringement could impede innovation by making it excessively difficult and expensive to license or avoid all relevant patents.[60] Yet these effects are hard to show empirically.[61] One provocative explanation set out in Mark Lemley's aptly titled *Ignoring Patents* is that innovation occurs despite the patent system's myriad disfunctions because innovators generally disregard patents.[62]

Lemley suggests that, if innovators did not ignore patents, it would be almost impossible to make a product such as a gene chip, which includes thousands of patented genes (and would therefore need licenses to thousands of patents)—yet gene chips exist.[63] In another example, when a U.S. Court of Appeals for the Federal Circuit decision in 2002[64] held

Id. The case later settled. Bill Donahue, Tinder, Bumble Settle Dating App IP War, Law360 (June 19, 2020, 12:13 PM), https://www.law360.com/articles/1284816/tinder-bumble-settle-dating-app-ip-war [https://perma.cc/2KL7-KLWY].

[58] Christina Mulligan & Timothy B. Lee, Scaling the Patent System, 68 N.Y.U. Ann. Surv. Am. L. 289, 289 (2012); William F. Lee & A. Douglas Melamed, Breaking the Vicious Cycle of Patent Damages, 101 Cornell L. Rev. 385, 407 (2016) ("Modern devices may potentially infringe many thousands of patents . . . and a firm would have to negotiate a license with each of them individually. That would rarely—if ever—be feasible . . . .").

[59] See, e.g., Roger Allan Ford, Patent Invalidity Versus Noninfringement, 99 Cornell L. Rev. 71, 74 (2013) ("It is not unusual for a new technology product to be covered, or arguably covered, by thousands of distinct patents owned by hundreds of different patent holders, many likely to be invalid. It is impossible to analyze all these patents . . . .").

[60] See, e.g., Michael A. Heller & Rebecca S. Eisenberg, Can Patents Deter Innovation? The Anticommons in Biomedical Research, 280 Science 698, 698 (1998); James Bessen & Michael J. Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk 53 (2008).

[61] See infra note 69 and accompanying text.

[62] Lemley, supra note 7, at 21.

[63] Id.; see also Jian-Chiun Liou, DNA Gene Microarray Biochip and Applications, *in* Microfluidics and Bio-MEMS: Devices and Applications 255, 272 (Tuhin S. Santra ed., 2021) (explaining that scientists can use gene chips "to simultaneously and quantitatively analyze large (tens of thousands) gene expressions").

[64] Madey v. Duke Univ., 307 F.3d 1351, 1362 (Fed. Cir. 2002).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

that university research activities were not exempt from patent infringement, many commentators predicted a dire drop in academic research.[65] However, this generally did not happen, perhaps because scientists ignore patents.[66]

There is ample direct evidence of Lemley's hypothesis. Many companies instruct scientists and engineers not to read patents—deliberately encouraging ignorance of potential patent infringement.[67] Companies even ignore cease and desist letters from patentees claiming infringement because many of these letters never result in litigation.[68] A

[65] Rebecca S. Eisenberg, Patent Swords and Shields, 299 Science 1018, 1018 (2003) (calling the decision "an alarming wake-up call to the academic community"); David Malakoff, Academia Gets No Help from U.S. in Patent Case, 300 Science 1635, 1635 (2003) (explaining the case "stunned many university administrators, who predict[ed] . . . slow[er] academic research and increase[ed] costs"); Janice M. Mueller, The Evanescent Experimental Use Exemption from United States Patent Infringement Liability: Implications for University and Nonprofit Research and Development, 56 Baylor L. Rev. 917, 920 (2004) (arguing that the Federal Circuit's unfriendliness towards the research exemption will cause research "to be shifted offshore to legally hospitable forums").

[66] Lemley, supra note 7, at 21.

[67] This is thought to occur because actual knowledge of a patented invention can trigger treble damages in a litigation. See, e.g., Edwin H. Taylor & Glenn E. Von Tersch, A Proposal to Shore up the Foundations of Patent Law that the Underwater Line Eroded, 20 Hastings Commc'ns & Ent. L.J. 721, 737 (1998) ("As matters now stand many companies discourage employees from reading patents. This presumably lessens the chance that the company will be found to have knowledge of a patent."); Lemley, supra note 7, at 21 ("Companies and lawyers tell engineers not to read patents in starting their research, lest their knowledge of the patent disadvantage the company by making it a willful infringer."); see also Colleen V. Chien, Opening the Patent System: Diffusionary Levers in Patent Law, 89 S. Cal. L. Rev. 793, 834 ("Firms are disincentivized from reading others' patents because doing so 'avoid[s] the risk of any knowledge of relevant patents and thus any willful infringement.' "); Jeanne C. Fromer, Patent Disclosure, 94 Iowa L. Rev. 539, 588 (2009) (noting that most companies "routinely advise their employees not to read outside patents, thereby avoiding the risk of . . . any willful infringement"); Timothy R. Holbrook, Possession in Patent Law, 59 SMU L. Rev. 123, 142 (2006) ("Given the risk of enhanced damages, a competitor has a significant incentive *not* to review patents at all."); Lisa Larrimore Ouellette, Who Reads Patents?, 35 Nature Biotechnology 421, 421 (2017) ("[L]egal scholars have asserted that scientists do not read patents . . . because reading patents might lead to increased liability for 'willful' patent infringement."); Dmitry Karshtedt, Enhancing Patent Damages, 51 U.C. Davis L. Rev. 1427, 1445 (2018) ("[T]he current rule effectively rewards firms for refusing to search for patents . . . ."). This may happen less after the Supreme Court's decision in *Halo Electronics, Inc. v. Pulse Electronics, Inc.*, 136 S. Ct. 1923, 1933 (2016). See Karshtedt, supra, at 1470.

[68] Lemley, supra note 7, at 22. There are similar anecdotes from university technology transfer offices. John P. Walsh, Ashish Arora & Wesley M. Cohen, Effects of Research Tool Patents and Licensing on Biomedical Innovations, *in* Patents in the Knowledge-Based Economy 285, 317 (Wesley M. Cohen & Stephen A. Merrill eds., 2003) ("One university technology transfer officer reports that the university will indeed receive letters of notification of infringement. The respondent indicated that the typical response was effectively to ignore

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

study of the effects of gene patents on follow-on innovation found that gene patents had no effect at all, although other studies in different contexts found that certain patents do impact follow-on innovation.[69]

The hypothesis that patents are broadly ignored has important policy consequences. It is perhaps most influential on the question of what resources should be allocated to reviewing patents at the examination stage.[70] At present, the examination process makes many errors, including incorrectly granting patents that fail to meet various criteria for patentability.[71] At least some of these errors could be fixed by investing more in patent examination so that examiners could more carefully review patents.[72] However, if the vast majority of patents are ignored, then many erroneously granted patents create little harm.[73] Therefore, the cost of preventing these examination errors may outweigh the cost of erroneously granting patents.[74] If most patents are ignored, then it makes sense to spend less on ex ante examination and put more resources towards ex post review—namely litigation—to resolve disputes that arise in the context of commercially valuable patents.

such letters and inform the IP holder that the university was engaged in research, did not intend to threaten the firm's commercial interests, and would not cease its research. However, receiving such letters is not that common.").

[69] Bhaven Sampat & Heidi L. Williams, How Do Patents Affect Follow-On Innovation? Evidence from the Human Genome, 109 Am. Econ. Rev. 203, 203 (2019). Note that Sampat and Williams studied downstream research from before the Supreme Court altered the rules governing the patentability of genes. See Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576, 576 (2013). However, other studies have found that patents affect downstream research. See, e.g., Alberto Galasso & Mark Schankerman, Patents and Cumulative Innovation: Causal Evidence from the Courts, 130 Q.J. Econ. 317, 317 (2015); Kenneth G. Huang & Fiona E. Murray, Does Patent Strategy Shape the Long-Run Supply of Public Knowledge? Evidence from Human Genetics, 52 Acad. Mgmt. J. 1193, 1193 (2009); Fiona Murray & Scott Stern, Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-Commons Hypothesis, 63 J. Econ. Behav. & Org. 648, 648 (2007) (finding a ten to twenty percent drop in citations to a technology after a patent grant).

[70] Lemley, supra note 6, at 1508.

[71] Id. at 1495.

[72] Id. at 1508.

[73] Id. at 1511.

[74] Id.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

This thesis—that the Patent Office is "rationally ignorant"—has been enormously influential,[75] although it is not universally accepted.[76] More broadly, the idea that patents are ignored has been used to respond to many criticisms of the patent system. For example, unlike many countries, the United States has no research exception to exempt early-stage research activities from patent infringement.[77] This lack is broadly viewed as problematic because fear of patent infringement could inhibit valuable early-stage research[78]—except that if patents are ignored, it may not matter.[79] Similarly, some scholars are concerned that there are simply too many patents and that they make innovation difficult by bogging down potential researchers.[80] But if patents are ignored, this challenge goes away. Yet another example is royalty stacking, a problem that occurs when a product infringes many patents and the infringing producer has to pay a royalty to each patentee until the total cost of the royalties exceeds

[75] Michael D. Frakes and Melissa F. Wasserman note that "[t]he influence of Lemley's contention that the Patent Office is, and ought to be, 'rationally ignorant' is incontestable. Lemley is the most frequently cited scholar in the field of intellectual property and *Rational Ignorance at the Patent Office* is his most cited article." Michael D. Frakes & Melissa F. Wasserman, Irrational Ignorance at the Patent Office, 72 Vand. L. Rev. 975, 988 (2019).

[76] See, e.g., John F. Duffy, Reasoned Decisionmaking vs. Rational Ignorance at the Patent Office, 104 Iowa L. Rev. 2351, 2355 (2019) (explaining that there is no legal basis for rational ignorance, and also contesting the theory on other grounds); Frakes & Wasserman, supra note 75, at 975–76 (responding to Lemley's article, Rational Ignorance at the Patent Office, and arguing that some of the numbers used to calculate the costs and benefits of increasing review at the Patent Office were inaccurate); Arti K. Rai, Engaging Facts and Policy: A Multi-Institutional Approach to Patent System Reform, 103 Colum. L. Rev. 1035, 1081 (2003) (arguing that the rational ignorance hypothesis does not account for all costs of invalid patents).

[77] Janet Freilich, Paths to Downstream Innovation, 55 U.C. Davis L. Rev. 2209, 2218–19 (2022). For a list of research exceptions in other countries, see Standing Comm. on the L. of Pats., WIPO, Reference Document on Research Exception, at annex 9 tbl.2 (Nov. 26, 2018), https://www.wipo.int/edocs/mdocs/scp/en/scp_29/scp_29_3.pdf [https://perma.cc/4CPP-TDYR].

[78] See, e.g., Rebecca S. Eisenberg, Patents and the Progress of Science: Exclusive Rights and Experimental Use, 56 U. Chi. L. Rev. 1017, 1071 (1989); Rochelle Cooper Dreyfuss, Reconsidering Experimental Use, 50 Akron L. Rev. 699, 712 (2016); Rochelle Dreyfuss, Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?, 46 Ariz. L. Rev. 457, 466 (2004); Maureen A. O'Rourke, Toward a Doctrine of Fair Use in Patent Law, 100 Colum. L. Rev. 1177, 1203–04 (2000); Katherine J. Strandburg, What Does the Public Get? Experimental Use and the Patent Bargain, 2004 Wis. L. Rev. 81, 85.

[79] Rebecca S. Eisenberg, Noncompliance, Nonenforcement, Nonproblem? Rethinking the Anticommons in Biomedical Research, 45 Hous. L. Rev. 1059, 1076 (2008).

[80] Fed. Trade Comm'n, The Evolving IP Marketplace: Aligning Patent Notice and Remedies with Competition 56 (2011).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

the profit from the product.[81] If most patents are never enforced, then concerns about stacking may be overblown.[82]

Even unenforced and unlicensed patents may hinder innovation.[83] They may have an *in terrorem* effect—scaring potential innovators away from a field even if, had the innovator chosen to enter the field, she would not have been sued for patent infringement. However, if patents are systematically ignored, even this effect disappears. As Lemley points out, the *in terrorem* effect occurs only if competitors know about patents—and companies appear to ignore patents both in the sense that most patents are not enforced but also in the sense that they do not review the patents of others.[84]

In short, while the patent system may appear to have many problems, if most patents are ignored, then these problems are more theoretical than practical.

C. Patent Analysis

While the hypothesis that most patents are ignored is widely accepted, nobody argues that *all* patents are ignored. A small subset of patents is licensed, enforced, and has important practical consequences for the shape of innovation.[85] This Section turns away from patents that are ignored and towards patents that matter. For these patents, in-depth analyses are necessary. It is difficult to draw any conclusions about a patent or make any predictions about its scope or enforceability without an in-depth analysis. The simple fact of a patent's existence says little about the presence of a legal right.

[81] Lemley & Shapiro, supra note 2, at 1993, 2025–29. For more detail on royalty stacking, see Jorge L. Contreras, Standards, Royalty Stacking, and Collective Action, Competition Pol'y Int'l Antitrust Chron., Mar. 2015, at 2.

[82] Lemley, supra note 7, at 21.

[83] Lemley, supra note 6, at 1516 (discussing the concern that "potential competitors or follow-on innovators . . . might be deterred from entering the field by the existence of patents owned by their competitors").

[84] Id. ("Certainly the issuance of bad patents has the *potential* to deter competition . . . . [But it does not in practice because the] vast majority of these patents simply exist; the in terrorem concern requires us to believe that competitors are regularly searching patent databases to make sure they are not infringing a patent that no one has brought to their attention. In my experience, this is simply not the way businesses operate.").

[85] See John R. Allison, Mark A. Lemley, Kimberly A. Moore & R. Derek Trunkey, Valuable Patents, 92 Geo. L.J. 435, 436–37 (2004).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

A key example is validity. Patent applications are examined by the Patent Office and, if granted, are presumed to be valid.[86] However, this presumption can and is challenged in almost every patent case.[87] Courts find granted patents to be invalid approximately half the time, and the true number of invalid patents may be much higher, especially in some emerging industries.[88]

One reason that invalid patents are so common is that the validity analysis is complex. For instance, an invention is patentable only if it is non-obvious, meaning that the invention is not an obvious variation on already-existing knowledge.[89] The obviousness analysis thus requires a deep understanding of the universe of knowledge publicly available before the patent was filed (called "prior art"). It also necessitates deep thinking about how prior art might be combined or changed to form the patented invention, and why such a combination or change may be obvious. Even then, the obviousness analysis is notoriously unpredictable, and the U.S. Supreme Court has rejected bright line tests.[90] It is therefore difficult to know with any certainty whether or not a patent is valid.

It is also difficult to understand precisely what a patent covers—what activities are and are not infringing. The scope of a patent right is defined by a portion of the patent called the "claim," a one-sentence legal formula.[91] Claim interpretation is challenging. Because claims are written at the genesis of an invention—at the time the patent is filed—they rarely refer to an invention by its commercial name but instead are more likely to be described with reference to their composition, components, and function.[92] Further, claims often include language that is imprecise, fuzzy,

[86] 35 U.S.C. § 282.

[87] See Lemley, supra note 6, at 1502 ("Virtually every patent infringement lawsuit includes a claim that the patent is either invalid or unenforceable due to inequitable conduct (or commonly both).").

[88] John R. Allison, Mark A. Lemley & David L. Schwartz, Our Divided Patent System, 82 U. Chi. L. Rev. 1073, 1099–100 (2015).

[89] 35 U.S.C. § 103.

[90] KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 419 (2007) (rejecting the Federal Circuit's "rigid and mandatory formula[]" for testing obviousness).

[91] 35 U.S.C. § 112; see also Cont'l Paper Bag Co. v. E. Paper Bag Co., 210 U.S. 405, 419 (1908) ("[T]he claims measure the invention.").

[92] For example, a patent on the blockbuster drug Nexium claimed:

> A method for treatment of gastric acid related diseases by inhibition of gastric acid secretion comprising administering to a mammal in need of treatment a therapeutically effective amount of a proton pump inhibitor consisting essentially of [esomeprazole] or

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

ambiguous, and difficult to interpret—sometimes as a deliberate strategy to defer decisions about the scope of the claim.[93] Words such as "about," "approximately," and "substantially," cannot easily be defined with precision.[94]

Since claim language is vital to understanding the scope of the patent and therefore the starting point for almost every inquiry into the patent, patent law has detailed protocols to guide the interpretation of claim language.[95] In litigation, claim construction is done in a separate proceeding called a "*Markman* hearing."[96] Claims are interpreted through the eyes of a scientist in the field of the invention, meaning that the same word could have very different meanings in different contexts (the word "buffer," for instance, refers to quite distinct concepts in the context of computers and in the context of chemistry).[97] Claims are also interpreted in light of the other information in the patent, which includes a narrative description of the invention called the specification, as well as all communication between the patent applicant and patent examiner.[98] Finally, though of less importance, claim construction may draw on

> a pharmaceutically acceptable salt thereof, so as to effect decreased interindividual variation in plasma levels (AUC) during treatment of gastric acid related diseases.

U.S. Patent No. 5,877,192 col. 7 l. 18–27 (filed Apr. 11, 1997).

[93] See Nautilus, Inc. v. Biosig Instruments, Inc., 572 U.S. 898, 911–12 (2014); Fed. Trade Comm'n, supra note 80, at 85 (explaining the "incentive to be as vague and ambiguous as you can with your claims and to defer clarity at all costs" (internal quotation marks omitted)).

[94] A search on Docket Navigator on June 2, 2021, found 197 cases construing the meaning of the term "about," 11 cases construing "approximately," and 53 cases construing "substantially." Docket Navigator, https://search.docketnavigator.com (last visited June 2, 2021).

[95] See Phillips v. AWH Corp., 415 F.3d 1303, 1321–28 (Fed. Cir. 2005); see generally Peter S. Menell, Matthew D. Powers & Steven C. Carlson, Patent Claim Construction: A Modern Synthesis and Structured Framework, 25 Berkeley Tech. L.J. 711 (2010) (providing an overview of legal doctrines governing claim construction, how claim construction is approached by courts, and procedural aspects of claim construction).

[96] Named for the case that originated the proceedings, *Markman v. Westview Instruments, Inc.*, 517 U.S. 370, 391 (1996). Ballard Med. Prods. v. Allegiance Healthcare Corp., 268 F.3d 1352, 1358 (Fed. Cir. 2001) (explaining that, while *Markman* does not require specific procedures, district courts often hold hearings to construe claims).

[97] Merriam-Webster defines "buffer" as both "a section of computer memory for temporarily storing information" and "a substance capable in solution of neutralizing both acids and bases." Buffer, Merriam-Webster Online Dictionary, https://www.merriam-webster.com/dictionary/buffer [https://perma.cc/X5RE-JM36] (last visited Jan. 19, 2023). It is also used colloquially in Britain to mean "an old man." Id.

[98] Datamize, LLC v. Plumtree Software, Inc., 417 F.3d 1342, 1348 (Fed. Cir. 2005) ("Intrinsic evidence in the form of the patent specification and file history should guide a court toward an acceptable claim construction.").

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

outside evidence such as textbooks and inventor testimony.[99] The upshot of this interpretation process is that claim construction is difficult, expensive, and unpredictable, and there may ultimately be no clear answer. Yet it is vital and often case dispositive.[100]

Because two central elements of a patent—its scope and validity—require in-depth review, it is functionally unmanageable to answer questions like "do I infringe?" or "what patents are relevant?" or "how worried should I be about patents when entering this industry?" without detailed analysis. This is impractical to do manually for large numbers of patents, so the requirement for in-depth review has historically blocked the possibility of analyzing broad groups of patents.[101] Thus, most patents are ignored; a few are analyzed in-depth.

II. PATENTS' NEW SALIENCE

Technology is changing not only the subject matter of patents but also how the patent system functions. This Article argues that technological developments are altering the ways in which players in the patent system interact with patents—specifically that technology creates new ways in which broad swaths of patents can be impactful, a far cry from the previous world where most patents were ignored. Yet this attention to breadth comes at the cost of depth: when many patents are processed, they are often reviewed only in a superficial or cursory way, foregoing the deep analysis that is necessary to understand many aspects of patents.

Below, I provide three case studies where new technology makes patents matter. Each Section begins with a description of the technology followed by an explanation of its implications for patent law.

A. Automated Freedom-to-Operate Analyses

Some nascent technologies help innovators conduct freedom-to-operate searches.[102] An innovator who aims to work in a given field might

[99] *Phillips*, 415 F.3d at 1317–19.

[100] Most patent cases either settle or are decided on summary judgment after claim construction. Lemley, supra note 6, at 1501.

[101] See, e.g., Mulligan & Lee, supra note 58, at 317 ("[P]atent clearance is practically impossible. In software, for example, patent clearance would require the services of many more patent attorneys than exist in the United States.").

[102] See, e.g., Assad Abbas, Limin Zhang & Samee U. Khan, A Literature Review on the State-of-the-Art in Patent Analysis, 37 World Pat. Info. 3, 3 (2014) (summarizing trends in automated patent analysis); Isumo Bergmann et al., Evaluating the Risk of Patent Infringement

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

want to understand whether their project is covered by any third-party patents in order to assess the risks of working in the field. As explained above, historically this has simply not been practical in many fields because of the abundance of potentially relevant patents and the difficulties in searching non-standardized and vague language.[103] Technology has not (and perhaps cannot) solved all of these problems, but there are hints that, at least in some fields, computers are able to guide efforts to avoid competitors' patents.

Automated freedom-to-operate analysis appears to be most advanced in the field of chemistry.[104] This is not surprising, as chemistry uses a partially standardized vocabulary and taxonomy that makes patents easier to search and classify.[105] Researchers recently developed software to identify synthesis pathways that avoid using molecules or methods that are covered by patents.[106] The technology has been well received by the scientific community and has been praised as both novel and

by Means of Semantic Patent Analysis: The Case of DNA Chips, 38 R&D Mgmt. 550, 550 (2008) (describing an automated method of analyzing technology claimed in patents); Changyong Lee, Bomi Song & Yongtae Park, How to Assess Patent Infringement Risks: A Semantic Patent Claim Analysis Using Dependency Relationships, 25 Tech. Analysis & Strategic Mgmt. 23, 23 (2013) (exploring semantic analysis to narrow the pool of patents that might be infringed by a technology in order to make manual review more efficient); Hyunseok Park, Janghyeok Yoon & Kwangsoo Kim, Identifying Patent Infringement Using SAO Based Semantic Technological Similarities, 90 Scientometrics 515, 515 (2012) (proposing a system to automatically detect competitors' infringing behavior); Inchae Park & Byungun Yoon, A Semantic Analysis Approach for Identifying Patent Infringement Based on a Product–Patent Map, 26 Tech. Analysis & Strategic Mgmt. 855, 855 (2014) (developing methods to detect patent infringement).

[103] Bessen & Meurer, supra note 60, at 53–54.

[104] The only commercially available technology of which I am aware is in the field of chemistry. See SYNTHIA™ Retrosynthesis Software, MilliporeSigma, https://www.sigmaaldrich.com/US/en/services/software-and-digital-platforms/synthia-retrosynthesis-software [https://perma.cc/2RS7-ZJ2M] (last visited Feb. 10, 2023).

[105] See Fed. Trade Comm'n, supra note 80, at 10, 84 (noting that "in biotech and chemistry there is a 'relatively predictable set of terminology' or nomenclature for describing inventions," and that, by contrast, there is "difficulty in performing patent clearance" in technology areas where there is a "lack of predictable vocabulary"). For a discussion of some of the challenges involved in searching chemical patents despite the standardized vocabulary, see Raul Rodriguez-Esteban & Markus Bundschus, Text Mining Patents for Biomedical Knowledge, 21 Drug Discovery Today 997, 997–98 (2016).

[106] Karol Molga, Piotr Dittwald & Bartosz A. Grzybowski, Navigating Around Patented Routes by Preserving Specific Motifs Along Computer-Planned Retrosynthetic Pathways, 5 Chem 460, 460 (2019).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

impressive.[107] It is commercially available via MilliporeSigma's SYNTHIA™ retrosynthesis software.[108]

The software developers published specific examples of how the program could be used to avoid patents on different pharmaceutical drugs[109]: sitagliptin (JANUVIA®),[110] linezolid (ZYVOX®),[111] and panobinostat (FARYDAK®).[112] Each drug is protected by numerous patents and, with just manual review, it seemed difficult to design around the patents. One developer reported the following: "When we started this

[107] It was covered favorably in both *Nature* and *Science* magazines. Sarah Crunkhorn, Patent-Evading Drug Synthesis, 18 Nature Revs. Drug Discovery 174, 174 (2019) (describing the use of software to avoid patent claims); Derek Lowe, Retrosynthesis: Here it Comes, Science: In the Pipeline (Mar. 6, 2018), https://www.science.org/content/blog-post/retrosynthesis-here-comes [https://perma.cc/PM45-76S2] (explaining that the software "broke the patented route" to a compound); Derek Lowe, The Machines Rise a Bit More, Science: In the Pipeline (Oct. 20, 2020), https://www.science.org/content/blog-post/machines-rise-bit-more [https://perma.cc/23ZS-53X3] ("There are particular advantages to a computational approach to retrosynthesis that are harder to realize with one's brain: avoiding a thicket of process patents, for example . . . ."); see also Iqra Farooq, Computer Programme That Could Bypass Patents to Produce Synthetic Drugs, Eur. Pharm. Rev. (Jan. 18, 2019), https://www.europeanpharmaceuticalreview.com/news/83106/intellectual-property-patent/#:~:text=Researchers%20in%20Poland%20and%20South,medication%20and%20other%20pharmaceutical%20products [https://perma.cc/MA6M-4T35] (praising "[t]he ability of the software to 'dodge' patents" and stating that it "may lead to chemists changing the way they approach patent law and intellectual property"); Kira Welter, Patent-Busting AI Tool Navigates Around Protected Drug Pathways, Chemistry World (Jan. 21, 2019), https://www.chemistryworld.com/news/patent-busting-ai-tool-navigates-around-protected-drug-pathways/3010015.article [https://perma.cc/YD45-FDZB] (emphasizing how technical advances could benefit the patent process); Dan Maloney, AI Patent Trolls Now on the Job for Drug Companies, Hackaday (Jan. 30, 2019), https://hackaday.com/2019/01/30/ai-patent-trolls-now-on-the-job-for-drug-companies/ [https://perma.cc/XG6N-GXXA] (noting that the "implications of this development are potentially far-reaching" and expressing concern that the technology might be used to delay entry of generic drugs); Mike James, Software Bypasses Drug Patents, I Programmer (Feb. 5, 2019), https://www.i-programmer.info/news/99-professional/12491-software-bypasses-drug-patents.html [https://perma.cc/3GNB-5NYM] (calling the software "clever computing combined with some deep knowledge of chemistry").

[108] MilliporeSigma to Release Synthia™ Digital Chemical Synthesis Tool, BioSpace (Aug. 16, 2018), https://www.biospace.com/article/milliporesigma-to-release-synthia-digital-chemical-synthesis-tool/ [https://perma.cc/CSN7-3ZRT] ("In one instance, the Synthia™ software provided an alternative pathway to a patented route, producing a commercially viable product.").

[109] Molga et al., supra note 106, at 461.

[110] A treatment for diabetes. Nat'l Libr. of Med., Sitagliptin, MedlinePlus (Feb. 15, 2021), https://medlineplus.gov/druginfo/meds/a606023.html [https://perma.cc/BJH4-NRQX].

[111] An antibiotic. Nat'l Libr. of Med., Linezolid, MedlinePlus (May 15, 2022), https://medlineplus.gov/druginfo/meds/a602004.html [https://perma.cc/V4B6-HUMP].

[112] A chemotherapy. Nat'l Libr. of Med., Panobinostat, MedlinePlus (Mar. 15, 2017), https://medlineplus.gov/druginfo/meds/a615020.html [https://perma.cc/3EQ5-75NN].

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

project, I was somewhat skeptical that the machine would find any viable synthetic alternatives—after all, these are blockbuster drugs worth gazillions of dollars, and I was sure that the respective companies had covered the patent space so densely that no loopholes remained."[113]

However, the software successfully found several synthesis routes that were not protected by patents.[114] The implication is that software can help guide competitors around patents, making it easier to avoid infringement. The software may also be of use to patent drafters who want to make their patents airtight and avoid such potential design-around.[115]

More recently, the software has been used to design around patents on technologies in short supply during COVID. The software was used to suggest syntheses for hydroxychloroquine and remdesivir that avoided any relevant patents.[116] While it is not clear how frequently automated freedom-to-operate software has been used, other researchers have reported using the software to develop methods of synthesis that designed around patented methods.[117]

[113] Quote from Bartosz Grzybowski, the senior author on the project. Cell Press, This Computer Program Makes Pharma Patents Airtight, EurekAlert! (Jan. 17, 2019) (internal quotation marks omitted), https://www.eurekalert.org/news-releases/681987 [https://perma.cc/N3P3-FHU9].

[114] Id.

[115] Although this particular application runs into the problem of whether AI can be an inventor on a patent. See Ryan Abbott, I Think, Therefore I Invent: Creative Computers and the Future of Patent Law, 57 B.C. L. Rev. 1079, 1079 (2016); Tabrez Y. Ebrahim, Automation & Predictive Analytics in Patent Prosecution: USPTO Implications & Policy, 35 Ga. St. U. L. Rev. 1185, 1187 (2019); W. Michael Schuster, Artificial Intelligence and Patent Ownership, 75 Wash. & Lee L. Rev. 1945, 1981 (2018); Shlomit Yanisky Ravid & Xiaoqiong Liu, When Artificial Intelligence Systems Produce Inventions: An Alternative Model for Patent Law at the 3A Era, 39 Cardozo L. Rev. 2215, 2216 (2018). This problem also occurs in copyright. See, e.g., Annemarie Bridy, Coding Creativity: Copyright and the Artificially Intelligent Author, 2012 Stan. Tech. L. Rev. 5, 18–22; James Grimmelmann, Copyright for Literate Robots, 101 Iowa L. Rev. 657, 657 (2016); Shlomit Yanisky-Ravid, Generating Rembrandt: Artificial Intelligence, Copyright, and Accountability in the 3A Era—The Human-Like Authors Are Already Here—A New Model, 2017 Mich. St. L. Rev. 659, 660. For further discussion of the use of AI to draft patents, see Sean Tu, Amy Cyphert & Sam Perl, Limits of Using Artificial Intelligence and GPT-3 in Patent Prosecution, 54 Tex. Tech L. Rev. 255, 256 (2022).

[116] Sara Szymkuć et al., Computer-Generated "Synthetic Contingency" Plans at Times of Logistics and Supply Problems: Scenarios for Hydroxychloroquine and Remdesivir, 11 Chem. Sci. 6736, 6736 (2020). As the authors note, hydroxychloroquine itself is off-patent, but molecules and methods used in its synthesis may not be.

[117] See, e.g., Tomasz Klucznik et al., Efficient Syntheses of Diverse, Medicinally Relevant Targets Planned by Computer and Executed in the Laboratory, 4 Chem 522, 525 (2018) (using Chematica software to design around patents on the synthesis of MULTAQ® (dronedarone),

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

1. Implications

The technology is not yet perfected nor in common use, and it is much further away in fields other than chemistry,[118] but the development of algorithms to avoid infringement nonetheless heralds a change in how patents are used. Most importantly, it gives weight to patents that were previously ignored, increasing the breadth of patent analysis.

As explained in Section I.B, *supra*, patents are generally ignored in part because it is prohibitively expensive to find the relevant patents. In this context, manual searches for all possible synthesis steps and intermediaries would be similarly prohibitive. But by automating that process, software makes it possible to conduct such searches relatively cheaply. Patents that were previously ignored may now be an essential part of decision-making if their presence in a search result causes the software to design around the patent and recommend a synthesis route that avoids the patent. Thus, where a researcher might previously have remained in ignorance about the dozens or hundreds of relevant patents, every one of those patents now guides the researcher's behavior. The full breadth of the patent universe is available, accessible, and impactful.

However, this breadth of analysis is accompanied by a decrease in depth of analysis. For instance, it is not clear how the software interprets the meaning of claim terms—if at all. While terms in chemistry may be less ambiguous than in other fields, there is still ample room for ambiguity.[119] It is quite possible that many of the designed-around patents

noting that the drug choice "was motivated by the fact that tens of patents have been granted to protect dronedarone's synthesis").

[118] Such freedom-to-operate searches are more difficult in other fields because they lack standardized vocabulary and may have more fragmented patent rights. See, e.g., Fed. Trade Comm'n, supra note 80, at 54–56; Janet Freilich & Jay P. Kesan, Towards Patent Standardization, 30 Harv. J.L. & Tech. 233, 233–34 (2017).

[119] One of the patents analyzed using the automated freedom-to-operate technique to design around syntheses on dronedarone is U.S. Patent No. 6,828,448, which includes the term "in the presence of" in claim 2, an independent claim directed to a method of preparing a compound. U.S. Patent No. 6,828,448 col. 8 l. 50–51 (filed Dec. 10, 2001). The term is sufficiently ambiguous that it was the subject of a claim construction dispute in a case involving another patent with the same term. BASF Agro B.V. v. Cheminova, Inc., No. 10-cv-274, 2011 WL 3473352, at *1 (M.D.N.C. Aug. 9, 2011) (construing the term to mean "in the same place as, in the vicinity of, or in the area immediately near," which does not make the term's interpretation notably easier (internal quotation marks omitted)). A striking example of ambiguity in chemical patents is the case of *Idenix Pharmaceuticals LLC v. Gilead Sciences Inc.*, where the plaintiff's patent claimed "ß-D-2'-methyl-ribofuranosyl nucleosides" and the defendant manufactured the compound sofosbuvir (sold under the brand names HARVONI® and SOVALDI®), which the plaintiff alleged was a "ß-D-2'-methyl-

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

did not in fact cover the syntheses avoided by the software. In addition, it is also possible—indeed likely—that many of the designed-around patents are not valid. If the software does not evaluate validity,[120] it is almost certainly designing around patents that do not actually need to be avoided.[121]

Further, there is no attempt to analyze whether the proposed synthesis would fall into an exception to infringement or whether a patent is owned by a patentee who would be likely to sue.[122] Since these analyses require an understanding of the user's goals, in addition to the patents themselves, they are difficult for any software to do. The software does, however, provide a list of designed-around patents, which enables a user to do their own analyses.[123] However, the users are scientists, not lawyers, and these analyses are difficult to do without extensive legal knowledge. It is perhaps telling that, as best I was able to find, the commercial applications of automated freedom-to-operate analyses were created by scientists whereas lawyers who create AI-based patent analytics have not tried to automate the entire freedom-to-operate analysis and in fact caution against such automation.[124]

ribofuranosyl nucleoside." See 941 F.3d 1149, 1155 (Fed. Cir. 2019). The category "ß-D-2'-methyl-ribofuranosyl nucleosides" does not have a standard definition in the industry, so the outcome was not clear. In a claim construction hearing, the court held that sofosbuvir is indeed a "ß-D-2'-methyl-ribofuranosyl nucleoside," leading to a $2.5 billion judgment against Gilead (which was later overturned on appeal when the plaintiff's patent was found to be invalid for lack of enablement). Idenix Pharms. LLC v. Gilead Scis., Inc., 271 F. Supp. 3d 694, 696 (D. Del. 2017), *aff'd in part, rev'd in part*, 941 F.3d 1149.

[120] The software is proprietary and I do not have access to it to determine whether or not it incorporates a validity analysis. However, in published examples of the software's use, no validity analysis is included. SYNTHIA™ Retrosynthesis Software, MilliporeSigma, https://www.sigmaaldrich.com/US/en/services/software-and-digital-platforms/synthia-retrosynthesis-software [https://perma.cc/BC76-GR76] (last visited Feb. 10, 2023).

[121] This is not necessarily an irrational choice for the software developers. Determining validity is a difficult, in-depth analysis, see supra Section I.C, and validity cannot easily be predicted. Invalidating a patent requires adjudication either in court or at the Patent Trial and Appeal Board, both of which are expensive (even if the latter is significantly less expensive). If there are many possible routes of synthesis, it may not be worthwhile to attempt to analyze validity.

[122] As explained in Section I.A, supra, most patents are not enforced.

[123] See Karol Molga, Piotr Dittwald & Bartosz A. Grzybowski, Navigating Around Patented Routes by Preserving Specific Motifs Along Computer-Planned Retrosynthetic Pathways, at Section S4 (Elsevier 2018).

[124] For instance, DorothyAI, an AI-based patent analytics platform founded by patent attorneys, "has created a first of its kind Freedom to Operate search engine." Curtis Wadsworth, Your Freedom-to-Operate (FTO) Primer, DorothyAI (Feb. 5, 2021), https://wolf-chartreuse-5fg8.squarespace.com/blog/fto-primer [https://perma.cc/PK34-WLVD].

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

In short, instead of producing in-depth analysis which assigns different risk probabilities to different patents, automated freedom-to-operate software values all patents equally and treats each patent as an identically weighted obstacle. This almost certainly pushes scientists to design more widely around existing synthesis routes than is necessary. While a wide design-around may be unproblematic in some circumstances, in others it may be more expensive than a targeted route, or in some cases may not be possible at all, halting projects completely.

B. Amazon's Neutral Patent Evaluation Program

The following example—exploring Amazon's Neutral Patent Evaluation program—comes not from technological advancement in patent analysis but from the interpretation of patent law by a technologically advanced company.

Amazon, an online retailer, sells a huge variety of products produced both by Amazon itself and by third parties. Amazon has struggled to respond to the problem of patent infringement and has been plagued by accusations both that it was allowing too many sales of infringing goods and that it was over-enforcing patents by banning sales of non-infringing goods under the cover of spurious infringement claims.[125]

In 2019, Amazon launched a pilot program to address claims of patent infringement against sellers on Amazon's platform.[126] This program, called "Neutral Patent Evaluation," was designed to provide for the fast and efficient resolution of patent disputes.[127] It costs $4,000 for each party[128] and is completed within a few months.[129] The adjudicator is a

However, its creators warn that while searching can be automated, "[t]he second step in the process (analyzing what was found) is even more difficult, and definitely requires a patent lawyer." Id. They further explain that "patents are tricky things." Id.

[125] Rory Van Loo, Federal Rules of Platform Procedure, 88 U. Chi. L. Rev. 829, 837–38 (2021); see, e.g., Complaint at 1–3, Wanna Play Prods. Inc. v. Emery, No. 20-cv-00010 (N.D. Ga. dismissed Feb. 10, 2020) (alleging that Amazon had taken down a product based on an expired patent and an irrelevant patent).

[126] Amazon, Amazon Utility Patent Neutral Evaluation Procedure 1 (2019), https://img1.wsimg.com/blobby/go/7f797a3a-f5f3-42f5-bbfa-7e82cf29ada9/downloads/Amazon%20Utility%20Patent%20Neutral%20Evaluation%20Proce.pdf [https://perma.cc/G7KB-5RF4].

[127] Id. Amazon states that the purpose of the program is "[t]o efficiently resolve claims that third-party product listings infringe utility patents" and calls the procedure "fast." Id.

[128] With the possibility of getting some of that money back depending on the outcome. Id. at 1–3.

[129] Id. at 1–2.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

"neutral individual" who is an attorney with experience in patent litigation in the United States.[130] The procedure does not involve discovery, oral hearings, or a trial.[131]

The patent owner initiates the procedure by identifying the asserted patent and allegedly infringing products and signing an agreement to waive any claims against Amazon.[132] The defendant (the seller of the allegedly infringing products) can then choose to participate in the procedure or to settle.[133] Each party submits written arguments of no more than twenty pages (for the patent owner) or fifteen pages (for the defendant).[134] The adjudicator then makes a decision within fourteen days of receiving the last written argument.[135]

Notably, the procedure assesses infringement only.[136] It does not address validity.[137] To prevail, the defendant must win one of three arguments: (1) that their product does not infringe; (2) that the patent under evaluation has been found invalid or unenforceable by a court, the Patent Office, or the International Trade Commission; or (3) that the defendant's products were on sale at least one year before the patent was filed.[138] The procedure thus adjudicates infringement but effectively outsources determinations of validity to other institutions.

If the patent owner prevails, Amazon will remove the defendant's products and will return $4,000 to the patent owner.[139] If the patent owner loses, Amazon will return $4,000 to the defendant.[140] Either party can separately seek a judgment in litigation or arbitration related to the dispute and, if the results contradict the findings of Amazon's Evaluator, Amazon will restore or remove the products, as appropriate.[141]

[130] Id. at 1.

[131] Id. at 2.

[132] Amazon, Amazon Utility Patent Neutral Evaluation Agreement (2019), https://img1.wsimg.com/blobby/go/7f797a3a-f5f3-42f5-bbfa-7e82cf29ada9/downloads/Amazon%20Utility%20Patent%20Neutral%20Evaluation%20Agree.pdf [https://perma.cc/CG4T-XQQB].

[133] Amazon Utility Patent Neutral Evaluation Procedure, supra note 126, at 1.

[134] Id.

[135] Id. at 2.

[136] Id.

[137] Id.

[138] Id. Note that the last option (that the defendant's products were on sale at least one year before the patent was filed) means that the asserted patent is invalid under 35 U.S.C. § 102 for lack of novelty.

[139] Amazon Utility Patent Neutral Evaluation Procedure, supra note 126, at 2–3.

[140] Id. at 2.

[141] Id. at 3.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

Amazon's program has attracted significant interest from patentees.[142] Without the program, patentees may be powerless to enforce their patent against infringing products either because the sellers are not in the United States[143] or because litigation costs are prohibitively high.[144]

1. Implications

As use of Amazon's program rises—and perhaps sparks similar programs at other online retailers—it will increase the number of patents that can be enforced. Most notably, Amazon's program vastly decreases the cost of patent enforcement, meaning that enforcement is economical in more situations. Patent trials are expensive, costing over a million dollars on average.[145] Low-value claims are not, therefore, generally worthwhile. By contrast, Amazon's program costs $4,000—greatly altering the economic calculus of enforcement. Of course, a countervailing effect is that opportunities for large damage awards are also limited.

Further incentivizing enforcement, patentees participating in Amazon's program do not risk losing their patent. In conventional patent litigation, defendants almost always allege that the plaintiff's patent is in

[142] See, e.g., Jiajv Chen & Wei Li, Patent Infringement Evaluation and Liability of E-Commerce Platforms in China, 15 J. Intell. Prop. L. & Prac. 791, 792–93 (2020); Kaity Y. Emerson, From Amazon's Domination of E-Commerce to Its Foray into Patent Litigation: Will Amazon Succeed as "The District of Amazon Federal Court"?, 21 N.C. J.L. & Tech. 71, 84–85 (2019); Joshua Fruchter, Amazon Takes Aim at Patent Infringement in Its Marketplace, Nat'l L.F. (July 16, 2019), https://nationallawforum.com/2019/07/16/amazon-takes-aim-at-patent-infringement-in-its-marketplace/ [https://perma.cc/Z2TN-6G7Q]; Weijun Huang & Xiaoqiu Li, The E-Commerce Law of the People's Republic of China: E-Commerce Platform Operators Liability for Third-Party Patent Infringement, 35 Comput. L. & Sec. Rev. 1, 5 (2019); Gaston Kroub, Arbitration in the Age of Amazon, 12 Landslide 22, 22 (2019); Robert Sprague, It's a Jungle Out There: Public Policy Considerations Arising From a Liability-Free Amazon.com, 60 Santa Clara L. Rev. 253, 257 (2020).

[143] If the products are being sold in the United States, then they infringe U.S. patents because the seller is importing the product. See 35 U.S.C. § 271 (listing "import[ing]" as an infringing action). However, in practice it can be difficult to enforce a judgment against a foreign defendant.

[144] This may be a particular problem when there are many different defendants, as might be the case on Amazon. Each defendant adds cost to a suit so, while in the aggregate the damage caused by multiple defendants might be large, it may still be cost-prohibitive to sue each defendant.

[145] Russ Krajec, Current Patent Litigation Costs Are Between $2.3 to $4M, Associated Press (July 10, 2020), https://apnews.com/article/technology-business-intellectual-property-patents-a5dd5a7d415e7bae6878c87656e90112 [https://perma.cc/8X4Z-TPRP].

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

fact invalid.[146] If a court finds a patent invalid, the (former) patentee not only loses the case, but also cannot enforce the patent against anyone else.[147] By contrast, Amazon's program adjudicates only infringement, not validity. This removes a substantial source of risk to the patentee that is a part of traditional litigation. To the extent that that risk reduced incentives to enforce patents, removing the risk of invalidity should increase enforcement.

In addition, reputational costs are also a constraint on litigation.[148] Patent holders may be reluctant to sue infringers in situations where a lawsuit will generate negative publicity.[149] Amazon's program is not public—unlike civil litigation—which may reduce the reputational cost of bringing an infringement claim.[150]

A final reason for increased enforcement is that Amazon's platform makes infringement easier to find. Amazon is popular because its algorithm makes it considerably easier for consumers to find items as compared to shopping at brick-and-mortar stores or going to many different retail websites.[151] The same logic applies to patent holders: where they might never find out about an infringing product sold at a small store, they can thoroughly search Amazon's products. Relatedly, Amazon's popularity means that there is great incentive for sellers to use the platform. This consolidates sales of infringing items in one place, again making it easier for patentees to find the infringement.

The reason that Amazon can run a cheap adjudication program—thereby increasing the breadth of patents that can be enforced—is because it sacrifices depth of analysis. Amazon's program makes it almost impossible to argue that a patent is invalid which—aside from increasing enforcement—means that invalid patents are of equal value to valid patents from the perspective of the patentee.

---

[146] See Lemley, supra note 7, at 22.

[147] Blonder-Tongue Labs., Inc. v. Univ. of Ill. Found., 402 U.S. 313, 350 (1971).

[148] See, e.g., Jacob H. Rooksby, When Tigers Bare Teeth: A Qualitative Study of University Patent Enforcement, 46 Akron L. Rev. 169, 176–77 (2013).

[149] Granted, Amazon sellers will not always be sympathetic plaintiffs. Reputational costs might be more significant when suing institutions like research universities or hospitals. Cristina Weschler, The Informal Experimental Use Exception: University Research After *Madey v. Duke University*, 79 N.Y.U. L. Rev. 1536, 1538 (2004).

[150] Although, any of the parties could presumably publicize the infringement claim.

[151] See Shira Ovide, How Amazon Won Shopping, N.Y. Times (Aug. 17, 2021), https://www.nytimes.com/2021/08/17/technology/how-amazon-won-shopping.html [https://perma.cc/39LC-5C5D].

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

Amazon's program means that even blatantly invalid patents can be asserted. Take, for example, U.S. Patent No. 6,360,693, which claims to have invented a stick.[152] The patent is not valid because it is not novel: sticks were known long before the patent was filed in 1999.[153] The patent was so clearly invalid that, after it was granted, the Director of the Patent Office issued an order for reexamination, an extremely rare occurrence, after which the Patent Office cancelled the claims of the patent.[154] Yet if the patent had been asserted under Amazon's program before the reexamination, the patentee would have won, because Amazon's program does not evaluate validity even in extreme circumstances.

And there are many, many products for sale on Amazon that fall within the scope of the stick patent's claims[155]—including a decorative tree,[156] marshmallow roasting sticks,[157] wooden hair pins,[158] National Geographic's model ballista kit,[159] wooden mallets,[160] and a variety of

[152] U.S. Patent No. 6,360,693 (filed Dec. 2, 1999).

[153] This proposition needs no citation, but if the reader desires a source, *The Epic of Gilgamesh* mentions sticks. The Epic of Gilgamesh 17 (Wolf Carnahan ed., Maureen Gallery Kovacs trans., 1998) ("As soon as we have gone down into the Cedar Forest, let us split open the tree (?) and strip off its branches(?)." (internal quotation marks omitted)).

[154] Gene Quinn, The Strange Case of the Animal Toy Patent: Reexam Redux, IPWatchdog.com (Dec. 3, 2010, 11:19 AM), https://ipwatchdog.com/2010/12/03/the-strange-case-of-the-animal-toy-patent-reexam-redux/id=13648/ [https://perma.cc/M5QE-8WJF].

[155] The patent claims an animal toy comprising "a solid main section" with "at least one protrusion attached" wherein the toy "is adapted to float on the water." U.S. Patent No. 6,360,693 col. 4 l. 56–67 (filed Dec. 2, 1999).

[156] PEIDUO, Valentine Tree Valentines Day Decor, Easter Tree Battery Powered Timer, Lighted Birch Tree with LED Lights, Artificial Tree Lamp for Christmas Home Decor (2FT Warm White), Amazon, https://www.amazon.com/Padoo-Pre-lit-Battery-Powered-Wedding/dp/B07X4GGBYS/?th=1 [https://perma.cc/GK48-WUEJ] (last visited Feb. 12, 2023).

[157] Y-me, Marshmallow Roasting Sticks, Smores Sticks for Fire Pit, Smores Kit for Fire Pit, Smores Skewers for Fire Pit, Marshmallow Sticks for Campfire, Hot Dog Sticks for Campfire, Set of 8, 32 Inch, Amazon, https://www.amazon.com/kubo-Telescoping-Marshmallow-Roasting-Cookware/dp/B07GVBBCTW [https://perma.cc/PX2T-TU4D] (last visited Feb. 12, 2023).

[158] Marycrafts, Wooden Flower Hair Pin, Hair Fork, Hair Stick, Hair Accessory Handmade Abstract 4.5", Amazon, https://www.amazon.com/MaryCrafts-Wooden-Accessory-Handmade-Abstract/dp/B013B46DUC [https://perma.cc/W788-RUKL] (last visited Feb. 12, 2023).

[159] Nat'l Geographic, Construction Model Kit – Wooden 3D Puzzle Models, Craft Kits Make Great Gifts for Girls and Boys, an Amazon Exclusive Science Kit, Amazon, https://www.amazon.com/NATIONAL-GEOGRAPHIC-Engineering-Construction-Functioning/dp/B07C4KBJ1X?th=1 [https://perma.cc/U6DT-PAUL] (last visited Feb. 12, 2023).

[160] Toyvian, Wooden Hammer for Chocolate 20pcs Wood Mallet Pounding Toy Breakable Heart Hammer Small Shellfish Hammer Tool Beating Gavel Toys for Boys Girls, Amazon, https://www.amazon.com/Toyvian-Wooden-Hammer-Pounding-Beating/dp/B07QVGWS1B [https://perma.cc/A6C2-D87A] (last visited Feb. 12, 2023).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

dog chew toys.[161] A broad, invalid patent has the potential to wreak havoc under Amazon's program, and indeed, suits have accused patentees of asking Amazon to enforce an invalid or unenforceable patent.[162]

Amazon's program changes the way that patents are used because it increases enforcement—elevating the impact of patents—and decreases the applicability of defenses to infringement, giving weight to lower-quality patents. It effectively trades depth of analysis for breadth of analysis. Amazon's program may herald a change in patent enforcement as product sales are increasingly consolidated on platforms that have the power to adjudicate patent infringement in non-traditional ways.

C. Portfolio Analysis, Patent Landscaping, and Patent Analytics

In the aggregate, patents contain vast amounts of information about new technology.[163] This information can be analyzed to learn about trends in innovation and activities of competitors or potential collaborators.[164] Although patent information has long been useful,[165] it has historically been difficult to access. Initially, it was available only through manual search at the Patent Office or certain specialized libraries.[166] With the advent of computerized search technology and the internet, patent

[161] E.g., USonline911, Petdexon Dog Toothbrush Chew Toys, Natural Rubber Indestructible Teeth Cleaning Dog Toys Brushing Stick Dental Oral Care for Aggressive Chewer for Small Medium Dogs, Amazon, https://www.amazon.com/Petdexon-Toothbrush-Indestructible-Cleaning-Aggressive/dp/B08C77PXPN [https://perma.cc/5DFW-DWH6] (last visited Feb. 12, 2023).

[162] See Mike Leonard, Corporate Roundup: Amazon Pet Case Settles, Delaware Suits End, Bloomberg L. (June 21, 2021), https://news.bloomberglaw.com/antitrust/corporate-roundup-amazon-pet-case-settles-delaware-suits-end [https://perma.cc/N4TX-UQ7Z] (Garmon Corp. accused Vetnique Labs LLC of intentionally asserting unenforceable patents through Amazon's Neutral Patent Evaluation program); Complaint at 13, Blue Echo Care LLC v. Ackerman, No. 20-cv-03586 (N.D. Ga. dismissed Dec. 3, 2020) (alleging that the defendant was presented with information proving that its patent was invalid but continued asserting the patent through Amazon's program).

[163] Aristodemou et al., supra note 15, at Introduction ("Patent data has long been considered the world's largest repository of technological information.").

[164] Id.

[165] With the caveat that much information in patents may be useless. See, e.g., Janet Freilich, Prophetic Patents, 53 U.C. Davis L. Rev. 663, 691–92 (2019); Fromer, supra note 67, at 543; Seymore, supra note 40, at 632.

[166] Jeffrey L. Furman, Markus Nagler & Martin Watzinger, Disclosure and Subsequent Innovation: Evidence from the Patent Depository Library Program 2 (Nat'l Bureau of Econ. Rsch., Working Paper No. 24660, 2018).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

information could be found more easily.[167] More recently, advances in machine learning and artificial intelligence have increased our ability to search, classify, organize, and extract information from millions of patents.[168] Further, these advances have greatly expanded the audience for patent data.[169]

These technological advances have revolutionized patent informatics and in doing so opened a wide array of functions to which information from patents can be applied.[170] The goal is to use information from patents to understand how and where innovation is happening in order to inform policy, investment, and business decisions.[171] Patents in a particular technological field are surveyed (called "patent landscaping"[172] or "patent

[167] For example, on the website of the United States Patent and Trademark Office, there is an easily accessible search engine for patents. Search for Patents, U.S. Pat. & Trademark Off., https://www.uspto.gov/patents/search [https://perma.cc/93RR-6DFK] (last visited Feb. 10, 2023).

[168] See, e.g., Andrew A. Toole, Nicholas A. Pairolero, James Q. Forman & Alexander V. Giczy, The Promise of Machine Learning for Patent Landscaping, 36 Santa Clara High Tech. L.J. 433, 434 (2020) (explaining that patent landscaping had "traditionally been a time consuming and complex process relying on the careful construction of queries to identify relevant patents"). See also Aristodemou et al., supra note 15, at Introduction (stating that recent technological advances have the potential to deliver "breakthrough progress to enable completely new use cases for patent data with substantial economic benefits"); Anthony Trippe, WIPO, Guidelines for Preparing Patent Landscape Reports 2 (2015), https://www.wipo.int/edocs/pubdocs/en/wipo_pub_946.pdf [https://perma.cc/NJB2-JCXM] ("With the institution of patent analytics . . . it is possible for these critical decisions to be made with data-driven, evidence-based approaches that deliver informed choices . . . .").

[169] Aristodemou et al., supra note 15, at Introduction.

[170] Toole et al., supra note 168, at 434–35, 438 (contrasting previous technology, which was time-consuming, complex, and quickly outdated and mirrored "*a priori* expectations about where technology is" to machine learning which may "allow the landscape to extend beyond preconceived notions of where, and what constitutes the technology" and thus "allow[] for better decision-making by business leaders and policy-makers"); see also Sungjoo Lee, Seonghoon Lee, Hyeonju Seol & Yongtae Park, Using Patent Information for Designing New Product and Technology: Keyword Based Technology Roadmapping, 38 R&D Mgmt. 169, 169, 178 (2008) (explaining that historical procedures for technology road-mapping "too often require vast amounts of information and also have considerable costs in terms of time and human resources across diverse fields" but that automated analysis of patent data has the potential to improve the procedure).

[171] Aaron Abood & Dave Feltenberger, Automated Patent Landscaping, 26 A.I. & L. 103, 104 (2018) (explaining that patent landscaping is used by "companies that desire to assess risk posed by other patent holders and understand their own relative strength, . . . academics and governments that seek to gauge the level of R&D investment and innovation in particular fields, . . . [and] investors looking to value companies and assess risk").

[172] Id. at 103 ("Patent landscaping is the process of finding patents related to a particular topic. It is important for companies, investors, governments, and academics seeking to gauge innovation and assess risk.").

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

analytics"[173]) to provide insight about technology and technological changes that can be leveraged in setting goals and pursuing outcomes.[174] The market for patent analytics is large and fast-growing, currently pegged at approximately $658 million per year and expected to rise to nearly $1.7 billion by 2027.[175]

One application for patent analytics is to guide policy making by governments and intergovernmental organizations.[176] For example, the World Intellectual Property Organization ("WIPO") and World Health Organization ("WHO") jointly produced a patent landscape on vaccine-related patents, a report that was designed to provide factual evidence for WHO decision-making.[177] The report informed projects to facilitate vaccine manufacturing around the world and sometimes led WHO to support particular research paths.[178] WIPO and WHO also collaborated on a patent landscape for essential medicines directed to determining how to distribute low-cost generic medications.[179] The United Nations-backed Medicines Patent Pool created a patent landscape for key antiretrovirals and compiled a database of the patents.[180] WIPO has produced a variety of other patent landscape reports in collaboration with international

[173] Aristodemou et al., supra note 15, at Introduction (defining patent analytics as "the science of analysing large amounts of patent information to derive meaningful insights to support decision making").

[174] Toole et al., supra note 168, at 434 ("Patent landscaping identifies patents in a specific technology area to understand the business, economic, and policy implications of technological change."); Trippe, supra note 168, at 2 ("Patent Landscape Reports (PLRs) support informed decision-making, and are designed to efficiently address the concerns associated with making high stakes decisions in various areas of technology . . . .").

[175] Fortune Bus. Insights, Patent Analytics Market to Reach USD 1,668.4 Million by 2027, GlobeNewswire (May 18, 2020), https://www.globenewswire.com/en/news-release/2020/05/18/2035078/0/en/Patent-Analytics-Market-to-Reach-USD-1-668-4-Million-by-2027-Integration-of-Machine-Learning-and-Artificial-Intelligence-to-Spur-Business-Opportunities-states-Fortune-Business-Insi.html [https://perma.cc/U57J-4NL7].

[176] Trippe, supra note 168, at 33 (reporting on behalf of the World Intellectual Property Organization that "[p]atent landscaping . . . can inform, support and strengthen the factual basis for discussions, so assisting the policymakers in those fields to set future directions on health, the environment, and food security").

[177] Id. at 34.

[178] Fr. Innovation Scientifique & Transfert S.A., WIPO, Patent Landscape Report on Vaccines for Selected Infectious Diseases 1, 12–14 (2012), https://www.wipo.int/edocs/pubdocs/en/patents/946/wipo_pub_946_3.pdf [https://perma.cc/Y6X9-RRUJ]; see also Trippe, supra note 168, at 35 (explaining that WHO monitors patenting activity relating to vaccines and "in some cases WHO supports research on alternative technologies or negotiates licenses with the right holders on behalf of developing country manufacturers").

[179] Trippe, supra note 168, at 34.

[180] Id.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

organizations in such varied fields as desalination technologies,[181] marine genetic resources in Southeast Asia,[182] and palm oil production waste treatment technologies.[183]

National governments also fund patent landscape reports to assess competitiveness, understand collaborations and knowledge flows between companies, select areas of intensive focus, and devise innovation policy.[184] The United Kingdom's Intellectual Property Office ("UK IPO") formed an informatics team to use patent data to "mine, reveal, and inform, for government and for industry."[185] The UK IPO has created reports on a variety of technologies including stem cells and 3D TVs.[186] IP Australia has a "Patent Analytics Hub" which includes, as of November 2022, patent landscape reports on low-emission technologies and innovation in the mining sector.[187] The Korean government worked with academic researchers to use patent data to model product development needs in the aerospace industry.[188]

Academics use patent data to study innovation, clustering, performance, and trends in various industries. For example, a study of innovation in the car industry in Korea used patent documents to pinpoint which companies were making progress in which areas.[189] The study

[181] Helena van der Vegt, Ilian Iliev, Quentin Tannock & Sarah Helm, WIPO, Patent Landscape Report on Desalination Technologies and the Use of Alternative Energies for Desalination 6 (2011), https://www.wipo.int/edocs/pubdocs/en/patents/948/wipo_pub_948_2.pdf [https://perma.cc/UML3-G2KQ].

[182] Paul Oldham, WIPO, Patent Landscape Report: Marine Genetic Resources 1 (2019), https://www.wipo.int/edocs/pubdocs/en/wipo_pub_947_6.pdf [https://perma.cc/Z2KU-ZZS8].

[183] Haopeng Wang, Anthony Coleman, Kapil Dhall & Mahender Singh, WIPO, Patent Landscape Report: Palm Oil Production and Waste Treatment Technologies 1 (2016), https://www.wipo.int/edocs/pubdocs/en/wipo_pub_947_4.pdf [https://perma.cc/QL23-EVGB].

[184] Trippe, supra note 168, at 33–34.

[185] Id. at 36.

[186] Id.

[187] Patent Analytics Hub, IP Austl., https://www.ipaustralia.gov.au/tools-and-research/Professional-resources/Data-research-and-reports/Patent-analytics [https://perma.cc/7DTH-A5KR] (last visited Feb. 10, 2023).

[188] Lee et al., supra note 170, at 169–71 (using a technique called "technology roadmapping" to determine what products should be developed over the next decade to meet identified market needs). The researchers also looked at gaps between the abilities of Korean firms to produce certain products and the abilities of competitor firms.

[189] Gabjo Kim, Joonhyuck Lee, Dongsik Jang & Sangsung Park, Technology Clusters Exploration for Patent Portfolio Through Patent Abstract Analysis, 8 Sustainability 1252, 1253 (2016).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

found different companies had different specialties—Hyundai in air conditioning and vehicle interface devices, Kia in eco-routing navigation and creep torque control systems, LG in battery monitoring devices, and Samsung in integrated charging modules and lithium battery packs.[190] Another academic group used patent data to study the dye-sensitized solar cells industry.[191] The patent data was used to model which companies had complementary technologies that could be improved by collaboration, hopefully leading to increased efficiency and reduced costs.[192] Similar analyses have been conducted for many different technologies including electric vehicles,[193] robotics,[194] and refrigerators.[195]

Patent analytics also inform corporate decision-making. Private companies use patent landscape reports to get information on competitors.[196] When companies move into new markets, they may commission a patent landscape to better understand the nuances of the market.[197] Patent analytics may also be used to help companies decide between developing a technology themselves or acquiring another company already involved in the area.[198] Similarly, patent data informs merger and collaboration targets.[199] So-called "whitespace analysis" can

[190] Id. at 1261–62.

[191] Xuefeng Wang, Rongrong Lia, Ying Huang & Pingping Ma, Identifying R&D Partners for Dye-Sensitized Solar Cells: A Multi-Level Patent Portfolio-Based Approach, 31 Tech. Analysis & Strategic Mgmt. 356, 356 (2018). Dye-sensitized solar cells improve on traditional silicon solar cells because they are easier to make and the materials are more environmentally friendly. Id. at 361–62.

[192] Id. at 362, 365, 370.

[193] Philipp Borgstedt, Bastian Neyer & Gerhard Schewe, Paving the Road to Electric Vehicles – A Patent Analysis of the Automotive Supply Industry, 167 J. Cleaner Prod. 75 (2017).

[194] Paul P.J. Chen, Amy I.C. Trappey, Betty H.L. Lin & Charles V. Trappey, Patent Analytics of Robotics Technology for Intelligent Manufacturing in the Semiconductor Industry, 2018 IEEE 22d Int'l Conf. on Comput. Supported Coop. Work in Design Proc. 213.

[195] Dragan Kukolj et al., Technology Status Visualisation Using Patent Analytics: Multi-Compartment Refrigerators Case, 4 J. Mechatronics, Automation & Identification Tech. 1 (2017).

[196] Trippe, supra note 168, at 39. Competitors are aware that patents are used in this regard, and sometimes include "decoy" information in patents. See, e.g., Corinne Langinier, Using Patents to Mislead Rivals, 38 Canadian J. Econ. 520, 522 (2005) ("There is considerable evidence that firms use 'decoy patents' . . . ."); Janet Freilich, Patent Clutter, 103 Iowa L. Rev. 925, 962 (2018).

[197] Trippe, supra note 168, at 40.

[198] Id.

[199] Id.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

highlight where patents are not prevalent, thereby providing companies with leads on under-developed technologies.[200]

Dr. Joakim Isaksson, the Lead IP Analyst at Philips, a large multinational company, explains that Philips uses patent analytics to provide data that "can be a direct or indirect driver of both operational and strategic decisions."[201] He further states that patent data "provides valuable input" for strategic decisions and sometimes points to "specific applications, technology or product solutions, or trends with respect to investment and R&D."[202] Philips uses patent data to guide some aspects of their product development and business strategies[203] and to inform partnership and acquisition targets.[204] Intellectual property ("IP") analysts in private companies were historically used to find particular pieces of information, and Isaksson argues that as technology improves the breadth and utility of patent data, a patent analyst now serves as an "insights-generator" and "strategist."[205]

In sum, patents provide enormous amounts of information that can be scrutinized to inform decision-making in the private and public sector.

1. Implications

Applying machine learning and artificial intelligence to patent analytics enables analysis of a greater breadth of patents. If patent analyses are done substantially by hand, it limits the number of patents that can be reviewed and included in the analysis. Thus, patents that would not have been reviewed or assessed are now included in reports. This means that patents that were historically ignored are now incorporated into decision-making.

---

[200] For instance, a report by Clarivate Analytics shows gaps in the AI hardware space. Aditi Varshney & Kannan Narayanan, Identifying Gaps in the AI Hardware Patent Landscape to Grow Market Share 1, 4 (2022), https://www.morganlewis.com/-/media/files/publication/outside-publication/white-paper/identifying-gaps-in-the-ai-hardware-patent-landscape-to-grow-market-share-clarivate.pdf [https://perma.cc/6WLJ-3VJ3].

[201] Derwent, Reinventing the Role of Patent Analysis: How Insight from Patent Intelligence Can Drive Competitive Advantage 1, 5 (2020), https://clarivate.com/derwent/wp-content/uploads/sites/3/dlm_uploads/2020/03/DW424883067_WP_PHILIPS_US.pdf [https://perma.cc/AH3G-LQKZ] (interviewing Dr. Joakim Isaksson).

[202] Id.

[203] Id. at 6.

[204] Id.

[205] Id. at 7.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

As patent analytics becomes more feasible and increasingly adopted, the patents that make up the report have greater impact. For instance, government-sponsored patent landscapes can drive public investments.[206] In private institutions, patent landscapes can be used as the basis for identification of merger and acquisition targets, and decisions to pursue research and development in certain areas.[207]

This enhances the potential *in terrorem* effect of patents. As explored above, enforcing patents would logically deter others from working in an area covered by a patent, but it is not clear that the mere presence of an unenforced patent would do the same.[208] In particular, if nobody knows about the presence of an unenforced patent (because patents are hard to find and searches are difficult) then the patent will certainly not have a deterrent effect.[209]

AI-driven patent analytics means that significantly more patents can be incorporated into decision-making, possibly heightening the *in terrorem* effect. If companies indeed use patent landscape reports as part of a decision about whether to go into a field, they might be deterred by a finding that the field has thousands of patents, as it would be impractical

[206] Trippe, supra note 168, at 38 (explaining how the use of patent analytics "can influence decisions around investments in academic and non-profit funding for the creation of economically favorable technologies" and that "[g]overnments use [patent analytics] to ensure that investments in R&D will be directed to technologies and industries that will ensure their future competitiveness in high impact areas").

[207] Id. at 38–40.

[208] Supra notes 83–84 and accompanying text.

[209] This is important because scholars worry about the potential for incorrectly granted patents to erroneously deter others. See, e.g., Michael D. Frakes & Melissa F. Wasserman, Does Agency Funding Affect Decisionmaking: An Empirical Assessment of the PTO's Granting Patterns, 66 Vand. L. Rev. 67, 71 (2013); Janet Freilich, The Replicability Crisis in Patent Law, 95 Ind. L.J. 431, 435–36 (2020); Mark A. Lemley & Bhaven Sampat, Is the Patent Office a Rubber Stamp?, 58 Emory L.J. 181, 185 (2008); Robert P. Merges, As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform, 14 Berkeley Tech. L.J. 577, 588–89 (1999); Michael J. Meurer, Controlling Opportunistic and Anti-Competitive Intellectual Property Litigation, 44 B.C. L. Rev. 509, 541 (2003); Lisa Larrimore Ouellette, *Pierson*, Peer Review, and Patent Law, 69 Vand. L. Rev. 1825, 1827 (2016); Arti K. Rai, Growing Pains in the Administrative State: The Patent Office's Troubled Quest for Managerial Control, 157 U. Pa. L. Rev. 2051, 2080 (2009); Sean B. Seymore, Heightened Enablement in the Unpredictable Arts, 56 UCLA L. Rev. 127, 131 (2008); see also James Bessen & Michael Meurer, Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk 2, 5–6 (2008) (discussing the societal costs of incorrectly granted patents); Dan L. Burk & Mark A. Lemley, The Patent Crisis and How the Courts Can Solve It 30–31 (2009) (same); 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 (2004) (same).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

and expensive to license them all. As more patents are incorporated into decision-making, ignorance of patents no longer prevents *in terrorem* effects.

Patent landscape analysis makes the *information* in patents matter. Patents contain a great deal of information about inventions, and while this information has long been of theoretical interest to scholars, it was assumed to be of little practical importance—and was ignored.[210] Now, information in the patent can be used in more extensive ways, again, increasing the influence of patents.[211]

While patent landscape analysis has expanded patent impact, the landscapes vary significantly in how deeply they analyze individual patents, ranging from deeply sophisticated review to no review at all. This variation may be partially a function of cost. For instance, the World Intellectual Property Organization compiles a list of freely available patent landscape reports.[212] I reviewed the nineteen English-language reports published in 2018 and 2019 and found that only one analyzed validity, only two weighed patents in some manner based on strength, relevance, or other criteria, and only five excluded expired patents from their analysis. Similarly, a report on patent landscapes published in life sciences academic journals found that a large majority did not report details of the analysis conducted in sufficient detail to allow for interpretation of results.[213] By contrast, many companies offer very sophisticated reports for paying clients and my conversations with these

[210] Both because the disclosure function of patents does not work very well and because scientists do not read patents. See, e.g., Colleen Chien, Contextualizing Patent Disclosure, 69 Vand. L. Rev. 1849, 1852 (2016); Alan Devlin, The Misunderstood Function of Disclosure in Patent Law, 23 Harv. J.L. & Tech. 401, 403–04 (2010); Fromer, supra note 67, at 560–61; Jason Rantanen, Peripheral Disclosure, 74 U. Pitt. L. Rev. 1, 13–14 (2012); Seymore, supra note 40, at 625.

[211] See, e.g., Research: Original Research, Ctr. for AI & Pat. Analysis, Carnegie Mellon Univ., https://www.cmu.edu/epp/patents/research/index.html [https://perma.cc/39ZH-RJ6K] (last visited Feb. 10, 2023) (explaining an initiative to leverage natural language processing to analyze information in patent specifications).

[212] Patent Landscape Reports by Other Organizations, WIPO, https://www.wipo.int/patents cope/en/programs/patent_landscapes/plrdb.html [https://perma.cc/Y87M-SWLB] (last visited Feb. 10, 2023).

[213] James A. Smith, Zeeshaan Arshad, Hannah Thomas, Andrew J. Carr & David A. Brindley, Evidence of Insufficient Quality of Reporting in Patent Landscapes in the Life Sciences, 35 Nature Biotechnology 210, 211 (2017).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

companies suggest that they are able to provide substantial in-depth analysis.[214]

Patent landscapes with cursory or absent review of individual patents make it difficult for readers to interpret provided information. For instance, patent landscapes can be used to see how many companies are working in a field. But the presence of a patent in a particular field can mean very different things, depending on the patent and how it is used. Some patents may indicate that their owner is actively manufacturing an invention. But other patents may only indicate that their owner has thought about an invention. Patents can be entirely based on speculative and hypothetical technologies that have never been tried.[215] Even if the patent describes a real, tested technology, it may not be in use and, even if in use, the particular aspect of interest may not be the one in use.[216] Further, it is quite common for patents to disclose a technological application as one of hundreds of possible uses, and such a brief mention says little about the intensity with which the patentee is working on that application.[217]

Some patent landscapes make these nuances impossible to discern. The strategies used to find relevant patents or to assign patents to different technologies groupings can be—as with many AI applications—a black box.[218] It is therefore difficult to know from a patent landscape report whether the presence of patents in an area should be a deterrent to entering that area or actually means that an area is entirely undeveloped. In some

[214] Examples include Cipher IP, Clarivate Analytics, LexisNexis, and others. Fortune Bus. Insights, supra note 175.

[215] Freilich, supra note 165, at 691; Janet Freilich & Lisa Larrimore Ouellette, Science Fiction: Fictitious Experiments in Patents, 364 Science 1036, 1036 (2019).

[216] See, e.g., Jorge L. Contreras, Rohini Lakshané & Paxton M. Lewis, Patent Working Requirements and Complex Products, 7 N.Y.U. J. Intell. Prop. & Ent. L. 1, 1–2, 4 (2017) (explaining the complexities of the working requirement).

[217] Freilich, supra note 196, at 946–48.

[218] See, e.g., W. Nicholson Price II, Regulating Black-Box Medicine, 116 Mich. L. Rev. 421, 423 (2017); Charlotte A. Tschider, Beyond the "Black Box," 98 Denv. L. Rev. 683, 683 (2022) ("[E]ven their creators cannot easily explain how [AI] work[s]."); Shlomit Yanisky-Ravid & Sean K. Hallisey, Equality and Privacy by Design: A New Model of Artificial Intelligence Data Transparency via Auditing, Certification, and Safe Harbor Regimes, 46 Fordham Urb. L.J. 428, 439 (2019). Moreover, many machine learning and AI applications are protected as trade secrets, meaning that their owners deliberately avoid disclosing the details of the application. Jeanne C. Fromer, Machines as the New Oompa-Loompas: Trade Secrecy, the Cloud, Machine Learning, and Automation, 708 N.Y.U. L. Rev. 706, 717 (2019). For a discussion of trade secrets, see, e.g., Courtney Cox, Legitimizing Lies, 90 Geo. L. Rev. 297, 300–01 (2022).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

patent landscapes, all patents on a particular topic are given equal weight even if some patents discuss an area briefly and others at length.[219] Some reports omit even very basic information such as patent ownership, whether patents are granted, and whether patents have expired.[220]

Patent landscapes with superficial review of individual patents may be a temporary problem. As AI becomes ubiquitous, AI-based in-depth analysis may be more widely (and cheaply) adopted, and more uses of patents may include advanced analysis of individual patents. But at the moment, some patent landscapes provide a great deal of information about patents but in a shallow and cursory way.

III. CONSEQUENCES FOR PATENT THEORY

This Part discusses overarching themes that unify the case studies above, specifically increased impact of patents (Section III.A), decreased depth of analysis (Section III.B), the propensity of private decisions in these contexts to counteract judicial and congressional actions (Section III.C), and the possibility that choices made by private platforms will displace substantive patent law (Section III.D). The Article then turns to policy reform and improvements for technology, the technology-patent interface, and patent law.

A. Patent Impact

Historically, the vast majority of patents have simply been ignored.[221] For many, no one outside the team involved in filing the patent even knew the patent existed.[222] Functionally, therefore, these patents did not matter. While it is still true that the vast majority of patents are never enforced, never licensed, and perhaps never read, patents are increasingly influential in different ways. Technology is changing how we pay attention to patents and is augmenting the power and impact of previously ignored patents.

Strikingly, many of the ways in which technology has made patents matter are not driven by the patentee. This is not much changed with new technology (Amazon's program aside). For freedom-to-operate and

[219] See supra note 212 and accompanying text.

[220] Supra note 212 and accompanying text.

[221] Lemley, supra note 7, at 21 ("[B]oth researchers and companies in component industries simply ignore patents. Virtually everyone does it. They do it at all stages of endeavor.").

[222] Id. at 21–22.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

patent landscape analyses, patentees still do not enforce or seek licenses to their patents. Rather, it is members of the public who have taken it upon themselves to increase the influence of patents. It is, in a sense, a twisted form of self-help. Members of the public are using patents to make decisions even though those patents might otherwise never have mattered. Throughout, the patentees themselves are passive.

Yet patentees may benefit from this trend towards taking patents seriously. Patentees certainly benefit from Amazon's program, which allows increased enforcement of a patent. Though the program does not give the patentee damages, Amazon will take down infringing products—effectively enjoining the infringing behavior—leaving the patentee the ability to either charge higher prices as the now-monopolistic seller of a product or negotiate a license with the infringer.

Freedom-to-operate analyses and patent analytics do not directly lead to increased revenue for a patentee, but patentees may still benefit indirectly. For the former, a scientist investigating ways to synthesize a molecule may find that there are simply no unpatented paths—and therefore that they need to negotiate for a license.[223] Alternatively, the scientist may find that the patent-free syntheses are more expensive, and therefore that it is economical to license a patent. Patent landscape analyses have also led to patent licenses when it becomes clear that some desirable technological path is blocked by a patent.[224] Further, patent landscape analyses sometimes use patents to understand the technology being developed by companies and then use that understanding to identify potential collaborators or targets for acquisition.[225] Here, a company's patents bring them attention that they might not have received absent the patents.

This builds on previous literature that has noted that patents matter in a variety of ways that are uncoupled from enforcement.[226] Companies use patents as signals of technological accomplishment.[227] Others use patents

[223] Or put themselves at risk of treble damages, which may create an additional incentive for patentees to sue. 35 U.S.C. § 284(a).

[224] See supra Section II.C.

[225] Supra Section II.C.

[226] Mark A. Lemley, The Surprising Resilience of the Patent System, 95 Tex. L. Rev. 1, 41 (2016).

[227] Stuart J.H. Graham & Ted Sichelman, Why Do Start-Ups Patent?, 23 Berkeley Tech. L.J. 1063, 1067 (2008); Clarisa Long, Patent Signals, 69 U. Chi. L. Rev. 625, 651 (2002).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

as a show of strength to deter lawsuits or "bully" competitors.[228] There are a variety of ways in which private behavior can increase the impact of patents. This Article builds on that literature to document a change in patent impact driven by technology. Increasingly, patents matter, patents have weight, and patents drive behavior.

B. Depth of Analysis

Technology is also changing the way in which patents are analyzed. In the case studies above, some platforms conduct deep analyses of a broad array of individual patents.[229] Others do very little or no analysis of key aspects of patent law.[230] There are therefore circumstances in which enforcement of patents and access to patent-based information is democratized without providing the concomitant opportunity to understand and interpret those patents.

This presents dangers. For one, it reduces or even eliminates the role of defenses in patent law. Attacking the validity of an opponent's patent is the most important defense to accusations of patent infringement,[231] but it plays no role in how patents are used in some of the scenarios described above. Similarly, the various exceptions to patent infringement are not considered.[232] Non-infringement is also a common defense in patent infringement cases, often accompanied by an argument that a patent's claims should be construed in such a way as to exclude a particular product or use.[233] Because claim construction is not a major element of the procedures described above, this defense may be minimized. In a sense, technological developments have precipitated a swing from ignoring *patents* to ignoring *defenses*.

Further, there is less room for uncertainty in analyses that omit deep analysis. Historically, uncertainty has been nearly a certainty in any patent

[228] Ted Sichelman, The Vonage Trilogy: A Case Study in "Patent Bullying," 90 Notre Dame L. Rev. 543, 550–52 (2014).

[229] See supra Subsection II.C.1.

[230] See supra Subsection II.C.1.

[231] See John R. Allison & Mark A. Lemley, Empirical Evidence on the Validity of Litigated Patents, 26 AIPLA Q.J. 185, 205 (1998) (finding that approximately half of patents litigated to judgment are invalid).

[232] See supra Subsection II.B.1.

[233] See, e.g., Pitney Bowes, Inc. v. Hewlett-Packard Co., 69 F. Supp. 2d 325, 326 (D. Conn. 1998) (construing the patent-in-suit's claims such that the defendant's product did not infringe), *overruled by* 182 F.3d 1298, 1300 (Fed. Cir. 1999).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

analysis.[234] Patent validity and patent scope are profoundly uncertain.[235] In-depth analyses can cabin this uncertainty in some ways, for instance, by identifying patents that are almost certainly not valid and others that have a good chance at being upheld. In-depth analyses can also explain the sources of uncertainty and the ways in which it might affect different aspects of patent use. Without in-depth analysis of individual patents, most of that uncertainty is removed.

Some uncertainty is not removed, but is instead hidden in black boxes. For instance, all patents contain claims, and all claims have at least some ambiguity.[236] Most patent analyses, freedom-to-operate searches, or patent adjudications must grapple with claims in some way, making choices about how to interpret claim language. However, those choices are often obscured. In AI-driven patent landscape analyses, for example, how exactly are relevant patents identified? AI developers make some choice about what data to feed the AI so that it can learn how to categorize patents, but the methodology for that choice is not always disclosed.[237] This is in contrast to hiring a lawyer to write a report about certain patents of interest—while the lawyer will undoubtedly make choices about claim interpretation, the lawyer should explain those choices in the report (and if they do not, they can be asked).[238]

Black box decision-making is not only an AI phenomenon. In Amazon's Neutral Patent Evaluation program, the adjudicator must decide whether or not a product infringes and therefore must make some choice about interpreting claim language but—unlike in a traditional trial with a *Markman* hearing and briefing from both sides—the rationale for the decision is not explained.[239] The decision is a black box.

---

[234] See, e.g., Mark A. Lemley & Carl Shapiro, Probabilistic Patents, 19 J. Econ. Persps. 75, 76 (2005) (explaining that "the uncertainty associated with patents is especially striking, and indeed is fundamental to understanding the effects of patents on innovation and competition").

[235] Id.

[236] Any word is at least somewhat ambiguous, particularly in the hands of a talented lawyer.

[237] For instance, a report on patent landscapes in the life sciences found that "[p]roprietary software is often used to generate [patent] cluster maps, but the algorithms underpinning such software are rarely discussed or detailed in the papers using them, and in some cases . . . do not appear to be publicly available at all." Smith et al., supra note 213, at 213.

[238] Liza K. Tóth & Marc Sandy Block, Electronic and Software Patents: Law and Practice § 13.03 (Steven W. Lundberg, Stephen C. Durant & Ann M. McCrackin eds., 4th ed. 2018).

[239] Amazon explains that "[t]he Evaluator will not provide reasoning if the Evaluator decides that the Patent Owner is likely to prove that the Accused Product infringes the asserted claim. . . . The Participants will not contact or question the Evaluator regarding his or her decision." Amazon Utility Patent Neutral Evaluation Procedure, supra note 126, at 2.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

C. Trends Driven by Private Action

One striking aspect of the trends discussed in this Article is that they are all driven by private action. None of these platforms and applications are required by any government authority. There are no patent laws that either force or constrain these technologies. Rather, private parties created the technology and other private parties opt in to using it.

Interestingly, this has created a privately driven trend towards making patents matter *more*, which is in direct contrast to a trend in substantive, public patent law towards making patents matter *less*.[240] There have been recent changes to patent doctrine that have made patents harder to enforce either by making patents easier to invalidate or by promoting paths that end infringement cases more quickly. Below, I summarize this trend and the scholarly consensus that the pendulum is swinging away from patentees. I contrast this trend with the trends towards paying attention to patents that I identify above, and argue that public and private approaches to patents are moving in opposite directions.

1. The Public Trend: Toward Invalidity

Changes to patent law that make it easier to prove infringement favor patentees while changes to patent law facilitating the process of proving invalidity favor accused infringers. The policy pendulum has swung back and forth between favoring patentees and favoring accused infringers, but in recent years has moved firmly toward the latter.[241]

However, an attorney who participated in these proceedings suggests that Federal Circuit rules for claim construction may be applied:

> [I]n a Neutral Patent Evaluation in which I represented an Amazon Marketplace seller . . . the patent owner took a claim construction and infringement position that would cause the asserted claim to read on the cited prior art, effectively invalidating the patent. The proposed claim construction would also have excluded the asserted patent's preferred embodiment. The evaluator did not accept the patent owner's argument, abiding by Federal Circuit principles that claims cannot be construed one way in order to obtain their allowance and in a different way against accused infringers . . . .

Mark J. Rosenberg, Insight on Amazon's Neutral Patent Evaluation Procedure, Tarter Krinsky & Drogin LLP (Aug. 26, 2020), https://www.tarterkrinsky.com/publications/insight-on-amazons-neutral-patent-evaluation-procedure [https://perma.cc/37MZ-G2PZ].

[240] I use the terms "private" and "public" here to indicate choices made by private individuals as opposed to choices made by public bodies such as courts and legislatures.

[241] Lemley, supra note 226, at 14 ("[I]n the past thirty years we have seen the pendulum [of patent law] swing toward stronger [patent] protection and then, more recently, toward weaker protection.").

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

This trend toward easing the process of invalidating patents involves both substantive law and procedure and has been documented by numerous scholars.[242] On the substantive side, the Supreme Court has consistently interpreted patentability requirements in ways that make it easier to invalidate patents. In *KSR International Co. v. Teleflex Inc.*, the Court relaxed the rules around proving obviousness, making it harder to get patents and favoring parties opposing them.[243] In several cases—*Bilski v. Kappos*, *Mayo Collaborative Services v. Prometheus Laboratories*, *Inc.*, *Association for Molecular Pathology v. Myriad Genetics, Inc.*, and *Alice Corp. v. CLS Bank International*—the Court heightened requirements for patent eligibility in certain categories of technologies, making it substantially easier to invalidate those patents.[244]

Procedural changes have also diminished the burden of proving invalidity.[245] In 2011, Congress created several administrative review proceedings with the power to invalidate patents—processes designed to make it quick and easy to challenge a patent's validity.[246] The proceedings can only be brought for purposes of arguing that a patent is invalid—they cannot address infringement. Most instituted proceedings end with

[242] See, e.g., Gugliuzza, supra note 37, at 624 ("[M]any of the recent changes in patent law that facilitate quicker decisions do so by favoring accused infringers."); Masur, supra note 37 at 517, 520 (discussing the Supreme Court's trend toward reining in patent scope and observing that "[c]onversely, there is much less evidence of patent-friendly trends in doctrines related exclusively to infringement"); Peter Lee, Patent Law and the Two Cultures, 120 Yale L.J. 2, 44 (2010) ("For most observers, the Court's aggressiveness reflects an attempt to rein in patent rights that had become too expansive . . . .").

[243] KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 415 (2007).

[244] *Association for Molecular Pathology v. Myriad Genetics, Inc.*, 569 U.S. 576, 596 (2013), made it considerably more difficult to patent genes and related technologies. *Mayo Collaborative Services v. Prometheus Laboratories, Inc.*, 566 U.S. 66, 92 (2012), made it harder to patent diagnostic technologies. Other cases heightened patentability requirements for software and business method technologies. See Bilski v. Kappos, 561 U.S. 593, 658–59 (2010) (Breyer, J., concurring in judgment); Alice Corp. v. CLS Bank Int'l, 573 U.S. 208, 226–27 (2014).

[245] Many of these are catalogued in Gugliuzza, supra note 37, at 641–76.

[246] Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified at 28 U.S.C. § 1454; 35 U.S.C. §§ 123, 257, 298–299, 321–329). The most popular, inter partes review, allows third parties (even those who would not have standing in court) to argue that a granted patent is invalid for lack of novelty or because it is obvious. Brian J. Love, Shawn P. Miller & Shawn Ambwani, Determinants of Patent Quality: Evidence from Inter Partes Review Proceedings, 90 U. Colo. L. Rev. 67, 96–97 (2019). Other America Invents Act-created proceedings, "post-grant review" and "covered business method patent . . . review," also allow challenges to patent validity. Id. at 96 (internal quotation marks omitted). The proceedings take place before a panel of administrative patent judges from the Patent Trial and Appeal Board ("PTAB"). Id. at 97.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

invalidation of the patent.[247] The proceedings have been so successful at invalidating patents that Randall Rader, the former chief judge of the Federal Circuit, described them as "death squads, killing property rights."[248]

Procedures in federal courts have also eased the burden of proving invalidity and made it harder for patentees to succeed. Many patentees preferred to file cases in the Eastern District of Texas, which was famously plaintiff-friendly and hosted forty percent of U.S. patent cases.[249] In *TC Heartland LLC v. Kraft Foods Group Brands LLC*, the Supreme Court changed venue rules such that most patentees can no longer file cases in the U.S. District Court for the Eastern District of Texas.[250] The most common patent venue is now Delaware, which is considered much less favorable to patentees.[251]

In addition, courts often decide certain questions of validity—in particular whether an invention comprises patent-eligible subject matter—as questions of law.[252] These questions can be decided early in the case, before discovery, often on motions to dismiss.[253] Courts can therefore find a patent invalid early on and dismiss a case—a relatively quick and cheap process for the alleged infringer—whereas a patentee seeking to prove infringement generally must proceed through discovery.[254] It is therefore more expensive to win as a patentee than to win as an alleged infringer (at least on certain issues). The trend toward easing the process of invalidating patents reflects deep concerns about the prevalence and consequences of invalid patents.

[247] See Analytics: Cases by Phase and Status, Unified Pats., LLC, https://portal.unifiedpatents.com/ptab/analytics/case-level/by-status-and-phase [https://perma.cc/73Q6-8ZMD] (last visited Feb 10, 2023).

[248] Lisa Shuchman, PTAB: Not a Property Rights 'Death Squad,' Law.com (May 31, 2015) (internal quotation marks omitted), https://www.law.com/2015/05/31/ptab-not-a-property-rights-death-squad/?slreturn=20230124221318 [https://perma.cc/K552-9X7K].

[249] J. Jonas Anderson, Reining in a "Renegade" Court: *TC Heartland* and the Eastern District of Texas, 39 Cardozo L. Rev. 1569, 1571 (2018).

[250] 137 S. Ct. 1514, 1520–21 (2017).

[251] Steve Brachman, Patent Litigation Shows Shift Towards Delaware, Decrease in High-Volume Plaintiff Filings, IP Watchdog (June 13, 2018), https://ipwatchdog.com/2018/06/13/patent-litigation-shows-shift-towards-delaware/id=98060/ [https://perma.cc/3X99-JHVC].

[252] Gugliuzza, supra note 37, at 651.

[253] Id.

[254] Id. at 653.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

2. The Private Trend: Ignoring Invalidity

This Article points to a countervailing trend: while patent policy moves toward easier invalidity favoring alleged infringers, private parties have made substantial strides toward easing the infringement analysis and, by-and-large, they ignore the potential for invalidity. For example, while Congress created administrative review proceedings that can evaluate invalidity but not infringement, Amazon's program can evaluate infringement but not invalidity. The administrative review procedures put all the risks on the patentee; Amazon's program puts all the risks on the potential infringer.

Amazon's program—should it become popular—might destabilize the progress made by administrative review proceedings, which create a relatively fast and cheap way to invalidate bad patents.[255] Administrative review proceedings would allow these patents to be removed before they could do harm, that is, before they could be used to threaten others with lawsuits or deter others from selling cheaper products or working in an area. However, Amazon's program is an even faster and cheaper way for patentees to enforce their patents compared to administrative review proceedings. Amazon's program takes several months; administrative review takes a year and a half. Amazon's program costs $4,000 in addition to fees for a lawyer to write a fairly short brief; administrative review costs $41,500[256] in addition to fees for a lawyer to manage a more complex proceeding for over a year—an average cost of $350,000.[257]

It is unlikely that most sellers targeted by a patent in Amazon's program could afford to initiate an administrative review proceeding or a court case. They therefore have essentially no way to make use of the various defenses to patent infringement.

Automated freedom-to-operate searches also counter the public trend toward easing invalidity. Here, steps to make adjudicatory decisions

[255] Stephen Yelderman, Prior Art in Inter Partes Review, 104 Iowa L. Rev. 2705, 2706 (2019).

[256] The USPTO charges $19,000 to request review and an additional $22,500 if review is instituted. Summary of FY 2020 Final Patent Fee Rule, U.S. Pat. & Trademark Off., https://www.uspto.gov/about-us/performance-and-planning/summary-fy-2020-final-patent-fee-rule [https://perma.cc/UT8Z-JFCX] (last visited Feb. 10, 2023) (final Rule became effective October 2, 2020.). There are also additional fees under certain circumstances.

[257] Andrew Rapacke, IPR Can be Expensive, But Can Be Worth It, Rapacke L. Grp. (Oct. 29, 2018), https://arapackelaw.com/inter-partes-review/inter-partes-review-worth-it/#:~:text=According%20to%20the%20AIPLA%20Report,additional%20%24100%2C000%2D%24150%2C000%20dollars [https://perma.cc/L83L-LETT].

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

about validity easier, cheaper, and faster never come into play because adjudicatory bodies have no role in enforcing patents. Rather, patents are privately enforced by those who are conducting the freedom-to-operate search (in the sense that the patented areas are avoided). Procedural changes surrounding validity decisions are simply irrelevant.

D. Displacement of Substantive Patent Law

In many fields, scholars have noted that when algorithms are used to interpret law or when platforms create their own quasi-judicial systems, substantive legal doctrines can be displaced.[258] So too in patent law. When platforms such as Amazon create separate patent adjudication systems, they erase legal doctrines (such as validity) that are not part of their system. When algorithms conduct automated freedom-to-operate analyses or patent landscape analyses, programmatic choices substitute for policy choices about certain aspects of patent law such as validity and claim construction.

The concern about displacement of substantive law has been particularly acute in copyright law.[259] Platforms such as YouTube have algorithms to assess whether works uploaded to their sites violate copyright.[260] However, such an assessment is not simple. It requires an evaluation of the similarities between the copyrighted and allegedly infringing work and then an appraisal of defenses, most commonly fair use.[261] Some platforms receive too many takedown notices to assess them

[258] For a discussion of algorithms displacing substantive law, see, e.g., Maayan Perel & Niva Elkin-Koren, Black Box Tinkering: Beyond Disclosure in Algorithmic Enforcement, 69 Fla. L. Rev. 181, 188–89 (2017); W. Nicholson Price II, Drug Approval in a Learning Health System, 102 Minn. L. Rev. 2413, 2440–41 (2018); Sag, supra note 35, at 499 (discussing "the potential displacement of substantive copyright law"). For a discussion of platforms or other private systems displacing substantive law, see, e.g., Pamela K. Bookman, The Arbitration-Litigation Paradox, 72 Vand. L. Rev. 1119, 1121 (2019) (discussing views that arbitration erodes substantive law); J. Maria Glover, Disappearing Claims and the Erosion of Substantive Law, 124 Yale L.J. 3052, 3075 (2015) (suggesting that arbitration gives private parties "the power, through contract, effectively to negate substantive law"); Van Loo, supra note 125, at 837–38; Margaret Jane Radin, Boilerplate: The Fine Print, Vanishing Rights, and the Rule of Law 33 (2013) (arguing that boilerplate overrides substantive legal rights).

[259] Sag, supra note 35, at 499.

[260] Id. The Digital Millennium Copyright Act contains a safe harbor that protects platforms hosting user-generated content from copyright lawsuits (if that content infringes) as long as platforms remove infringing material when notified by the copyright owner. 17 U.S.C. § 512.

[261] 17 U.S.C. § 107 (setting out the fair use factors). In *Lenz v. Universal Music Corp.*, 815 F.3d 1145, 1157 (9th Cir. 2015), the Ninth Circuit held that an assessment of fair use should be part of takedown procedures.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

individually and have created algorithms for that task.[262] The ability of algorithms to properly assess fair use—a notoriously unpredictable doctrine—is controversial.[263]

The problem takes on different contours in patent law but has some of the same elements: algorithmic assessment of uncertain legal doctrines and platform governance. Amazon's procedure for assessing infringement and removing products is highly analogous to copyright notice-and-takedown procedures.

In copyright, there has been some discourse around the dynamic of powerful companies and small, less powerful artists, and the role of platforms in picking and choosing which legal rules matter.[264] Matthew Sag writes that "[i]n a world where communication and expression is policed by copyright robots, the substantive content of copyright law matters only to the extent that those with power decide that it should matter."[265] So too, if Amazon is willing to kick products off its platform based on an allegation of patent infringement but without assessing the patent's validity, then validity no longer matters.

In the context of patent analytics and algorithmic freedom-to-operate analyses, the analogy to copyright is weaker because here, users opt in to algorithm use and voluntarily choose to react to the presence of patents. However, it could become a concern if use of such programs were to become an industry norm or even required to avoid willful patent infringement.[266] Software programmers' design choices about how to interpret substantive patent law would become de facto requirements for users. Software's embedded choices and judgments around patent scope, validity, and value will be deeply influential.

Even if most people never face an Amazon adjudicatory proceeding and never commission a patent landscape analysis, choices embedded in platforms and algorithms shape public behavior[267] and, in the patent

[262] Sag, supra note 35, at 538.

[263] See, e.g., Lawrence Lessig, Free Culture: How Big Media Uses Technology and the Law to Lock Down Culture and Control Creativity 187 (2004). Others find it less unpredictable, though not necessarily amenable to algorithmic analysis. See Matthew Sag, Predicting Fair Use, 73 Ohio St. L.J. 47, 49 (2012).

[264] Sag, supra note 35, at 499, 561.

[265] Id. at 500.

[266] Id. at 548.

[267] Dan L. Burk, Algorithmic Fair Use, 86 U. Chi. L. Rev. 283, 285 (2019) ("[T]he design values embedded in automated systems become embedded in public behavior and consciousness. Thus, algorithmic fair use carries with it the very real possibility of habituating

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

context, may lead to more cautious infringement or avoidance of patent-heavy landscapes.

IV. POLICY AND REFORM

At the outset, although the technologies described herein upset settled understanding of patent law, they are not inherently negative or problematic. Rather, it is exciting to see experimentation with new strategies to mine and use patent information as well as understand and enforce patents. However, by moving patent usage from a system where patents are broadly ignored and a minority deeply analyzed to a system where patents are widely relevant but shallowly analyzed, these technologies disrupt certain aspects of the patent system and some of those disruptions are troubling.

There are two avenues for reform, discussed in turn below. First, technology can be improved. Technology can conduct better in-depth legal analyses, and indeed there is work currently being done to enable this. Second, the patent system can adapt and change to better align with the new ways in which patents are used.

A. Improving Technology

Some of the described problems can be fixed by improving technology. For instance, artificial intelligence and machine learning applications are being developed to assess the validity of a patent.[268] Part of the problem with current technology is that the use of AI to mine patent text has improved more quickly than the ability of AI to provide information about patent validity. But this may be a temporary imbalance in technological capabilities that will be remedied as AI improves. However, though technology will undoubtedly advance, these advances are unlikely to be a complete solution. Below, I discuss how AI may be able to bring depth to patent analysis and where it will be limited.

First, AI can be leveraged to add nuance and depth to currently superficial patent analysis. One example is in evaluating validity. Although AI cannot currently predict validity (neither can humans), there

new media participants to its own biases and so progressively altering the fair use standard it attempts to embody.").

[268] See, e.g., Research, Ctr. for AI & Pat. Analysis, Carnegie Mellon Univ., https://www.cmu.edu/epp/patents/research/index.html [https://perma.cc/RLE3-DVQZ] (last visited Feb. 10, 2023) (describing projects to analyze claim definiteness).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

are some aspects of validity where computer-assisted interpretation may be useful. Note that none of the scenarios below rely *entirely* on AI, but rather envision an AI-human partnership.

Patents can be invalid in many different ways. AI shows the most promise at detecting patents that are invalid because they fail to meet the definiteness requirement. Patent claims must "particularly point[] out and distinctly claim[] the subject matter" of the invention.[269] Dean Alderucci, a computer scientist and lawyer, suggests that AI begin by checking whether the term is defined in the specification, or in common use outside the patent.[270] AI could also flag terms with "unspecified limits," which can either be indefinite or require claim construction to understand.[271] This information could either be presented for a lawyer's review or aggregated into a numerical score that would indicate risk of indefiniteness.[272]

AI may also be leveraged to aid the anticipation and obviousness analyses by finding relevant scientific information. A patent is only valid if it has never before been publicly disclosed and is not obvious over current public disclosures.[273] In order to make this determination, it is necessary to know what is in prior public disclosures, called "prior art." However, the universe of prior art is near infinite[274] and may not use consistent terms to describe a technology, making it difficult to search. AI can help.[275] The USPTO has developed a pilot program to incorporate AI

[269] 35 U.S.C. § 112(b).

[270] Either (and ideally both) would suggest that the term is not indefinite. Dean Alderucci, The Automation of Legal Reasoning: Customized AI Techniques for the Patent Field, 58 Duq. L. Rev. 50, 78–79 (2020) [hereinafter Alderucci, Customized Techniques]; Dean Alderucci & Kevin D. Ashley, Using AI to Analyze Patent Claim Indefiniteness, 9 IP Theory 1, 26 (2020); Dean Alderucci & Douglas Sicker, Applying Artificial Intelligence to the Patent System, 20 Tech. & Innovation 415, 420 (2019).

[271] Alderucci, Customized Techniques, supra note 270, at 79–80.

[272] Id. at 81.

[273] 35 U.S.C. §§ 102–103.

[274] It includes all public disclosures from before the patent's filing date—in any language, from any country, and even those that were only circulated to a small number of people.

[275] Though there are limitations to this application of AI. See, e.g., Arti K. Rai, Machine Learning at the Patent Office: Lessons for Patents and Administrative Law, 104 Iowa L. Rev. 2617, 2633–38 (2019); Rossitza Setchi et al., Artificial Intelligence for Patent Prior Art Searching, 64 World Pat. Info., Mar. 2021, at 10–11. For a discussion of searching in the context of trademark law, see Sonia K. Katyal & Aniket Kesari, Trademark Search, Artificial Intelligence, and the Role of the Private Sector, 35 Berkeley Tech. L.J. 501, 522–34 (2020).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

into prior art searches.[276] However, fully automated anticipation and obviousness analyses are still not possible.[277]

While AI can—and no doubt will—improve over time, there is no guarantee that AI will ever be able to completely address questions of validity and patent scope. In the context of copyright's fair use analysis—another complex and unpredictable question—scholars have argued that current technology does not permit a "judge on a chip"[278] and may never be able to do so.[279] A particular problem is that aspects of patent law, particularly patent claim scope, sometimes cannot be fully determined without reference to an infringing product. They are therefore difficult to resolve ex ante, and algorithms, even ones with great computational power, may not be able to predict all possible contexts for future claim construction decisions.[280]

An additional problem is that AI struggles with common-sense analyses and integrating information that is not explicitly part of the text being reviewed, both of which are major parts of evaluating patent validity.[281] Further, even if AI is theoretically capable of fulfilling basic

[276] Dani Kass, AI Offers 'Substantial' Pros at the USPTO, But Not Without Risks, Law360 (Feb. 18, 2020), https://www.law360.com/articles/1244928/ai-offers-substantial-pros-at-uspto-but-not-without-risks [https://perma.cc/2XCA-AY93].

[277] Rossi Setchi & Irena Spasić, U.K. Intell. Prop. Off., AI-Assisted Patent Prior Art Searching – Feasibility Study 32 (2020) (concluding that "it was not feasible with current AI tools to provide a fully automated solution as part of the application filing process").

[278] Edward W. Felten, A Skeptical View of DRM and Fair Use, 46 Commc'ns of the ACM 57, 58 (2003) (explaining that an algorithm that "gets all fair use judgements right would in effect be a 'judge on a chip' predicting with high accuracy how a real judge would decide a lawsuit challenging a particular use").

[279] Julie E. Cohen, Between Truth and Power: The Legal Constructions of Informational Capitalism 192 (2019) (arguing that automated processes "may not align well (or at all) with applicable legal requirements that are couched in shades of gray").

[280] This point has been made with reference to fair use. Burk, supra note 267, at 288 (noting that fair use is difficult to decide ex ante without a potentially infringing work to make the decision with respect to because "no one can be entirely certain in advance how a court will weigh the four factors"). It is therefore difficult for algorithms to predict fair use outcomes. Peter K. Yu, Can Algorithms Promote Fair Use?, 14 FIU L. Rev. 329, 332 (2020) ("Under the current copyright system, courts refrain from making ex ante determinations on what uses would be considered fair. Instead, they allow users to test the law's limits. Should conflicts arise and the cases go to courts, judges will make determinations after the fact. By contrast, computer programmers need to know in advance what legal rules and outcomes should be built into automated systems.").

[281] Alderucci, Customized Techniques, supra note 270, at 73. Obviousness is a good example. The obviousness analysis requires asking whether a scientific expert in the field would find the patented invention obvious. 35 U.S.C. § 103; Graham v. John Deere Co., 383

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

patent analysis, care must be taken to be conscious of errors and biases built into AI.[282]

A more feasible alternative is for AI to provide a risk score for different elements of validity that can be used to flag patents for further review by a lawyer—as is currently offered by some patent analytics firms.[283] Even if AI is capable of some depth of analysis, it should not totally supplant lawyers.[284] Relatedly, AI programmers should consult with legal experts as they design their software, which does not always happen today.[285]

A final important component of using AI for patent analysis—whether to improve depth or simply to provide cursory review of a broad range of patents—is to be as transparent as possible about what the AI is doing and the data on which the AI was trained. If a report yields a set of relevant patents, how were those patents found? Was there any weighting for validity concerns? Was there restriction to a set of dates or countries? Some of these questions are easy to answer; others, in the context of AI, are perhaps not possible.[286] But transparency should be a key goal of programmers and a central expectation of users. Transparency will allow users to interpret the results of AI-generated information.

U.S. 1, 3 (1966). The question of what would make something obvious incorporates common-sense reasoning.

[282] Yu, supra note 280, at 335–36; see also Sandra G. Mayson, Bias In, Bias Out, 128 Yale L.J. 2218, 2218 (2019) (discussing bias in algorithms in the criminal law context).

[283] Interview with attorney who purchases patent analytics reports (on file with author).

[284] For a discussion of the importance of having lawyers work with machines, see Frank Pasquale, A Rule of Persons, Not Machines: The Limits of Legal Automation, 87 Geo. Wash. L. Rev. 1, 1 (2019); Tim Wu, Will Artificial Intelligence Eat the Law? The Rise of Hybrid Social-Ordering Systems, 119 Colum. L. Rev. 2001, 2001 (2019) (promoting the use of hybrid machine-human systems as a more viable alternative than completely automating legal processes).

[285] Yu, supra note 280, at 332–33 (noting that translating law into computer code can "bring up complicated questions concerning the computer programmers' understanding and interpretation of the law").

[286] The particular search strategies used by AI to find a set of patents may not be known, even to the AI programmers. See Yavar Bathaee, The Artificial Intelligence Black Box and the Failure of Intent and Causation, 31 Harv. J.L. & Tech. 889, 893 (2018) (explaining that some AI programs make "predictions and decisions . . . without being able to communicate [their] reasons for doing so").

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

B. Improving the Technology-Patent Interface

There are many aspects of patent documents that make them difficult to analyze, including non-standard language,[287] deliberate vagueness,[288] and lack of good information about ownership.[289] These can be improved. In many contexts, scholars have pushed for better and clearer information in patent documents.[290] Many of these techniques would be useful for computer-assisted analysis of patents. For instance, Michael Meurer and Peter Menell suggest strategies such as specifying up front certain limitations on claims, designating a default reference dictionary, developing standard glossaries, and including hyperlinks for reference.[291] All of these strategies would help computerized analysis, as would increased standardization of information in patents.[292]

Other information could simply be made easier to find so that anyone (machine or human) looking at a patent would have the information available to contextualize the patent. For instance, the USPTO could require recordation of the patent's owner or exclusive licensee.[293] The USPTO could end its practice of reviving applications abandoned and patents expired for failure to pay maintenance fees. Currently, such applications and patents can be revived upon filing a petition, even years after they appear dead.[294] This creates the potential for zombie patents that look dead but are not—and makes it hard to know whether it is safe to exclude expired patents from a search. Jorge Contreras has suggested

[287] Alderucci, Customized Techniques, supra note 270, at 78–79.

[288] Id.

[289] Chien, supra note 1, at 283.

[290] See Jeanne C. Fromer, Dynamic Patent Disclosure, 69 Vand. L. Rev. 1715, 1716 (2016); Timothy R. Holbrook, Patents, Presumptions, and Public Notice, 86 Ind. L.J. 779, 784 (2011); Lisa Larrimore Ouellette, Do Patents Disclose Useful Information?, 25 Harv. J.L. & Tech. 545, 548–49 (2012); Jason Rantanen, Patent Law's Disclosure Requirement, 45 Loy. U. Chi. L.J. 369, 370 (2013).

[291] Peter S. Menell & Michael J. Meurer, Notice Failure and Notice Externalities, 5 J. Legal Analysis 1, 33 (2013).

[292] Freilich & Kesan, supra note 118, at 234.

[293] Who has standing to sue? See Advanced Video Techs. LLC v. HTC Corp., 879 F.3d 1314, 1324 n.3 (Fed. Cir. 2018).

[294] 37 C.F.R. § 1.378 (2007) (permitting reinstatement of an expired patent or abandoned application upon petition and a showing that the delay in payment was unintentional: "upon petition, the patent shall be considered as not having expired"). Formerly, it was sufficient to merely state that the delay was unintentional; now, additional evidence is required if the payment was more than two years late. Clarification of the Practice for Requiring Additional Information in Petitions Filed in Patent Applications and Patents Based on Unintentional Delay, 85 Fed. Reg. 12222 (Mar. 2, 2020) (to be codified at 37 C.F.R. pt. 1).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

a "Shepard's for patents" which would compile "contextual information" about patents (a term coined by Colleen Chien) such as prior litigation, expiration and maintenance data, assignments, licensing, and other economically relevant information.[295]

More generally, if patents contain clear and useful information in formats that are amenable to computer analysis, it will improve AI's ability to use the information in patents.[296]

C. Improving Patents

Even if technology improves and is able to work with humans to aid deeper analysis of patents, the patent system must still respond to the increased importance and impact of patents. The several aspects of the patent system that depend on patents being ignored may need reform.

Of particular note is patent examination. As explored in more detail above, USPTO review is relatively quick and the agency erroneously grants many invalid patents.[297] It is likely that the error rate could be significantly reduced if the USPTO were given more resources and examiners could spend more time reviewing each application.[298] However, it is not clear whether increasing resources to reduce the error rate is economical. After all, because most patents are ignored and better USPTO review would be expensive, it may not be worth the cost to reduce

[295] Colleen V. Chien, Contextualizing Patent Disclosure, 69 Vand. L. Rev. 1849, 1849 (2016); Jorge L. Contreras, Shepardizing Patents, Patently-O (June 16, 2021), https://patentlyo.com/patent/2021/06/contreras-shepardizing-patents.html [https://perma.cc/F8RV-CQ22].

[296] One line of scholarship also recommends shifting legal doctrines and tests to make them easier to apply with AI. See, e.g., Shine Sean Tu, Use of Artificial Intelligence to Determine Copyright Liability for Musical Works, 123 W. Va. L. Rev. 835, 835 (2021). While I do not adopt that type of proposal in this paper, such a change would certainly make the patent system more amenable to AI-based analysis.

[297] Quick in terms of the number of hours spent by the examiner in reviewing the patent (approximately twenty). The process is not necessarily quick from the perspective of the applicant. It can take several years from application to grant. U.S. Pat. & Trademark Off., FY 2018 Performance and Accountability Report 19 (2018), https://www.uspto.gov/sites/default/files/documents/USPTOFY18PAR.pdf [https://perma.cc/TZR9-KKPM]. Some scholars argue that the Patent Office currently does not even give a cursory examination of certain elements of patentability; rather, it functions more as a registration system. E.g., Greg Reilly, The Complicated Relationship of Patent Examination and Invalidation, 69 Am. U. L. Rev. 1095, 1110–12 (2020).

[298] Frakes & Wasserman, supra note 75, at 975–76. However, some types of errors may be difficult to resolve even with additional funding. Janet Freilich, Ignoring Information Quality, 89 Fordham L. Rev. 2113, 2117 (2021).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

erroneously granted patents.[299] Rather, commercially important patents can be addressed in litigation, where a court can determine their validity.[300] It may be better, therefore, to make a quick and cheap decision ex ante at the USPTO and defer more thorough examination to ex post litigation.

This "rational ignorance" argument—so named because it was pioneered by Mark Lemley in an article titled Rational Ignorance at the Patent Office—is not universally accepted. Michael Frakes and Melissa Wasserman provide a counterpoint in Irrational Ignorance at the Patent Office where they estimate the cost of improving USPTO review and the cost of granting invalid patents and conclude that better ex ante review is in fact justified.[301] While Lemley's cost-benefit analysis favors deferring review until litigation, Frakes and Wasserman conclude the opposite.

However, both sides of the debate view the primary cost of invalid patents to lie in litigation and licensing of those patents. This Article suggests that, as patents are used in different ways, those costs will expand to new venues and must be calculated in new ways. The phenomenon described in this Article—less ignorance of patents and more impact—therefore means recalculating the cost of ignorance at the USPTO.[302] Rational ignorance at the USPTO may still be worthwhile, but all the technologies reviewed here push the needle away from rational ignorance and, as they are adopted and developed further, may eventually tip the cost balance enough that more stringent USPTO review becomes economical.[303]

Further, review at the USPTO is not the only policy that relies on the rational ignorance theory. Another example is the lack of a research exception in the United States.[304] Many other countries allow researchers, particularly at non-profit institutions, to infringe patents in the course of

[299] Lemley, supra note 6, at 1497.

[300] Frakes & Wasserman, supra note 75, at 979 ("[I]t may be rational for the Patent Office not to screen patent applications too rigorously because there is another institutional player that could weed out bad patents: the courts. . . . [B]ecause so few patents are litigated or licensed, it is better to rely on litigation to make detailed validity determinations in those rare instances rather than increasing the resources to the Patent Office.").

[301] Id. at 975–76.

[302] The calculation is not straightforward, and I do not attempt it here.

[303] For those who argue that it is already economical, more impactful patents increase the margin by which additional review at the USPTO is needed.

[304] Madey v. Duke Univ., 307 F.3d 1351, 1360–61 (Fed. Cir. 2002).

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

their research without fear of liability.[305] The United States does not. The lack of a research exception is unpopular, but fears of its potential consequences—most notably, impeding follow-on research—are lessened because patents are broadly ignored.[306] Several studies on academic research found that most researchers ignore patents and it may not therefore matter whether or not there is a formal, legal research exception.[307] If patents are not ignored, calls for a research exception may take on new urgency.

A related policy challenge is the anticommons or "too many patents" problem. Some scholars worry that if too many patents cover a particular product, it will lead to an anticommons—a scenario in which new products are not developed because the transaction costs involved in searching and licensing all relevant patents are too high.[308] Other scholars note that—although there are indeed a large number of patents—there is little evidence that these patents actually deter innovation, either because

[305] The World Intellectual Property Organization has collected a list of countries' research exceptions. WIPO, supra note 77, at annex 9 tbl.2.

[306] The Supreme Court, for instance, has worried that patents "confer power to block off whole areas of scientific development, without compensating benefit to the public." Brenner v. Manson, 383 U.S. 519, 534 (1966); see, e.g., Eisenberg, supra note 78, at 1056 (explaining that a system that requires "a license from the original discoverer" in order for downstream research to proceed is a "less satisfactory means of promoting scientific progress than free access to such discoveries," which suggests that upstream patents block free access to downstream discoveries); Rochelle Dreyfuss, Reconsidering Experimental Use, 50 Akron L. Rev. 699, 712 (2016) (discussing ways in which patents could block downstream innovation); Rochelle Dreyfuss, Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?, 46 Ariz. L. Rev. 457, 463 (2004) (same); O'Rourke, supra note 78, at 1203–04 (arguing that "research, if enjoined [as patent infringement] would frustrate further progress" of science); Strandburg, supra note 78, at 82, 91 (explaining that patents can "slow technical progress if the best follow-on inventors are prevented from building upon the inventive idea during the patent term" and that patents "make it more difficult to build on the inventions of others . . . either because an improved invention still falls within the claims of a prior patent . . . or . . . because the research and development process for a new invention requires the practice of a prior patent").

[307] See Zhen Lei, Rakhi Juneja & Brian D. Wright, Patents Versus Patenting: Implications of Intellectual Property Protection for Biological Research, 27 Nature Biotechnology 36, 37 (2009); John P. Walsh, Wesley M. Cohen & Charlene Cho, Where Excludability Matters: Material Versus Intellectual Property in Academic Biomedical Research, 36 Res. Pol'y 1184, 1191 (2007); Walsh et al., supra note 68, at 286; John P. Walsh, Ashish Arora & Wesley M. Cohen, Working Through the Patent Problem, 299 Science 1021, 1021 (2003).

[308] Heller & Eisenberg, supra note 60, at 698; Lemley & Shapiro, supra note 2, at 1992, 2010.

COPYRIGHT © 2023 VIRGINIA LAW REVIEW ASSOCIATION

the market is able to find solutions[309] or because innovators simply ignore patents.[310]

Many innovators ignored patents because the alternative—detecting all relevant patents—was not possible. Technological advances—such as AI—change that calculus and make it more possible to identify and analyze all patents relevant to a particular product or service.[311] This means that patents *matter* in a way that was previously not true. At present, most companies do not use AI to analyze patents and most still ignore patents. But on the margins, technology is making patents a bit harder to ignore. This may mean that the anticommons concern becomes closer to reality and various proposed solutions—including the use of patent pools, compulsory licenses, and moving remedies away from injunctions—become more appealing.

CONCLUSION

This Article highlights three technological developments that enhance the impact and consequence of patents. Each of these technologies is driven by private choices to opt in to using the service. Private entities are unlikely to stop using these services, and their impact will only increase as AI technology improves and more commerce moves online.

It is therefore vital to understand how new technology is transforming the interpretation and enforcement of patents. It is equally important to open the black box of these new technologies to understand precisely how private services make decisions about patents. This will allow users of these services to better calibrate their actions and to react to the patents they encounter, scholars to identify potential dangers to the patent system, and policy makers to help the patent system adapt.

[309] David E. Adelman, A Fallacy of the Commons in Biotech Patent Policy, 20 Berkeley Tech. L.J. 985, 991–92 (2005); Jonathan M. Barnett, The Anti-Commons Revisited, 29 Harv. J.L. & Tech. 127, 141 (2015); Robert P. Merges, Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations, 84 Calif. L. Rev. 1293, 1300 (1996); Chester Shiu, Of Mice and Men: Why an Anticommons Has Not Emerged in the Biotechnology Realm, 17 Tex. Intell. Prop. L.J. 413, 415 (2009).

[310] See supra Section I.A.

[311] E.g., Ted Sichelman, Are There Too Many Patents to Search? A Response, New Priv. L. Blog (July 2, 2015), https://blogs.harvard.edu/nplblog/2015/07/02/are-there-too-many-patents-to-search-a-response-ted-sichelman/ [https://perma.cc/EY7C-LSJE].