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THE MYTH OF "BAD" PATENTS: IMPACT OF PROSECUTION LENGTH ON PATENT LITIGATION OUTCOMES

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ABSTRACT

In recent years, the U.S. Patent and Trademark Office ("USPTO") has been criticized for allegedly issuing numerous "bad patents" and enabling patent trolls to exploit litigation with vague or overbroad claims. This quantitative study aims to investigate whether the thoroughness of examination by the USPTO correlates with subsequent patent litigation outcomes. By analyzing over 89,000 patents litigated since March 2000, this study explores the relationship between the thoroughness of examination at the patent office and rates of invalidity, infringement, and unenforceability in patent litigation. This Article uniquely measures the "thoroughness" of examination by looking at the length of prosecution in terms of the number of rejections (i.e., office actions) a patent application receives before it is issued as a patent. It hypothesizes that more rejections result in longer, narrower claims, potentially reducing the risk of invalidity. The study further posits a decrease in the likelihood of infringement with increased office actions due to the narrowing of claim scope during prosecution. Additionally, the study considers the influence of prosecution length on unenforceability, hypothesizing a potential increase in findings of unenforceability with prolonged examination.

Contrary to expectations, the analysis of litigation outcomes shows that an increase in the number of office actions correlates with a heightened risk of invalidation, dispelling the myth that patents allowed more quickly by the patent office are "bad" and easier to invalidate. This suggests that a higher number of rejections is indicative of a more crowded prior art landscape, which would explain the increased incidence of invalidity. However, patents examined by tougher examiners (i.e., lower allowance rate) are associated with lower invalidity rates, highlighting the importance of rigorous examination in strengthening patent

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validity. Furthermore, the analysis shows a strong inverse relationship between the number of office actions and the success of patents in infringement cases. As expected, more office actions lead to narrower claims that are less likely to read on a potential infringer's product or process. Surprisingly, examiner toughness has no significant impact on overall infringement rates, suggesting that infringement outcomes are independent of examination rigor. Finally, the analysis shows that unenforceability remains relatively unaffected by the number of office actions, indicating that inequitable conduct and other grounds for unenforceability are dependent wholly on actions by the applicant and not the USPTO.

By employing a novel measure of examination thoroughness based on the number of office actions, the study offers the first comprehensive empirical analysis of the relationship between examination rigor and subsequent litigation outcomes. By shedding light on these correlations, the study provides a nuanced understanding of patent examination processes and their implications for litigation strategies. The findings of this research contribute valuable insights for patent practitioners, offering actionable guidance for optimizing both the prosecution and litigation processes to enhance portfolio value and improve the likelihood of successful litigation outcomes.

TABLE OF CONTENTS

I. INTRODUCTION

The U.S. Patent and Trademark Office ("USPTO") has been criticized in recent years for issuing numerous "bad patents," i.e., low-quality patents that allegedly would be found invalid if reexamined by the patent office or challenged in federal district court.[1] These supposedly low-quality patents are blamed for allowing "patent trolls" to abuse litigation by asserting patents with vague or overbroad claims against as many entities as possible.[2] Many of these critics believe the USPTO fails to adequately examine patent applications and instead rubber stamps applications to issue low-quality patents with inherent

1. *See, e.g.*, Mytheos Holt, *USPTO Needs to Be Forced to Do Its Job and Reject Bad Patents*, THE HILL (Mar. 9, 2018), https://thehill.com/opinion/white-house/377603-uspto-needs-to-be-forced-to-do-its-job-and-reject-bad-patents [https://perma.cc/F2KD-MH7R] ("A Harvard University study shows that patent trolls deliberately snatch up patents granted by lenient USPTO staff, knowing those patents are more likely to be flawed in a way that favors indiscriminate litigation.").

2. *See, e.g.*, *id.* ("[T]he so-called patent trolls, who thrive on snatching up vague, overbroad, or otherwise weak patents, and weaponizing their weakness as an excuse to sue as many companies and individuals as possible.").

problems.[3] Such criticism appears to assume that a more thorough examination by the USPTO would lead to fewer low-quality patents being issued. The purpose of this Article is to determine whether there are correlations between the thoroughness of examination by the USPTO and the subsequent litigation outcomes of patents. Previous research in this area has looked at correlations between litigation outcomes and overall time in prosecution (i.e., number of days from filing to issuance), and litigation outcomes and examiner toughness.[4] This Article measures the "thoroughness" of examination by looking at the length of prosecution in terms of the number of rejections (i.e., office actions) a patent application receives before it issues as a patent. Patent examiners have strict productivity quotas and are allocated only a limited amount of time to review an application, search for prior art, compare the prior art with the patent application, write an office action, respond to the applicant's arguments, and conduct interviews with the applicant.[5] Given the time constraints created by this quota system, looking at the number of office actions issued during prosecution may be a better predictor of examiner thoroughness than either time or examiner toughness. The analysis in this Article is intended to determine if there are at least some correlative factors between prosecution length and the ultimate litigation outcomes. In particular, this Article analyzes 89,248 patents litigated from March 2000 to April 2021 to determine how the number of office actions to allowance impacts rates of invalidity, infringement, and unenforceability in litigation.

The primary assumption of this Article is that more office actions lead to longer, narrower claims.[6] In view of this assumption, the following hypotheses were formed prior to analyzing any data.

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3. *See, e.g.*, *id.* ("The only way to stop abuse of the process is for the USPTO to be forced to do its job and actually reject bad patents, rather than rubber stamping as many patents as possible to drive up its number of applications."); *see also* Michael D. Frakes & Melissa F. Wasserman, *Does the U.S. Patent and Trademark Office Grant Too Many Bad Patents?: Experience from Quasi-Experimentation*, 67 STAN. L. REV. 613, 676 (2015) ("In doing so, we provide . . . some of the first compelling empirical evidence that the [USPTO] is in fact biased toward granting patents."); Mark Lemley, *Fixing the Patent Office*, 13 INNOVATION POL'Y & ECON. 83, 83 (2013) ("The Patent and Trademark Office . . . has been issuing a large number of dubious patents over the past 20 years").

4. *See* Mark Lemley, *An Empirical Study of the Twenty-Year Patent Term,* 22 AIPLA Q.J. 369, 372 (1994) (analyzing a correlation between a time a patent spends in prosecution and its subsequent validity in litigation); Michael Sartori & Matt Welch, *Green, Yellow, Or Red: What Color Is Your Patent Examiner and Why Should You Care?*, IPWATCHDOG (Jan. 21, 2021), https://ipwatchdog.com/2021/01/21/green-yellow-red-color-patent-examiners/id=129219/ [https://perma.cc/392P-D3MH] (analyzing examiner toughness and patent allowance rates).

5. Michael D. Frakes & Melissa F. Wasserman, *Is the Time Allocated to Review Patent Applications Inducing Examiners to Grant Invalid Patents?: Evidence from Micro-level Application Data*, 99 REV. ECON. & STAT. 550, 552 (2017).

6. *See* Shine Sean Tu, *Patenting Fast and Slow: Examiner Rejections and Applicant Traversals to Nonprior Art Rejections*, 2021 MICH. ST. L. REV. 411, 430 (2021) (discussing that

First, regarding invalidity, this Article hypothesizes that a patent with a longer prosecution history will be less likely to have an inherent validity problem — i.e., less likely to be a "bad" patent. Presumably, the longer a patent was in prosecution, the more likely an examiner will have found relevant prior art, and the more likely the applicant will have narrowed the claims to avoid the art found by the examiner. Thus, more office actions should lead to narrower allowed claims, lessening the chance the court finds it anticipated or obvious under § 102 or § 103. Similarly, longer claims are more likely to include elements directed to practical applications and/or inventive concepts, lessening the likelihood of a court finding the patent ineligible under § 101. Finally, more office actions should lead to more discourse between the applicant and the examiner, giving both sides more time to identify and resolve written description, enablement, and definiteness issues with the claims under § 112.

Second, this Article hypothesizes that the likelihood of infringement will decrease as a patent receives more office actions. As patent claims get longer with increased prosecution length, the ability of the claims to successfully read on a potential infringer's product or process should decline due to the resulting patents having narrower claim scope.

Last, regarding unenforceability, it is important to take into account *Therasense, Inc. v. Becton, Dickinson & Co.*, in which the Federal Circuit tightened its standards for finding inequitable conduct.[7] Because of this major change in the law, this Article only analyzes unenforceability decisions from cases that were filed after this ruling was delivered in 2011.[8] It is not intuitive how the length of prosecution affects unenforceability. Longer prosecution means more time for applicants to become aware of relevant prior art (e.g., from related cases) that they might fail to disclose to the patent office. But failure to disclose prior art has become a less prevalent basis for finding inequitable conduct

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an increased number of rejections leads to a better and higher quality patent but also narrows the scope of the patent); *see also* Alan C. Marco, Joshua D. Sarnoff & Charles A. deGrazia, *Patent Claims and Patent Scope* 8 (USPTO, Econ. Working Paper No. 2016–04, 2016) ("[T]he examination process itself tends to narrow the scope of patents. Patent prosecution tends to add 45 words, on average, to the shortest independent claim"); JURISTAT, https://app.juristat.com/uspto/intelligence [https://perma.cc/K3DD-4T69] (showing that in 2022, the average independent claim added 53.46 words between filing and allowance, and that the average patent was allowed after 1.9 office actions, indicating that an average of 28.13 words are added to the independent claim per office action (53.46 divided by 1.9)).

7. Therasense, Inc. v. Becton, Dickinson & Co., 649 F.3d 1276, 1290 (Fed. Cir. 2011) (en banc) (discarding the previous "sliding-scale" approach to the intent and materiality prongs of the unenforceability standard and requiring instead that both prongs be independently met).

8. The litigation data extracted for this Article only includes the filing date of the lawsuit, not the decision date. *See infra* Section III.A. As such, the analysis of enforceability outcomes herein only uses litigation data from lawsuits filed after *Therasense* was decided to ensure a consistent standard for determining inequitable conduct was used across all cases in the analysis. *See infra* Section IV.C.

post-*Therasense*.[9] Longer prosecution also means more interactions with the patent office and more chances for applicants to make a material misrepresentation. Such misrepresentations have become the most prevalent basis for finding inequitable conduct post-*Therasense*.[10] As such, this Article hypothesizes that findings of unenforceability will increase with increased prosecution length.

When these three factors are taken together — a decline in invalidity, a decline in infringement, and an increase in unenforceability with increasing numbers of office actions — this Article hypothesizes that more office actions will lead to worse outcomes for patent owners, however slightly.

This Article attempts to answer these questions through an empirical analysis of prosecution and litigation data extracted from LexisNexis. In contrast to prior research that focused on the total number of days in prosecution, this Article advances the field by introducing a novel measure of "thoroughness" in patent examination, quantified through the actual number of office actions required before allowance, providing a more nuanced and granular understanding of the patent examination process and its potential implications on subsequent litigation outcomes. This Article will show that the number of office actions a patent incurs during prosecution has a correlative relationship to invalidity and infringement litigation outcomes. Part II of this Article provides a brief overview of the patent laws, patent litigation, and the patent examination process at the USPTO. Part III explains how the litigation and examination data were extracted from LexisNexis and filtered for analysis. It also describes what the dataset is comprised of, and how the dataset was checked for accuracy. Part IV describes the results of the quantitative data analysis. In particular, it shows the correlation between the number of office actions and the subsequent litigation outcomes. It provides analysis on a variety of axes, ranging from all of the data collected, to technology-center specific data, and examiner toughness analysis. Finally, Part V explains the practical impact of the correlations found in Part IV, and provides insight into how patent owners can optimize both the prosecution and litigation processes to improve their chances of having successful litigation outcomes.[11]

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9. *See* Matthew Avery, Matthew Kempf & Amy Liang, *The Return of the Plague: Inequitable Conduct After* Regeneron v. Merus, 34 SANTA CLARA HIGH TECH. L.J. 328, 335 (2018).

10. *See id.* at 334–35.

11. It is beyond the scope of this Article to analyze the following issues related to patent litigation outcomes: (1) Impact of Priority Claims: The dataset lacks information on priority claims; therefore, the analysis below does not explore whether continuation, divisional, or continuation-in-part applications have different litigation outcomes than original applications. (2) Patents in Settled Cases: As discussed in *infra* Section III.B, settled cases were excluded from the analysis. Settled cases may involve patents of varying strengths, potentially skewing the analysis of litigated patents herein towards lower-quality patents. (3) Unasserted Patents:

II. PATENTS AND PATENT LAW

A. Patentability

In general, patent laws state that a patent shall be granted to any person who invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof.[12] At a high level, the invention claimed in a patent application must be directed to patent-eligible subject matter under § 101, must be novel and non-obvious under § 102 and § 103, and must be adequately described in the specification under § 112.[13]

Under § 101, claims may be considered patent-eligible if they cover a new and useful process, machine, manufacture, or composition of matter, or a new and useful improvement thereof.[14] However, the Supreme Court has created numerous judicial exceptions to the scope of patentable subject matter, most recently in *Alice v. CLS Bank*[15] and *Mayo v. Prometheus.*[16]

To determine whether a claim is directed to patent-eligible subject matter, the USPTO applies a convoluted two-step test created in *Alice*.[17] At Step 1, if the examiner determines that the claim is directed to one of the patent-eligible statutory categories (a process, machine, manufacture, or composition of nature), then the examiner moves on to Step

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The majority of patents are never asserted; many are licensed or sold without ever being litigated. Previous studies showed that companies frequently face patent demands that are never litigated. *See* Robin Feldman & Evan Frondorf, *Patent Demands and Initial Public Offerings*, 19 STAN. TECH. L. REV. 52, 56 (2015). The patents involved in these unlitigated disputes may represent higher-quality patents, thus skewing the analysis of litigated patents herein towards lower-quality patents. (4) Litigation Outcomes on Appeal: The dataset lacks information on appeals to the Court of Appeals for the Federal Circuit. (5) Litigation Outcomes at the U.S. International Trade Commission ("ITC"): As discussed in *infra* Section III.A, the dataset lacks information on case outcomes at the ITC. (6) Impact of the USPTO's 101 Guidance: While there is commentary on how the USPTO's subject-matter eligibility guidance may affect subsequently issued patents, the analysis herein does not investigate its impact on litigation outcomes. Previous studies showed a decrease in § 101 rejections after the release of the January 2019 guidance. *See* Matthew Avery & Arya Moshiri, *The Impact of the January 2019 USPTO Guidance: One Year Later* (Mar. 26, 2020), BAKER BOTTS, https://www.bakerbotts.com/thought-leadership/publications/2020/april/the-impact-of-the-january-2019-uspto-guidance [https://perma.cc/YX4D-M43W]. This may have caused subsequently issued patents to be of lower quality.

12. 35 U.S.C. § 101 (2024) ("Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.").

13. 35 U.S.C. §§ 101, 102, 103, 112.

14. 35 U.S.C. § 101.

15. Alice Corp. Pty. v. CLS Bank Int'l, 573 U.S. 208 (2014).

16. Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012).

17. MANUAL OF PATENT EXAMINING PROCEDURE § 2106 (9th ed. 2023); *Alice*, 573 U.S. at 217–18 (2014).

2, which is divided into Steps 2A and 2B.[18] Step 2A asks whether the claim is directed to a judicial exception.[19] If the examiner determines at Step 2A that the claim is directed to an "abstract idea," then Step 2B asks whether the claim recites additional elements that amount to significantly more than the judicial exception.[20]

However, according to the USPTO, examiners have found it difficult to consistently apply Step 2A.[21] The lack of a clear framework gave examiners discretion to broadly interpret what constituted an "abstract idea" and then describe claims in such a way that they could be rejected under § 101.[22] In the interest of consistency, and to clear up confusion faced by applicants and examiners, the USPTO issued guidance in 2019 that clarified how to apply Step 2A with regard to abstract ideas by restructuring Step 2A into a two-prong analysis.[23] Prong One asks whether the claim recites a judicial exception such as an abstract idea, and Prong Two asks whether there are elements that integrate the judicial exception into a practical application (i.e., something "significantly more" than the judicial exception).[24]

The USPTO has defined three specific categories of abstract ideas — mathematical concepts, certain methods of organizing human activity, and mental processes — and further provided specific subcategories and examples of each type of abstract idea.[25] The USPTO has also provided examples of how the two-prong analysis should be applied, and instructed examiners that claims that do not recite subject matter within one of the three defined categories should not be deemed as covering an abstract idea, with only rare exceptions, thus limiting the discretion of examiners to classify a claim as being directed to an

18. MANUAL OF PATENT EXAMINING PROCEDURE § 2106 (9th ed. 2023); *Alice*, 573 U.S. at 217–18 (2014) ("First, we determine whether the claims at issue are directed to one of those patent-ineligible concepts . . . .").

19. MANUAL OF PATENT EXAMINING PROCEDURE § 2106.04 (9th ed. 2023).

20. Notice of 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019); *Alice*, 573 U.S. at 217–18 (2014) ("We have described step two of this analysis as a search for an 'inventive concept' — i.e., an element or combination of elements that is 'sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the [ineligible concept] itself.'" (quoting *Mayo*, 566 U.S. at 1292)).

21. *Id.* at 52. *See generally Alice*, 573 U.S. 208; *Mayo*, 566 U.S. 66.

22. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 50.

23. *Id.* at 50, 54.

24. *Id.*

25. MANUAL OF PATENT EXAMINING PROCEDURE § 2106.04 (9th ed. 2023); *see also* 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 52. Mathematical concepts can include mathematical relationships, mathematical formulas or equations, and mathematical calculations. Certain methods of organizing human activity can include fundamental economic principles or practices (including hedging, insurance, and mitigating risk), commercial or legal interactions (including agreements in the form of contracts, legal obligations, advertising, marketing or sales activities or behaviors, and business relations), managing personal behavior or relationships or interactions between people (including social activities, teaching, and following rules or instructions). Mental processes can include concepts performed in the human mind (including an observation, evaluation, judgment, and opinion).

abstract idea.[26] This additional guidance from the USPTO has led to a significant drop in the rate of § 101 rejections at the patent office.[27]

The next criteria for patent-eligibility are determining whether the claimed invention is novel and non-obvious in view of the prior art. Under § 102, a patent claim will be considered lacking novelty if a single item of prior art discloses each and every limitation of the claim, either expressly or inherently.[28] Prior art includes prior patents, publications, public use, sales and offers for sale, and disclosures that were "otherwise available to the public" before the priority date of the patent.[29]

Under § 103, patent claims will be considered obvious "if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains."[30]

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26. MANUAL OF PATENT EXAMINING PROCEDURE § 2106.04 (9th ed. 2023); *see also* 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 52; *supra* Tables 24–26; U.S. PAT. & TRADEMARK OFF., OCTOBER 2019 UPDATE: SUBJECT MATTER ELIGIBILITY 5 (2019) ("The term 'certain' qualifies the 'certain methods of organizing human activity' grouping as a reminder of several important points. First, not all methods of organizing human activity are abstract ideas . . . . Second, this grouping is limited to activity that falls within the enumerated sub-groupings . . . , and is not to be expanded beyond these enumerated sub-groupings except in rare circumstances . . . .").

27. Avery & Moshiri, *supra* note 11 (reporting that the frequency of § 101 rejections in office actions declined significantly after the USPTO guidance was published in January 2019, dropping from 15.72 percent in 2018 to 8.19 percent in 2019).

28. 35 U.S.C. § 102(b)(1)–(2); *see also* Verdegaal Bros. v. Union Oil Co. of Cal., 814 F.2d 628, 631 (Fed. Cir. 1987) ("A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.").

29. 35 U.S.C. § 102(a)(1); *see also* MANUAL OF PATENT EXAMINING PROCEDURE § 2152 (9th ed. 2023).

30. 35 U.S.C. § 103. According to *Graham v. John Deere Co.*, the court must make four factual inquiries to determine whether a claim is invalid under § 103: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) differences between the prior art and the claims at issue; and (4) secondary considerations, such as commercial success, long felt but unsolved needs, failure of others, etc., that may be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. 383 U.S. 1, 17–18 (1966); KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 406–07 (2007) (affirming *Graham*). Under the first prong of the *Graham* test, the scope and content of the prior art under § 103 includes all references and information that qualify as prior art under § 102. *See* J.A. LaPorte, Inc. v. Norfolk Dredging Co., 787 F.2d 1577, 1580 n.4 (Fed. Cir. 1986). The level of ordinary skill in the art is determined by considering many factors, including the "type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field." Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc., 807 F.2d 955, 962 (Fed. Cir. 1986). "The person of ordinary skill is a hypothetical person who is presumed to be aware of all the pertinent prior art." *Id.* Differences between the prior art and the claims at issue are then evaluated to determine whether the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention. *See, e.g.*, Yamanouchi Pharma. Co. v. Danbury Pharma., Inc., 231 F.3d 1339, 1342–45 (Fed. Cir. 2000). Secondary considerations include commercial success, the copying of the invention by others, or the filling of

Finally, the claims must satisfy the written description and enablement requirements of § 112(a) and the definiteness requirement of § 112(b).[31] To satisfy the written description requirement, the specification must "reasonably convey[] to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date."[32] To satisfy the enablement requirement under § 112(a), a patent specification "must teach those skilled in the art how to make and use the full scope of the claimed invention without undue experimentation."[33] Finally, to satisfy the definiteness requirement under § 112(b), the claim language must have a clear and definite meaning in view of the patent disclosure and the prior art when interpreted by one of skill in the art.[34]

B. Patent Litigation and Infringement

An essential aspect of patent ownership is being able to assert the patent against alleged infringers in litigation. In response to being sued, an accused infringer can raise a variety of defenses, including that the accused product or process does not infringe the patent, that the patent is invalid, or that the patent is unenforceable.[35]

An infringement analysis involves two steps: (1) a determination of the scope and construction of the patent claims asserted, and (2) a determination of whether the claims, as so construed, cover the accused

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a long-felt need, among others. Secondary considerations, also referred to as secondary indicia of non-obviousness, can be used to establish that the invention was in fact not obvious in light of the prior art. *Graham,* 383 U.S. 1 at 17–18. These secondary considerations can serve to protect against the improper use of hindsight analysis in determining whether combinations of prior art references would have been obvious to a person of ordinary skill in the art. *See* PharmaStem Therapeutics, Inc. v. ViaCell, Inc., 491 F.3d 1342, 1377 (Fed. Cir. 2007) (Newman, J., dissenting). The Court in *Graham* stated that secondary considerations can include commercial success, long-felt but unsolved need, and the failure of others. 383 U.S. 1 at 17–18. Other factors recognized by the Federal Circuit after *Graham* include whether the prior art teaches away from the invention, whether others have copied the invention, and whether the invention has received industry acclaim. *See* Ecolochem, Inc. v. S. Cal. Edison Co., 227 F.3d 1361, 1379–80 (Fed. Cir. 2000), *cert. denied*, 532 U.S. 974 (2001).

31. 35 U.S.C. §§ 112(a)–(b).

32. Ariad Pharm., Inc. v. Eli Lilly & Co., 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc) (citation omitted); *see also* 35 U.S.C. § 112(a) ("The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same . . . .").

33. Genentech Inc. v. Novo Nordisk A/S, 108 F.3d 1361, 1365 (Fed. Cir. 1997) (internal quotation marks omitted).

34. 35 U.S.C. § 112(b) ("The specification shall conclude with one or more claims *particularly pointing out and distinctly claiming* the subject matter which the inventor or a joint inventor regards as the invention.") (emphasis added); *see also* MANUAL OF PATENT EXAMINING PROCEDURE § 2173.02 (9th ed. 2023); Orthokinetics, Inc. v. Safety Travel Chairs, Inc., 806 F.2d 1565, 1576 (Fed. Cir. 1986).

35. 35 U.S.C. § 282(b).

product or process.[36] The second step of an infringement analysis — determining whether the claims as construed cover the accused product — is factual in nature.[37] The patent owner has the burden of proving by a preponderance of the evidence that every limitation of the patent claims asserted to be infringed is found in the accused product or process, either literally or under the "doctrine of equivalents."[38]

To find literal infringement, an accused product or process must possess features that literally correspond to each of the elements set forth in the claim.[39] Even when there is no literal infringement, the doctrine of equivalents permits infringement to be found where the differences between the accused product or process and the claim are insubstantial.[40] In applying the doctrine of equivalents, all limitations of a claim are material and must be satisfied equivalently.[41] This is so regardless of whether the limitations are necessary to achieve a claimed result.[42] However, the scope of the patent claims must be interpreted in light of the patent prosecution history.[43] Any narrowing amendment that the patent applicant made to satisfy any statutory requirement of the Patent Act may give rise to prosecution history estoppel.[44] When claims are narrowed during prosecution, it will be presumed that the amendments were made for patentability reasons and that all equivalence arguments are barred as to the narrowed claim element unless the applicant can prove otherwise.[45]

Under § 282, each claim of a patent shall be presumed valid — an accused infringer must prove invalidity by clear and convincing evidence.[46] This means the accused infringer will always have the burden of proving invalidity under one or more of § 101, § 102, § 103, or § 112.

In addition to challenging the scope and validity of a patent, an accused infringer can also assert that the patent is unenforceable. The reasons a patent may be unenforceable include inequitable conduct, patent misuse, prosecution history laches, equitable estoppel, and patent

36. Pitney Bowes, Inc. v. Hewlett-Packard Co., 182 F.3d 1298, 1304 (Fed. Cir. 1999).
37. SmithKline Diagnostics, Inc. v. Helena Labs. Corp., 859 F.2d 878, 889 (Fed. Cir. 1988).
38. *See id.*
39. Engel Indus., Inc. v. Lockformer Co., 96 F.3d 1398, 1405 (Fed. Cir. 1996); *see also* Odetics, Inc. v. Storage Tech. Corp., 185 F.3d 1259, 1267 (Fed. Cir. 1999).
40. Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 24 (1997).
41. Becton, Dickinson & Co. v. C.R. Bard Inc., 922 F.2d 792, 798 (Fed. Cir. 1990).
42. *Id.*
43. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 733 (2002).
44. *Id.* at 736.
45. *Warner-Jenkinson Co.*, 520 U.S. at 40–41.
46. Microsoft Corp. v. i4i Ltd. P'ship, 564 U.S. 91, 95 (2011).

exhaustion.[47] These may be raised as affirmative defenses, so that even if a patent is found to be valid and infringed, the accused infringer will not be liable for damages because the patent is unenforceable.[48] Among these equity-based defenses, the most used affirmative defense is the defense of inequitable conduct.[49] Under the doctrine of inequitable conduct, an accused infringer can raise a defense that a patent is unenforceable because it was procured from the USPTO improperly.[50] In order to prove inequitable conduct, the accused infringer must show with clear and convincing evidence that the patentee either failed to disclose information or presented false information to the patent office that: (1) was material to patentability; (2) was withheld with the specific

47. *See* Astrazeneca Pharms. LP v. Teva Pharms. USA, Inc., 583 F.3d 766, 770 (Fed. Cir. 2009) ("Upon determining that there was inequitable conduct in obtaining the patent, the district court may in its discretion declare the patent permanently unenforceable."); Princo Corp. v. Int'l Trade Comm'n, 616 F.3d 1318, 1321 (Fed. Cir. 2010) ("[T]he doctrine limits a patentee's right to impose conditions on a licensee that exceed the scope of the patent right."); Personalized Media Commc'ns, LLC v. Apple Inc., 57 F.4th 1346, 1354 (Fed. Cir. 2023) ("Prosecution laches may render a patent unenforceable where a patentee's conduct 'constitutes an egregious misuse of the statutory patent system.'"); Radio Sys. Corp. v. Lalor, 709 F.3d 1124, 1130 (Fed. Cir. 2013) ("[E]quitable estoppel . . . [can] bar a patentee's suit."); Quanta Computer, Inc. v. LG Elecs., Inc., 553 U.S. 617, 625 (2008) ("The longstanding doctrine of patent exhaustion limits the patent rights that survive the initial authorized sale of a patented item.").

48. *See, e.g.*, Tom Filarksi & Heather N. Shafer, *Patent Defenses in* PATENT LITIGATION STRATEGIES HANDBOOK 1282 (Barry L. Grossman & Gary M. Hoffman ed., 3rd ed. 2010).

49. *See* Lee Petherbridge & Jason Rantanen, *Inequitable Conduct and Patent Misuse in* RESEARCH HANDBOOK ON THE ECONOMICS OF INTELLECTUAL PROPERTY LAW Ch. 16 (Ben Depoorter, Peter Menell & David Schwartz ed. 2019). Rantanen and Petherbridge's research counted instances of the phrase "inequitable conduct" in answers filed in patent cases, finding between 2000 through 2015, inequitable conduct was asserted in twenty percent to forty percent of cases. *Id.* at 379 n.8; *see also* Robert D. Swanson, *The* Exergen *and* Therasense *Effects*, 66 STAN. L. REV. 695, 695 (2014) ("Before the Federal Circuit's recent *Exergen* and *Therasense* decisions, the [inequitable conduct] defense was seen as chronically overused."); Bao-Chi Chang & Shyh-Jen Wang, *The Shadow of Inequitable Conduct in the US Patent Application*, 12(5) HUM. VACCINES & IMMUNOTHERAPEUTICS 1318, 1318 (2016) ("Around eighty percent of patent infringement cases included allegations of inequitable conduct."); Christian E. Mammen, *Controlling the "Plague": Reforming the Doctrine of Inequitable Conduct*, 24 BERKELEY TECH. L.J. 1329, 1361 (2009) ("The overall volume of inequitable conduct cases at the Federal Circuit, both as a percentage of the Federal Circuit's patent case load, and in terms of absolute numbers of cases finding inequitable conduct, has trended slightly upward in the past several years."); Avery et al., *supra* note 9, at 330 (discussing how the use of inequitable conduct has sharply dropped since the *Therasense* decision). From our data, unenforceability dropped from 6.7 percent to 1.5 percent, invalidity increased from 22.3 percent to 39.0 percent, and infringement remained unchanged (at 60.1 percent) when looking at data pre- and post-*Therasense*. *See also* Swanson, *supra* note 49 at 718 ("As for pleading inequitable conduct, the data show that rates decreased more substantially after *Therasense* than *Exergen*, as expected . . . . [T]he *Therasense* decision could have restricted access to inequitable conduct such that patent litigators gave up on inequitable conduct as a possible defense. Support for this theory comes from the fact that so many in the patent bar considered inequitable conduct 'dead doctrine' after *Therasense*.").

50. Therasense, Inc. v. Becton, Dickinson & Co., 649 F.3d 1276, 1299 (Fed. Cir. 2011) (en banc).

intent to deceive the patent office; and (3) resulted in the patentee receiving an unwarranted claim.[51]

If the challenger raises an inequitable conduct defense, it can be based on the theory that either the inventor or the attorney that prosecuted the patent failed to disclose one or more pieces of prior art to the USPTO.[52] However, the Federal Circuit's decision in *Therasense* significantly raised the bar on what is needed to prove inequitable conduct.[53] First, the accused infringer has to show that the withheld prior art was but-for material — that is, but for the deception, the USPTO would not have allowed the claims.[54] Second, the accused infringer has to show that the inventor or prosecuting attorney made a deliberate decision to deceive the USPTO.[55] Merely showing that the patentee should have known the reference was material, or even showing that the patentee lacked a good-faith explanation for withholding the reference, is not sufficient to show intent to deceive.[56]

Furthermore, intent to deceive cannot be inferred from the materiality of the reference.[57] But-for materiality and intent to deceive must be proved separately, which will likely be difficult for any challenger to show without some egregious admission on the part of the patentee.[58] Consequently, inequitable conduct has rarely been successfully raised as a defense under the new *Therasense* standards.[59]

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51. *See id.* at 1290–92.

52. *See id.* at 1291.

53. *See id.*

54. *See id.*

55. *See id.* at 1290.

56. 1st Media, LLC v. Elec. Arts, Inc., 694 F.3d 1367, 1376–77 (Fed. Cir. 2012) (overturning the district court's finding of inequitable conduct where the patentee failed to submit prior art to the USPTO because the defendant failed to prove that the failure to submit prior art was intended as a deliberate fraud on the USPTO).

57. *Therasense*, 649 F.3d at 1290 ("Intent and materiality are separate requirements . . . a district court may not infer intent solely from materiality. Instead, a court must weigh the evidence of intent to deceive independent of its analysis of materiality. Proving that the applicant knew of a reference . . . does not prove specific intent to deceive.").

58. *1st Media*, 694 F.3d at 1376–77; *see also* Avery et al., *supra* note 9, at 335 (noting that *Therasense* made inequitable conduct "so difficult to prove . . . that it is now rarely raised as a defense, and even more rarely successful.").

59. *See, e.g.*, Ohio Willow Wood Co. v. Alps South, LLC, 813 F.3d 1350, 1361 (Fed. Cir. 2016) (affirming a finding of inequitable conduct where the patentee told the USPTO during a reexamination proceeding that there was no evidence to corroborate a competitor's testimony about prior art, but in fact the patentee knew about such corroborating evidence from a parallel litigation). *But see* Avery et al., *supra* note 9, at 352 (discussing how inequitable conduct findings may become more frequent due to the Federal Circuit's decision in *Regeneron Pharmaceuticals v. Merus N.V.*, 864 F.3d 1343 (Fed. Cir. 2017), which held that litigation misconduct could be used as a basis for a finding of inequitable conduct).

C. Examination by the USPTO

Before a patent can be asserted, it must be first examined and granted by the USPTO.[60] The examination corps at the USPTO includes over 10,000 employees and is divided into nine "technology centers," each of which specializes in a particular field of technology.[61] These technology centers are listed in Table 1:[62]

Technology Center	**Field**	**Overall Allowance Rate[63]**
1600	Biotechnology and Organic Chemistry	57.9%
1700	Chemical and Materials Engineering	65.1%
2100	Computer Architecture and Software	75.8%
2400	Networking, Multiplexing, Cable, and Security	78.7%
2600	Communications	79.7%
2800	Semiconductors/Memory, Circuits/Measuring and Testing, Optics/Photocopying, Printing/Measuring and Testing	83.1%

60. 35 U.S.C. § 154 (2024) (the term of a patent begins "on the date on which the patent issues and end[s] 20 years from the date on which the application for the patent was filed . . ."); *see also Managing a Patent*, US PAT. & TRADEMARK OFF. (Sept. 10, 2024), https://www.uspto.gov/patents/basics/manage [https://perma.cc/FK8C-WK57] ("Patent protection does not start until actually granted.").

61. *Patent Technology Centers Management*, US PAT. & TRADEMARK OFF., https://www.uspto.gov/patents/contact-patents/patent-technology-centers-management [https://perma.cc/2L9F-W8K3].

62. Note that this table excludes Technology Center 2900, which handles design patents and has an allowance rate of 94.0 percent. As noted *infra* Section III.A, Technology Center 2900 was excluded from the analysis because design patents are often allowed without any rejections from the USPTO. See *infra* note 97.

63. *See, e.g.*, *Biotechnology and Organic Chemistry Search Results*, PATENTADVISOR, https://go.patentadvisor.com/statistics.php?Parent=TechnologyCenter&TechnologyCenter=1 [https://perma.cc/JH2V-VM6K]. This data was retrieved February 23, 2024, and covers patent applications with electronic file histories that were filed on or after November 29, 2000. PatentAdvisor regularly updates this data, and these values reflect PatentAdvisor's data as of February 23, 2024. The overall allowance rates listed here were calculated by PatentAdvisor by taking the number of issued patents from a Technology Center and dividing it by the sum of issue patents and abandoned patents from the Technology Center. Email from Katie Fisher, Customer Success Manager, LexisNexis Intellectual Property, to authors (Nov. 8, 2024, 12:51 PST) (on file with author).

3600	Transportation, Construction, Electronic Commerce, Agriculture, and National Security	68.1%
3700	Mechanical Engineering, Manufacturing, Gaming, and Medical Devices/Processes	71.3%

Table 1: USPTO Technology Centers and Overall Allowance Rates

Each technology center is further subdivided into numerous "art units" that each focus on a specialty within that field of technology.[64] After an applicant files a patent application, the USPTO first assigns the application to one of these art units for examination.[65] Notably, quality control varies widely among the technology centers, with overall allowance rates ranging from a low of 57.9 percent in Technology Center 1600 (Biotechnology and Organic Chemistry) to a high of 83.1 percent in Technology Center 2800 (Semiconductors/Memory, etc.). As such, this Article hypothesizes that patent applications examined in "tougher" art units (i.e., those with lower allowance rates) will be examined more thoroughly, leading to narrower claims that are less likely to be found invalid.[66] Similarly, this Article also hypothesizes that courts will be less likely to find infringement of patents examined in "tougher" art units due to such patents presumably having narrower claims. Furthermore, within a given art unit, it is common for allowance rates to vary widely from examiner to examiner, with each art unit having its share of "easy" and "tough" examiners.[67] This Article further hypothesizes that patents examined by these "tougher" examiners will

64. US PAT. & TRADEMARK OFF., PRODUCTION DATA CONTROL SECTION (2022), https://www.uspto.gov/sites/default/files/documents/caau.pdf [https://perma.cc/83SK-LB79].

65. MANUAL OF PATENT EXAMINING PROCEDURE § 909.01(b) (9th ed. 2023) ("Utility applications are routed to an examiner using an automated routing system. The automated routing system takes into account the CPC classifications of an application and compares them to examiner portfolios (i.e. the classification areas to which the examiner has been assigned).").

66. Kyle W. Higham, Gaétan de Rassenfossee & Adam B. Jaffe, *Patent Quality: Towards a Systematic Framework for Analysis and Measurement* 46 (Nat'l Bureau of Econ. Rsch., Working Paper 27598, 2020) ("Specifically, as independent claim length (and particularly the length of the first claim) increases, the more specific the claim becomes, and the narrower the patent may be, and the faster it can be granted. We include the words in the first claim (CFW) in this work, as this has been expertly validated as a measure of patent scope." (internal citations omitted) (emphasis omitted)); Qiang Lu, Amanda Myers & Scott Beliveau, *USPTO Patent Prosecution Data: Unlocking Office Action Traits* 5 (US Pat. & Trademark Off., Econ. Working Paper No. 2017-10, 2017) ("The applicant typically submits a response with some combination of arguments and amendments to the claims to clarify them or to narrow their scope to avoid encompassing the prior art."); *see also* Marco et al., *supra* note 6, at 8 ("[T]he examination process itself tends to narrow the scope of patents. Patent prosecution tends to add 45 words, on average, to the shortest independent claim . . . .").

67. Sartori & Welch, *supra* note 4.

be examined more thoroughly, leading to narrower claims that are less likely to be found invalid, but also less likely to be found to infringe compared to patents examined by "easier" examiners.

After an application is assigned to an art unit, the application is eventually assigned to a specific examiner and added to their work queue.[68] Eventually, after an average waiting period of 20.3 months, the examiner will review the patent application and issue a first action, which is typically a non-final rejection.[69] When preparing this first action, patent examiners face stringent bi-weekly productivity quotas, with only a limited timeframe to assess the application, search for prior art, compare it with the claims, and issue the rejection.[70]

The USPTO enforces these productivity quotas using a "count" system to measure the amount of work done by the examiner.[71] First, the USPTO sets the number of production units needed for an examiner to hit a quarterly productivity goal.[72] The number of production units required to hit the examiner's productivity goal for a given time period is determined by the following formula: the number of examining hours in the time period multiplied by the examiner's seniority factor (i.e., position on the government's General Schedule pay scale), all of which is divided by an "unadjusted expectancy" factor corresponding to the technological complexity of the technology handled by the art unit.[73]

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68. MANUAL OF PATENT EXAMINING PROCEDURE § 909.01(b) (9th ed. 2023) ("Once the application has received these classifications, the automated routing system can assign the application to an examiner.").

69. *Patents Pendency Data July 2024*, US PAT. & TRADEMARK OFF. [hereinafter *Patents Pendency Data*], https://www.uspto.gov/dashboard/patents/pendency.html [https://perma.cc/9Z3G-HK9Z]; *see also* Michael Carley, Deepak Hedge & Alan Marco, *What is the Probability of Receiving a U.S. Patent?*, 17 YALE J.L. & TECH. 203, 207 (2015) ("The USPTO allowed 11.4% of the progenitor applications at first action and delivered a non-final rejection decision for 86.4% of the applications, with the remaining 2.3% abandoned prior to a first action decision.").

70. Frakes & Wasserman, *supra* note 5, at 552; U.S. PAT. & TRADEMARK OFF., EXAMINATION TIME AND THE PRODUCTION SYSTEM 1, 10 [hereinafter USPTO EXAMINATION TIME], https://www.uspto.gov/sites/default/files/documents/Examination%20Time%20and%20the%20Production%20System.pdf [https://perma.cc/D4XW-W4XY]; *see also* USPTO EXAMINATION TIME at 19; Conner Kerrigan, *Examiners Who Procrastinate and How To Keep Them From Derailing Your Practice*, JURISTAT (Dec. 14, 2022) https://blog.juristat.com/examiner-end-loading-2022 [https://perma.cc/6K92-6329] (describing the end-loading phenomenon where examiner productivity would increase in the final bi-weeks of a quarter: "We define an examiner's end-loading rate as the percentage of i) notices of allowance (NOAs) and ii) adverse office actions completed by the examiner in the last 3 weeks of the quarter minus 3/13ths."). While not clear, this end-loading examination practice may contribute or have contributed to lower-quality office actions.

71. USPTO EXAMINATION TIME, *supra* note 70, at 13.

72. *Id.* at 12.

73. *Id.*; *see also* Frakes & Wasserman, *supra* note 5, at 552. For example, for a junior examiner (GS-7) in an art unit that examines fishing lures, which would be considered a relatively simple technology, the examiner would have seventy-two examining hours per bi-weekly period, multiplied by a seniority factor of 0.7 for being a GS-7, divided by an unadjusted expectancy factor of 16.6 hours/production unit corresponding to the technology

One production unit is equal to two counts.[74] A fraction of the two counts is awarded for each major Office Action type, with a larger weighting given for the first non-final Office Action (1.25 counts), and a smaller weighting given for a final rejection Office Action (0.25 counts).[75] No count credit is given for rework, such as a second non-final rejection.[76] The reduction in counts for subsequent office actions and rework is intended to encourage examiners to follow compact prosecution principles.[77] Under these compact prosecution principles, examiners are encouraged to dispose of a patent application in order to complete prosecution rather than continue to issue rejections.[78] That is, the system is intended to encourage proactivity at the beginning of prosecution, reducing the need for subsequent rounds of examination by the USPTO.[79] Finally, the examiner will be awarded 0.5 counts for either an allowance, abandonment, or appeal disposal.[80] Thus, when faced with the choice of issuing either a final office action (0.25 counts) or a

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complexity associated with fishing lure arts, which equals 3.0 production units per bi-week. USPTO EXAMINATION TIME, *supra* note 70, at 18.

74. USPTO EXAMINATION TIME, *supra* note 70, at 12.

75. *Id.* at 13; *Patent Examiner Count System*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patents/initiatives/patent-examiner-count-system#heading-1 [https://perma.cc/GFJ8-DHGA] ("One of the purposes of the new examiner production system is to reduce the instances in which it is necessary for an applicant to file a request for continued examination (RCE) to complete prosecution of his or her application. Although the USPTO recognizes that RCEs are necessary in some cases, the new count system provides incentives to examiners to conduct early interviews with applicants in the hope that RCE filings will become less necessary in many cases.").

76. USPTO EXAMINATION TIME, *supra* note 70, at 13.

77. *Id.* at 19.

78. U.S. PAT. & TRADEMARK OFF., JOINT LABOR AND MANAGEMENT COUNT SYSTEM TASK FORCE 1, 10, https://www.uspto.gov/sites/default/files/patents/init_events/Count_System_changes-Overview_3-8-2010.ppt [https://perma.cc/G85B-Y8UF]; *see also* Alan C. Marco, Andrew A. Toole, Richard D. Miller & Jesse P. Frumkin, *USPTO Patent Prosecution and Examiner Performance Appraisal* 1, 11 (USPTO Econ. Working Paper No. 2017-08, 2017) [hereinafter Marco et al., *Performance Appraisal*] ("An examiner's expectancy is defined in terms of time allotted to reach a balanced disposal (BD) for an application. A BD is a 'completed' examination cycle . . . [that] starts when the examiner begins their first action on an application . . . and ends when the application reaches disposal (allowance, abandonment, examiner's answer, or RCE)."); *Patents Pendency Data*, *supra* note 69 (defining final disposal as when "the application has reached final disposition (e.g., issued as a patent or abandoned)"); MANUAL OF PATENT EXAMINING PROCEDURE § 706.07 (9th ed. 2023) (defining a Request for Continued Examination as reopening prosecution of a patent application: "This action is a final rejection and closes the prosecution of this application. Applicant's reply under 37 CFR 1.113 to this action is limited to an appeal to the Patent Trial and Appeal Board, an amendment complying with the requirements set forth below, or a request for continued examination (RCE) to reopen prosecution where permitted." (emphasis omitted)).

79. JOINT LABOR AND MANAGEMENT COUNT SYSTEM TASK FORCE, *supra* note 78, at 10; *see also* MANUAL OF PATENT EXAMINING PROCEDURE, § 2660 (9th ed. 2023) (describing how front-loading the time under compact prosecution principles may allow examiners to determine and apply the best prior art at the first office action: "The examiner's first action should be comprehensive and address all issues as to the prior art patents and/or printed publications.").

80. USPTO EXAMINATION TIME, *supra* note 70, at 13. Again, note that two counts are equivalent to one production unit.

notice of allowance (0.5 counts), the USPTO's quota system appears to incentivize examiners to issue an allowance instead of another rejection. Such incentives may impact examiner behavior, as discussed more herein.

As noted above, the amount of time an examiner receives to draft an office action is based on the complexity of the technology being examined. The base amount of time received is the "unadjusted expectancy" of hours per production unit.[81] These unadjusted expectancies range from 13.8 hours per production unit for the least complex technologies, to 31.6 hours per production unit for the most complex technologies.[82] For example, an application covering fishing lures may receive 16.6 hours per production unit, while more complex technologies such as immunotherapy and satellite communications may receive 25.9 and 27.7 hours per production unit, respectively.[83] The unadjusted expectancies are then adjusted based on an examiner's seniority.[84] As examiners get promoted and move to a higher pay grade, their allocation of hours per production unit is reduced, as it is expected that they should be working more efficiently.[85]

The incentive to encourage proactivity at the beginning of prosecution might lead one to expect more diligence, and time, afforded to the first non-final office action as a result of the heavier weighting given for these actions compared to the lighter weighting given for subsequent actions. This may lead one to hypothesize that the additional prior art raised in later actions by the examiner would be weaker, or less well

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81. *Id.* at 15.

82. *Id.*

83. *Id.*

84. *Id.* at 15–16 ("Individual utility examiner production expectancies are calculated by dividing the unadjusted expectancy by the Seniority Factor. Therefore, GS-12 examiners have an adjusted expectancy that is equal to the unadjusted expectancy . . . , GS-11 examiners and below have an adjusted expectancy that is higher than the unadjusted expectancy and GS-13 examiners and above have an adjusted expectancy that is lower than the unadjusted expectancy."); *see also* U.S. PAT. & TRADEMARK OFF., PATENT PUBLIC ADVISORY COMMITTEE QUARTERLY MEETING: UPDATES TO EXAMINATION TIME, APPLICATION ROUTING, AND EXAMINER PERFORMANCE APPRAISAL 1, 10, https://www.uspto.gov/sites/default/files/documents/ExaminationProcessUpdatesMay2019.pptx [https://perma.cc/DU3F-6JLC] (describing additional time being added to examination time for "individual applications that are more difficult to examine or need more time (e.g., high number of claims, pages of specification, pages of IDS, etc.)").

85. Frakes & Wasserman, *supra* note 5, at 552. For example, a junior examiner (GS-7) in an art unit examining fishing lure applications may have a quota of only 3.0 production units per bi-week, while a primary examiner (GS-14) in the same art unit may have a quota of 5.9 production units per bi-week. *See id.* Thus, the junior examiner gets nearly double the amount of time to do any given task compared to the primary examiner. *See also Promotions*, PAT. OFF. PRO. ASS'N, http://www.popa.org/about/advocacy/promotions/ [https://perma.cc/Q4VF-AFSJ] ("Patent Examiners are promoted regularly under the career ladder process up to the full-performance level of GS-13 . . . . [T]he Examiner must demonstrate that their performance under the Production Element of their Performance Appraisal Plan is halfway between the production requirements for their current grade and the next grade in the promotion ladder . . . .").

researched, resulting in diminishing improvements in quality as more actions, and thus more time, are spent examining the application. If this hypothesis were true, we would expect to observe early gains in the likelihood of validity after the first office action, followed by small changes from additional actions. However, we hypothesize the incremental efforts in follow-up office actions (and thus, longer prosecution histories) will contribute, meaningfully, to the likelihood a patent survives validity challenges. This is because, in our experience, amendments are generally incremental in response to follow-up office actions, such that the amount of time spent by the examiner in reviewing these amendments, even if diminished in comparison to the time spent in earlier steps in examination, still should be sufficient to provide a thorough examination.[86]

As an example, during the allocated time, the examiner must determine what the applicant has invented and is seeking to patent, identify any utility for the invention, review the detailed disclosure, review the claims, conduct a thorough search of prior art, determine whether the claims are directed to patent-eligible subject matter, evaluate the claims for novelty and obviousness, and evaluate whether the claims comply with the written description and enablement requirements.[87] Based on this review and evaluation, the examiner must then compose a first (non-final) office action that accepts or rejects the claims in the application.[88] This process may repeat in a subsequent (final) office action, and may further repeat if the applicant files a request for continued examination ("RCE"), which extends the examination process.[89] For example, to meet their quota of production units, a primary examiner may only get 20.1 hours of examining time per disposal, including to review a patent application, search for prior art, compare the prior art to the

86. Jeffrey M. Kuhn & Neil C. Thompson, *The Ways We've Been Measuring Patent Scope are Wrong: How to Measure and Draw Causal Inferences with Patent Scope*, 26 INT'L J. ECON. BUS. 5, 13 (2019) ("The average patent has 130 words in the first claim at the time of filing and 181 words in the first claim at the time of issuance."); JURISTAT, *supra* note 6 (showing that in 2022, the average independent claim added 53.46 words between filing and allowance, and that the average patent was allowed after 1.9 office actions, indicating that an average of 28.13 words are added to the independent claim per office action (53.46 divided by 1.9)).

87. Frakes & Wasserman, *supra* note 5, at 551; *see also* 35 U.S.C. §§ 101, 102, 103, 112.

88. Frakes & Wasserman, *supra* note 5, at 551–552.

89. *Id.* (describing the "rejection and acceptance process [as] somewhat iterative in nature, often entailing some back and forth between the examiner and applicant"); *see also* Ron D. Katnelson, My 2010 Wishes for the U.S. Patent Examiner 5 (Jan. 8, 2010) (unpublished manuscript), http://works.bepress.com/rkatznelson/60 [https://perma.cc/9CKY-3A3J] (suggesting that the average production goal is set at 19.5 GS-12 equivalent hours, based on the 1976 PTO annual report); MANUAL OF PATENT EXAMINING PROCEDURE § 706.07 (9th ed. 2023) (defining an RCE as reopening prosecution of a patent application: "This action is a final rejection and closes the prosecution of this application. Applicant's reply under 37 CFR 1.113 to this action is limited to an appeal to the Patent Trial and Appeal Board, an amendment complying with the requirements set forth below, or a request for continued examination (RCE) to reopen prosecution where permitted." (emphasis removed)).

patent application, write a non-final (first) rejection, conduct an interview with the applicant's attorney, review the applicant's response, perform an updated search, and write a final (second) rejection.[90] The same examiner will have fewer hours to consider a response after the filing of an RCE and prepare subsequent office actions to maintain their efficiency rate.[91] Continuing the prior example, a primary examiner who has 20.1 hours of examining time per application may only get 13.1 hours of examining time following a first RCE (for the second disposal to prepare a third and fourth rejection), and 11.3 hours following any subsequent RCEs (for the third disposal to prepare a fifth and sixth rejection, and so on).[92]

III. DATA & ANALYSIS

A. Data Extraction

All data analyzed for this Article was extracted from PatentAdvisor,[93] which is powered by Lex Machina.[94] Both are owned by LexisNexis.

First, we downloaded prosecution and litigation data related to all patents available from these LexisNexis services. PatentAdvisor has litigation data for patents that have completed litigation from March 1, 2000 and onward, provided they have electronic file histories. The litigation data includes results from U.S. district courts and from the Patent Trial and Appeal Board ("PTAB").[95]

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90. Michael A. Leonard II, *USPTO Examiner Expectancies*, FOUNDPERSUASIVE, http://www.foundpersuasive.com/examiner_expectancies.aspx [https://perma.cc/8483-69B7]; *see also* Frakes & Wasserman, *supra* note 5, at 551–552. Recall that a patent disposal is defined as when "the application has reached final disposition (e.g., issued as a patent or abandoned)." *Patents Pendency Data*, *supra* note 69. In general, a single "disposal" would include when an examination cycles from first action to one of allowance, abandonment, examiner's answer, or RCE. Marco et al., *Performance Appraisal*, *supra* note 78, at 11; *see also* Dennis Parad, *Tips from a Former Examiner on How to Conduct Interviews at the USPTO*, IP WATCHDOG (May 19, 2022), https://ipwatchdog.com/2022/05/19/tips-former-examiner-conduct-interviews-uspto/id=149124/ [https://perma.cc/X7AM-8K9S] ("The examiner has a finite amount of time they can spend on a single case. USPTO examiners are only given one hour for the whole interview process, including preparation before the interview and writing the interview summary afterwards."); MANUAL OF PATENT EXAMINING PROCEDURE § 713.01 (9th ed. 2023) ("The examiner should not hesitate to state, when appropriate, that claims presented for discussion at an interview would require further search and consideration.").

91. Frakes & Wasserman, *supra* note 5, at 551–52; *see also* USPTO EXAMINATION TIME, *supra* note 70, at 13 ("The distribution of count credit is structured to incentivize a thorough and complete first action on the merits by awarding most of the PU at first action and less credit for follow-on actions.").

92. Leonard, *supra* note 90.

93. PATENTADVISOR, https://go.patentadvisor.com/ [https://perma.cc/9S3E-53PC].

94. LEX MACHINA, https://lexmachina.com/ [https://perma.cc/GDD6-GCNS].

95. The data extracted from PatentAdvisor also includes data from the ITC. However, the Case Outcome field for all ITC cases is listed as "N/A" in PatentAdvisor. As such, ITC cases were not included in the analysis.

To download the litigation data, we utilized the "Litigation Statistics" tab for each USPTO technology center in PatentAdvisor.[96] This download yields a comma-separated value ("CSV") file of metadata on all patents litigated from a given technology center, subject to the date and filing conditions above. We downloaded data from every technology center at the USPTO except the design patent technology center (Technology Center 2900), thus obtaining metadata on all utility patents and their subsequent cases.[97] This resulted in a raw dataset with 89,248 rows, representing outcomes for patent litigations filed between March 2000 to April 2021.[98]

To download the prosecution data, we created a script to look up how many office actions each litigated patent went through. First, the script searches for the patent number on PatentAdvisor.[99] Then, the script counts the number of non-final and final rejections in its history. This count of non-final and final rejections makes up the total number of office actions a patent went through prior to allowance.[100]

Between the initially downloaded litigation statistics and the script to pull the additional prosecution data, we collected the following data points on each litigated patent: application number, patent number, case number, case status, court filing date, outcome(s) of the case, number of office actions, art unit, application filing date, application issue date, examiner name, examiner ETA, and examiner allowance rate. A sample row in our final dataset contains information such as that seen in Table 2.

Application Number	09/970,060
Patent Number	6845931
Case Number	1:16-cv-00873
Case Status	closed
Court Filing Date	2016-07-08
Case Outcomes	Infringement
Number of Office Actions	2
Art Unit	3752
Application Filing Date	2001-10-03
Application Issue Date	2005-01-25

96. *See, e.g.*, *Biotechnology and Organic Chemistry Search Results*, *supra* note 63.

97. Technology Center 2900 was excluded from the analysis because design patents are often allowed without any rejections from the USPTO. Additionally, PatentAdvisor does not seem to have any litigation data from patents issued by Technology Center 2900.

98. A Microsoft Excel file containing the initial, non-processed data is available from the Authors. Based on the Authors' review of the raw data and correspondence from PatentAdvisor, it appears it only has a partial dataset for patents litigated in 2000–2002. For 2003 onward, the dataset from PatentAdvisor appears to include all litigated patents.

99. *See, e.g.*, QuickPAIR, PATENTADVISOR, https://go.patentadvisor.com/quickpair/?patentNumber=6725444 [https://perma.cc/ZV9N-MFFJ].

100. The impact of non-final versus final office action was not analyzed.

Examiner Name	Rosenbaum, Mark
Examiner ETA	1.7
Allowance Rate	81.4%

Table 2: Sample Row from Dataset

The data was then manipulated to make analysis easier. This was necessary because some litigation cases listed multiple outcomes. To fix this issue, the outcomes were tokenized and separated to make them more manageable for analysis. In their final form, the rows end up looking like Table 3.

Application Number	10/972,213
Patent Number	6990941
Case Number	5:06-cv-00802
Case Status	closed
Court Filing Date	2006-04-25
Case Outcomes	No Unenforceability | No Invalidity | Infringement
Number of Office Actions	2
Art Unit	3747
Application Filing Date	2004-08-26
Application Issue Date	2006-01-31
Examiner Name	Kwon, John
Examiner ETA	0.8
Allowance Rate	91.4%
Tokenized Case Outcomes	No Unenforceability | No Invalidity | Infringement

Table 3: Sample Tokenized Row from Dataset

Note in the example above how the "No Unenforceability," "No Invalidity," and "Infringement" outcomes are all part of the same string in the Case Outcomes field, and then broken into separate values and added as a new field at the end of the row. From left to right, the fields of the processed data rows are: application number, patent number, case number, case status, court filing date, outcome(s) of the case, application filing date, application issue date, examiner name, examiner ETA, examiner allowance rate, and tokenized litigation outcomes.

B. Data Checks and Cleanliness

Next, we set out to make sure the extracted data was both clean and valid. There were some cleanliness issues with the raw dataset. First,

out of the 89,248 cases in the raw dataset, there were 401 cases that had dates where suit was filed in court before the patent application was filed. We investigated why this was, and determined these patents were joined to existing litigations. Because these patents all had non-duplicative prosecution and litigation data, we determined they were relevant to our analysis and decided to leave them in the dataset.

Additionally, case outcomes are not discrete — some rows have case outcomes that contradictory for the patent in that row. They typically are, but there are rare occurrences where this is not the case. Table 4 shows an example.

Application Number	09/850,222
Patent Number	6396722
Case Number	4:04-cv-02000
Case Status	closed
Court Filing Date	2004-05-20
Case Outcomes	No Infringement | No Infringement | Infringement | No Unenforceability | Invalidity | No Invalidity
Number of Office Actions	1
Art Unit	3838
Application Filing Date	2001-05-07
Application Issue Date	2002-05-28
Examiner Name	Patel, Rajnikant B
Examiner ETA	1.2
Allowance Rate	91.5%

Table 4: Sample Row with Multiple Outcomes from Dataset

Notice that the case outcomes for this patent indicate that it is both invalid and not invalid. After investigating what happened in this case, it became clear that this case had different outcomes for different claims within the '722 patent (some valid, and some not). Spot checks were performed for an additional seven cases with similar conflicting outcomes to confirm these types of outcomes come from varied rulings for claims within a patent. These types of conflicting outcomes are rare in the dataset (320 in total) and were filtered out in our subsequent analysis to avoid unwanted noise.[101] Finally, we also filtered out outcomes that were not relevant to our hypotheses. In particular, we excluded

101. Because all outcomes in this Article are analyzed with respect to opposing outcome pairs (e.g., validity vs. invalidity, or infringement vs. no infringement), excluding cases with conflicting outcomes should have a negligible impact on the overall analysis since these data points would effectively cancel each other out when calculating the rates of those outcomes.

cases where there was no finding related to infringement, validity, or enforcement (for example, a case that was dismissed or ended in settlement).

After all such filtering, we are ultimately left with 10,174 rows from 6,877 cases, which includes 6,382 outcomes from district court cases and 3,792 outcomes from PTAB cases.[102] Note that some cases will be counted multiple times in our analysis. This is because our analysis is done on a patent-case pair basis. In other words, every unique patent and case is considered a separate outcome to count. This is done in our analysis because, for certain cases where multiple patents are litigated, different outcomes are attached for the different patents in the case.[103] Similarly, a patent can be litigated multiple times in different cases. Thus, the only way to capture every outcome is by using patent and case number pairs.

From the remaining cases and patents, numerous spot checks were done through PACER records to verify accuracy of the data extracted from LexisNexis. In all but one case, the data from LexisNexis matched the information available on PACER. Spot checks were performed for roughly 120 cases (approximately 1.2 percent of total rows), which were randomly selected.[104] During our review of the data, we observed that the "Examiner ETA" field, which is a measure of examiner toughness calculated by PatentAdvisor, was missing for 535 rows out of the 10,174 total rows (5.26 percent). According to PatentAdvisor, the "Examiner ETA" information is missing for these cases because the examiners associated with the patents are supervisory patent examiners ("SPEs") and they do not calculate the ETA metric for supervisors.[105] While not clear from PatentAdvisor's explanation, we assume that the listed examiner in each of these cases was a normal (non-supervisory) examiner at the time the cases were prosecuted, and was subsequently promoted to SPE, at which point PatentAdvisor stopped calculating an ETA metric for the examiner. We decided to leave these patents in our analysis because they still contain valid prosecution and litigation data

102. As noted previously, our analysis only includes cases from district court and PTAB cases and does not include patents litigated at the ITC.

103. For example, examining case number 5:18-cv-00094, we see that five different patents are attached to it. Furthermore, the outcome for each patent is different. Two patents (U.S. patent nos. 6,340,035 and 6,557,588) had outcomes of no infringement. However, for U.S. patent no. 9,869,103, there was an outcome of invalidity and no infringement. Finally, U.S. patent nos. 10,214,930 and 10,323,429 had outcomes listed as "n/a."

104. During a spot check, the Authors found one case where PatentAdvisor mislabeled the outcome as "All Claims Unpatentable" for a case where the independent claims were found to be invalid while some dependent claims were found to be valid. PatentAdvisor has assured us this type of mislabeling is not common, and there is nothing in the data to indicate that such mislabeling of outcomes is prevalent. However, the dataset may contain some slight imperfections like this.

105. Email from Katie Fisher, Customer Success Manager, LexisNexis Intellectual Property, to authors (Sept. 15, 2024, 07:28 PDT) (on file with author).

pertinent to the correlations we are attempting to study. However, the portions of our analysis related to correlations between examiner toughness and litigation outcomes do not include these 535 rows for obvious reasons.

Additional checks were also in place to ensure data integrity. This included, but was not limited to: verifying percentages were indeed percentages, verifying no patent listed a negative integer for the number of office actions, and verifying that the data scraped by the script matched the same number of rows from the initial set of downloaded CSVs. Overall, the final dataset provides clear reliable data points that create a solid foundation for analysis.

C. Analysis Overview

Next, we analyzed our data to see if the number of office actions correlates with litigation outcomes. As a first step, each litigated patent was categorized, or "bucketed," by the number of office actions issued during its prosecution. The total number of patents in each bucket is shown in Table 5 below. Because the number of cases with five or more office actions is significantly smaller than cases with zero to four office actions, these cases were grouped into a "5+" bucket. The impact of this bucketing into a "5+" category is discussed more below.

# of OAs	**0**	**1**	**2**	**3**	**4**	**5+**	**Total**
PTAB	485	1504	859	399	225	320	3792
District Court	995	2499	1473	611	321	483	6382
Total Sample	1480	4003	2332	1010	546	803	10,174

Table 5: Litigation Outcome Count by Number of Office Actions

One way to see if the number of office actions causes a shift in litigation outcomes is to take a pair of opposed outcomes (e.g., invalidity and no invalidity) and graph the percentage change of the outcomes based on the number of office actions for each patent application.

For example, take a hypothetical dataset with twenty litigated patents, where ten patents had two office actions, and the other ten patents had three office actions. For the two-office-action cases, eight were held invalid, and the others were not held invalid. Then, for the ten patents that had three office actions, half were held invalid, and the other half were not held invalid. This would leave us with two data points for invalidity, and two data points for no invalidity. For invalidity, the plotted points would be (2, 0.8) and (3, 0.5). For no invalidity, the plotted points would be (2, 0.2) and (3, 0.5).

Plotting percentages, as opposed to the raw number of outcomes, makes trends easier to identify. Because there is a significant drop in the number of patents that have received a higher number of office actions, plotting raw numbers can mask trends. For example, out of all the patents that received two office actions, say only forty were declared invalid. Additionally, out of all the patents that received five or more office actions, also say forty were declared invalid. If only the raw number of cases were graphed, both these data points would look the same (forty invalid cases for each "bucket" of number of office actions). However, because there are many more patents that went through two office actions compared to those that went through five or more, a patent in this hypothetical example is much more likely to be invalid if it went through five or more office actions as opposed to two. Graphing data points as percentages allows us to identify such trends more clearly compared to simply graphing the raw number of outcomes.

We plotted these opposing outcomes for validity, infringement, and enforceability. After making these plots, it became apparent that for litigated patents with numerous office actions, the data was too sparse to get accurate results. Again, there are many more patents that have gone through two office actions compared to patents that have gone through ten, but the percentages are always out of 100. For example, if there were 1,000 litigated patents that had two office actions, and two patents that had ten office actions, a single validity or infringement decision would have a much larger effect in the ten-office-action bucket compared to the two-office-action bucket. Because of these small sample size office action buckets, fitting a trendline to all points is difficult. To remedy this, the buckets with small sample sizes were combined into a single bucket. Specifically, instead of having individual buckets for five office actions (387 cases), six office actions (195 cases), seven office actions (107 cases), eight office actions (61 cases), etc., all patents with five or more office actions were grouped into a single bucket (803 total cases). This grouping of cases into a "5+ office actions" bucket helped reduce the uncertainty of the data while maintaining its integrity. However, this grouping assumes that the impact of additional office actions after the fifth action has a minimal impact on outcome, whether it be invalidity, infringement, or unenforceability.

Then, trendlines were fitted to the data points, and R-squared and root mean squared error ("RMSE") values were calculated.[106] A few different regressions were tried, but ultimately linear regression was the best fit as the litigation outcomes appeared to track linearly with the

106. Root mean squared values were calculated by summing the squared difference between the fit point and the actual data point. That sum is then divided by the number of samples, and the square root of that is the root mean squared error.

number of office actions each patent received. The plotted points were fitted using least squared polynomial fit.[107] The R-squared value for a trendline represents how much the change in percentage of a given litigation outcome can be explained by the change in office actions.[108] An R-squared value of 1 would mean that the change in percentage can be completely attributed to a change in the number of office actions, and that the predictive model predicts this change perfectly. Conversely, an R-squared of 0 means that a change in the number of office actions does not affect the percentage of the litigation outcome at all. The RMSE is a measure of how well the trendline fits the data points. The data points in our dataset all range between 0 and 1 — thus an RMSE value of 1 indicates an extremely poor fit. For example, if all observed data points were 0, and all fit points were 1, this would yield an RMSE of 1, which is the worst possible fit. In contrast, an RMSE value of 0 indicates a perfect fit of the data to the trendline. The lower the RMSE, the better the fit. This Article assumes that, in general, an RMSE value of 0.02 or lower indicates that the model can relatively predict the data accurately.[109]

Note that in all figures the data points are represented as fractions, rather than percentages, are mirror images of each other, and sum to 1.0 (e.g., 0.8 no invalidity vs. 0.2 invalidity, or 0.7 infringement vs. 0.3 no infringement). As such, the R-squared values in all figures where opposing outcomes are shown are the same for both trendlines. Results for the pairwise comparisons are below, along with the individual data points.

IV. RESULTS

This section presents the results of our empirical analysis, exploring the correlation between the number of office actions a patent

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107. Specifically, data was fitted using a numpy.polyfit function. *See Numpy.polyfit*, NUMPY, https://numpy.org/doc/stable/reference/generated/numpy.polyfit.html [https://perma.cc/Q4ER-3KNH].

108. *See R-Squared*, CORP. FIN. INST., https://corporatefinanceinstitute.com/resources/data-science/r-squared/ [https://perma.cc/T93V-5ZTF] ("[R-squared] is a statistical measure in a regression model that determines the proportions of variance in the dependent variable that can be explained by the independent variable.").

109. There are no strict guidelines for evaluating RMSE values. For example, R-squared is often referred to as a goodness of fit measure, and it is, but if the independent variables have no effect on the dependent variables, this number will be close to 0. To evaluate how well our plots fit the data, the reader is encouraged to look at the points, the line, the RMSE, and the R-squared values. However, we think that having an R-squared value of approximately 0.5 or greater and an RMSE value of approximately 0.02 or less would be a reasonably well-fit line given the data. The reader should also note that while our analysis is rigorous, the data is human. Fits will not be perfect. Furthermore, we did not create bias plots or perform every exhaustive statistical measure possible on our outcomes. The intention is to provide initial, sound, and simple statistical guidance on how the number of office actions influences litigation outcomes.

undergoes during prosecution and subsequent litigation outcomes. Through comprehensive data examination and trend analysis, these results shed light on the impact of prosecution length on patent validity, infringement, and enforceability, providing valuable insights for patent owners and practitioners seeking to optimize their prosecution and litigation strategies.

A. Validity

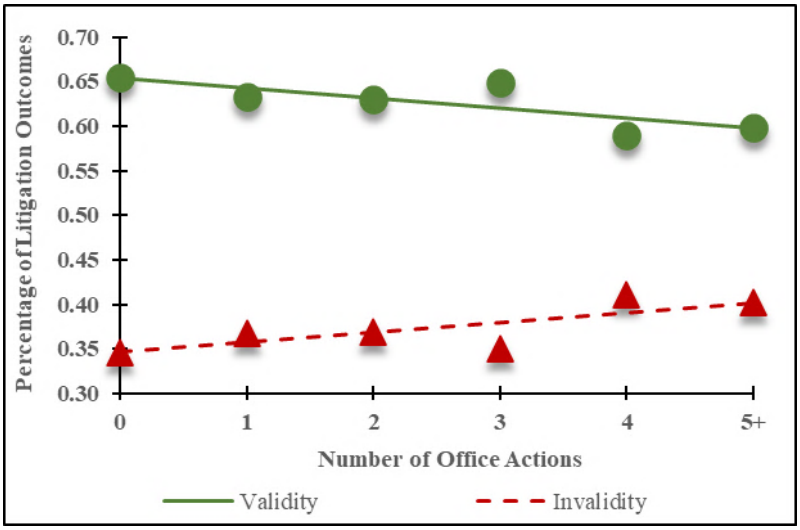

Figure 1: Plot of Invalidity and Validity Rates Overall

R-squared: 0.65, RMSE: 0.025, Total Sample Size: 7633

# of OAs	**0**	**1**	**2**	**3**	**4**	**5+**
Invalidity	35%	37%	37%	35%	41%	41%
No Invalidity	65%	63%	63%	65%	59%	59%
Sample Size	1080	3087	1707	770	429	560

Table 6: Data for Figure 1

Figure 1 is a plot of validity outcomes for litigated patents in terms of percentage of total outcomes where there was a finding of validity.[110]

110. This graph comprises district court cases with outcomes "Invalidity," "No Invalidity," and "Institutional Decision: Denied Institution," and PTAB cases with outcomes "Final Decision: All Claims Unpatentable," "Final Decision: All Claims Upheld," and "Institutional Decision: Denied Institution." "Final Decision: All Claims Unpatentable" maps to "Invalidity," "Final Decision: All Claims Upheld" maps to "No Invalidity," and "Institutional

The data for the plot is provided in Table 6. The validity outcomes were plotted against the number of office actions received by a patent with a given litigation outcome. As discussed in Section III.C, validity outcomes for patents with five or more office actions were grouped together in a single bucket. The trendlines in Figure 1 show a positive correlation between the likelihood of invalidity and the number of office actions, apparent by the R-squared value of 0.65, and a close fit of the data to the trendlines, with an RMSE of 0.025.[111] In other words, the more office actions a patent application receives before allowance, the more likely the issued patent will be found invalid during litigation. While the data shows only a small increase in the likelihood of invalidity — from thirty-five percent at zero office actions to forty-one percent at five or more office actions — this trend is significant because it contradicts the hypothesis of this Article — that more rejections lead to narrower claims that are less likely to be found invalid. In other words, these results dispel the myth that patents allowed more quickly by the patent office are "bad" and easier to invalidate.

While the reasons for this unexpected trend are not clear, there are a few possible explanations. First, it is possible that a higher number of

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Decision: Denied Institution" maps to "No Invalidity." "Institutional Decision: Denied Institution" maps to "No Invalidity" because it is the primary step where the PTAB considers prosecution history, and because of this, if the board denies the institution, it is equivalent to the board deeming the patent valid.

111. While the trendline here is shown as a linear trend, it may be more accurate to interpret as a step function. The invalidity rate appears to jump in a stepwise fashion, from an approximately 36% invalidity rate at zero to three office actions, then moving to a 41% invalidity rate at four and five or more office actions. The abrupt shift in invalidity rate suggests that the quality of examination declines after the fourth office action. This step-function type trend may be caused by the USPTO's productivity quotas influencing examiner behavior. The fourth office action is typically a final office action, which means the applicant must file a RCE to make any amendments and reopen examination. As noted in Section II.C, when considering the type of action to issue following an applicant's response to a final office action with a RCE, the count system may incentivize examiners to issue a notice of allowance instead of a new non-final office action. When the examiner initially examines the application, they receive 1.25 counts to prepare a non-final office action, but this decreases to 1.00 counts after the filing of a first RCE, and decreases again to 0.75 counts for the second and subsequent RCE. Thus, the count system may be incentivizing examiners to issue a notice of allowance after the fourth office action (worth 0.50 counts) rather than issuing a fifth office action (which is typically a third non-final action, and thus worth only 0.75 counts). While the examiner receives slightly more counts for preparing the fifth office action in this scenario, the examiner may prefer to allow the case rather than issue another rejection because preparing a new non-final office action would likely be significantly more work than preparing the notice of allowance. *See supra* Section II.C; *see also* USPTO JOINT LAB. & MGMT. COUNT SYS. TASK FORCE, OVERVIEW OF COUNT SYSTEM INITIATIVE AND CHANGES 1, 7 (Mar. 8, 2010), https://www.uspto.gov/sites/default/files/patents/init_events/Count_System_changes-Overview_3-8-2010.ppt [https://perma.cc/G85B-Y8UF] (while an allowance would net an examiner 0.5 counts and another non-final or first action on the merits following a second RCE would net 0.75 counts, the mere additional 0.25 counts earned for the effort of performing a prior art search and drafting a rejection may incentivize examiners to simply allow the claims instead); Frakes & Wasserman, *supra* note 5, at 551–552; *see also* USPTO EXAMINATION TIME, *supra* note 70, at 13 ("In most but not all cases, RCEs carry a fraction of a PU (e.g., 1.75 counts) and the credit for a first action is reduced by a corresponding amount.").

office actions is indicative of a patent space that is more crowded with prior art.[112] Thus, even for patents that were significantly narrowed during prosecution to overcome multiple office actions, because the patent space is more crowded, litigants may be able to easily find alternative prior art to use when challenging the novelty and non-obviousness of the patent under §§ 102 and 103, respectively. Second, it is possible that as the number of office actions increases, the likelihood of the applicant adding new matter to the claims increases as the applicant attempts to overcome rejections. Every time the applicant amends the claims, they risk adding claim elements that lack support in the specification in violation of written description and enablement requirements of § 112, thus increasing the likelihood of invalidity. Unfortunately, the data extracted from PatentAdvisor for this Article does not include information on the specific types of statutory rejections the patents received during prosecution.[113] As such, it cannot be determined if one, both, or neither explanation is correct.

In prior research on this topic, Professor Mark Lemley proposed two alternative hypotheses as to whether a longer prosecution history would lead patents to be more frequently found invalid or valid in litigation.[114] First, Lemley hypothesized that patents with a longer prosecution history would be more likely to be found invalid because applicants are somehow able to "wear[] down" patent examiners, such that they grant allowances out of fatigue rather than merit.[115] Such applications would be hypothetically allowed notwithstanding any deficiencies related to validity and thus would be more likely found invalid in litigation.[116] Second, Lemley hypothesized in the alternative that

112. As used here, "patent space" indicates the available analogous art in the technical field of the patent claims.

113. This may be an interesting area of investigation for future researchers. After discussing these results with numerous patent litigation experts, the Authors' educated guess is that the first explanation — that more office actions are indicative of a more crowded patent space — is likely correct.

114. Lemley, *supra* note 4, at 417 ("Hypothesis 3a: Patents with a long prosecution history are more likely to be found invalid in litigation than patents with a short prosecution history."); *id.* at 418 ("Hypothesis 3b: Patents with a long prosecution history are more likely to be found valid in litigation than patents with a short prosecution history.").

115. *Id.* at 417 ("As a result of the structure of the PTO examination system, therefore, it might be reasonable to hypothesize that patents with a long prosecution history are of dubious validity — that they result from wearing the Examiner down rather than from an Examiner's change of heart about patentability."). Note this theory of "wearing the Examiner down" may explain the step-function type trend observed in Figure 1, where the examiner grants a notice of allowance after the fourth or subsequent office action due to fatigue rather than take the time to issue another rejection. *See supra* note 111.

116. *See* Lemley, *supra* note 4, at 417–18 ("It is received wisdom among litigators that patents that have been 'thoroughly' examined by the PTO are more likely to be held valid than patents that 'sailed through' the Office . . . . Thus, if the Examiner has actually considered most of the relevant prior art, the patent may be harder to attack in litigation."). Lemley argued that this would be because a determined applicant may amend its application numerous

patents with longer prosecution histories would be less likely to be found invalid because the presumed additional scrutiny and prior art searches from the longer prosecution would be more trusted by the court.[117] Lemley also speculated, similarly to this Article, that additional examination length would lead to narrower claims that would be more likely found valid.[118] However, both hypotheses proved to be incorrect — Lemley's research found that prosecution length has no effect on patent validity in litigation.[119] Lemley's research reviewed 197 reported utility patent decisions between 1989 and 1994, in which 110 patents were found valid and eighty-seven were found invalid during litigation.[120] The valid patents had an average prosecution length of 1,238 days, while the invalid patents had an average prosecution length of 1,320 days.[121] Given the difference in average prosecution length between valid and invalid patents was only 82 days (6.6%), Lemley concluded there was no significant relationship between the length of time a patent spends in prosecution and validity.[122]

But Lemley's conclusion is contradicted by the results of this Article, which show a positive correlation between an increasing number of office actions and an increasing likelihood of invalidity. The contradiction between Lemley's results and those of this Article may be explained by several reasons. Firstly, Lemley analyzed far fewer cases and outcomes than this Article — only 197 litigation outcomes compared to 7,633 litigation outcomes in this Article.[123] As such, Lemley's dataset simply may have been too small to observe any trends with statistical significance. Secondly, and likely of more consequence,

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times, or abandon and re-file continuations or continuations-in-part, as many times as needed until an allowance is achieved. *Id.* at 417. Lemley hypothesized that applications with any sort of lengthy prosecution history are likely ultimately accepted by examiners out of convenience rather than for substance. *Id.* He also hypothesized that patents with longer prosecution histories are more likely to be found invalid as a result of wearing the Examiner down rather than from an Examiner's change of heart about patentability. *Id.*

117. *Id.* at 417–18.

118. *Id.* ("It is received wisdom among litigators that patents that have been 'thoroughly' examined by the PTO are more likely to be held valid than patents that 'sailed through' the Office. In part, this is because fact-finders are often unwilling to second-guess the Examiner regarding a particular piece of prior art. Thus, if the Examiner has actually considered most of the relevant prior art, the patent may be harder to attack in litigation. A long examination period may also mean a series of amendments to claim language, which have narrowed the claims sufficiently that they are more likely to be valid.").

119. *Id.* at 421 ("There is no significant relationship between the length of time a patent spends in prosecution and whether or not it is found valid in court. Hence, both Hypothesis 3a and 3b must be rejected.").

120. *Id.* at 418–20.

121. To calculate prosecution timeframe, Lemley took the time in between the issue date and the filing date of the patent. *Id.* at 384 ("This number was calculated by measuring the length of time (in days) between the first United States filing of a related application and the date on which the patent was issued.").

122. *Id.* at 419–20.

123. *Id.* at 371.

Lemley's measure of prosecution "length" is different than the measure used in this Article. In Lemley's article, the length of prosecution was measured using a direct measure of time — the number of days from when a patent application was filed to when the patent was issued.[124] By contrast, this Article measures the "length" of prosecution using an indirect measure of time — the number of office actions a patent receives before it is issued. Because patent examiners are only allocated a limited amount of time to review an application, looking at the number of office actions issued during prosecution is likely a better predictor of examination thoroughness than Lemley's direct measure of time from filing to issuance.

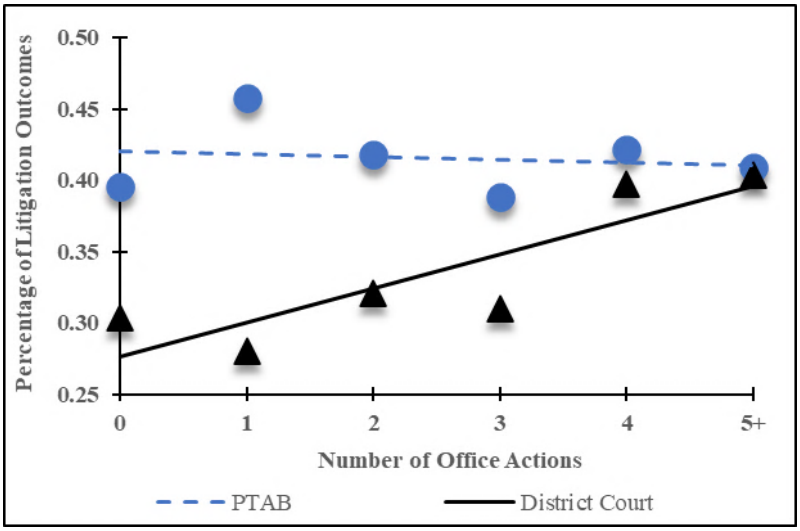

Figure 2: Plot of Invalidity Rates by Tribunal

# of OAs	0	1	2	3	4	5+	Sample Size	R-Squared	RMSE
District Court	30%	28%	32%	31%	40%	40%	3841	0.75	0.047
PTAB	40%	46%	42%	39%	42%	41%	3792	0.023	0.022

Table 7: Data for Figure 2

Next, the invalidity data was separated by tribunal. District courts and the PTAB have different procedures and standards for claim

124. *Id.* at 384.

construction. Notably, the PTAB applies the "broadest reasonable construction" standard, which is the same standard used by examiners during prosecution.[125] By contrast, district courts will construe claims using their ordinary and customary meaning, in the context of the specification and file history, and read to preserve validity.[126] Thus, which tribunal a patent is challenged in should have an impact on litigation outcomes. Figure 2 is a plot of validity outcomes for litigated patents in terms of percentage of total outcomes by tribunal. The data for the plot is provided in Table 7. The district court data includes validity outcomes for litigated patents where there was a finding of either "invalidity" or "no invalidity," which is how validity outcomes are reported by PatentAdvisor. The PTAB data includes the same validity outcomes (which are denoted as "Final Decision: All Claims Upheld" for a valid patent, and "Final Decision: All Claims Unpatentable" for an invalid patent), and additionally includes the outcome of "Institutional Decision: Institution Denied," which is counted as a "no invalidity" outcome since a denial of institution indicates that the petitioner failed to demonstrate a reasonable likelihood that any claims would be found unpatentable.[127] It is also notable that "Institutional Decision: Denied Institution" represents a large number of outcomes, and discarding it would lead to a skewed analysis.[128] As discussed in Section III.C, validity outcomes for patents with five or more office actions were grouped together in a single bucket.

The trendlines in Figure 2 show a striking difference between validity outcomes in district courts compared to the PTAB. Like the general trendlines in Figure 1, the trendline for district court outcomes

125. *See* In re Cuozzo Speed Techs., LLC, 793 F.3d 1268, 1276–77 (Fed. Cir. 2015) ("This court has approved of the broadest reasonable interpretation standard in a variety of proceedings, including initial examinations, interferences, and post-grant proceedings such as reissues and reexaminations . . . . [W]e have cited the long history of the PTO's giving claims their broadest reasonable construction."); Cuozzo Speed Techs., LLC v. Lee, 579 U.S. 261, 283 (2016) ("The Patent Office is legally free to accept or reject such policy arguments on the basis of its own reasoned analysis. Having concluded that the Patent Office's regulation, selecting the broadest reasonable construction standard, is reasonable in light of the rationales described above, we do not decide whether there is a better alternative as a policy matter.").

126. Phillips v. AWH Corp., 415 F.3d 1303, 1312 (Fed. Cir. 2005) ("We have frequently stated that the words of a claim 'are generally given their ordinary and customary meaning.'"); *id.* at 1327 ("[W]e have acknowledged the maxim that claims should be construed to preserve their validity."); *id.* at 1317 ("In addition to consulting the specification, we have held that a court 'should also consider the patent's prosecution history' if it is in evidence.").

127. 35 U.S.C. § 314(a) ("The Director may not authorize an inter partes review to be instituted unless the Director determines that the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.").

128. There are 1704 outcomes of "Institutional Decision: Denied Institution" in our data, representing 44.9% (1704/3792) of PTAB outcomes in our dataset. *See also* ELAINE CHOW, LEX MACHINA PATENT LITIGATION REPORT 2024 30 (2024) (stating that "Institutional Decision: Denied Institution" makes up 21% of all PTAB cases from 2021–2023).

shows a positive correlation between the likelihood of invalidity and the number of office actions, apparent by the R-squared value of 0.75, and a close fit of the data to the trendline, with an RMSE of 0.047. This aligns with the general trend for invalidity observed for all patents illustrated in Figure 1 — the more office actions a patent application receives before allowance, the more likely the issued patent will be found invalid during litigation. By contrast, the trendline for PTAB outcomes shows essentially no correlation between the likelihood of invalidity and the number of office actions, with a low R-squared value of 0.023, and a close fit of the data to the trendline, with an RMSE of 0.022. These results show that patents are more likely to be found invalid at the PTAB compared to district court, and that these patents are more consistently found invalid, regardless of the number of office actions and corresponding thoroughness of examination of those patents. As such, the simple takeaway from these results is that patent challengers should almost always attempt to invalidate patents at the PTAB, while patent holders should seek to avoid such invalidation attempts before the PTAB.[129]

While the reasons for the difference between district court and PTAB outcomes are not clear, several potential explanations warrant consideration. Firstly, as noted above, the PTAB uses a broader claim construction standard, which should make it easier for challengers to invalidate claims based on novelty or obviousness grounds. Secondly, the elevated invalidity rate at the PTAB may be attributed to the stringent qualifications mandated for administrative patent judges, who are required by statute to possess "competent legal knowledge and scientific ability."[130] This prerequisite ensures that PTAB judges are comparatively well-versed in both patent and technical matters, which may foster a heightened skepticism towards patent claims, irrespective of the thoroughness of examination of those claims during their prior

129. *See, e.g.*, *PTAB Statistics Background*, US INVENTOR, https://usinventor.org/ptab-statistics [https://perma.cc/G2LG-VCR4] ("Once instituted, a patent is stripped of the presumption of validity and the procedures heavily favor invalidation. Previous reports have shown that the PTAB invalidates 84% of patents (in part or whole) that reach a final decision.").

130. 35 U.S.C. § 6 ("The administrative patent judges shall be persons of competent legal knowledge and scientific ability."); *see also* USPTO, APJ RECRUITMENT BROCHURE 2, https://www.uspto.gov/sites/default/files/documents/ptab_brochure_v2_4_10_14.pdf [https://perma.cc/M76T-33TB] (The basic qualifications for an administrative patent judge include "[m]any years of experience in the practice of patent law" and "[d]egree(s)/work experience in science or engineering."). Kymab Group Ltd, *Kymab Announces that the US Patent Trial and Appeal Board Rejects a Fifth Request by Regeneron for Invalidation of Kymab's US Patents*, https://www.globenewswire.com/en/news-release/2020/06/03/2042773/0/en/Kymab-announces-that-the-US-Patent-Trial-and-Appeal-Board-rejects-a-fifth-request-by-Regeneron-for-invalidation-of-Kymab-s-US-patents.html [https://perma.cc/D68X-X887] ("Administrative patent judges are required by statute to be 'persons of competent legal knowledge and scientific ability.' Thus, every APJ must have a technical background, in addition to a law degree, and experience in the legal field. Many APJs also have had distinguished engineering or scientific careers in addition to their extensive legal experience").

prosecution. Thirdly, the PTAB uses a lower standard than district courts for finding invalidity. In district court, invalidity must be proven by "clear and convincing" evidence, which gives patents a relatively strong presumption of validity in litigation.[131] In contrast, invalidity at the PTAB only needs to be proven using the lesser "preponderance of evidence" standard, which significantly diminishes the presumption of validity during these administrative proceedings.[132] Thus, the higher invalidity rates at the PTAB for all patents, regardless of the number of office actions associated with them, should be expected. Finally, the procedural differences between PTAB and district court proceedings contribute to distinct adjudicative approaches. Once a patent is instituted for review at the PTAB, the panel does not give deference to the examination history and instead focuses on identifying examiner errors.[133] Consequently, the panel's scrutiny is not influenced by the thoroughness of the examination process, potentially amplifying the likelihood of invalidity findings. By contrast, district court proceedings may be influenced more by the examination history, wherein the frequency of rejections may signal proximity to prior art, facilitating a more robust invalidity defense.[134] This divergence underscores the importance of litigation strategies tailored to the nuances of each adjudicative forum, where factors such as judicial expertise and procedural considerations exert considerable influence on validity determinations.

131. MANUAL OF PATENT EXAMINING PROCEDURE § 2286 (9th ed. 2023) ("Specifically, invalidity in a district court must be shown by "clear and convincing" evidence, whereas in the Office, it is sufficient to show unpatentability by a "preponderance of evidence." Since the "clear and convincing" standard is more difficult to satisfy than the "preponderance" standard, deference will ordinarily be accorded to the factual findings of the court where the evidence before the Office and the court is the same.").

132. *Id.*; *see also* 35 U.S.C. § 316(e) ("In an inter partes review instituted under this chapter, the petitioner shall have the burden of proving a proposition of unpatentability by a preponderance of the evidence.").

133. *See* Cuozzo Speed Techs. LLC v. Lee, 579 U.S. 261, 279 (2016) (explaining that the "basic purpose[]" of inter partes review is "to reexamine an earlier agency decision").

134. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., Ltd., 535 U.S. 722, 733 (2002) ("Prosecution history estoppel requires that the claims of a patent be interpreted in light of the proceedings in the PTO during the application process."); *see also* Pacific Coast Marine Windshields Ltd. v. Malibu Boats, LLC, 739 F.3d 694, 700 (Fed. Cir. 2014) (applying *Festo*).

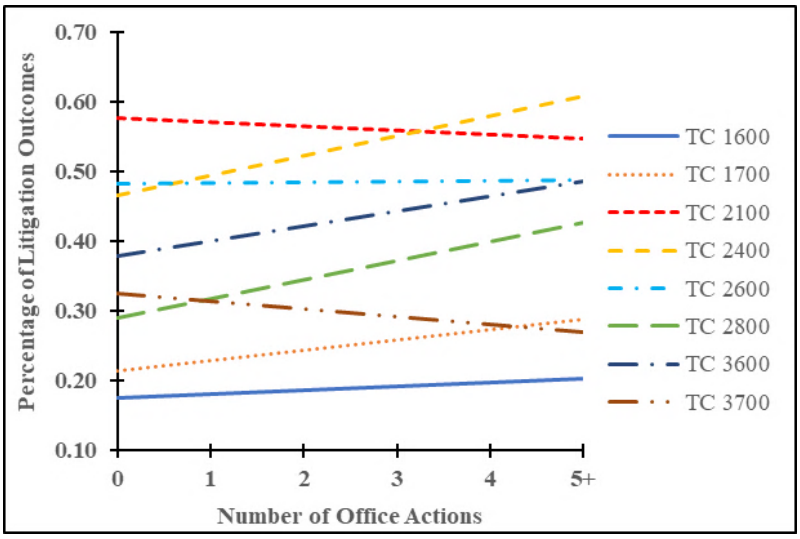

Figure 3: Plot of Invalidity Rates by Technology Center

# of OAs	0	1	2	3	4	5+	Sample Size	R-Squared	RMSE
TC 1600	17%	21%	19%	15%	20%	22%	1559	0.15	0.022
TC 1700	14%	28%	28%	27%	31%	23%	481	0.21	0.049
TC 2100	60%	53%	58%	54%	59%	53%	656	0.11	0.028
TC 2400	49%	47%	50%	51%	70%	55%	778	0.39	0.060
TC 2600	47%	51%	53%	44%	41%	55%	986	0.0014	0.051
TC 2800	32%	31%	35%	29%	46%	43%	1214	0.52	0.045
TC 3600	37%	46%	37%	38%	52%	48%	1250	0.36	0.048
TC 3700	31%	26%	32%	40%	27%	22%	709	0.11	0.053

Table 8: Data for Figure 3

Table 8 above shows the invalidity data separated by technology center. As discussed above, because each technology center has a different allowance rate and a different average number of actions to allowance, the thoroughness of examination would be expected to vary by technology center. Thus, which technology center a patent application gets assigned to should have an impact on litigation outcomes.

Consistent with the hypotheses of this Article, one would expect technology centers with lower allowance rates (indicative of "tougher" examiners) to have lower invalidity rates. In other words, the "tougher" technology centers should produce higher-quality patents that are less likely to be invalidated. The allowance rate in prosecution for each technology center compared to the invalidity rate for that technology center is shown in the table below. The technology centers are sorted in order of allowance rate, and this table shows invalidity rates do not align with allowance rates. Rather, the high invalidity rates for technology centers are likely more influenced by § 101 issues, as seen in Technology Centers 2100, 2400, and 3600, each of which has above-average rates of patentable subject matter rejections.[135]

Technology Center	**Field**	**Allowance Rate**[136]	**Invalidity Rate**[137]
1600	Biotechnology and Organic Chemistry	57.9%	19.2%
1700	Chemical and Material Engineering	65.1%	26.0%
3600	Transportation, Construction, Electronic Commerce, Agriculture, and National Security	68.1%	42.5%
3700	Mechanical Engineering, Manufacturing, Gaming, and Medical Devices/Processes	71.3%	29.3%
2100	Computer Architecture and Software	75.8%	55.5%
2400	Networking, Multiplexing, Cable, and Security	78.7%	50.6%
2600	Communications	79.7%	50.1%
2800	Semiconductors/Memory, Circuits/Measuring and Testing, Optics/Photocopying, Printing/Measuring and Testing	83.1%	32.5%

Table 9: Allowance and Invalidity Rates by Technology Center

135. *See* Avery & Moshiri, *supra* note 11, at Figure 1 (showing at least Technology Centers 2100, 2400, and 3600 had a higher rate of Section 101 rejections in 2018 than the average among all technology centers, and Technology Center 3600 continued to have a higher rate of Section 101 rejections in 2019, even after the issuance of the January 2019 Guidance).

136. *See, e.g.*, *Biotechnology and Organic Chemistry Search Results*, *supra* note 63. This data was accessed February 23, 2024, and covers patent applications with electronic file histories that were filed on or after November 29, 2000. PatentAdvisor regularly updates this data, and these values reflect PatentAdvisor's data as of February 23, 2024.

137. To calculate "Invalidity Rate," we took the total number of patents that were marked invalid or not invalid in our dataset. We then separated them by Technology Center, and then we calculated the respective percentage of patents that were deemed invalid by dividing the total number of invalid patents by the sum of invalid and not invalid patents.

The trendlines in Figure 3 show that, for nearly every technology center, the rate of invalidity increases as patents receive more office actions. The trends for most of the individual technology centers align with the general trend for invalidity observed for all patents illustrated in Figure 1. The only exceptions are Technology Center 2100, which handles applications in the field of Computer Architecture and Software, and Technology Center 3700, which handles applications in Mechanical Engineering, Manufacturing, Gaming, and Medical Devices/Processes. In both Technology Centers 2100 and 3700, there is a slight negative correlation between the likelihood of invalidity and the number of office actions, apparent by the R-squared value of 0.11 for both trendlines. Notably, the sample sizes for these technology centers are among the smallest that were individually analyzed, so it is possible that the data is not representative and the unexpected trends may be the result of statistical error. But, assuming the data is representative and not a result of statistical error, there may be some possible explanations for these deviations from the general trend.

For Technology Center 2100, one explanation for the deviation may be that it has among the highest rates of § 101 rejections during examination at the patent office, and these infirmities with respect to subject matter eligibility may be revisited during litigation.[138] However, subject matter eligibility cannot be raised as a grounds for invalidity at the PTAB — as such, the frequency of § 101 rejections in Technology Center 2100 can only partially explain this trend.[139] In addition to the high rate of § 101 rejections, Technology Center 2100 also has one of the highest overall allowance rates, at 75.8 percent. When these factors — the inconsistent application of the two-step test from *Alice v. CLS Bank*, the high allowance rate suggesting less thorough examination, and the uncertain nature of many cases facing § 101 rejections — are considered together, it becomes apparent that Technology Center 2100 is likely allowing a significant number of patents that are marginal with respect to subject matter eligibility. This combination of factors may explain why subsequent district court litigation tends to result in higher rates of invalidation for patents from Technology

138. *See* Avery & Moshiri, *supra* note 11 (showing a pre-January 2019 USPTO Guidance rate of 40.73 percent for office actions with § 101 rejections); *see also* Samuel Hayim & Kate Gaudry, *Eligibility Rejections are Appearing in Greater Frequency Across all Computer Related Technology Centers*, IP WATCHDOG (May 24, 2018), https://ipwatchdog.com/2018/05/24/eligibility-rejections-greater-frequency-uspto/id=97615/ [https://perma.cc/5KTH-CEQU] (showing § 101 rejections were common across computer related technology centers).

139. *See* 37 C.F.R. § 42.104(b) (identifying only the specific statutory grounds of 35 U.S.C. § 102 and/or § 103 on which the challenge to the claim may be based).

Center 2100, especially when there are fewer office actions during prosecution.[140]

As for Technology Center 3700, one explanation of its deviation from the general trend may be that examiners in Technology Center 3700 spend a relatively short amount of time examining applications, with most spending no more than fifteen hours to do an initial examination of an application and prepare a first office action.[141] This initial lack of thoroughness in examination could explain why an increase in office actions (i.e., more time for examination) could lead to lower invalidity rates. This theory seems reasonable, especially when Technology Center 3700 is compared to Technology Center 2400, which has the second highest percentage of examiners (fifty-six percent) reporting spending more than sixteen hours on the first office action on the merits, and one of the highest correlation metrics (R-squared of 0.39) between increase in office action and increase in invalidity.[142]

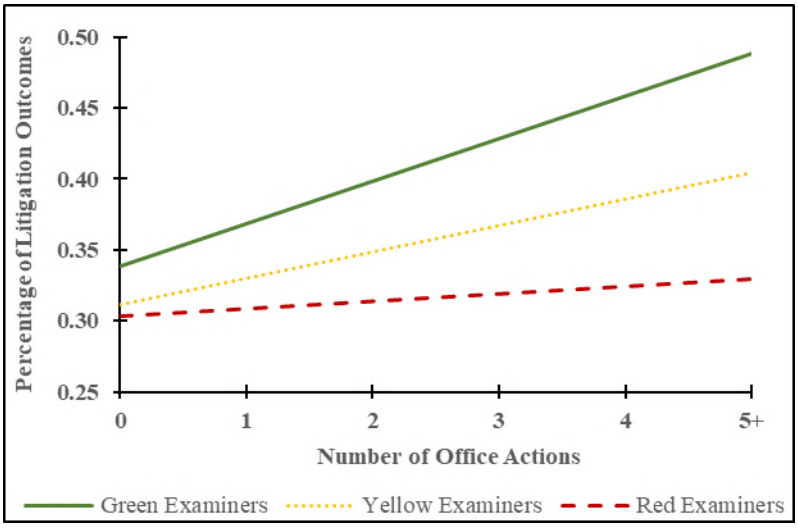

Figure 4: Plot of Invalidity Rates by Examiner Toughness

140. *See, e.g.*, Alice Corp. Pty. v. CLS Bank Int'l, 573 U.S. 208 (2014); Mayo Collaborative Servs. v. Prometheus Lab'ys., Inc., 566 U.S. 66 (2012); *see also* Avery & Moshiri, *supra* note 11 ("[A]ccording to the USPTO, Examiners have found it difficult to consistently apply Step 2A.8. The lack of a clear framework gave Examiners discretion to broadly interpret what constituted an 'abstract idea' and described in such a way that it could be rejected under Section 101").

141. *See* U.S. GOV'T ACCOUNTABILITY OFF., GAO-16-478SP, SURVEY OF PATENT EXAMINERS (2016), https://files.gao.gov/special.pubs/gao-16-478sp/results.htm#question_192 [https://perma.cc/GA56-ST8S]. A survey of all patent examiners from 2016 stated that Technology Center 1600 and Technology Center 3700 had two of the three lowest sixteen+ hour reviews, by percentage of examiners, for First Office Actions on the Merits. *Id.*

142. *See id.*

# of OAs	0	1	2	3	4	5+	Sample Size	R-squared	RMSE
Green	36%	38%	38%	38%	48%	51%	3952	0.83	0.024
Yellow	30%	35%	36%	34%	41%	40%	2617	0.74	0.019
Red	29%	31%	32%	30%	39%	29%	702	0.065	0.034

Table 10: Data for Figure 4

Finally, validity data was analyzed with respect to examiner "toughness," which is shown in Figure 4 and Table 10. As discussed previously, this Article hypothesizes that the thoroughness of examination is expected to correlate with the toughness of the examiner. For toughness, this Article borrows the definition used by PatentAdvisor, where examiners are categorized as "Red" (i.e., the toughest examiners with relatively low allowance rates and a high average number of office actions to allowance), "Yellow" (i.e., moderately tough examiners), and "Green" (i.e., the easiest examiners with relatively high allowance rates and a low average number of office actions to allowance).[143] The classification of an examiner as being Green, Yellow, or Red is based on a propriety calculation by PatentAdvisor, which they call an "ETA measurement."[144] According to PatentAdvisor, the calculation is based on a number of factors, including the examiner's allowance rate; years of service with the USPTO; and total number of issued patents, abandoned applications, and pending applications.[145] These factors are used to calculate a single value between zero and ninety-nine, which is what PatentAdvisor calls an ETA measurement.[146] A Green examiner has an ETA measurement between 0.1 and 2.5 (inclusive). A Yellow examiner has an ETA measurement between 2.6 and 5.9 (inclusive). A Red examiner has an ETA measure of 6.0 and above.[147] This Article adopts an identical definition of "Green," "Yellow," and "Red" examiners. Note that 362 rows out of the 7,633 total rows (4.74 percent) used in the

143. *See* PATENTADVISOR, https://go.patentadvisor.com/tools/online-manual.php?fn=ETA.pdf [https://perma.cc/M59X-UMXM] (explaining that PatentAdvisor measures examiner toughness using a proprietary metric that takes "into consideration the examiner's pending portfolio, how long they have been at the Patent Office, number of office actions written and a number of other factors"). PatentAdvisor does not disclose exactly how the various factors are used to determine their ETA metric.

144. *Id.*

145. *Id.*

146. *Id.*; *see also Patent Prosecution Analytics No Longer Just a Nice to Have*, LEXISNEXIS (Aug. 31, 2021) https://www.lexisnexisip.com/wp-content/uploads/2022/06/Patent-Prosecution-Analytics-No-longer-a-nice-to-have-SLIDES.pdf [https://perma.cc/9SWR-4SA5].

147. *See* PATENTADVISOR, *supra* note 143.

overall validity analysis above are missing ETA values, as explained in Section III.B, and thus are not included in this analysis.[148]

The average allowance rates for each type of examiner compared to the invalidity rates for patents examined by that type of examiner are shown in the table below. As expected, this table shows that the average allowance rate for each type of examiner positively correlates with the respective invalidity rate for litigated patents examined by those examiners.

Examiner Toughness	**Average Allowance Rate**[149]	**Invalidity Rate**[150]
Green	83.2%	40.5%
Yellow	65.9%	38.0%
Red	42.7%	31.6%

Table 11: Allowance and Invalidity Rates by Examiner Toughness

As seen in Figure 4, for patents that face the toughest examiners ("Red"), there is almost no correlation between the likelihood of invalidity and the number of office actions (R-squared = 0.065). The likelihood of invalidity stays approximately constant at thirty-one percent as the number of office actions increases. Taken together, these trends suggest that these tough examiners provide a more consistently thorough examination, regardless of the number of office actions. In other words, additional office actions are not needed for a tough examiner to provide a thorough examination.

In contrast, for patents examined by the easiest examiners ("Green"), there is a strong positive correlation between the likelihood of invalidity and the number of office actions (R-squared = 0.83). Finally, for patents examined by Yellow examiners, there is also a significant positive correlation between the likelihood of invalidity and the number of office actions (R-squared = 0.74). These results align with hypotheses of this Article. Examiners that are tougher will be more likely to thoroughly scrutinize patent applications at every stage of examination and less likely to give an allowance. Thus, if these tougher examiners do give an allowance, it suggests the application survived a more rigorous examination process. As a result, it follows that patents

148. *See supra* text accompanying note 105.

149. Average allowance rate is calculated by summing each individual examiner's allowance rate of that type and dividing by how many examiners there are of that type.

150. To calculate "Invalidity Rate," we took the total number of patents that were marked invalid or not invalid in our dataset. We then separated them by examiner toughness, and then we calculated the respective percentage of patents that were deemed invalid by dividing the total number of invalid patents by the sum of invalid and not invalid patents for that examiner type.

granted by Red examiners are less likely to be found invalid when litigated.

Prior research by Dr. Michael Sartori gathered data with respect to examiner toughness (i.e., Green, Yellow, and Red examiners) between 2009 and 2019 and its effect on the relative number of patents issued each year for each of Green, Yellow, and Red examiners.[151] Sartori performed analysis on Green, Yellow, and Red examiners to determine if an applicant had to expend additional effort during prosecution.[152] The study showed that applications assigned to Red examiners, after receiving a final rejection, had lower allowance rates post amendment, were less likely to win on appeal, and more likely to require the applicant to file a Request for Continued Examination.[153]

Additional analysis was performed by Sartori to determine how these patents, sorted by examiner type, performed in litigation.[154] Sartori separately analyzed district court outcomes and PTAB outcomes.[155] He then defined a "win" outcome for each outcome with respect to the patent holder.[156] For district court, a "win" was defined as a finding of no invalidity, infringement, or no unenforceability.[157] For the PTAB, a "win" was defined as a pre-institution decision where the proceeding is procedurally dismissed, an institution decision where institution is denied, a post-institution decision where the proceeding is procedurally dismissed, or a final decision with all claims upheld.[158]

After plotting the percentage of each case "win" against cases litigated from 2009 to 2019, Sartori averaged the win rates to come up

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151. Michael Sartori & Matt Welch, *How USPTO Examiner Type Affects Patents: Part 1*, LAW360 (May 15, 2020), https://www.law360.com/ip/articles/1263311/how-uspto-examiner-type-affects-patents-part-1 [https://perma.cc/MPD9-8MDW].

152. Michael Sartori & Matt Welch, *How USPTO Examiner Type Affects Patents: Part 3*, LAW360 (July 15, 2020), https://www.law360.com/articles/1283670/how-uspto-examiner-type-affects-patents-part-3 [https://perma.cc/KX79-QX2B]; Michael Sartori & Matt Welch, *How USPTO Examiner Type Affects Patents: Part 2*, LAW360 (June 16, 2020), https://www.law360.com/articles/1282928/how-uspto-examiner-type-affects-patents-part-2 [https://perma.cc/D8P8-UMGW] (Stating that their data revealed that the type of examiner can lead to increased effort by applicants, as reflected in higher allowance rates, more office actions per disposal, longer time to disposal, and a higher incidence of final office actions, interviews, and multiple final or restriction office actions.).

153. Michael Sartori & Matt Welch, *How USPTO Examiner Type Affects Patents: Part 3*, LAW360 (July 15, 2020), https://www.law360.com/articles/1283670/how-uspto-examiner-type-affects-patents-part-3 [https://perma.cc/KX79-QX2B].

154. Michael Sartori & Matt Welch, *How USPTO Examiner Type Affects Patents: Part 4*, LAW360 (Aug. 21, 2020), https://www.law360.com/ip/articles/1283679/how-uspto-examiner-type-affects-patents-part-4 [https://perma.cc/B9HG-BB3L].

155. *Id.*

156. *Id.*

157. *Id.*

158. *Id.* In contrast to Sartori and Welsh, this Article does not count "a post-institution decision where the proceeding is procedurally dismissed" as equivalent to a "no invalidity" outcome. The focus of this Article is on the merits of the examination at the USPTO, not procedural dismissals, which do not necessarily reflect on the merits of the underlying patent.

with a single number to compare Green, Yellow, and Red examiners.[159] Sartori found that in district court, patents examined by Green examiners were six percent more likely to win than those examined by Red examiners.[160] However, in the PTAB, patents examined by Red examiners were thirty-three percent more likely to win than those examined by Green examiners.[161] Sartori hypothesized that one possible reason for the success of patents examined by Red examiners in the PTAB was that these patents are subject to longer prosecutions, which leads to narrow claims that are more likely to withstand invalidity contentions.[162]

These findings only partially align with our results. While Sartori found that patents from Green examiners performed better in district court while those from Red examiners performed better at the PTAB, our analysis shows that patents from Red examiners performed better in *both* forums.[163] These differing findings are most likely due to how our results were tabulated compared to Sartori's results. Critically, Sartori potentially double-counts "wins" — meaning if a single patent was found to be both valid and infringed, that would be counted as two "wins."[164] Furthermore, Sartori averages percentages of "wins" over year-to-year totals.[165] This result means that a win rate of fifty percent one year and sixty percent the next would result in a fifty-five percent overall win rate.[166] In this Article, validity "wins" are analyzed separately from infringement "wins," and thus there is no double-counting.[167]

Sartori also examined what he considered "losses" in the PTAB.[168] In the PTAB a "loss" is defined as: a pre-institution decision where the

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159. *Id.*

160. *Id.*

161. *Id.* ("Comparing patents examined by green examiners to patents examined by red examiners, patents examined by red examiners have a 33% better chance of a patent owner win at the PTAB.").

162. *Id.* (Explaining that patents examined by Red examiners with longer prosecutions "may tend to be more vetted by having more prior art applied and/or more narrowing claim amendments . . . result[ing] in a patent less prone to invalidity challenges at the PTAB. This viewpoint may help to explain why patents examined by red examiners are more likely to have patent owner wins at the PTAB than those examined by green examiners.").

163. While not shown in Figure 2, we separately calculated that validity rates in district court for patents from Green examiners were sixty-seven percent while those from Red examiners were seventy-one percent. Similarly, we calculated that validity rates at the PTAB for patents from Green examiners were fifty-four percent, while those from Red examiners were sixty-six percent.

164. Sartori & Welch, *supra* note 152. Note that it is not entirely clear from Sartori's article if they include a separate "win" from each outcome. Either way, Sartori's counting system seems distinct from the one in this Article.

165. *Id.*

166. *Id.*

167. In our analysis, a validity "win" is counted for a case outcome of "No Invalidity" in district court, and a case outcome of either "Institutional Decision: Denied Institution," or "Final Decision: All Claims Upheld" at the PTAB.

168. Sartori & Welch, *supra* note 152.

patent owner disclaimed all claims; a post-institution decision where the patent owner disclaimed all claims; a final decision with all claims unpatentable; and a final decision with all claims amended.[169] The analysis in Sartori's work concluded that patents examined by "Red" examiners have a lower chance to "lose" in the PTAB compared to patents examined by Green examiners.[170]

This conclusion aligns with our data. Overall, patents examined by Red examiners have a lower invalidity rate, both in district court and in the PTAB. Furthermore, patents examined by Red examiners are also more likely to win infringement cases in District Court, as will be discussed in Section IV.B. Overall, it seems that patents examined by Red examiners are of higher-quality — from both a validity and infringement perspective — than patents examined by either Yellow or Green examiners.

169. *Id.* ("A patent owner loss includes: a pre-institution decision where the patent owner disclaimed all claims; a post-institution decision where the patent owner disclaimed all claims; a final decision with all claims unpatentable; and a final decision with all claims amended.").

170. *Id.*

B. Infringement

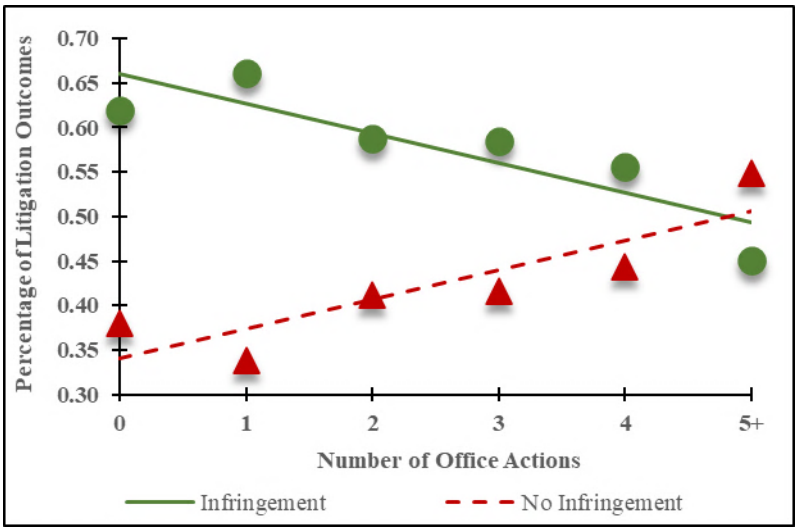

Figure 5: Plot of Infringement and No Infringement Rates Overall

R-squared: 0.76, RMSE: 0.032, Total Sample Size: 4654

# of OAs	0	1	2	3	4	5+
No Infringement	38%	34%	41%	42%	44%	55%
Infringement	62%	66%	59%	58%	56%	45%
Sample Size	710	1825	1073	457	221	368

Table 12: Data for Figure 5

Figure 5 is a plot of infringement outcomes for litigated patents in terms of percentage of the total outcomes where there was a finding of either "no infringement" or "infringement," which is how infringement outcomes are reported by PatentAdvisor. The infringement outcomes were plotted against the number of office actions received by a patent with a given litigation outcome. The data for the plot is provided in Table 12. As discussed in Section III.C, infringement outcomes for patents with five or more office actions were grouped together in a single bucket. The trendlines in Figure 5 show a strong negative correlation between the likelihood of infringement and the number of office actions, apparent by the R-squared value of 0.76, and a close fit of the

data to the trendline, with an RMSE of 0.032.[171] In other words, the more office actions a patent application receives before allowance, the less likely the issued patent will be found infringing during litigation. This trend aligns with the hypothesis of this Article — that more rejections lead to narrower claims that are less likely to be infringed.

This Article assumes that as the number of office actions increases, the applicant will make more amendments to overcome rejections, and each round of amendments will further narrow the scope of the claims.[172] For example, to overcome an obviousness rejection under § 103, the applicant may make amendments to the claims to differentiate the claimed subject matter from the cited art. Each amendment to a claim risks narrowing its scope, either directly by adding additional elements or indirectly via prosecution history estoppel.[173] Therefore, more office actions tend to lead to narrower claims. Because a patent's claims are narrower, the likelihood that a given product or process would fall within the scope of the claims and infringe the patent should decrease, as hypothesized by this Article and illustrated by the trendlines in Figure 5.

171. Note that patents with zero office actions do not seem to follow this trend. We hypothesize that this is because patents that are accepted without any office actions are likely drafted far too narrowly. Because the zero-office-action patents are likely far narrower than one-office-action patents, one-office-action patents will have a higher likelihood of success when asserting infringement.

172. Shine Sean Tu, *Patenting Fast and Slow: Examiner Rejections and Applicant Traversals to Nonprior Art Rejections*, 2021 MICH. ST. L. REV. 411, 430 (2021) ("It is true that more rejections may greatly narrow the scope of the patent . . . ."); *see also* JURISTAT, *supra* note 6 (showing that in 2022, the average independent claim added 53.46 words between filing and allowance, and that the average patent was allowed after 1.9 office actions, indicating that an average of 28.13 words are added to the independent claim per office action (53.46 divided by 1.9).

173. As explained in *supra* Section II.B, any narrowing amendment by the patent applicant to satisfy a statutory requirement of the Patent Act will give rise to prosecution history estoppel, barring equivalence arguments as to the narrowed claim element when determining infringement. *See* Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 736 (2002); *see also* Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 40–41 (1997).

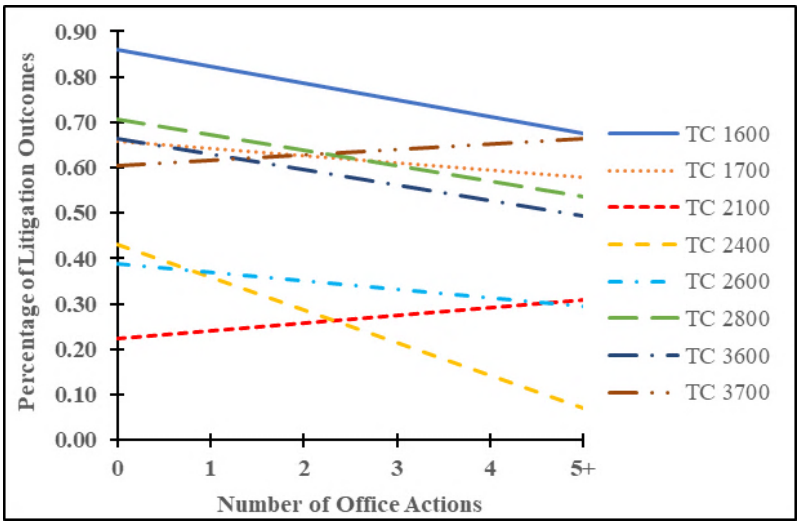

Figure 6: Plot of Infringement Rates by Technology Center

# of OAs	0	1	2	3	4	5+	Sample Size	R-squared	RMSE
TC 1600	87%	84%	75%	79%	66%	70%	1420	0.77	0.034
TC 1700	62%	61%	65%	75%	54%	54%	277	0.14	0.067
TC 2100	16%	39%	11%	36%	29%	29%	345	0.086	0.098
TC 2400	35%	34%	47%	19%	13%	3%	309	0.68	0.084
TC 2600	40%	41%	25%	35%	32%	31%	382	0.33	0.045
TC 2800	74%	68%	63%	57%	45%	65%	650	0.42	0.070
TC 3600	61%	64%	66%	61%	48%	47%	748	0.64	0.044
TC 3700	57%	67%	64%	58%	68%	67%	523	0.24	0.036

Table 13: Data for Figure 6

Next, the infringement data was separated by technology center. Like the invalidity outcomes discussed in Section IV.A, the technology center to which a patent application gets assigned should also have an impact on infringement outcomes. The allowance rate in prosecution for each technology center compared to the infringement rate in litigation for patents from that technology center is shown below in Table 14. The technology centers are sorted in order of average allowance rates,

and this table shows that, in general, technology centers with lower allowance rates tend to have more success at infringement, while those with higher allowance rates tend to produce patents with lower infringement rates. For example, Technology Center 1600 has the lowest allowance rate at 57.9 percent and the highest infringement rate at 79.3 percent. In contrast, the three easiest technology centers, Technology Centers 2100, 2400, and 2600, have the worst infringement rates, ranging from 22.0 to 35.3 percent.[174]

174. Notably, Technology Center 2800 does not follow this trend — it has the highest allowance rate among the technology centers we analyzed at 83.1%, and the second highest infringement rate at 67.5%. This suggests that examiners in this technology center are allowing relatively broad claims with a relatively unthorough examination, which may be due, at least in part, to the ease with which applicants are able to overcome subject matter rejections under § 101. *See Technology Center Deep Dive: A Look at TC 2800*, JURISTAT (Sept. 21, 2020), https://blog.juristat.com/tc-2800 [https://perma.cc/K6E9-6JY8] ("As the technology center that handles computer-related technologies, Alice rejections are a common issue for applicants. But examiners in TC 2800 issue far fewer Alice rejections than their peers in notoriously Alice-prone TC 3600, and the allowance rate for applications that receive Alice rejections in TC 2800 is considerably higher. Thus, . . . there are notably fewer barriers to allowance in TC 2800 than elsewhere at the USPTO.").

Technology Center	**Field**	**Allowance Rate**[175]	**Infringement Rate**[176]
1600	Biotechnology and Organic Chemistry	57.9%	79.3%
1700	Chemical and Material Engineering	65.1%	62.8%
3600	Transportation, Construction, Electronic Commerce, Agriculture, and National Security	68.1%	62.3%
3700	Mechanical Engineering, Manufacturing, Gaming, and Medical Devices/Processes	71.3%	64.4%
2100	Computer Architecture and Software	75.8%	25.8%
2400	Networking, Multiplexing, Cable, and Security	78.7%	22.0%
2600	Communications	79.7%	35.3%
2800	Semiconductors/Memory, Circuits/Measuring and Testing, Optics/Photocopying, Printing/Measuring and Testing	83.1%	67.5%

Table 14: Allowance and Infringement Rates by Technology Center

The trendlines in Figure 6 and data in Table 13 show that, for most technology centers, the rate of infringement decreases as patents receive more office actions. These trends for the individual technology centers align with the general trend for infringement observed for all patents illustrated in Figure 5. The only exceptions are Technology Centers 2100 and 3700. In Technology Centers 2100 and 3700, the trendlines show a slight positive correlation between likelihood of

175. *See, e.g.*, *Technology Center Search for Biotechnology and Organic Chemistry*, PATENTADVISOR, https://go.patentadvisor.com/statistics.php?Parent=TechnologyCenter&TechnologyCenter=1 [https://perma.cc/SAR2-7LG8]. This data was pulled on February 23, 2024, and covers patent applications with electronic file histories that were filed on or after November 29, 2000. PatentAdvisor regularly updates this data, and these values reflect PatentAdvisor's data as of February 23, 2024.

176. To calculate "Infringement Rate," we took the total number of patents that were marked "infringement" or "not infringement" in our dataset. We then separated them by Technology Center, and then we calculated the respective percentage of patents where infringement was found by dividing the total number of infringement patents by the sum of infringement and not infringement patents.

infringement and the number of office actions, apparent by the R-squared values of 0.086 and 0.24, respectively. This is the reverse of the trend in other technology centers — i.e., in Technology Centers 2100 and 3700, more rejections lead to claims that are *more* likely to be infringed. This reverse trend also contradicts the hypothesis of the Article — that more rejections lead to narrower claims that are less likely to be found infringing. Notably, the sample size for Technology Center 2100 is one of the smallest among the technology centers that were individually analyzed. This suggests that the data may not be representative and may be the result of statistical error. It is also of note that both Technology Centers 2100 and 3700 did not follow the validity trends discussed in Section IV.A, which suggests that these technology centers are general outliers within the USPTO. There are a few possible reasons why this may be. First, as noted in both Section IV.A and here, the statistical fits are relatively poor for these two technology centers compared to other technology centers. It is possible that the data for these two centers is simply too noisy, too scarce, or otherwise ill-suited to statistical interpretation. Alternatively, it is possible that additional examination time in these technology centers simply lends itself to higher-quality patents. Further research would be needed to confirm this, which is beyond the scope of this Article.

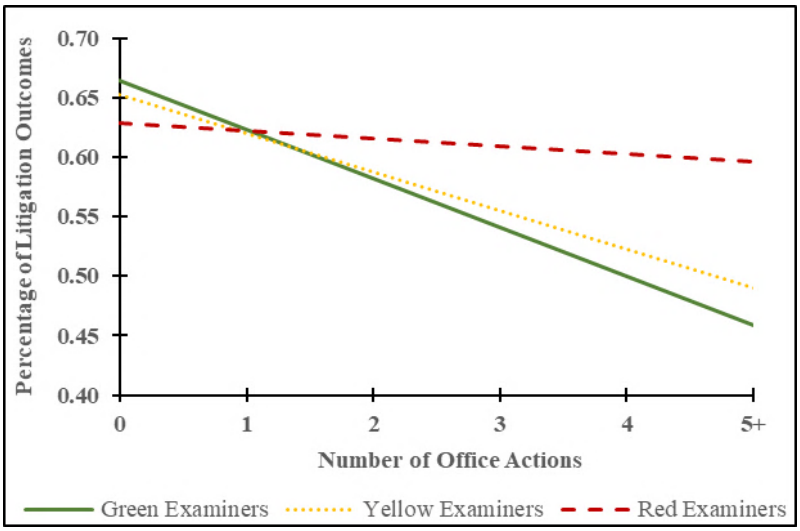

Figure 7: Plot of Infringement Rates by Examiner Toughness

# of OAs	0	1	2	3	4	5+	Sample Size	R-squared	RMSE
Green	58%	67%	59%	67%	47%	33%	2303	0.51	0.083

Yellow	62%	63%	63%	50%	62%	43%	1579	0.48	0.058
Red	65%	73%	47%	59%	51%	72%	501	0.013	0.098

Table 15: Data for Figure 7

Finally, infringement data was analyzed with respect to examiner "toughness," as in Section IV.A. The allowance rates for each type of examiner compared to the infringement rates for patents examined by that type of examiner are shown in Table 16 below. Note that 271 rows out of the 4,654 total rows (5.82 percent) used in the overall infringement analysis above are missing ETA values, as explained in Section III.B, and thus are not included in this analysis.[177] Unexpectedly, the below table suggests that the allowance rate for an examiner does not affect the respective infringement rate for litigated patents examined by the examiner. Patents are found to be infringed approximately sixty percent of the time, regardless of the toughness of the examiner that examined the underlying patent application.

Examiner Toughness	**Average Allowance Rate**[178]	**Infringement Rate**[179]
Green	83.2%	61.4%
Yellow	65.9%	59.0%
Red	42.7%	61.5%

Table 16: Allowance and Infringement Rates by Examiner Toughness

However, when infringement rates are examined with respect to prosecution length, trends that differentiate between different types of examiners begin to appear. As seen in Figure 7 and Table 15, for patents examined by Green and Yellow examiners, there is a strong negative correlation between the likelihood of infringement and the number of office actions, with the trendlines having R-squared values of 0.51 and 0.48, respectively. These trends suggest that earlier allowances by these easier examiners lead to broader claims that are easier to infringe, which aligns with the hypotheses of this Article. Notably,

177. *See supra* text accompanying note 105.

178. To calculate "Average Allowance Rate," we took every examiner who examined any patent in our dataset, we then took that examiner's average allowance rate and averaged it with the other examiners of the corresponding toughness.

179. To calculate "Infringement Rate," we took the total number of patents that were marked "infringement" or "not infringement" in our dataset. We then separated them by examiner toughness, and calculated the respective percentage of patents that were deemed infringed by dividing the total number of infringed patents by the sum of infringed and non-infringed patents.

the likelihood of infringement for patents examined by the easiest examiners ("Green") has the largest decline with increasing numbers of office actions, dropping from sixty-seven percent for patents with only one office action to thirty-three percent for patents with five or more office actions. Similarly, the likelihood of infringement for patents examined by Yellow examiners declines from sixty-three percent for patents with only one office action to forty-three percent for patents with five or more office actions. These trends for both Green and Yellow examiners align with the hypothesis of this Article — that more office actions lead to narrower claims that lower the likelihood of infringement. In contrast, for patents examined by the toughest examiners ("Red"), there is almost no correlation between the likelihood of infringement and the number of office actions, with the trendline having an R-squared value of 0.013. The likelihood of infringement for these patents examined by Red examiners averages 61.5 percent. Interestingly, this trend suggests that patents examined by tougher examiners are able to more consistently win infringement claims compared to patents examined by easier examiners. These results seem to be in tension with the hypotheses of this Article. Assuming that tougher examiners more thoroughly review applications with respect to the prior art, applications allowed by these tough examiners should have relatively narrow claims regardless of the number of rejections preceding allowance, and thus we would expect the trendline to show a lower likelihood of infringement at all points. The flat trendline for Red examiners and higher baseline infringement rate suggests that additional rejections do not in fact cause applicants to narrow their claims.[180] This further suggests that the way applicants respond to rejections from the toughest examiners may be fundamentally different from the way applicants respond to rejections from easier examiners. For example, applicants facing a rejection from a Red examiner may be more likely to merely shift scope (i.e., change claim elements without adding additional elements) with their claim amendments rather than strictly narrow scope. Or, perhaps, the types of rejections issued by the toughest examiners are fundamentally different from the types of rejections issued by easier examiners. For example, Red examiners may be more likely to issue subject matter rejections under § 101 than other types of examiners, leading to different types of responses from applications (e.g., traversing arguments instead of amendments) that do not necessarily narrow the scope of the claims. Unfortunately, as noted previously, the data extracted from PatentAdvisor for this Article does not include information on the specific types of rejections the patents received during

180. Note that the sample sizes for Red examiners at higher numbers of office actions are relatively small in Figure 7, with only fifty-six outcomes at three office actions, thirty-five outcomes at four office actions, and seventy-four outcomes at five or more office actions.

prosecution, or the nature of the applicants' responses to these rejections.[181]

While the total difference in outcomes between Green and Red examiners is slight, it is worth noting that the outcomes for patents examined by Red examiners are much more consistent. This is evident not only by the trendline for Red examiners having a lower R-squared value, but also by the raw percentages. Red examiners maintain the best floor for infringement rate by office action (47 percent for Red examiners, compared to 33 percent for Green and 43 percent for Yellow). Furthermore, Red examiners also have the highest ceiling for infringement rate, by office actions, of the three examiner types (73 percent compared to 67 percent for Green and 63 percent for Yellow). Although the average allowance rate for Red examiners is substantially lower than the rates for Yellow and Green examiners (a lowest rate of 42.7 percent, compared to 65.9 percent and 83.2 percent, respectively), if an applicant is actually able to get its patent allowed by a Red examiner, the patent may be of substantially higher quality from both a validity and infringement perspective, and thus be of substantially higher value to the owner.

Prior research by Sartori, discussed in Section IV.A with respect to validity outcomes, also analyzed the impact of examiner toughness on infringement outcomes.[182] This research showed that patents examined by the easiest examiners ("Green") have a 6 percent better chance of a patent owner "win" in district courts than patents examined by the toughest examiners ("Red").[183] Sartori hypothesized that because Red examiners tend to examine patents more thoroughly than Green examiners, patents issuing under Green examiners will have shorter prosecution histories (and thus fewer prosecution history estoppel issues and more favorable claim constructions) that leads to more patent owner "wins" in litigation.[184] This trend is somewhat at odds with the findings of this Article that patents examined by tougher Red examiners have infringement rates that are both more consistent and often higher, particularly for higher numbers of office actions, than patents examined by easier examiners. The differing conclusions between Sartori's results and those of this Article are likely explained by Sartori's research only

181. This may be another interesting area of investigation for future researchers.

182. Sartori & Welch, *supra* note 152.

183. *Id.* at n.1 ("The 6% better chance was calculated by dividing the rounded patent owner win rate for green Examiners (71%) by the rounded patent owner win rate for red Examiners (67%)."). Sartori's article defines a patent owner "win" as "a finding of infringement, no invalidity, or no unenforceability, and a patent owner loss is a finding of no infringement, invalidity, or unenforceability." *Id.*

184. *Id.* ("In U.S. district court litigation, having less prosecution history may result in more favorable claim construction for a patent owner, which could tend to result in a patent owner winning more often. This viewpoint may help to explain why patents examined by green examiners are more likely to have patent owner wins in the U.S. district courts than those examined by red examiners.").

looking at overall "win" rates rather than win rates at different numbers of office actions. Sartori's observations are roughly accurate for patents with lower numbers of office actions (e.g., zero to three actions), but at higher numbers of office actions (e.g., four or more actions), patents examined by Red examiners clearly have better infringement outcomes.

C. Enforceability

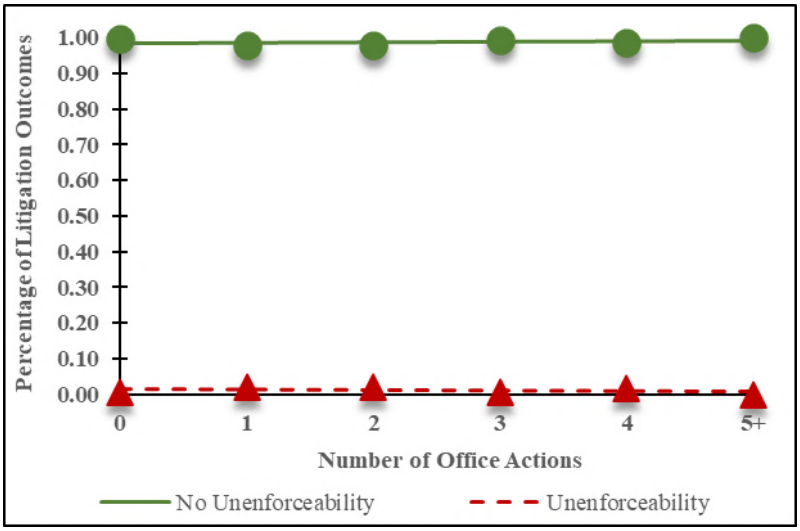

Figure 8: Plot of Unenforceability and No Unenforceability Rates Overall

R-squared: 0.10, RMSE: 0.0079, Total Sample Size: 1372

# of OAs	**0**	**1**	**2**	**3**	**4**	**5+**
No Unenforceability	99.6%	97.9%	98.1%	99.3%	98.5%	100%
Unenforceability	0.4%	2.1%	1.9%	0.7%	1.5%	0.0%
Sample Size	225	608	260	134	65	80

Table 17: Data for Figure 8

Figure 8 is a plot of enforceability outcomes for litigated patents in terms of percentage of total outcomes where there was a finding of either "no unenforceability" or "unenforceability," which is how enforceability outcomes are reported by PatentAdvisor. The enforceability outcomes were plotted against the number of office actions received by a patent with a given enforceability outcome. As discussed in

Section III.C, enforceability outcomes for patents with five or more office actions were grouped together in a single bucket. The data for the plot is provided in Table 17.

As discussed in Section II.B, inequitable conduct is an affirmative defense that can be raised by an accused infringer during patent litigation.[185] If the accused infringer can show with clear and convincing evidence that the patent was procured from the USPTO improperly, the patent will be considered unenforceable, regardless of whether it is found to be valid and/or infringed.[186] However, inequitable conduct is not raised as a defense in every litigation. Out of the total sample of 10,174 patent cases analyzed for this Article, only 1,969 patents (19.4 percent) indicated a finding of either "no unenforceability" or "unenforceability" in PatentAdvisor. This Article assumes that for cases where PatentAdvisor does not indicate a finding of either "no unenforceability" or "unenforceability," inequitable conduct was not raised as an affirmative defense. Also, as noted earlier, the analysis here includes only cases that were filed after the *Therasense* decision.[187] Because *Therasense* significantly heightened the standard for finding inequitable conduct, the sample of cases used in Section IV.C excludes 597 outcomes from the cases decided before the *Therasense* decision in October 2011. As such, the sample size used for Figure 8 is 1,372 outcomes, which consists of outcomes from all post-*Therasense* cases in our dataset.[188]

The trendlines in Figure 8 show a slight negative correlation between the likelihood of unenforceability and the number of office actions, with an R-squared value of 0.10, and an extremely close fit of the data to the trendline, with an RMSE of 0.0079. In other words, the more office actions a patent application receives before allowance, the less likely the patent will be found unenforceable during litigation. This trend contradicts the hypothesis of this Article — that more rejections lead to more opportunities for the applicant to make misrepresentations to the USPTO and engage in inequitable conduct.

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185. Astrazeneca Pharms. LP v. Teva Pharms. USA, Inc., 583 F.3d 766, 770 (Fed. Cir. 2009) ("Upon determining that there was inequitable conduct in obtaining the patent, the district court may in its discretion declare the patent permanently unenforceable.").

186. Therasense, Inc. v. Becton, Dickinson & Co., 649 F.3d 1276, 1290 (Fed. Cir. 2011) (en banc) ("To prevail on a claim of inequitable conduct, the accused infringer must prove that the patentee acted with the specific intent to deceive the PTO . . . the accused infringer must prove by clear and convincing evidence that the applicant knew of the reference, knew that it was material, and made a deliberate decision to withhold it.").

187. *See supra* note 8 and accompanying text; *supra* Section II.B. The Federal Circuit's 2011 decision in *Therasense, Inc. v. Becton, Dickinson & Co.* changed the standard on what is needed to prove inequitable conduct. 649 F.3d 1276, 1299 (Fed. Cir. 2011) (en banc).

188. Note that outcomes from PTAB cases were not included in the analysis for Section IV.C because inequitable conduct cannot be raised in PTAB hearings. 35 U.S.C. § 311(b) ("A petitioner in an inter partes review may request to cancel as unpatentable 1 or more claims of a patent only on a ground that could be raised under section 102 or 103 and only on the basis of prior art consisting of patents or printed publications.").

While the reasons for this trend are not clear, there are a few possible explanations. This Article hypothesized that a longer prosecution would create more opportunities for the applicant to make a material misrepresentation to the patent office — instead, a longer prosecution may give the applicant more time to fix such mistakes. For example, if there is prior art known by the applicant that should be disclosed under Rule 56, having a longer prosecution may give the prosecuting attorney more time to file an Information Disclosure Statement ("IDS") to submit that relevant art.[189] Alternatively, if the applicant made a misstatement in a filing (e.g., mischaracterizing the prior art in the background section of the application), a longer prosecution may allow the prosecuting attorney more time to correct the misstatement.[190] However, with unenforceability rates ranging from 0.0 percent to only 2.1 percent, the weak negative correlation observed in Figure 8 is so slight that it could be read as essentially no correlation. This would suggest that inequitable conduct and other grounds for unenforceability are dependent wholly on actions by the applicant and not the USPTO.

However, it must be cautioned that the results presented here are likely not representative of any correlation between prosecution length and unenforceability. Out of the 1,372 outcomes analyzed for Figure 8, only twenty-one cases (1.5 percent) indicated a finding of unenforceability. All twenty-one cases were checked to confirm that the unenforceability outcome was based on a finding of inequitable conduct. This shows that very few patents are ever deemed unenforceable due to inequitable conduct.[191] Because of how rare unenforceability is, it is

189. Under Rule 56, patent applicants and their attorneys have a duty to disclose any prior art known to them that is relevant to patentability of the claims. *See* 37 C.F.R. § 1.56 (2023) ("Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section."); *see, e.g.*, Aventis Pharma S.A. v. Hospira, Inc., 675 F.3d 1324, 1335 (Fed. Cir. 2012) (holding that failure to disclose a prior art reference is sufficient to satisfy the but-for materiality requirement for showing inequitable conduct if the withheld art can be used to render the claims invalid).

190. *See, e.g.*, Am. Calcar, Inc. v. Am. Honda Motor Co., Inc., 651 F.3d 1318, 1335 (Fed. Cir. 2011) (holding that a misleading partial description of anticipatory prior art in the background section of the patent satisfied the but-for materiality requirement for showing inequitable conduct).

191. Note that other affirmative defenses that can lead to a finding of unenforceability include patent misuse, laches, equitable estoppel, and patent exhaustion. *See Astrazeneca Pharms. LP v. Teva Pharms. USA, Inc.*, 583 F.3d at 770 ("Upon determining that there was inequitable conduct in obtaining the patent, the district court may in its discretion declare the patent permanently unenforceable."); Princo Corp. v. Int'l Trade Comm'n, 616 F.3d 1318, 1321 (Fed. Cir. 2010) (" . . . the doctrine limits a patentee's right to impose conditions on a licensee that exceed the scope of the patent right."*);* Personalized Media Commc'ns, LLC v. Apple Inc., 57 F.4th 1346, 1354 (Fed. Cir. 2023) ("Prosecution laches may render a patent unenforceable where a patentee's conduct 'constitutes an egregious misuse of the statutory patent system.'"); Radio Sys. Corp. v. Lalor, 709 F.3d 1124, 1130 (Fed. Cir. 2013)

extremely difficult to gather any insights from this analysis. Notwithstanding the close fit of the data to the trendline, any instance of unenforceability is merely noise in this type of statistical analysis.

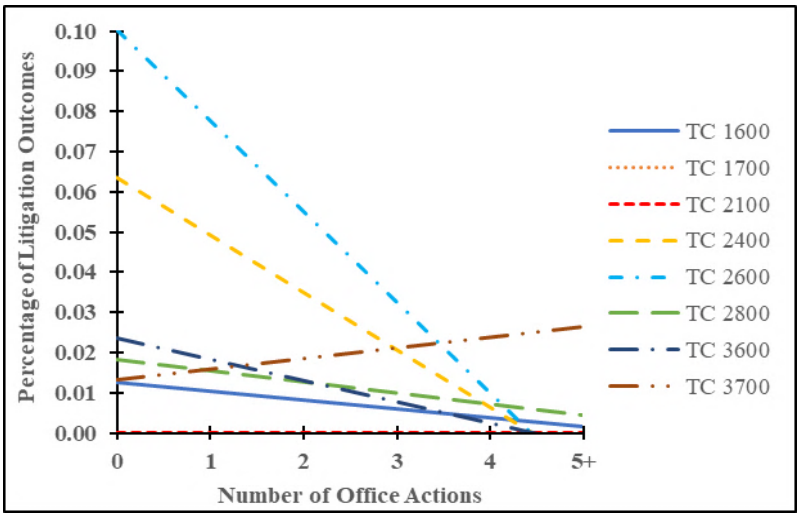

Figure 9: Plot of Unenforceability Rates by Technology Center

# of OAs	0	1	2	3	4	5+	Sample Size	R-Squared	RMSE
TC 1600	1.3%	0.36%	1.4%	1.1%	0.0%	0.0%	678	0.40	0.0046
TC 1700	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	62	N/A	0.00
TC 2100	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12	N/A	0.00
TC 2400	0.0%	16.7%	0.0%	0.0%	0.0%	0.0%	11	0.15	0.057
TC 2600	0.0%	26.3%	0.0%	0.0%	0.0%	0.0%	33	0.15	0.090
TC 2800	0.0%	1.5%	5.3%	0.0%	0.0%	0.0%	222	0.062	0.019
TC 3600	0.0%	6.2%	0.0%	0.0%	0.0%	0.0%	177	0.15	0.021
TC 3700	0.0%	0.0%	6.7%	0.0%	5.3%	0.0%	177	0.025	0.028

Table 18: Data for Figure 9

("[E]quitable estoppel . . . [can] bar a patentee's suit."); Quanta Computer, Inc. v. LG Elecs., Inc., 553 U.S. 617, 617 ("The longstanding doctrine of patent exhaustion limits the patent rights that survive the initial authorized sale of a patented item.").

Next, the enforceability data was separated by technology center. The trendlines in Figure 9 and data in Table 18 show that, for most technology centers, the rate of unenforceability decreases as patents receive more office actions. These trends for the individual technology centers align with the general trend for unenforceability observed for all patents illustrated in Figure 8. The only exceptions are Technology Centers 1700, 2100, and 3700. In Technology Centers 1700 (Chemical and Materials Engineering) and 2100 (Computer Architecture and Software), the trendlines are completely flat because zero cases had findings of unenforceability. As for Technology Center 3700 (Mechanical Engineering, etc.), there is a decrease in the unenforceability rates from 6.7 percent at two office actions down to 5.3 percent at four office actions, causing the trendline to show a slight negative correlation between the likelihood of unenforceability and the number of office actions, with an R-squared value of only 0.025. However, there are zero unenforceability findings at the remaining office action plot points in Technology Center 3700. As such, even in technology centers with non-zero numbers of unenforceable cases, so few patents are deemed unenforceable in all of these technology centers that the difference between trendlines is essentially negligible. Furthermore, as noted above, because findings of unenforceability are so infrequent, it is problematic to extract any type of meaningful understanding from these trends.

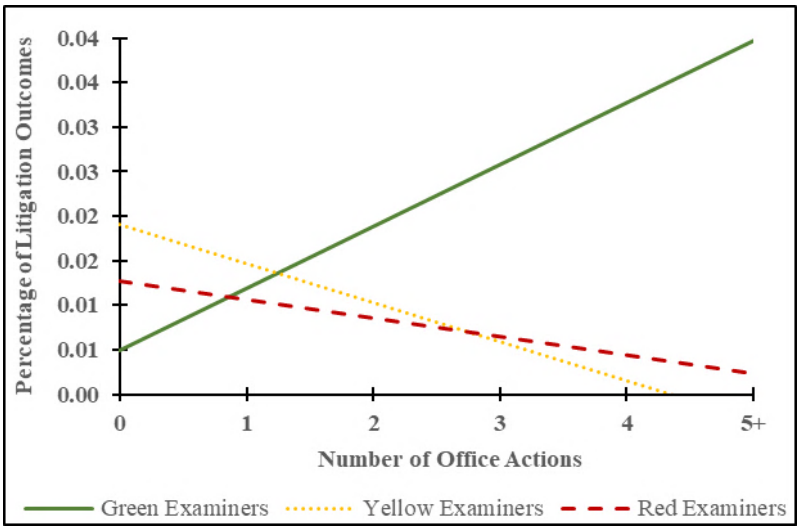

Figure 10: Plot of Unenforceability Rates by Examiner Toughness

# of OAs	0	1	2	3	4	5+	Sample Size	R-squared	RMSE
Green	0.0%	1.1%	2.2%	0.0%	10.0%	0.0%	628	0.11	0.034
Yellow	2.0%	1.2%	1.6%	0.0%	0.0%	0.0%	464	0.80	0.0037
Red	0.0%	1.4%	3.1%	0.0%	0.0%	0.0%	228	0.090	0.011

Table 19: Data for Figure 10

Finally, enforceability data was analyzed with respect to examiner "toughness," as in Sections IV.A and IV.B. Note that 52 rows out of the 1,372 total rows (3.79 percent) used in the overall unenforceability analysis above are missing ETA values, as explained in Section III.B, and thus are not included in this analysis.[192] As seen in Figure 10 and Table 19, for patents examined by Yellow and Red examiners, there is a negative correlation between the likelihood of unenforceability and the number of office actions, with the trendlines having R-squared values of 0.80 and 0.090, respectively. In contrast, for patents examined by the easiest examiners ("Green"), the trend reverses, with a positive correlation between the likelihood of unenforceability and the number of office actions, with the trendline having an R-squared value of 0.11. This positive correlation aligns with the hypothesis of this Article — that more rejections lead to more opportunities for the applicant to make misrepresentations to the USPTO and engage in inequitable

192. *See supra* text accompanying note 105.

conduct. Given that this trend only appears with Green examiners, this suggests that applicants are more likely to make misrepresentations to these easier examiners or, conversely, that Green examiners are less likely to push back against such misrepresentations compared to their "tougher" peers. Another possible explanation may be that Green examiners that allow applications quickly do not leave prosecuting attorneys time to fix mistakes (e.g., file an IDS) before allowance. The allowance rates for each type of examiner compared to the unenforceability rates for patents examined by that type of examiner are shown below in Table 20 below.

Examiner Toughness	**Average Allowance Rate**[193]	**Unenforceability Rate**[194]
Green	83.2%	1.1%
Yellow	65.9%	1.1%
Red	42.7%	0.9%

Table 20: Allowance and Unenforceability Rates by Examiner Toughness

The aggregate unenforceability rates for each type of examiner shown in this table suggest that the allowance rate for an examiner (and thus their toughness) does not affect the respective unenforceability rate for litigated patents examined by the examiner. Patents are found to be unenforceable at approximately a constant rate, regardless of the toughness of the examiner that examined the underlying patent application.

Again, however, because the total number of unenforceable patents in the dataset is so small, the differences between the trendlines are essentially insignificant. Notably, of the twenty-one cases indicating a finding of unenforceability in the overall dataset, seven of those cases are missing ETA values. This means that thirty-three percent (7/21) of the total unenforceability outcomes are not included in this analysis. In view of the large portion of relevant data missing from this analysis, it is particularly difficult to make any reliable conclusions from these trends.

193. To calculate "Average Allowance Rate," we took every examiner who examined any patent in our dataset. We then took that examiner's average allowance rate and averaged it with the other examiners of the corresponding toughness.

194. To calculate "Unenforceability Rate," we took the total number of patents that were marked "enforceable" or "unenforceable" in our dataset. We then separated them by examiner toughness, and then we calculated the respective percentage of patents that were deemed unenforceable by dividing the total number of unenforceable patents by the sum of enforceable and unenforceable patents.

V. OPTIMIZING LITIGATION OUTCOMES

A. Prosecution and Portfolio Management

A common question facing entities with large patent portfolios is whether to prune pending applications or issued patents from their portfolios. The average cost for preparing and prosecuting a U.S. non-provisional utility patent can exceed $50,000, which includes attorney fees and USPTO fees.[195] Furthermore, there is an ongoing cost associated with holding an issued patent and keeping it valid — the USPTO requires patent owners to pay maintenance fees of $2150, $4040, and $8280 at 3.5, 7.5, and 11.5 years after issuance of the patent, respectively.[196] If the patent owner is unable to effectively monetize the patent asset — for example, by bringing infringement claims with a patent, or subsequently, if the patent is more likely to be deemed invalid when subject to litigation — the cost associated with prosecuting an application to issuance or maintaining an issued patent may not be worth it.[197]

The results in Part IV show that patents subject to a relatively high number of office actions tend to fare worse in litigation, especially those patents examined by the easiest examiners (Green).[198] For example, patents that received five or more office actions from a Green examiner have an infringement rate of only thirty-three percent and a validity rate of only 49 percent.[199] Managers of large patent portfolios may want to consider pruning patent assets like this from their portfolios — either by abandoning pending applications that have already gone through five or more actions, or by letting these types of issued patents lapse by not paying maintenance fees as these patents are more likely to be found invalid and less likely to be infringed. In contrast,

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195. Russ Krajec, *How Much Does a Patent Cost?*, BLUEIRON (Jan. 16, 2022), https://blueironip.com/how-much-does-a-patent-cost/ [https://perma.cc/X839-Z92A]. This does not cover the cost of enforcing a patent, which typically runs in the six- to seven-figure range. *Id; see also* Russ Krajec, *What Are the Costs to Enforce or Defend a Patent?*, BLUEIRON (Jan. 1, 2020), https://blueironip.com/what-are-the-costs-to-enforce-or-defend-a-patent/ [https://perma.cc/P6VJ-ZP4M] (estimating costs through the claim construction phase of litigation between $250,000 and $2,375,000, and costs through trial between $700,000 and $4,000,000).

196. *See* 89 Fed. Reg. 91898 (Nov. 20, 2024); *USPTO Fee Schedule*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/learning-and-resources/fees-and-payment/uspto-fee-schedule [https://perma.cc/S6PC-C4Y4]. These are the standard fees for a "large" entity. The fees for "small entities" are discounted by sixty percent off these standard fees. Failure to pay maintenance fees will cause the issued patent to lapse. *Maintain Your Patent*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patents/maintain [https://perma.cc/EF3A-MUJA].

197. It is beyond the scope of this Article to analyze the impact of prosecution length on other ways of monetizing patent assets, such as through licensing or sale of patents. However, it should be noted that the number of patents that never get litigated is much larger than the number of patents that get challenged in the PTAB or in courts.

198. *See infra* Section V.B.

199. *See supra* Sections IV.A and IV.B.

patents with a relatively low number of office actions are more likely to be successfully asserted, particularly those patents that were examined by tougher examiners (Yellow or Red).[200] For example, patents that received only one office action from a Red examiner have an infringement rate of 73 percent and a validity rate of 69 percent.[201] As such, portfolio managers may want to consider prioritizing these types of patent assets in their portfolios. While prosecuting an application with a tougher examiner may be more expensive due to the cost of responding to additional office actions (or possibly the cost of responding to more difficult office actions), an allowed patent may also be more valuable as they are the least likely to be invalidated and are more consistently found to be infringed.

Patent applicants may also want to consider how the USPTO's productivity quotas influence examiner behavior, and thus the number of office actions received. As noted in Section II.C, when considering the type of action to issue following an applicant's response to a non-final office action, the count system may incentivize examiners to issue a notice of allowance (worth 0.5 counts) instead of a final office action (worth 0.25 counts). Further, there is a relatively high likelihood of allowance after a third office action (which is typically the second non-final action).[202] Taking these factors together, we hypothesize that the count system is incentivizing examiners to issue a notice of allowance after the third office action (worth 0.5 counts) rather than issuing a fourth office action (which is typically a second final action, and thus worth only 0.25 counts).[203] Patent practitioners may find it advantageous to use the examiner's inherent incentives when timing certain claim amendments. For example, if the applicant believes certain amendments are likely to move a case to allowance, it may be beneficial to wait to make these amendments until after the third office action rather than earlier in prosecution when the examiner is given more time to review the amendments. After the third office action, the examiner may be incentivized by their productivity quotas to proceed with an allowance (worth 0.5 counts) that will net them more counts than a second final office action (worth 0.25 counts) would net.[204] Furthermore, reviewing an extensive amendment may require a commensurately extensive amount of work to search and review new prior art — as such,

200. *See infra* Section V.B.

201. *See supra* Sections IV.A and IV.B.

202. A proprietary analysis by Baker Botts LLP of USPTO allowance data for utility patents shows that the incremental allowance rate at each stage of prosecution increases from only 10.8% at zero office actions to 31.7% at three office actions. Internal memorandum from Baker Botts LLP on Incremental Allowance and Abandonment Rates at the USPTO (Dec. 30, 2024) (on file with author).

203. USPTO EXAMINATION TIME, *supra* note 70, at 13.

204. *Id.*

the low count award for reviewing and searching may be disfavored by the examiner in view of simply allowing the patent application.

In light of the litigation outcome statistics outlined in Part IV, patent applicants may want to reconsider their strategies for prosecuting within the various technology centers, and particularly those centers with tougher patent examiners. When a patent application is filed with the USPTO, it is assigned to a particular technology center (and eventually an art unit and examiner) based on its classification under the Cooperative Patent Classification ("CPC") system, which is a hierarchical classification scheme for patent documents.[205] Initially, a patent application is sorted into a CPC section, class, subclass, and group based on the subject matter described in the application.[206] The USPTO then uses this class and subclass designation to route the application to the appropriate technology center, art unit group, and examiner.[207] Given the significant variability in allowance rates among examiners across different technology centers, some prosecuting attorneys will attempt to draft applications such that they are classified in a way that routes the application towards technology centers perceived as more lenient. However, these application drafting strategies may not necessarily help the overall value of the eventual patent. For example, Technology Centers 2100 and 2400 cover similar types of technology, and have roughly similar prosecution and litigation statistics, as shown in Table 21 below.

Technology Center	**Field**	**Allowance Rate**	**Invalidity Rate**	**Infringement Rate**
2100	Computer Architecture and Software	75.8%	55.5%	25.8%
2400	Networking, Multiplexing, Cable, and Security	78.7%	50.6%	22.0%

Table 21: Allowance, Invalidity, and Infringement Rates at Technology Centers 2100 and 2400

From the statistics above, we see that Technology Center 2400 has a slightly better allowance rate than Technology Center 2100

205. *See* MANUAL OF PATENT EXAMINING PROCEDURE § 905 (9th ed. 2023).

206. *See id.*

207. *See id.* at § 909.01(b) ("Once the application has received these classifications, the automated routing system can assign the application to an examiner . . . . The automated routing system takes into account the CPC classifications of an application and compares them to examiner portfolios (i.e. the classification areas to which the examiner has been assigned).").

(approximately +3%), and thus may have slightly easier examiners. But efforts to route patents out of Technology Center 2100 and into Technology Center 2400 may have minimal benefit — the latter center only has a slightly better invalidity rate (approximately -5%) and a slightly worse infringement rate (approximately -3%). In contrast, when comparing Technology Centers 2100 and 3600 (which covers electronic commerce), we observe substantial differences in both allowance rates during prosecution and outcomes during litigation, as shown in Table 22.

Technology Center	**Field**	**Allowance Rate**	**Invalidity Rate**	**Infringement Rate**
2100	Computer Architecture and Software	75.8%	55.5%	25.8%
3600	Transportation, Construction, Electronic Commerce, Agriculture, and National Security	68.1%	42.5%	62.3%

Table 22: Allowance, Invalidity, and Infringement Rates at Technology Centers 2100 and 3600

While all of these technology centers handle patent applications directed to software-based inventions, the lower allowance rate in Technology Center 3600 suggests that it would be disadvantageous to have an application routed here. In fact, Technology Center 3600 is notorious for having some of the most difficult examiners — seventeen of the top twenty-five most difficult examiners at the USPTO are in Technology Center 3600.[208] And common wisdom among prosecuting attorneys is that this technology center should be avoided when possible. But, notwithstanding its lower allowance rate making it harder to obtain a patent, a patent from Technology Center 3600 may be much more valuable than a similar application prosecuted in Technology Center 2100 or 2400 given the significantly better litigation outcomes observed for patents from Technology Center 3600. Specifically comparing Technology Center 2100 to Technology Center 3600, the latter center has a significantly better invalidity rate (-13%) and an

208. *See* Danielle Hohmeier, *The Most Difficult Examiners at the USPTO*, JURISTAT (Apr. 26, 2023), https://blog.juristat.com/most-difficult-examiners-2023 [https://perma.cc/MT5U-W4NQ].

extraordinary improvement in infringement rate (approximately +37%). Thus, while avoiding a difficult technology center like Technology Center 3600 may seem advantageous from a prosecution standpoint, applications that issue from this center may perform significantly better in litigation and thus provide more value to applicants.

Similarly, applicants may want to rethink their priorities around prosecution in front of tough examiners. Many applicants will abandon an application if it gets assigned to a tough examiner (i.e., a "Red" examiner). However, as discussed previously, litigation outcomes for patents examined by easier examiners (Green and Yellow) are slightly worse than patents examined by the toughest examiners (Red), as shown in Table 23 below.

Examiner Toughness	**Average Allowance Rate**	**Invalidity Rate**	**Infringement Rate**
Green	83.2%	40.5%	61.4%
Yellow	65.9%	38.0%	59.0%
Red	42.7%	31.6%	61.5%

Table 23: Allowance, Invalidity, and Infringement Rates by Examiner Toughness

Notably, the average Red examiner only has an allowance rate of 42.7 percent, compared to the average Green examiner's allowance rate of 83.2 percent.[209] Viewed another way, the "abandonment rate" (i.e., the inverse of the allowance rate) for Red examiners is 57.3 percent, which is more than triple the rate for Green examiners at 16.8 percent. Furthermore, Red examiners issue 2.9 rejections on average before granting an allowance, while Green examiners issue only 1.5 rejections on average.[210] However, while prosecuting in front of a Red examiner may be both harder and longer, patents examined by the toughest examiners have better litigation outcomes in almost every scenario. When they are litigated, patents issued by the toughest examiners are more likely to be found valid (68 percent for Red examiners vs. 59 percent for Green examiners), are just as likely to be found infringed (61.5

209. *See supra* note 149.

210. Michael Sartori & Matt Welch, *How USPTO Examiner Type Affects Patents: Part 2*, LAW360 (June 16, 2020), https://www.law360.com/articles/1282928/how-uspto-examiner-type-affects-patents-part-2 [https://perma.cc/A9WR-VLFZ] ("[I]f an application is examined by a green examiner, the application will have about 50% less chance of having at least one final office action than if examined by a red examiner. In other words, about twice as many applications have at least one final office action if examined by a red examiner instead of by a green examiner."); *id.* ("Over the time period, the average number of office actions for all examiners is 2.0, and the average number of office actions for green, yellow and red examiners is 1.5, 2.4 and 2.9 respectively.").

percent for Red examiners vs. 61.4 percent for Green examiners), are far more consistent in infringement case outcomes (discussed in Section IV.B), and are less likely to be deemed unenforceable (0.9 percent for Red examiners vs. 1.1 percent for Green examiners).

Finally, applicants may also want to reconsider their strategies for filing continuing patent applications, particularly when the patent family is being examined by a tougher patent examiner.[211] When a patent application is allowed, it is common practice to consider filing a continuing application to cover additional or alternative embodiments disclosed in the original application.[212] Importantly, a continuing application is typically assigned to the same examiner as the parent application.[213] Thus, common wisdom among prosecuting attorneys is that it is advantageous to file a continuing application when the parent application was examined by an easier examiner.[214] Because both the applicant and the examiner are already familiar with the specification and the prior art in the patent space, it is more likely that the applicant will be able to work with the examiner to get the continuing application allowed with fewer rejections, which should increase the likelihood of the patent asset being found valid and infringed in a subsequent litigation. However, as discussed previously, litigation outcomes for patents examined by easier examiners (Green and Yellow) are slightly worse than for patents examined by the toughest examiners (Red). From the statistics above, we see that patents examined by Red examiners have a significantly better invalidity rate than those examined by Green examiners (approximately -9%) and essentially no change in infringement rate (approximately +0%). Thus, while avoiding tougher patent examiners may seem advantageous from a prosecution standpoint, applications that issue from these examiners may perform somewhat better in litigation and thus provide more value to applicants.

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211. *See* MANUAL OF PATENT EXAMINING PROCEDURE § 201.02 (9th ed. 2023) ("A continuing application is a continuation, divisional, or continuation-in-part application filed under the conditions specified in 35 U.S.C. 120, 121, 365(c), or 386(c) and 37 CFR 1.78.").

212. *Id.* at § 201.07 (9th ed. 2023) ("A continuation application is an application for the invention(s) disclosed in a prior-filed copending nonprovisional application, international application designating the United States, or international design application designating the United States. The disclosure presented in the continuation must not include any subject matter which would constitute new matter if submitted as an amendment to the parent application.").

213. Julian Boulanger, The Examination of Continuation Applications and the Problem of Invalid Patents in the U.S. 13 (Feb. 14, 2019) (unpublished manuscript) ("The incidence of relatedness is pretty high, with 84% of all continuations being examined by a related examiner [i.e., the same examiner], reflecting the established practice at the PTO of assigning continuations to the same examiner who examined the parent application.").

214. *See, e.g.*, *id.* An applicant who had an easy examiner during prosecution of a prior application may be incentivized to continue prosecuting further applications with the same examiner to build out a patent portfolio.

B. Strategic Assertion and Dispute Management

The average cost for enforcing or defending a high-value patent suit in U.S. district court is $2.3 million from filing a complaint to the end of discovery, and $4.4 million total to take the case through final disposition.[215] For patent owners looking to increase their likelihood of securing a return on this investment, the best candidates for assertion are patents with fewer office actions — in nearly every scenario analyzed by this Article, having fewer office actions correlates with a patent that is more likely to be found both valid and infringed. More specifically, a patent that was subject to three or fewer office actions will generally have a 58 to 66 percent success rate for infringement claims, and more than a 63 percent chance of being found valid. Another factor to consider is that patents with just a single office action tend to have a higher likelihood of success with respect to both surviving invalidity challenges and proving infringement. Additionally, patents granted by the toughest examiners (Red) are statistically the best candidates to assert regardless of the number of office actions — these patents are more likely to survive invalidity challenges and more likely to be found infringing, regardless of the number of office actions undergone during prosecution. Patents examined by Red examiners have an overall infringement rate of 61.5 percent and a validity rate of 69 percent, with relatively little variation on either metric as the number of office actions increases.[216]

Similarly, for entities facing numerous patent infringement lawsuits, the results in Part IV may be useful for determining what suits to litigate versus what suits to settle. Patents with only a single office action maximize both the likelihood of validity and infringement, suggesting that defendants may be wise to settle suits involving such patents. In contrast, defendants in patent suits are more likely to prevail in proving both invalidity and non-infringement when they are faced with patents that have received higher numbers of office actions,

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215. NICHOLAS CAMILLO, AIPLA, REPORT OF THE ECONOMIC SURVEY 2023 67 (2023) (showing mean estimated total cost of patent infringement suits when greater than $25 million is at risk as being $2,284 million inclusive of discovery, motions and claim constructions, and $4.416 million inclusive of pretrial, trial, post-trial, and appeal); *see also How Much Does Patent Litigation Cost?*, COPPERPOD INTELL. PROP. (May 11, 2022) https://www.copperpodip.com/post/how-much-does-patent-litigation-cost [https://perma.cc/PKN8-A7TE] (estimating costs, assuming the average patent case where $1 million to $25 million is at stake); Russ Krajec, *What are the Costs to Enforce or Defend a Patent?*, BLUEIRON (Jan. 1, 2020) https://blueironip.com/what-are-the-costs-to-enforce-or-defend-a-patent/ [https://perma.cc/3XAY-K5GH] (estimating costs through the claim construction phase of litigation between $250,000 and $2,375,000, and costs through trial between $700,000 and $4,000,000); Catherine Rajwani, *Controlling Costs in Patent Litigation*, 16 INTELL. PROP. MGMT. 266, 266 (2010) ("When $1–$25 million is at risk, litigation costs are $1.5 million through the end of discovery and $2.5 million through final disposition. When more than $25 million is at risk, costs are $3 million through the end of discovery and $5.5 million through disposition.").

216. *See supra* Sections IV.A and IV.B.

particularly patents with five or more office actions. Furthermore, defendants may be more successful in challenging the validity of patents examined by easier examiners (Green or Yellow). As such, it may be a wise tactic to not settle and actively defend against suits involving patents examined by these easier examiners, including by filing validity challenges at the patent office in response to lawsuits, such as an inter partes review ("IPR") or a post-grant review ("PGR"). However, validity challenges against patents examined by the toughest examiners (Red) are less likely to succeed in general, particularly as the number of office actions increases. While every patent is different and should be evaluated individually, an accused infringer may want to consider settling lawsuits involving patents issued by Red examiners rather than risking liability from a loss in litigation.

For entities looking to monetize large patent portfolios that may be time- and/or cost-prohibitive to sift through, a practical takeaway may be to utilize the litigation statistics revealed by this Article to filter out candidate patents for assertion by determining what patents are statistically more likely to be successful in infringement actions. A first step for considering what patents are prime candidates for assertion may involve narrowing the portfolio down to patents that were subject to a threshold number of office actions (e.g., three or fewer office actions). Another filter may be to consider whether the patents were granted by tougher (Red) examiners versus easier (Yellow or Green) examiners. The data shows that patents examined by Red examiners perform better in litigation, having both higher validity and infringement rates. It also shows that infringement win-rate decreases with the number of office actions, and the chance a patent is deemed invalid increases with office actions. Plaintiffs should consider these factors when deciding whether to proceed with an infringement action. Similarly, defendants should also keep these factors in mind when evaluating the weaknesses of a patent. If a patent from an easy (Green) examiner with many office actions is being asserted, the defendant has a much higher likelihood in succeeding in its defense. However, if a patent from a tough (Red) examiner with few office actions is being asserted, the defendant may want to consider settling, as the plaintiff will be more likely to prevail. Additionally, patent holders should seek to avoid IPRs if possible, as the likelihood of the patent being deemed invalid greatly increases if the PTAB decides to institute the IPR. Again, these rules are not absolute — for example, infringement win rates seems to remain relatively stable for Red examiners regardless of the number of office actions. Thus, even if a patent has a relatively high number of office actions, plaintiffs may still want to consider bringing suit and defendants may still want to consider settling. Cost may also play a role — IPRs generally cost between $128,000 and $895,000, depending on the stage

reached in the proceeding.[217] The median costs of pursuing an IPR are approximately $138,000 to file, $197,000 through institution, and $320,000 to a final decision.[218] Also, IPRs are typically pursued in parallel with District Court litigation, and thus the costs associated with an IPR may be in addition to the underlying cost of defending against a patent infringement action.[219] Because the cost is both substantial and possibly optional, defendants contemplating IPR challenges may adopt a more discerning approach, opting to file an IPR petition only if a patent exhibits apparent vulnerabilities to prior art. Consequently, the observed invalidity rate may be inflated due to challengers predominantly targeting patents perceived as more susceptible to invalidation. In other words, accused infringers may be inclined to contest only "weaker" patents at the PTAB, and thus the tribunal's elevated invalidity rate may be attributed primarily to petitioner selection rather than inherent characteristics of the Board itself.

VI. CONCLUSION

Analyzing the comprehensive data presented in this Article reveals discernible trends with profound implications for patent prosecution and litigation strategies. Notably, as the number of office actions increases, patents face a heightened risk of invalidation, showing a small positive correlation between prosecution length and invalidity rates. This dispels the myth that patents allowed more quickly by the patent office are "bad" and easier to invalidate, and raises questions about the role prior art plays during lengthy prosecutions. The data extracted for this Article does not include information on the specific types of statutory rejections the patents received during prosecution, but it is possible that a higher number of office actions is indicative of a patent space that is more crowded with prior art, leading to a higher incidence of invalidity.

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217. *IPRs: Balancing Effectiveness v. Cost*, RPX CORP. (June 17, 2016), https://www.rpxcorp.com/blog_post/iprs-balancing-effectiveness-vs-cost/ [https://perma.cc/V44Y-TMH9] ("Data confirm that an IPR generally costs in the six figures. Most range from about $100,000 to $700,000, depending on the litigation stage reached."). Adjusting these numbers for inflation from June 2016 to January 2024 gives a range of approximately $128,000 to $895,000. *See CPI Inflation Calculator*, U.S. BUREAU OF LAB. STAT., https://data.bls.gov/cgi-bin/cpicalc.pl [https://perma.cc/2QXL-VL9P].

218. *See IPRs: Balancing Effectiveness v. Cost*, *supra* note 217 ("Figure 1: The Median and Range of Costs per IPR Petition (Cumulative, by Stage)," stating the median costs of pursuing an IPR are $108,000 to file, $154,000 thru institution, and $250,000 to a final decision). Adjusting these numbers for inflation from June 2016 to January 2024 gives values of $138,000 to file, $197,000 through institution, and $320,000 to a final decision. *See CPI Inflation Calculator*, U.S. BUREAU OF LAB. STAT., https://data.bls.gov/cgi-bin/cpicalc.pl [https://perma.cc/2QXL-VL9P].

219. U.S. PAT. & TRADEMARK OFF., PATENT TRIAL AND APPEAL BOARD PARALLEL LITIGATION STUDY 3 ("The vast majority of petitioners (about 80% or higher) have been sued by patent owners in another venue prior to filing their petitions.").

The results of this Article also show that as average allowance rates decrease from Green examiners to Yellow and Red examiners, invalidity rates similarly decrease. This tracks with the notion that the tougher an examiner (e.g., Red examiners), the more likely it is that the patent underwent rigorous examination, which accordingly would lead to lower invalidity rates. Meanwhile, patents facing validity challenges under less tough examiners (Yellow and Green examiners) saw increasing invalidity rates that one might expect from a less rigorous examination.

Furthermore, the results of this Article show a strong inverse relationship between the number of office actions and the success of patents in infringement cases, proving our second hypothesis. Patents undergoing a protracted examination process, resulting in multiple office actions, are notably more constrained, and tailored to a narrow segment of the prior art. Unsurprisingly, this narrowing process poses hurdles in infringement suits, where the patent's applicability to a broader scope of potentially infringing products or processes may be compromised. The robust correlation between infringement outcomes and prosecution length underscores the strategic importance of early grants and examiner selection in shaping a patent's litigation potential.

Perhaps surprisingly, the results of this Article also show that as average allowance rates decrease from Green examiners to Yellow and Red examiners, infringement rates remain generally unaffected — the infringement rates for Green and Red examiners were nearly identical while Yellow examiners saw a slight decrease. As such, the difficulty level of the examiner (Green, Yellow, or Red) appears to have no bearing on infringement. An argument in support of this may be that infringement reads are agnostic of what occurs under the examiner's purview at the USPTO — potential infringement is something that examiners are not concerned about.

Despite these pronounced correlations for other litigation outcomes, unenforceability remains relatively unaffected by the number of office actions, establishing a consistent landscape in patent litigation. It is noteworthy that the rarity of patents being deemed unenforceable, irrespective of their prosecution history, underscores the resilience of patents in this aspect. This stability reinforces the notion that unenforceability challenges are less influenced by actions by the examiner or the USPTO and more likely contingent on other independent factors, such as the thoroughness of prior art disclosures by the applicant, or mischaracterizations made in statements to the patent office.

In summary, the depth of quantitative analysis in this Article, which goes far beyond what has been done in any prior studies, highlights the predictive power of the number of office actions a patent undergoes in forecasting its fate in litigation. A longer prosecution history portends a higher risk of invalidity and a diminished likelihood of

success in infringement suits. To optimize litigation outcomes, patentees are advised to prioritize early grant achievements and examiner selection judiciously. Specifically, aiming for a single office action and securing approval from tougher (Red) examiners emerges as an optimal outcome. In the complex landscape of patent prosecution and litigation, these insights offer actionable guidance for applicants, patent owners, and accused infringers seeking to navigate the intricate dynamics of the patent system with strategic acumen.

APPENDIX

Table 24: Raw Data for Figure 1

Number of Office Actions	No Invalidity	Invalidity
0	707	373
1	1954	1133
2	1076	631
3	500	270
4	253	176
5	156	89
6	85	53
7	52	39
8	24	30
9	15	6
10	5	5
11	3	4
12	3	4
13	0	0
14	0	1
15	0	0
16	1	0

Total Samples	No Invalidity %	Invalidity %
7,633	63.2%	36.8%

Table 25: Raw Data for Figure 2

Number of Office Actions	(PTAB) No Invalidity	(PTAB) Invalidity
0	293	192
1	815	689
2	500	359
3	244	155
4	130	95
5	76	53
6	49	29
7	32	23
8	14	16
9	12	4
10	4	2
11	1	4
12	0	0
13	0	0
14	0	0
15	0	0
16	1	0

Total Samples	(PTAB) No Invalidity %	(PTAB) Invalidity %
3,792	57.3%	42.7%

Number of Office Actions	(non-PTAB) No Invalidity	(non-PTAB) Invalidity
0	414	181
1	1139	444
2	576	272
3	256	115
4	123	81
5	70	36
6	36	24
7	20	16
8	10	14
9	3	2
10	1	3
11	2	0
12	1	1
13	0	0
14	0	1
15	0	0

Total Samples	(non-PTAB) No Invalidity %	(non-PTAB) Invalidity %
3,841	69.00%	31.00%

Table 26: Raw Data for Figure 3

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	1600	141	29
1	1600	489	127
2	1600	297	70
3	1600	162	28
4	1600	71	18
5	1600	50	13
6	1600	18	4
7	1600	20	5
8	1600	8	3
9	1600	0	0
10	1600	0	0
11	1600	2	1
12	1600	1	1
13	1600	0	0
14	1600	0	1
15	1600	0	0
16	1600	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
1,559	1600	80.8%	19.2%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	1700	55	9
1	1700	122	48
2	1700	90	35
3	1700	30	11
4	1700	29	13
5	1700	12	6
6	1700	9	1
7	1700	5	1
8	1700	1	0
9	1700	2	0
10	1700	1	1
11	1700	0	0
12	1700	0	0
13	1700	0	0
14	1700	0	0
15	1700	0	0
16	1700	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
481	1700	74.0%	26.0%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	2100	27	41
1	2100	113	127
2	2100	66	92
3	2100	36	42
4	2100	16	23
5	2100	20	20
6	2100	7	9
7	2100	3	9
8	2100	3	1
9	2100	1	0
10	2100	0	0
11	2100	0	0
12	2100	0	0
13	2100	0	0
14	2100	0	0
15	2100	0	0
16	2100	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
656	2100	44.5%	55.5%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	2400	61	59
1	2400	151	136
2	2400	81	80
3	2400	46	48
4	2400	14	33
5	2400	8	11
6	2400	6	9
7	2400	9	6
8	2400	4	7
9	2400	4	4
10	2400	0	1
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
778	2400	49.4%	50.6%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	2600	62	54
1	2600	206	217
2	2600	100	113
3	2600	59	47
4	2600	32	22
5	2600	7	17
6	2600	10	7
7	2600	8	8
8	2600	1	9
9	2600	5	0
10	2600	2	0
11	2600	0	0
12	2600	0	0
13	2600	0	0
14	2600	0	0
15	2600	0	0
16	2600	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
986	2600	50.0%	50.0%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	2800	189	87
1	2800	392	174
2	2800	141	77
3	2800	52	21
4	2800	22	19
5	2800	10	5
6	2800	9	3
7	2800	1	3
8	2800	3	2
9	2800	0	1
10	2800	0	0
11	2800	0	3
12	2800	0	0
13	2800	0	0
14	2800	0	0
15	2800	0	0
16	2800	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
1214	2800	67.5%	32.5%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	3600	111	66
1	3600	258	224
2	3600	192	112
3	3600	77	48
4	3600	31	34
5	3600	20	16
6	3600	17	17
7	3600	4	4
8	3600	3	6
9	3600	2	1
10	3600	2	3
11	3600	1	0
12	3600	0	0
13	3600	0	0
14	3600	0	0
15	3600	0	0
16	3600	1	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
1250	3600	57.5%	42.5%

Number of Office Actions	Tech Center	No Invalidity	Invalidity
0	3700	61	28
1	3700	223	80
2	3700	109	52
3	3700	38	25
4	3700	38	14
5	3700	19	1
6	3700	9	3
7	3700	2	3
8	3700	1	2
9	3700	1	0
10	3700	0	0
11	3700	0	0
12	3700	0	0
13	3700	0	0
14	3700	0	0
15	3700	0	0
16	3700	0	0

Total Samples	Tech Center	No Invalidity %	Invalidity %
709	3700	70.7%	29.3%

Table 27: Raw Data for Figure 4

Number of Office Actions	Examiner Toughness	No Invalidity	Invalidity
0	Green	425	237
1	Green	1167	701
2	Green	515	318
3	Green	194	121
4	Green	67	61
5	Green	34	36
6	Green	15	14
7	Green	9	16
8	Green	2	4
9	Green	9	1
10	Green	2	0
11	Green	1	3
12	Green	0	0
13	Green	0	0
14	Green	0	0
15	Green	0	0
16	Green	0	0

Total Samples	Examiner Toughness	No Invalidity %	Invalidity %
3952	Green	61.7%	38.3%

Number of Office Actions	Examiner Toughness	No Invalidity	Invalidity
0	Yellow	185	79
1	Yellow	576	305
2	Yellow	413	233
3	Yellow	218	110
4	Yellow	123	85
5	Yellow	71	41
6	Yellow	53	25
7	Yellow	27	18
8	Yellow	16	25
9	Yellow	4	4
10	Yellow	2	1
11	Yellow	1	1
12	Yellow	0	0
13	Yellow	0	0
14	Yellow	0	0
15	Yellow	0	0
16	Yellow	0	0

Total Sam-ples	Examiner Toughness	No Invalidity %	Invalidity %
2617	Yellow	64.6%	35.4%

Number of Office Actions	Examiner Toughness	No Invalidity	Invalidity
0	Red	73	30
1	Red	126	57
2	Red	100	48
3	Red	62	26
4	Red	44	28
5	Red	40	9
6	Red	13	11
7	Red	15	5
8	Red	4	1
9	Red	2	0
10	Red	1	3
11	Red	1	0
12	Red	1	1
13	Red	0	0
14	Red	0	1
15	Red	0	0
16	Red	0	0

Total Sam-ples	Examiner Toughness	No Invalidity %	Invalidity %
702	Red	68.7%	31.3%

Table 28: Raw Data for Figure 5

Number of Office Actions	No Infringement	Infringement
0	270	440
1	618	1207
2	442	631
3	190	267
4	98	123
5	131	77
6	53	41
7	9	24
8	2	14
9	4	1
10	1	0
11	2	4
12	0	5
13	0	0
14	0	0
15	0	0
16	0	0

Total Samples	No Infringement %	Infringement %
4,654	39.1%	60.9%

Table 29: Raw Data for Figure 6

Number of Office Actions	Tech Center	No Infringement	Infringement
0	1600	24	155
1	1600	85	447
2	1600	77	231
3	1600	35	132
4	1600	32	62
5	1600	11	45
6	1600	24	19
7	1600	4	18
8	1600	0	8
9	1600	1	0
10	1600	0	0
11	1600	1	4
12	1600	0	5
13	1600	0	0
14	1600	0	0
15	1600	0	0
16	1600	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
1420	1600	20.7%	79.3%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	1700	17	28
1	1700	42	67
2	1700	27	50
3	1700	5	15
4	1700	6	7
5	1700	5	2
6	1700	1	5
7	1700	0	0
8	1700	0	0
9	1700	0	0
10	1700	0	0
11	1700	0	0
12	1700	0	0
13	1700	0	0
14	1700	0	0
15	1700	0	0
16	1700	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
277	1700	37.2%	62.8%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	2100	70	13
1	2100	77	50
2	2100	74	9
3	2100	18	10
4	2100	5	2
5	2100	8	4
6	2100	2	0
7	2100	1	1
8	2100	0	0
9	2100	0	0
10	2100	0	0
11	2100	1	0
12	2100	0	0
13	2100	0	0
14	2100	0	0
15	2100	0	0
16	2100	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
345	2100	74.2%	25.8%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	2400	17	9
1	2400	42	22
2	2400	24	21
3	2400	52	12
4	2400	7	1
5	2400	88	0
6	2400	5	3
7	2400	1	0
8	2400	2	0
9	2400	2	0
10	2400	1	0
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
309	2400	78.0%	22.0%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	2600	33	22
1	2600	91	64
2	2600	79	27
3	2600	20	11
4	2600	15	7
5	2600	4	1
6	2600	4	1
7	2600	1	1
8	2600	0	1
9	2600	0	0
10	2600	0	0
11	2600	0	0
12	2600	0	0
13	2600	0	0
14	2600	0	0
15	2600	0	0
16	2600	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
382	2600	64.7%	35.3%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	2800	37	106
1	2800	100	216
2	2800	48	82
3	2800	13	17
4	2800	6	5
5	2800	4	7
6	2800	3	5
7	2800	0	0
8	2800	0	1
9	2800	0	0
10	2800	0	0
11	2800	0	0
12	2800	0	0
13	2800	0	0
14	2800	0	0
15	2800	0	0
16	2800	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
650	2800	32.5%	67.5%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	3600	46	72
1	3600	108	190
2	3600	69	134
3	3600	25	39
4	3600	15	14
5	3600	6	9
6	3600	11	3
7	3600	1	2
8	3600	0	2
9	3600	1	1
10	3600	0	0
11	3600	0	0
12	3600	0	0
13	3600	0	0
14	3600	0	0
15	3600	0	0
16	3600	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
748	3600	37.7%	62.3%

Number of Office Actions	Tech Center	No Infringement	Infringement
0	3700	26	35
1	3700	73	151
2	3700	44	77
3	3700	22	31
4	3700	12	25
5	3700	5	9
6	3700	3	5
7	3700	1	2
8	3700	0	2
9	3700	0	0
10	3700	0	0
11	3700	0	0
12	3700	0	0
13	3700	0	0
14	3700	0	0
15	3700	0	0
16	3700	0	0

Total Samples	Tech Center	No Infringement %	Infringement %
523	3700	35.6%	64.4%

Table 30: Raw Data for Figure 7

Number of Office Actions	Examiner Toughness	No Infringement	Infringement
0	Green	180	247
1	Green	350	708
2	Green	199	283
3	Green	55	113
4	Green	32	28
5	Green	63	33
6	Green	8	9
7	Green	0	0
8	Green	1	4
9	Green	0	1
10	Green	0	0
11	Green	0	0
12	Green	0	0
13	Green	0	0
14	Green	0	0
15	Green	0	0
16	Green	0	0

Total Samples	Examiner Toughness	No Infringement %	Infringement %
2303	Green	38.6%	61.4%

Number of Office Actions	Examiner Toughness	No Infringement	Infringement
0	Yellow	64	103
1	Yellow	199	343
2	Yellow	141	245
3	Yellow	101	100
4	Yellow	41	66
5	Yellow	55	32
6	Yellow	35	18
7	Yellow	4	15
8	Yellow	1	7
9	Yellow	4	0
10	Yellow	1	0
11	Yellow	1	3
12	Yellow	0	0
13	Yellow	0	0
14	Yellow	0	0
15	Yellow	0	0
16	Yellow	0	0

Total Samples	Examiner Toughness	No Infringement %	Infringement %
1579	Yellow	41.0%	59.0%

Number of Office Actions	Examiner Toughness	No Infringement	Infringement
0	Red	18	34
1	Red	37	102
2	Red	77	68
3	Red	23	33
4	Red	17	18
5	Red	10	23
6	Red	8	13
7	Red	2	8
8	Red	0	3
9	Red	0	0
10	Red	0	0
11	Red	1	1
12	Red	0	5
13	Red	0	0
14	Red	0	0
15	Red	0	0
16	Red	0	0

Total Samples	Examiner Toughness	No Infringement %	Infringement %
501	Red	38.5%	61.5%

Table 31: Raw Data for Figure 8

Number of Office Actions	No Unenforceability	Unenforceability
0	224	1
1	595	13
2	255	5
3	133	1
4	64	1
5	43	0
6	12	0
7	13	0
8	8	0
9	1	0
10	0	0
11	2	0
12	1	0
13	0	0
14	0	0
15	0	0
16	0	0

Total Samples	No Unenforceability %	Unenforceability %
1,372	98.5%	1.5%%

Table 32: Raw Data for Figure 9

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	1600	77	1
1	1600	274	1
2	1600	141	2
3	1600	86	1
4	1600	37	0
5	1600	29	0
6	1600	8	0
7	1600	12	0
8	1600	6	0
9	1600	0	0
10	1600	0	0
11	1600	2	0
12	1600	1	0
13	1600	0	0
14	1600	0	0
15	1600	0	0
16	1600	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
678	1600	99.3%	0.7%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	1700	10	0
1	1700	22	0
2	1700	21	0
3	1700	2	0
4	1700	4	0
5	1700	3	0
6	1700	0	0
7	1700	0	0
8	1700	0	0
9	1700	0	0
10	1700	0	0
11	1700	0	0
12	1700	0	0
13	1700	0	0
14	1700	0	0
15	1700	0	0
16	1700	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
62	1700	100.0%	0.0%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	2100	2	0
1	2100	7	0
2	2100	0	0
3	2100	1	0
4	2100	0	0
5	2100	2	0
6	2100	0	0
7	2100	0	0
8	2100	0	0
9	2100	0	0
10	2100	0	0
11	2100	0	0
12	2100	0	0
13	2100	0	0
14	2100	0	0
15	2100	0	0
16	2100	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
12	2100	100.0%	0.0%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	2400	0	0
1	2400	5	1
2	2400	2	0
3	2400	3	0
4	2400	0	0
5	2400	0	0
6	2400	0	0
7	2400	0	0
8	2400	0	0
9	2400	0	0
10	2400	0	0
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
11	2400	90.9%	0.1%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	2600	7	0
1	2600	14	5
2	2600	4	0
3	2600	3	0
4	2400	0	0
5	2400	0	0
6	2400	0	0
7	2400	0	0
8	2400	0	0
9	2400	0	0
10	2400	0	0
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
33	2600	84.8%	15.2%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	2800	71	0
1	2800	128	2
2	2800	18	1
3	2800	2	0
4	2400	0	0
5	2400	0	0
6	2400	0	0
7	2400	0	0
8	2400	0	0
9	2400	0	0
10	2400	0	0
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
222	2800	98.6%	1.4%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	3600	34	0
1	3600	61	4
2	3600	41	0
3	3600	22	0
4	3600	5	0
5	3600	4	0
6	3600	2	0
7	3600	1	0
8	3600	2	0
9	3600	1	0
10	2400	0	0
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
177	3600	97.7	2.3%

Number of Office Actions	Tech Center	No Unenforceability	Unenforceability
0	3700	23	0
1	3700	84	0
2	3700	28	2
3	3700	14	0
4	3700	18	1
5	3700	5	0
6	3700	2	0
7	3600	1	0
8	3600	2	0
9	3600	1	0
10	2400	0	0
11	2400	0	0
12	2400	0	0
13	2400	0	0
14	2400	0	0
15	2400	0	0
16	2400	0	0

Total Samples	Tech Center	No Unenforceability %	Unenforceability %
177	3700	98.3%	1.7%

Table 33: Raw Data for Figure 10

Number of Office Actions	Examiner Toughness	No Unenforceability	Unenforceability
0	Green	127	0
1	Green	346	4
2	Green	88	2
3	Green	44	0
4	Green	9	1
5	Green	5	0
6	Green	0	0
7	Green	0	0
8	Green	1	0
9	Green	1	0
10	Green	0	0
11	Green	0	0
12	Green	0	0
13	Green	0	0
14	Green	0	0
15	Green	0	0
16	Green	0	0

Total Samples	Examiner Toughness	No Unenforceability %	Unenforceability %
628	Green	98.9%	1.1%

Number of Office Actions	Examiner Toughness	No Unenforceability	Unenforceability
0	Yellow	48	1
1	Yellow	165	2
2	Yellow	125	2
3	Yellow	48	0
4	Yellow	34	0
5	Yellow	17	0
6	Yellow	12	0
7	Yellow	4	0
8	Yellow	5	0
9	Yellow	0	0
10	Yellow	0	0
11	Yellow	1	0
12	Yellow	0	0
13	Yellow	0	0
14	Yellow	0	0
15	Yellow	0	0
16	Yellow	0	0

Total Samples	Examiner Toughness	No Unenforceability %	Unenforceability %
464	Yellow	98.9	1.1%

Number of Office Actions	Examiner Toughness	No Unenforceability	Unenforceability
0	Red	44	0
1	Red	72	1
2	Red	31	1
3	Red	29	0
4	Red	17	0
5	Red	21	0
6	Red	0	0
7	Red	8	0
8	Red	2	0
9	Red	0	0
10	Red	0	0
11	Red	1	0
12	Red	0	0
13	Red	0	0
14	Red	0	0
15	Red	0	0
16	Red	0	0

Total Samples	Examiner Toughness	No Unenforceability %	Unenforceability %
228	Red	99.1	0.9%