Florida Law Review

Volume 66 | Issue 3 Article 2

February 2015

# Law's Algorithm

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# LAW'S ALGORITHM

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Abstract

This Article offers a historical, theoretical, and practical perspective on law as an information technology. Law fundamentally concerns information—providing information to the community about the content of legal norms and, at least in its common law form, eliciting information about the world from the disputes before a court. This Article first surveys law's history as an information technology and shows how law is changed by the information technology of its day. It then applies information theory to understand how the computer—the key technology of our day—is changing how practitioners conduct legal search and thereby which forms of law are the most efficient. Information theory focuses on the signal to noise ratio of communication. The key to creating a better computerized legal search engine is to reduce the signal to noise ratio in the link between the user and the search engine. As this ratio decreases, this Article shows that legal search translates the uncompressed form of legal information into an algorithm for predicting what the law will be in a particular situation.

The ongoing improvement in legal search is transforming the optimal form of the law by changing the cost of finding it. It rebalances the weights in the classic debate between rules and standards. In particular, exponential increases in computational power make standards relatively more attractive than rules by decreasing the costs of their application. These same increases also allow us to embed information gathering processes within the law itself by creating what we call "dynamic rules." Dynamic rules are rules that change automatically in response to changing empirical information. Legislatures are already beginning to enact such rules. Since this Article posits that legal standards and dynamic rules are likely to be important forms of legal rules in the coming era, this Article closes with a comparison of their relative costs and benefits.

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* George C. Dix Professor in Constitutional Law, Northwestern University School of Law. We are grateful to Robert C. Berring, Jr., Jonathan C. Carlson, Nelson Lund, Andrew Meerkin, Robert T. Miller, Mark L. Movsesian, Mark J. Osiel, Max M. Schanzenbach, and participants in a conference on law and information technology at the Law and Economics Center at George Mason University School of Law and at faculty workshops at the University of Iowa College of Law and Northwestern University Law School for helpful comments on previous drafts.

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## INTRODUCTION

Law has always been caught between two conflicting impulses. First, it aims to achieve ready comprehensibility so that people can plan their lives around the norms of their community. Second, it aims to achieve

flexibility so that it can take into account the wide range of factors that make for just and socially optimal results. The first aim tends toward simplicity and clear rules. The second aim tends toward complexity and open-ended legal standards.

Both functions of law involve information. To give notice of its mandates to the relevant community, law facilitates the flow of information from the governing to the governed.[1] But law can also permit information to flow from the governed to the governing, as it incorporates new data from legal disputes, thereby potentially improving its content.[2] A common law standard can mutate as judges learn from the diverse and changing concrete disputes that come before them.[3] A legislative command also can change as the legislature updates a law in response to the altered circumstances of the world or changing preferences of their constituents.[4]

Law thus works necessarily in part as an information technology—a tool for the distribution of information to the world that may itself change through the infusion of more information from the world. And as with any information technology, its structure as well as its content is subject to transformation by the available information capacity, by what we might call the legal bandwidth of the era. In particular, the process of finding the positive law of a society reflects the surrounding information technology of a given age. As that technology improves, law becomes easier to find, and its content easier to pinpoint.

As the computational revolution reduces these information costs, law can better achieve its twin goals of informing the relevant community and being informed by the world. At the limit point of costless and completely effective legal search, law can be flexible and yet instantly discoverable. It can update on the information made available in legal disputes while simultaneously informing the community of its norms. If one could input natural language questions about any legal issue and get a firm answer

1. *See* Jeffrey J. Rachlinski, *Bottom-Up Versus Top-Down Lawmaking*, 73 U. CHI. L. REV. 933, 933–34 (2006) (noting that legislation is often produced from the "top down" by declaring general legal principles intended to apply to future disputes).

2. *See id.* at 934 (noting that adjudication by courts creates law from "the ground up" as the courts decide disputes with the intent of making sound dispositions in each case).

3. *See* Rosa Ehrenreich, *Dignity and Discrimination: Toward a Pluralistic Understanding of Workplace Harassment*, 88 GEO. L.J. 1, 55 (1999) ("The genius of the common law is that it changes over time, adapting to reflect changing technologies, structures, and social mores.").

4. Phillip H. Corboy et al., *Illinois Courts: Vital Developers of Tort Law as Constitutional Vanguards, Statutory Interpreters, and Common Law Adjudicators*, 30 LOY. U. CHI. L.J. 183, 236 (1999) ("A change in circumstances upon which the law is based has always been a justification for updating law by the legislature or the courts . . . ."); *see* Stephanos Bibas, *Originalism and Formalism in Criminal Procedure: The Triumph of Justice Scalia, the Unlikely Friend of Criminal Defendants?*, 94 GEO. L.J. 183, 188 (2005) (noting the common originalist view that legislatures are primarily responsible for updating the law to accommodate changing times).

about the law, people could better plan to fit their conduct to law even if law were relatively complex. Perfect information could substantially temper the enduring conflicts between comprehensibility and complexity and the competing demands for clarity and flexibility.

Even before the ideal of perfect search is realized, improvements in computerized legal search help make this conflict less acute. First, open-ended standards become more attractive vis-à-vis determinate rules as improved legal search can better predict the application of standards to particular cases. Second, an essentially new form of law, "dynamic rules," can play a larger part in law. Dynamic rules are rules that change automatically by the application of prescribed formulas to new facts as those facts become available. As information technology permits us to update on changing facts through continuous, accurate monitoring, dynamic rules become more attractive compared to fixed rules that require legislative reconsideration when the world changes. Dynamic rules can respond faster to changes in the world while also giving the community a clearer view of the exact mechanisms that will drive legal transformation, thereby helping citizens plan for the future.

This Article offers a historical, theoretical, and practical view of law's function as an information technology. Part I shows that law has historically attempted to reconcile the incorporation of information to make better social norms while also providing clear information to the community about the content of those norms. These two factors are in substantial tension with one another. As the law incorporates more information from the outside world—generating more case law reports, for instance—it becomes harder to find a specific piece of information without some form of synthesis or indexing. Expansions in legal information therefore create additional demand for synthesis. Throughout history, the production of legal information and its synthesis have conformed to this push-and-pull pattern:

| CASE LAW EXPANSION | SYNTHESIS |
|---|---|
| Proto-case logs ("Year Books")/English Reports | Blackstone |
| West National Reporter | West's American Digest System, Law Restatements, Law Reviews |
| Electronic Case Law Database | Computerized Legal Search |

William Blackstone's *Commentaries* and West's American Digest System are in the same category as modern search engines because they all serve a similar purpose: they seek to reduce the body of case law to just those cases that are relevant to a particular issue. The difference

between them is in the specificity of their categorization. Blackstone, being one man with access to a printing press, divided his commentaries into 110 separate chapters.[5] West Publishing, having a large workforce of legal scribes and taking advantage of new methods of mass production, was able to create a digest that had thousands of discrete categories.[6] The electronic legal search made possible by computers now allows the user to create the category of cases that she wants to synthesize, freeing the lawyer from the straightjacket of prefabricated classifications.

The push to create more legal information and the pull of fashioning that unruly data into comprehensible rules has marked major disputes about the form of law throughout history, particularly over codification of the common law. For instance, in the late nineteenth century the famous legal theorist David Dudley Field hoped to reform much of the common law with his codes to summarize and regularize the law into easily accessible rules for informing the community.[7] The bar generally opposed this effort, with the head of the American Bar Association arguing that the codes would prevent the development of law that occurs through new case law.[8] Such disputes are the tragic conflict of right with right. They are inevitable in a world where legal search is expensive: law must make a trade-off between the clarity and ease of access inherent to rules, and the sensitivity to facts and open-endedness of common law standards.

Part II of this Article shows how the continuing computational revolution—which is necessarily a revolution in all information technologies, including law—helps resolve this trade-off. It moves to reconcile law's dual function in gathering information to improve norms and in informing the community of their content. It describes the current and likely future progress of modern computerized legal search. The exponential increase in the power of machine intelligence is making legal search more effective and less costly. This improvement relaxes the tension between comprehensibility and open-endedness that has bedeviled law throughout the ages.

To describe how legal search can achieve this reconciliation, this Article turns to information theory—a body of knowledge rarely

5. WILLIAM BLACKSTONE, COMMENTARIES.

6. *See* Robert C. Berring, *Legal Research and Legal Concepts: Where Form Molds Substance*, 75 CALIF. L. REV. 15, 24–26 (1987) (noting that West's legally trained editorial staff compiled common law cases in the American Digest System and organized the cases by subject through its Key Number System).

7. *See* Lewis A. Grossman, *Langdell Upside-Down: James Coolidge Carter and the Anticlassical Jurisprudence of Anticodification*, 19 YALE J.L. & HUMAN. 149, 153–54 (2007) (noting Field's position that his codification movement provided a digest of existing law that served to streamline pertinent legal information to practitioners). For a depiction of this process and its results, see generally David Dudley Field, *Codification in the United States*, 1 JURID. REV. 18, 18–25 (1889) (offering a description of the codification process in the United States and its results).

8. *See* Grossman, *supra* note 7, at 155–57, 159.

applied to law. First, it characterizes the efficiency of legal search through what information theory calls noise. Search engines can be more or less noisy, depending on the quality of the information link between searcher and search engine. The less noise there is, the more effective the search engine.

The theory of information compression then shows how efficient legal search can become law itself. Information theory demonstrates that uncompressed information can be compressed in the form of efficient algorithms. For instance, a continuous string of "01" repeated endlessly may seem on the surface to contain a lot of information but in reality can be described by a simple algorithm that simply provides a rule of repetition. Case law similarly contains a lot of uncompressed and redundant information. What efficient legal search can deliver is law's algorithm, compressing the uncompressed legal information as it provides answers to discrete legal questions.

Part III of this Article describes the practical effects of increasing computational power: it will shift the optimal form of law toward legal standards rather than rules and toward dynamic rules rather than closed rules. A legal rule has the advantage of clarity and comprehensibility over a standard, other things being equal. A classic example of a closed legal rule consists of a speed limit on a highway limiting cars to sixty-five miles an hour. It provides clear notice of the norms to which the community must comply. But this rule has disadvantages as well. Depending on the weather, highway conditions, and volume of traffic, a lower or higher speed limit might be optimal. "Drive at reasonable speed" would be a classic standard that could capture such factors in its application. But this standard has an Achilles heel: it fails to provide clear notice of the appropriate speed.

As increased computational power creates better legal search, standards become an ever more plausible form of law. For instance, we can imagine in the not-too-distant future an app on the dashboard that would take account of relevant factors such as weather condition and traffic—information that is itself gathered by the information technology of networked monitors—and provide a recommended speed limit in real time. The prediction would be based on previous cases about how judges would apply a standard of reasonable speed under those circumstances. Of course, speed limits are a relatively simple kind of legal problem: we would expect that improved legal search would be most likely to prompt a move to standards in relatively straightforward areas of law before permitting the introduction of standards in more complex areas.

As an alternative, the legislature could take advantage of our increased ability to create, analyze, and communicate information by implementing a dynamic rule. In the speed limit context, a dynamic rule would update the speed limit for a particular time and place according to some fixed

formula that took into account road conditions. The speed limit could be flashed on the dashboard by a government-approved app. The rule would be less open-ended than a standard because judges could not update the formula. Nevertheless, it would still generate better results than a more static rule, because it would automatically change on the basis of relevant factors. Both approaches would mitigate the enduring conflict between law's twin impulses of comprehensibility and flexibility.

This Article ends with a discussion of the relative virtues of standards and dynamic rules. It is the choice between these forms of law that will become more prevalent in our era of ever more powerful computation. Dynamic rules, which legislatures are already beginning to enact, set law's algorithm in silicon, permitting changes in law to occur only in response to previously specified information. Standards permit judges to change the algorithm itself as well as apply the old algorithm. Thus, the primary difference between the forms is how much confidence we have in judicial decision-making, which can result in ideological discretion and unnecessary uncertainty. Even computers cannot eliminate the enduring political questions of authority and trust.

## I. THE INFORMATION TECHNOLOGY OF LAW—A BRIEF HISTORY

Throughout history, law has focused on two kinds of information objectives—informing the community of its norms and gathering information from the world about what those norms should be. The first objective is most associated with the top-down legal ordering as when the sovereign provides a written code of commands. The second is associated with a bottom-up form of information ordering, as when the common law evolves through the application of broad principles to new facts. Whenever law has a more distributed form of ordering, however, the legal community tries to make a synthesis of decisions into more comprehensible rules. But because of limits to information capacity this synthesis is imperfect. Thus, throughout the history of the West, there has been tension between top-down and more distributed forms of ordering.

This Part begins by considering the differences between top-down ordering and distributed ordering that structure legal information. While most legal systems have aspects of top-down and distributed ordering, we can better perceive the mix by defining the polarities. Section I.B then provides a historical account of law's attempts to perform its two information functions of informing the community and informing the content of legal norms with facts from the world. It discusses how the legal community has tried to use the information technology of its time to synthesize the data from more distributed ordering to make more comprehensible rules. Section I.C ends by showing that despite attempts at synthesis, historically the two information functions of law have conflicted as people have battled over whether law should be codified or

permitted to develop though more bottom-up methods of adjudication, like the common law. Such conflict was inevitable given the limited information capacity of the technology of previous eras.

### A. *Top-Down Versus Distributed Forms of Legal Ordering as Information Structures*

There are two basic ways for law to organize information: (1) a centralized, top-down approach and (2) a distributed approach.[9] Legal information is centrally organized when there is a limited number of places (or even only one place) where information about the law is collected and disseminated.[10] The paradigmatic example of this approach is a comprehensive legal code that seeks to provide clear and reticulated rules for all regulation.[11] In contrast, a distributed approach relies on several decision makers who create and interpret the law. The best example of this approach is our system of common law, which is built upon the accumulated decisions of many judges.[12]

To be sure, almost all legal systems have aspects of both kinds of ordering.[13] For instance, adjudicators still have to apply a code, however reticulated, and their decisions about applications influence the course of law.[14] In a common law system, judges generally begin with accepted formulations of principles that have been handed down to them from history even if not from sovereigns.[15] But even if legal systems exist along a spectrum of top-down and distributed ordering, the dichotomy is useful in understanding how the structure of law relates to its two information functions of informing the community and being informed by the facts of the world.

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9. *See* Robert D. Cooter, *Decentralized Law for a Complex Economy*, 23 SW. U. L. REV. 443, 443–44 (1994).

10. *See id.*

11. *See id.* at 443–45 (noting that the paradigm of centralized legal information is the top-down implementation of the state's formulation of legal rules).

12. *See* Rachlinski, *supra* note 1, at 933–34 (noting that common law adjudication is a ground-up process by which law is produced when courts adopt legal principles generally to provide dispositions on legal disputes on an ad hoc basis).

13. *See id.* at 933 (suggesting that legislation is designed to be a general statement of legal principles that courts can apply in future legal disputes); Anthony T. Kronman, *Precedent and Tradition*, 99 YALE L.J. 1029, 1031–32 (1990) (noting that despite the common law tradition of creating legal principles through judicial adjudication, judges nonetheless respect precedent interpreting legal codes).

14. *See* James Gordley, *Comparative Legal Research: Its Function in the Development of Harmonized Law*, 43 AM. J. COMP. L. 555, 563 (1995).

15. *See* Nuno Garoupa & Andrew P. Morriss, *The Fable of the Codes: The Efficiency of the Common Law, Legal Origins, and the Codification Movements*, 2012 U. ILL. L. REV. 1443, 1460 (describing a model in which common law evolves from the application of general principles to specific fact patterns that arise in subsequent cases); Andrew J. Wistrich, *The Evolving Temporality of Lawmaking*, 44 CONN. L. REV. 737, 764–65 (2012) (describing common law adjudication as a decision-making process that is guided by reliance on past precedent through stare decisis).

A key strength of the top-down approach (and a key weakness of distributed decision-making) is that it reduces the informational cost of learning about the law.[16] It is generally easier to understand a set of specific rules than a body of case law that applies general principles to a myriad of facts.

However, this benefit of a top-down approach must be balanced by the benefits of distributed decision-making. Distributed decision-making takes advantage of distributed intelligence, which exists "as the dispersed bits of incomplete and frequently contradictory" components.[17] Using distributed intelligence is particularly valuable when the information sources used to make a decision are not centrally located. This distributed information is what economist F.A. Hayek called "the knowledge of the particular circumstances of time and place."[18] Hayek's formulation provides a very good description of the type of information that is the stuff of the common law.

Common law relies on judges to apply and even to create law that is adapted to "particular circumstances of time and place," each case being somewhat different from anything that has come before.[19] Ideally, the judge combines the unique information presented during the case with information gained from previous legal cases (precedent) to create a legal opinion.[20] In the process, an additional data point is created of which others can now work off. This process has been the essence of common law systems since its origin in England.[21]

There are two key factors in the structural effectiveness of a system of distributed intelligence. The first factor is the number of data points, such as the body of case law. As more case law is added, each with its own particular facts and circumstances, the structure of the law takes a finer grain and it becomes easier to place the particular facts of a given case in

16. *See* Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557, 562–63 (1992).

17. *See* F.A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519, 519 (1945) (observing that in society, relevant knowledge is not given to or possessed by a single mind, but rather is distributed among a dispersed set of separate minds, making for an incomplete and sometimes contradictory societal knowledge).

18. *Id.* at 521.

19. SCOTT J. SHAPIRO, LEGALITY 198–99 (2011) (using common law as an example of bottom-up or distributed decision-making); *see* Frederick Schauer, *Do Cases Make Bad Law?*, 73 U. CHI. L. REV. 883, 883 (2006) (recognizing that common law judges discover and make law, which is a method of lawmaking that is guided by adjudications made in concrete contexts).

20. *See* Emily Sherwin, *Judges as Rulemakers*, 73 U. CHI. L. REV. 919, 924 (arguing that adherence to precedent works to constrain potential judicial biases that arise out of the details of individual cases).

21. *See* Roscoe Pound, *Common Law and Legislation*, 21 HARV. L. REV. 383, 389–90 (1908) (tracing the origin of common law doctrine to English judge-made rules rather than "forgotten statutes").

the context of earlier decisions.[22] The second factor in effectiveness is the ability of individuals within the system to access these data points. Inaccessible data points are useless to the decision maker.

There is some tension between the multiplicity of data points and citizens' ability to comprehend these points as a guide to conduct. As case law expands, for instance, it becomes more difficult, absent technology, for any individual to obtain the collection of case law that precisely relates to their case. Expansions in case law therefore create additional demand for synthesis.

### B. *The Development of Law as an Information Technology*

Technology helps mediate the tension between distributed and top-down forms of the law. Humans are both creators and creatures of technology.[23] Everything we do is vitally connected to the tools we develop, and the law is no different.[24] Law itself is in part a tool and an information technology,[25] but its effectiveness depends on the larger domain of material technologies in which it nests. The nature of legal production depends on the technology of its age. This section offers a brief survey of western lawmaking that shows how intimately technology was connected to the creation and practice of law. The technology of an era both empowered and constrained law's capacity to fulfill its information functions of providing notice and being informed by the facts taken from the world.

Law in the western tradition began in Greece, where the law was carved on a series of stones called *stelae*.[26] These *stelae* were publicly displayed, so that all could see the law.[27] Indeed, it was presupposed that the law must be quickly accessible and visible to all citizens or else it had little utility.[28] The technology of the time, a world not only without a printing press but also without paper in the modern sense, radically

22. *See* Antonin Scalia, *The Rule of Law as a Law of Rules*, 56 U. CHI. L. REV. 1175, 1177 (1989) (noting that the purported genius of the common law system is that the law develops and progresses through an incremental case-by-case application of facts).

23. *See* JOHN O. MCGINNIS, ACCELERATING DEMOCRACY: TRANSFORMING GOVERNANCE THROUGH TECHNOLOGY 149–51 (2013) (observing that individuals throughout history have created and invented technologies for human benefit, which changes the manner individuals interact with each other and ultimately the structure of social governance over time).

24. On the nesting of specific technologies in a larger technological domain, see generally W. BRIAN ARTHUR, THE NATURE OF TECHNOLOGY: WHAT IT IS AND HOW IT EVOLVES (2009).

25. Law, of course, is not simply an information technology. Unlike a computer, for instance, it creates obligations.

26. Paul Douglas Callister, *Law's Box: Law, Jurisprudence and the Information Ecosphere*, 74 UMKC L. REV. 263, 273 (2005).

27. *Id.*

28. *Id.* at 275–76 ("Publication of law is essential to Greek democracy, and failure to do so is equated with tyranny.").

limited its ability to inform the public of a system of complex rules or to create structures of distributed information that could help change law through gathering information.[29]

Roman law took advantage of the technological invention of the codex, which was an important historical step in the long historical arc of reducing information costs.[30] A codex was a series of pages bound together in a volume, in contrast to a scroll, which is a single continuous page that one must unroll to read.[31] Because of a codex's separate pages, the codex allowed easier access to information than the scroll by permitting easier indexing and search.[32] It therefore created a more expansive rendition of law—a far more complex code of conduct than could be contained on the *stelae* of ancient Greece or even the scroll of an earlier age in Rome. It was still, in essence, a top-down structure, but a far more reticulated one than had existed before. The Roman use of written law came to its apex with the publication of Justinian's *Corpus Juris Civilis*, a sweeping codification of the entirety of Roman law.[33] After being essentially lost, this code was rediscovered in Italy during the eleventh century and went on to form the basis of civil law in continental Europe.[34]

The origins of the common law system lie elsewhere, in England.[35] There, the Roman law existed alongside a common law system based on precedent and prior case law.[36] The common law was built up first

29. *See id.* at 275 (noting that the *stelae* limited the Greeks' ability to transmit information, which made the compilation of voluminous legal precedent difficult).

30. *See* David J. Gerber, *Prometheus Born: The Middle Ages and the Relationship Between Law and Economic Conduct*, 38 ST. LOUIS U. L.J. 673, 691 n.81 (1994) (noting that Roman law was compiled in part in the codex).

31. *See* Peter Stallybrass, *Books and Scrolls: Navigating the Bible*, *in* BOOKS AND READERS IN EARLY MODERN ENGLAND: MATERIAL STUDIES 42–43 (Jennifer Andersen & Elizabeth Sauer eds., 2002) (describing the operation of a codex as opposed to a scroll).

32. *Id.* at 43 (noting that the codex, as compared to the scroll, was characterized by its openness and its indexical feature that guided the reader seamlessly throughout the text); *see also* Dennis Baron, *The Book, the Scroll, and the Web*, WEB LANGUAGE (Apr. 1, 2010, 12:15 PM), http://illinois.edu/blog/view/25/25030.

33. John W. Head, *Codes, Cultures, Chaos, and Champions: Common Features of Legal Codification Experiences in China, Europe, and North America*, 13 DUKE J. COMP. & INT'L L. 1, 39 (2003) (describing the *Corpus juris civilis* as a compilation and consolidation of Roman law ordered by Justinian in 528); *see also* Charles Donahue, Jr., *Roman Law Influence on the Civil Law*, 81 MICH. L. REV. 972, 972–73 (1983) (reviewing ALAN WATSON, THE MAKING OF THE CIVIL LAW (1981)).

34. Ronald K.L. Collins & David M. Skover, *Paratexts*, 44 STAN. L. REV. 509, 522 n.77 (1992); Head, *supra* note 33, at 39 (noting that the *Digest*, a component part of the collective *Corpus juris civilis*, contributed to the development of European law).

35. Stewart Jay, *Origins of Federal Common Law: Part One*, 133 U. PA. L. REV. 1003, 1059–60 (1985) (noting that the American legal system adopted the common law from England, the original source of the common law).

36. Berring, *supra* note 6, at 16.

through manuscript law reports that were prepared during court proceedings and began as early as 1292.[37] Again, this advance in legal technology depended on material technological change from the ancient era.[38] The cost of material for recording information had fallen sufficiently so that it was possible to memorialize more details of cases. These case notes, called "year books,"[39] built up to the point that the need for abridgement and synthesis developed. This was first done in 1470, "by Nicholas Statham, baron of the exchequer under Edward IV."[40]

The forms of legal knowledge changed again as legal information was put within a new domain of material technology—printing.[41] As movable type allowed for cheaper and faster printing, more case law reports came into existence, resulting in a greater need for synthesis.[42] William Blackstone created the masterwork of early legal synthesis with his *Commentaries on the Laws of England*, first published in 1765.[43] The *Commentaries* were important to legal technology for two key reasons. First, Blackstone extolled the common law as being every bit the equal of the centralized Roman law codifications.[44] His advocacy marked an early stride for the importance of distributed decision-making. Second, Blackstone's work was comprehensive, spanning four volumes and 110 chapters, permitting a powerful synthesis of information that accumulated over centuries.[45]

Despite these advances, systems of synthesis still were not available that rapidly made recently decided law available to subsequent decision makers.[46] The Supreme Court is notable in its early years for neglecting

37. *Id.* at 17.

38. 1 ELIZABETH L. EISENSTEIN, THE PRINTING PRESS AS AN AGENT OF CHANGE: COMMUNICATIONS AND CULTURAL TRANSFORMATIONS IN EARLY-MODERN EUROPE 90 (1979) (describing how the lower cost of paper made further indexing possible).

39. Berring, *supra* note 6, at 17.

40. F.J.C. Hearnshaw, *Legal Literature*, *in* 8 THE CAMBRIDGE HISTORY OF ENGLISH LITERATURE 354, 359 (A.W. Ward & A.R. Waller eds., 1912).

41. *See* 1 EISENSTEIN, *supra* note 38, at 103–05 (noting that the new tools available to printers helped provide order and method to the process of compiling bodies of public law).

42. *See* Mary Sarah Bilder, *James Madison, Law Student and Demi-Lawyer*, 28 LAW & HIST. REV. 389, 421–22 (2010) (noting that early compilations of the vast materials produced by the common law system were intended to provide some order to the common law). For other syntheses of the common law, see WILLIAM NELSON, AN ABRIDGMENT OF THE COMMON LAW (1725–1726), MATTHEW BACON, A NEW ABRIDGMENT OF THE LAW (London, A. Strahan 6th ed., 1807), and CHARLES VINER, A GENERAL ABRIDGMENT OF LAW AND EQUITY (photo. reprint 2009) (1746–1753).

43. David J. Bederman, *The Curious Resurrection of Custom: Beach and Judicial Takings*, 96 COLUM. L. REV. 1375, 1382 (1996).

44. *See* Berring, *supra* note 6, at 16.

45. *See* Harold J. Berman & Charles J. Reid, Jr., *The Transformation of English Legal Science: From Hale to Blackstone*, 45 EMORY L.J. 437, 443 & n.8 (1996) (describing Blackstone's achievement as a synthesis that was the culmination of methods pioneered by previous English legal thinkers).

46. *See* Berring, *supra* note 6, at 17–20 (noting that despite the efforts of the early common

precedent.[47] *Hodgson v. Bowerbank*,[48] for instance, was a case in which the Court declined to apply the portion of the Judiciary Act of 1789 to permit suits among aliens.[49] Marshall's opinion in *Hodgson* does not cite *Mossman v. Higginson*,[50] a case from 1800 that had covered the same ground.[51]

The difference in the use and reliance of precedent between the early Supreme Court and the present-day Supreme Court is partially a story of information technology. Justice Marshall's access to case law was far below that available today or even in the late nineteenth century.[52] Case reporters of American law did begin to appear in fits and starts soon after the country's founding.[53] However, these case reporters were far from comprehensive, as the editors enjoyed wide editorial license to include or exclude cases.[54] The quality and reliability of the reporters also varied greatly.[55] There was even a "reporter of reporters" that cataloged the various reporters and attempted to assess their quality.[56]

Without being informed of recent precedent, a judge fulfills only half of the potential benefits of distributed intelligence. He creates a new data point for others to rely on, but does not take advantage of the data points that came before, thereby lowering the overall quality of the system. As great as some of earlier judges were, the technology that makes precedent broadly available improves performance.

John B. West, who in 1876 founded the West Publishing Company in Minnesota, regularized the reporting of precedent.[57] He created the West National Reporter System, a series of books that grew to cover legal precedent in every state.[58] Two advances drove the growth of West

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law compilers, the early normative case reports were disorganized, and this disorganization meant that legal practitioners had to synthesize legal information themselves).

47. *See, e.g.*, David P. Currie, *The Constitution in the Supreme Court: State and Congressional Powers, 1801–1835*, 49 U. CHI. L. REV. 887, 972–73 (1982) (discussing Chief Justice Marshall's lack of attention to precedent).

48. 9 U.S. (5 Cranch) 303 (1809).

49. *Id.*

50. 4 U.S. (4 Dall.) 12 (1800).

51. *See id.* at 14.

52. *See* DAVID P. CURRIE, THE CONSTITUTION IN THE SUPREME COURT: THE FIRST HUNDRED YEARS, 1789–1888, at 163 (1985) (suggesting that the Court's lack of reliance on precedent can be explained, in part, by the fact that "indexing of cases was not what it is today").

53. Berring, *supra* note 6, at 17–19.

54. *Id.*

55. *Id.* at 18.

56. *Id.*; *accord* JOHN WILLIAM WALLACE, THE REPORTERS, CHRONOLOGICALLY ARRANGED: WITH OCCASIONAL REMARKS UPON THEIR RESPECTIVE MERITS (Philadelphia, T & J.W. Johnson, 3d ed. rev. 1855).

57. Robert M. Jarvis, *John B. West: Founder of the West Publishing Company*, 50 AM. J. LEGAL HIST. 1, 1–2, 8 (2008–2010).

58. *See id.* at 14 & n.83.

Reporters. The first was the practical idea to combine the reporting of several large states into one book.[59] This allowed West to publish weekly updates of case law and a full reporter book every year, as opposed to official reports, which could sometimes be five years or more out of date.[60]

The second advance was adapting mass-production techniques to the legal industry. An examination of the 1901 West pamphlet *Law Books by the Million* shows how technologically driven the National Reporter system was.[61] It was a product of the age of steam and steel no less than Blackstone was a product of the age of the printing press. In the span of twenty-five years, John B. West had created a legal information factory: hydraulic binding pressers, sixteen advanced model linotype machines, and a quarter-mile long vault containing 2.5 million pounds of metal type sheets, all powered by an in-house boiler room.[62] This industrialization of legal publishing reduced the costs and increased the availability of legal information. West made individual case decisions available for only a quarter, far below the $5 to $10 that official state reporters typically charged, radically reducing legal information costs.[63]

This explosion in information was not met by universal approval.[64] In a speech given in 1902, Pennsylvania Chief Justice James Mitchell spoke of the pre-West legal culture: "The legal world had not yet surrendered to the manufacturer and the bookmaker, nor would any publisher have dared, even if he could truthfully do so, to send out, as more than one does now, boasting circulars that he makes law books by the million."[65] Commercial interests that stood to lose business to the new enterprise also opposed the idea of publishing a comprehensive record of case law. Several competing concerns offered highly edited reporters, publishing only the "important" cases.[66] These selective reporting systems lost the commercial battle.[67]

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59. Jarvis, *supra* note 57, at 6 (noting the development of West's first regional reporter in 1877, which covered cases from several states); *see also* WILLIAM W. MARVIN, WEST PUBLISHING COMPANY: ORIGIN, GROWTH, LEADERSHIP 46–57 (1969) (tracking the early history of the West Reporters).

60. Jarvis, *supra* note 57, at 6 (noting the West brothers published weekly eight-page issues to provide lawyers with an efficient means to learn about recent case law). *See generally* MARVIN, *supra* note 59, at 46–57.

61. W. PUBL'G CO., LAW BOOKS BY THE MILLION 3–10 (1901) (announcing and describing West's new system of publishing).

62. *Id.* at 7–19.

63. *Id.* at 23.

64. *See* Ross E. Davies, *West's Words, Ho!: Law Books by the Million, Plus a Few*, 14 GREEN BAG 2D 303, 304 (2011).

65. James T. Mitchell, *Historical Address*, *in* ADDRESSES DELIVERED MARCH 13 1902 AND PAPERS PREPARED OR REPUBLISHED TO COMMEMORATE THE CENTENNIAL CELEBRATION OF THE LAW ASSOCIATION OF PHILADELPHIA PENNSYLVANIA 13, 15 (Law Ass'n of Phila. 1906).

66. Berring, *supra* note 6, at 21.

67. *Id.* (noting that the English model of selectively reporting only a small number of

Despite Justice Mitchell's views, lawyers have consistently shown that when it comes to information, they want more.[68]

To deal with this massive increase in legal data, the West Company did two important things. First, it standardized the reporting of individual cases by publishing all cases in its own proprietary form.[69] With West, reading cases was the same in any jurisdiction and under any topic.[70] As Professor Robert C. Berring notes, "Research skills were made fungible as research became a mechanical process."[71]

More importantly, West introduced the Key Number System, whereby West's attorney–editors catalogued case law by relevant topics.[72] This system contained four-hundred main topics that were then further broken down into subdivisions.[73] This was the critical innovation from West publishing. It gave lawyers the ability to identify a discrete topic that was relevant to their case and then pull up a heretofore unavailable amount of case law on that topic.

Outside the West Publishing Company, the increase in case law prompted other attempts to organize the law. One was the rise of law reviews associated with law schools. This phenomenon began with the Harvard Law Review in 1887 and then proliferated across the nation.[74] This development was also driven by technology: "the development of high-speed rotary presses and improved paper-making processes - that in the late nineteenth century radically lowered printing costs and made law school sponsorship of legal periodicals financially and conceptually plausible for the first time."[75]

Another of these attempts at synthesis was the Restatement of the Law project.[76] Originally, the restatements were meant to replace the messy expanse of common law.[77] Instead of citing to case law, a lawyer would cite to the restatement.[78] Like the would-be competitors to West's Reporters, this attempt to distill the common law down to discrete principals failed to supplant the flexibility and comprehensive value found

available common law decisions gave way to the more comprehensive method of case reporting).

68. *See, e.g.*, *id.* ("Lawyers [in the early years of the West Publishing Co.] chose the comprehensive style of reporting, preferring that all precedent be available.").

69. *Id.*

70. *See id.* at 21–22.

71. *Id.* at 22.

72. Alvin M. Podboy, *The Shifting Sands of Legal Research: Power to the People*, 31 TEX. TECH. L. REV. 1167, 1169 (2000).

73. *Id.*

74. Bernard J. Hibbits, *Last Writes? Reassessing the Law Review in the Age of Cyberspace*, 71 N.Y.U. L. REV. 615, 617 (1997).

75. *Id.*

76. *See* Berring, *supra* note 6, at 23 (noting that the *Restatement* effort was a response to the disorganization of the existing common law).

77. *Id.*

78. *Id.*

in the mass of case law. However, Restatement did resemble law reviews in providing a new data point of persuasive authority.[79]

Although West Publishing Company solidified its position in the legal world during the century after its founding, from today's perspective we can notice three key limitations. First, although it was more comprehensive than any other commercial case log, the West National Reporter did not include every opinion.[80] Second, the Key Number system, while detailed, could never actually cover every possible topic created by legal events. As a result, lawyers trained to use (rather than critically examine) the West Key Number System would feel pressure to wedge the facts from their case into arguments that could be developed from within the Key Topic system.[81]

Finally, (through no fault of West) during the National Reporter era, there was no equivalent of the Digest system for sources outside of case law. This gap made it hard for lawyers and judges to draw upon nonlegal references and secondary sources in briefs and opinions. An examination of turn-of-the-century Supreme Court cases, and even cases from the 1950s, show few references to secondary sources such as law reviews, treatises, international law, and nonlegal sources.[82] As we will see, these limitations disappear as law comes within the domain of computational technology with its exponentially greater capacity to gather and categorize data.

### C. *The Tension Created by Limits of Information Capacity*

Before the advent of the computer age, law's two information objectives—creating clear notice to the community and updating through taking account of the facts of the world—were in tension. A code could give clear notice of rules but did not provide the same opportunity as the common law to take account of facts to inform its broad principles. The flexibility of the common law gained additional advantages as the world became less static with the advent of industrialization.

The major debate throughout American history about the form law should take reflected this enduring tension. From the beginning of the

79. *See* Paul H. Robinson & Markus D. Dubber, *The American Model Penal Code: A Brief Overview*, 10 NEW CRIM. L. REV. 319, 323 (2007) (describing how restatements often become points of persuasive authority).

80. Stephen C. Carlson, Note, *The Law and Economics of Star Pagination*, 2 GEO. MASON U. L. REV. (Student Edition) 421, 427 (1995).

81. *See* Robert C. Berring, *Legal Information and the Search for Cognitive Authority*, 88 CALIF. L. REV. 1673, 1681, 1694 (2000); Robert C. Berring, *Full-Text Databases and Legal Research: Backing into the Future*, 1 HIGH TECH L.J. 27, 33 (1986) (arguing that the West Key Number System changed the way lawyers think of the law: "Lawyers began to think according to the West categories").

82. Frederick Schauer & Virginia J. Wise, *Nonlegal Information and the Delegalization of Law*, 29 J. LEGAL STUD. 495, 496 (2000).

Republic, movements arose to codify matters that common law had previously decided.[83] One of the main advantages touted for codification was the clarity and access to information that codification would provide.[84] To be sure, the debate was also pitched in terms of democratic enactment of a code by a legislature as opposed to control by judicial elites. Early American politician William Drayton stated that the "letter of the law" was needed to protect the people from becoming the "slaves [of] . . . magistrates."[85] But even such complaints about the potential tyranny of judges were related to the information technology surrounding the law at the time. In a world with such weak reporting of recent precedent, magistrates necessarily had a lot of discretion.[86]

The debate endured throughout the nineteenth century. The most powerful exponent of codification was Dudley Field, who proposed that legislatures adopt his so-called Field codes.[87] Field emphasized the information advantages of codes: codification would make the law accessible to layman, lawyers, and judges, thereby reducing the costs of finding the law.[88] Field was a sophisticated legal theorist. He acknowledged that no code would determine all the cases and no set of rules could foresee all future contingencies.[89] Interpretation would still be required to apply even well-defined and comprehensive rules, and thus glosses on the law would be generated. But he thought that more code would lead to more clear results than the alternative.[90]

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83. GORDON S. WOOD, EMPIRE OF LIBERTY: A HISTORY OF THE EARLY REPUBLIC, 1789–1815, at 403 (2009) (positing that around the time of the American Revolution, the Revolutionary leaders were interested in circumventing judicial discretion present in the common law through legislation).

84. *Id.*

85. *Id*. at 404 (internal quotation marks omitted).

86. *See* Caleb Nelson, Stare Decisis *and Demonstrably Erroneous Precedents*, 87 VA. L. REV. 1, 9–10, 29–30 (2001) (observing that a common theme of the antebellum period was the notion that the judiciary needed to adhere strictly to past precedent as a means to limit judicial discretion and that case reports were a means to achieve this limitation).

87. Stephen N. Subrin, *David Dudley Field and the Field Code: A Historical Analysis of an Earlier Procedural Vision*, 6 LAW & HIST. REV. 311, 316 (1988). Some modern literature has cast doubt on the benefits of codification. *See* Dru Stevenson, *Costs of Codification*, ILL. L. REV. (forthcoming 2014) (manuscript at 24–26), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2122741 (arguing that codification gives special interests greater ability to skew norms and focuses judges on words of the statute rather than their purposes).

88. Grossman, *supra* note 7, at 154. Field also makes other arguments for codification related to information capabilities. He states that codification will help clear up lawyers' bookshelves and make legal research easier—two problems resolved by modern technological advances despite retention of common law. *Id.*

89. *See* Aniceto Masferrer, *Defense of the Common Law Against Postbellum American Codification: Reasonable and Fallacious Argumentation*, 50 AM. J. LEGAL HIST. 355, 399 (2008–2010).

90. *See* Subrin, *supra* note 87, at 318–19, 334–35.

While Dudley Field emphasized the advantage that a top-down approach to law had for informing the community of legal norms, his great opponent, James Coolidge Carter, a leader of the American Bar Association, emphasized the advantages that a distributed form of legal ordering had for reaching better social results. According to Carter, the common law was better at reaching justice in an individual case because its broad principles were better able to capture the customs of society.[91] As a result, the common law was also better at legal development, adapting the law to changed circumstances.[92] Like Field, Carter was a sophisticated advocate of his favored approach. He recognized that it created uncertainty, but argued that it was worth the price.[93]

Again, as in the debate at the beginning of the Republic, there were undercurrents of populism versus elitism. The common law, it was argued, made more work for lawyers and gave more power to judges.[94] But again, tension is not unrelated to conflict between certainty and flexibility in a world of limited information. At the time before computerized search, more flexibility in the law was a direct boon to the income of lawyers because their knowledge of practice and precedent was essential to finding plausible answers to legal questions in the interstices of the common law. One commentator at the time observed that "every practitioner knows that when a hard case arises, the law books are ransacked from the time of the Norman Conquest and the court blindly applies any absolute precedent that may have been found by diligent counsel."[95] Just as men performed the calculating function reserved for the computers in our day, lawyers then necessarily performed much of the functions of computerized search today.[96]

Thus, the long debate between the virtues of the common law and codification dramatizes the tension between top-down and distributed decision making and between law's two information functions. As the debate went on through the decades, seasoned participants understood that it was about a trade-off between law's potential for certainty and its capacity for discovery. What was not so appreciated was that this tension

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91. Lewis A. Grossman, *James Coolidge Carter and Mugwump Jurisprudence*, 20 LAW & HIST. REV. 577, 579 (2002).

92. *See id.* (noting that, in Carter's view, statutory enactments contrasted with the common law in that the enactments remained static and therefore unable to respond to changing custom); Gordon S. Wood, *The Origins of Judicial Review*, 22 SUFFOLK U. L. REV. 1293, 1306–07 (1988).

93. *See* Masferrer, *supra* note 89, at 388.

94. *See* Subrin, *supra* note 87, at 318–19 (observing that the underlying themes of Field's codification movement were notions that the common law was rooted in an undemocratic past and that a written, codified system would provide citizens access to the law and simultaneously bind the courts).

95. Masferrer, *supra* note 89, at 364 (quoting FRANCIS BACON JAMES, CODIFICATION OF THE BRANCHES OF COMMERCIAL LAW 6 (1902)) (internal quotation marks omitted).

96. *See* JAMES GLEICK, THE INFORMATION: A HISTORY, A THEORY, A FLOOD 84 (2011).

was to a great degree a reflection of information scarcity. Computation systems at the time were simply not capable of ongoing, accurate synthesis of the growing number of discrete legal data points, particularly as they multiplied in a more complex and litigious society. This Article now turns to developments that are beginning to radically alter the world of information technology and so beginning to resolve this historic tension.

## II. CREATING LAW'S ALGORITHM

This section demonstrates how lowering information costs can transform the nature of legal search and reconcile law's two conflicting impulses—to gather information from the world and provide information to the community. First, it discusses the beginnings of computerized search, showing how it improves fundamentally on the deficiencies of previous legal search. It then describes the driving force behind this improvement—Moore's law—a continuing trend of the information age that suggests such improvement will continue. We also describe how legal search is likely to progress through the use of increasing computer power. Finally, it uses information theory to show how lowering information costs can help legal search create positive law from distributed information.

### A. *The Beginning of Computerized Legal Search*

Following the introduction of written law and the creation of legal indexes, the introduction of computer-aided legal search was the next great legal information transformation. Computerized legal search began in the mid-1960s when the Ohio State Bar Association tried to create an electronic system to sort through legal opinions.[97] That system became the foundation for the Lexis legal search system, which was introduced to the public in 1973.[98] Westlaw was offered soon after, but it was of limited utility since it did not allow researchers to search the full text of legal opinions.[99] During this same time, the Lexis system was handicapped by a less than complete database of case law.[100]

At first there was only limited access to even this fledgling computerized search. Lexis and Westlaw were both initially only available

97. F. Allan Hanson, *From Key Numbers to Keywords: How Automation Has Transformed the Law*, 94 LAW LIBR. J. 563, 573 (2002).

98. *Id.*

99. *Id.*

100. Paul Hellyer, *Assessing the Influence of Computer-Assisted Legal Research: A Study of California Supreme Court Opinions*, 97 LAW LIBR. J. 285, 286 (2005); *see The LexisNexis Timeline*, LEXISNEXIS 2–3, http://www.lexisnexis.com/anniversary/30th_timeline_fulltxt.pdf (last visited Apr. 3, 2014) (noting that Lexis launched with only Ohio and New York case law and that it did not complete expansion to all fifty states until 1980).

on minicomputer terminals.[101] These "terminals were huge, cumbersome machines, and their relative speed of access was frustratingly slow compared to early-twenty-first [century] computers."[102] Starting in 1979, Lexis offered searches on their custom built UBIQ desktop computers.[103] Having ready access to electronic databases was the first step in allowing lawyers to make legal search a routine part of their information gathering process. In that same year, Westlaw eliminated its biggest limitation by allowing search of the full text of cases, rather than just head notes.[104] By the next year, 1980, Lexis expanded its legal database so that it covered all fifty states and most federal cases, matching the database Westlaw had developed.[105] By 1980 the improvements at both Lexis and Westlaw made electronic search into a credible replacement for many traditional forms of acquiring legal information.[106]

Indeed, from 1980 to 1995 legal search experienced massive growth.[107] After 1995, most of the growth came from additional services, rather than adding more customers.[108] Several of the services added to legal search since 1980 have been critical additions.

For instance, in 1992, Westlaw became the first legal search engine to allow for limited natural language search, and Lexis followed one year later.[109] Natural language search allowed people to search without knowing how to use Boolean search terms. Unfortunately, the hardware and software available at the time limited the accuracy of the search.[110] Despite the limited initial effectiveness, natural language search, as it is refined, will have fundamental implications for legal search and ultimately the form of law.

Both search engines integrated Shephard's citation checking services into their case results in 1981.[111] In 1998, Westlaw developed its own proprietary citation checker, KEYCITE.[112] The integration of these services allowed researchers to instantly assess whether certain opinions

101. Casey R. Fronk, *The Cost of Judicial Citation*, 2010 U. ILL. J.L. TECH. & POL'Y 51, 57.

102. Mark Engsberg, *Computerized Research*, *in* THE OXFORD COMPANION TO AMERICAN LAW 135, 136 (Kermit L. Hall et al. eds., 2002).

103. *Id.*

104. Hellyer, *supra* note 100, at 286.

105. *See id.*

106. *See id.* at 286–87.

107. *Id.* at 287; *see also* Interview with Clemens Ceipek, Ian Koenig, and Steve Mann of LexisNexis (Dec. 14, 2011).

108. Interview with Clemens Ceipek, Ian Koenig, and Steve Mann of LexisNexis (Dec. 14, 2011).

109. Sarah Laidlaw Tilevitz, *Reconciling Space and Access Needs in a Small Firm Library: A "Modest Proposal,"* 88 LAW LIBR. J. 96, 103 (1996).

110. Interview with Clemens Ceipek, Ian Koenig, and Steve Mann of LexisNexis (Dec.14, 2011).

111. Berring, *supra* note 81, at 1696.

112. *Id.* at 1700.

were still good law. During the late 1990s, Lexis and Westlaw first allowed users to access their products through the Internet, greatly expanding the accessibility of legal search.[113]

Legal search added features, increased coverage, and offered greater accessibility as the cost of computerized search dramatically fell in real terms. In the 1970s, a search for the phrase "trial by jury" on Westlaw could have cost as much as $5,000.[114] A similar search today on WestlawNext would cost only $60.[115] While this represents a tremendous reduction, looking at the cost effectiveness of Westlaw or Lexis alone overlooks perhaps the most important change in the cost of legal search: the introduction of free legal search by services such as Google Scholar[116] and FindLaw.[117] On either of these sites, researchers have access to decades of case law, all fully searchable. Google Scholar even links cases by citation, so that a researcher can easily see all of the cases that have cited to a particular opinion.

Given the increase in accessibility, breadth, and cost-effectiveness of legal search, we would expect to see empirical changes in how legal documents are created, such as an increase in the number of citations in opinions and briefs. Two studies have shown this exact phenomenon. A study of California Supreme Court opinions shows that the average number of citations per opinion doubled from 1973 to 2003.[118] Federal Circuit Courts of Appeal opinions increased their citations at a similar rate, going from 13.8 citations per opinion in 1975, to 27.2 in 1993.[119]

Computerized legal research has also led to tremendous improvements in the accessibility of secondary sources and nonlegal sources. Lexis

113. *See* Hellyer, *supra* note 100, at 287 (noting the growth in online popularity).

114. Hellyer, *supra* note 100, at 286.

115. Ronald E. Wheeler, *Does WestlawNext Really Change Everything? The Implications of WestlawNext on Legal Research*, 103 LAW LIBR. J. 359, 361 (2011). WestlawNext charges an additional amount ($15 per document) for examining the contents of the search result. *Id.*

116. GOOGLE SCHOLAR, http://scholar.google.com/ (last visited Mar. 14, 2014).

117. FINDLAW, http://www.findlaw.com/casecode/ (last visited Mar. 14, 2014).

118. Hellyer, *supra* note 100, at 294 tbl.1. Professor Hellyer concludes that legal search has not increased the court's access to legal knowledge because the amount of citations per 10,000 words of an opinion has decreased. *See id.* at 297–98. This Article contends that citation density is a poor measure to judge the effect of legal research. Increased access to legal knowledge or case law would not necessarily affect the density of opinions, but by lowering the cost of accessing additional sources, it would plausibly increase the total number of citations. Furthermore, federal opinion data collected by Judge Richard A. Posner showed an increase in citations despite a *decrease* in the length of the opinions. RICHARD A. POSNER, THE FEDERAL COURTS 153 tbl.5.2 (1996).

119. POSNER, *supra* note 118, at 153 tbl.5.2; *cf. id.* (indicating that Supreme Court opinions went from an average of 22.7 citations per opinion in 1975 to an average of 40.8 citations per opinion in 1993). *But see id.* (indicating also that Supreme Court opinions had an average of 61.9 citations in 1983). However, the variation in the Supreme Court may be explained by its small docket, which would lend itself to larger variations year to year.

added its Nexis service in 1979, allowing customers to search journalism articles.[120] By 2000, LexisNexis was adding 8.7 million documents to its database every week.[121] Lexis and Westlaw also added law reviews and secondary sources to their databases.[122] Given that legal search engines have increased the availability of secondary and nonlegal sources, one might expect to find increasing citations to such sources. The empirical research appears to show this. A study of U.S. Supreme Court cases from 1950 to 1995 showed a large spike of nonlegal sources starting in 1991.[123]

Developments in legal search since then have increased the availability of secondary sources.[124] In 2004, Westlaw introduced a feature called ResultsPlus, which automatically gathers secondary sources that may be relevant to a search query and displays them in a sidebar next to the regular search results.[125] WestlawNext went even further with the introduction of database independent search.[126] Rather than requiring a researcher to specifically seek out information in secondary sources, WestlawNext automatically displays the relevant secondary sources, not in a sidebar but as a complete category of results displayed in the same format as the case law results.[127]

Thus, even the beginnings of computerized search have had dramatic effects, overcoming each of the defects this Article noted in the structure of search that West Publishing previously created in the late nineteenth

120. *About LexisNexis*, LEXISNEXIS, http://www.lexisnexis.com/en-us/about-us/about-us.page (last visited Mar. 14, 2014) (hover cursor over "1970s" under "Historical Milestones") (noting when the Nexis database was introduced).

121. Hellyer, *supra* note 100, at 287.

122. *See* Ian Gallacher, *Forty-Two: The Hitchhiker's Guide to Teaching Legal Research to the Google Generation*, 39 AKRON L. REV. 151, 162 n.51 (2006).

123. *See* Frederick Schauer & Virginia J. Wise, *Legal Positivism As Legal Information*, 82 CORNELL L. REV. 1080, 1108 (1997).

124. *See* Hellyer, *supra* note 100, at 292 (noting that computer-assisted legal research tools such as Westlaw and Lexis have improved access to secondary sources). Some scholars even argue that the rise of secondary sources leads to a "kaleidoscope of sources" that undermines authority. *See* Berring, *supra* note 81, at 1690.

125. *See* Michele Falkow, *Visual Literacy and the Design of Legal Web Sites*, 97 LAW LIBR. J. 435, 450 (2005).

126. Catherine M. Dunn, *The Next Generation of Westlaw: WestlawNext*, 54 LAW LIBR. LIGHTS (Law Librarian's Soc'y of Wash., D.C., Inc.), Fall 2010, at 1, *available at* http://www.llsdc.org/assets/LLL/54/lights_54-1.pdf.

127. *See* Wheeler, *supra* note 115, at 360–61 (noting that one of the innovative features of WestlawNext is that it allows users to search without first having to select a database and receive "faceted search results" that group sources, like cases, into categories). However, in assessing the effect of legal search on these sources, it is important to remember the goal of any individual attorney is winning the case, not presenting the most wide-ranging argument. Legal search can allow an attorney to quickly find the legal opinion that makes his case. In this way, legal search could depress the use of argument by analogy, which in turn might depress the use of secondary sources. Regardless of their eventual insertion into briefs or opinions, the important fact is that legal search makes the information available.

and twentieth century. First, a wider variety of opinions can be searched because of the ease of putting information online. Second, lawyers can search through categories of their own choosing, created by their own words, rather than depending on preset categories. Third, secondary literature can be searched and this search can be seamlessly integrated into searches for law. Perhaps most importantly, free computer search engines are now emerging—a first step to democratizing legal search and making even complex law available in real time to the citizen.

### B. *The Future Improvement of Computerized Legal Search*

In this section we first discuss the technology that is today creating ever more powerful search—the exponential increase of computation power. We then consider its practical effects and show search will soon become semantic in that it will not be limited by rigid language queries but can better mimic human communication. Finally, we apply the rudiments of information theory to legal search. Surprisingly, information theory has rarely been applied to law. Yet it yields a powerful result: a sufficiently powerful search can become, in an important sense, the law itself.

#### 1. Moore's Law and Powerful Natural Language Search

Given the dramatic changes that the introduction and improvement of legal search has already created, it is important to explore how legal search will likely develop, before discussing how these changes will affect the form of law. The main driver of continuing legal search improvement is Moore's law. Moore's law is a technology trend that Intel cofounder Gordon Moore identified in a 1965 article.[128] In the article, Moore noticed that the number of transistors on an integrated circuit had roughly doubled every year over the previous seven years.[129] With uncanny consistency, the exponential growth Moore identified has continued over the past forty-six years.[130] This exponential growth applies not only to processing power but also to the capacity of data storage—the so-called Kryder's law.[131]

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128. Gordon E. Moore, *Cramming More Components onto Integrated Circuits*, ELECTRONICS, Apr. 19, 1965, at 114.

129. *Id.* at 115. From 1965 forward, the rate of doubling was closer to once every twenty-four months. *See* Jerry Wu et al., *A Nanotechnology Enhancement to Moore's Law*, 2013 APPLIED COMPUTATIONAL INTELLIGENCE & SOFT COMPUTING 1, 1, *available at* http://www.hindawi.com/journals/acisc/2013/426962. This improvement, however, understates the overall improvement in integrated circuits, as it does not account for the increased speed of the transistors, improvements in chip architecture, and declining costs of the integrated circuit in real dollar terms.

130. RAY KURZWEIL, THE SINGULARITY IS NEAR 67 (2005).

131. *See* Daniel Martin Katz, *Quantitative Legal Prediction—or—How I Learned to Stop Worrying and Start Preparing for the Data-Driven Future of the Legal Services Industry*, 62 EMORY L.J. 909, 916 (2013).

And even this trend understates the stability of exponential growth. Inventor Ray Kurzweil has demonstrated that exponential growth in computing predates Gordon Moore's prediction by a full seventy years.[132] He found that the electro-mechanical devices used to compute the 1890 census experienced year-to-year exponential growth, as did the electronic relay and vacuum tube-based computers that followed.[133] After 120 years of consistent exponential growth, it is likely that similar growth will continue.[134]

Future legal search will take advantage of this relentlessly increasing processing power. Computers can take advantage of the new processing power to deploy advanced algorithms to accurately decipher natural language questions. Two recent technological advances outside law are harbingers of what the future of legal search will entail: IBM's *Jeopardy!* playing computer, Watson, and Apple's virtual assistant, Siri.

To enable Watson to play *Jeopardy!*, Watson has basic language rules programmed within it.[135] Watson also possesses over 100 separate modules with their own unique algorithm, each of which individually try to determine the correct answers to questions on the show (technically of course, according to the rules of *Jeopardy!* it finds the correct questions to answers).[136] Watson is also constituted by a separate layer of algorithms that balance the results suggested by the competing modules to find the right answer.[137]

Since the modules do not always agree on an answer, Watson does not generate one definitive answer but instead generates several possible answers, each with its own probability of being right.[138] During *Jeopardy!*, Watson attempted to answer a question only if the probability of the top-ranked answer reached a certain threshold.[139]

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132. KURZWEIL, *supra* note 130, at 67.

133. *Id.*

134. All exponential trends must end eventually, and there are theoretical limits to the computational ability of matter. However, current computers are nowhere near those limits. *See id.* at 34. Current research has already identified specific techniques that will extend Moore's law for at least ten more years. *15 Moore's Years: 3D Chip Stacking Will Take Moore's Law Past 2020*, PHYSORG (Mar. 10, 2010), http://phys.org/news187454589.html; Rick C. Hodgin, *New Research Suggests Moore's Law Will Not Cease Around 2020*, TG DAILY (Dec. 10, 2008, 1:04 PM), http://www.tgdaily.com/trendwatch-features/40515-new-research-suggests-moores-law-will-not-cease-around-2020.

135. Adam Lally & Paul Fodor, *Natural Language Processing with Prolog in the IBM* Watson *System*, ASS'N LOGIC PROGRAMMING (The Ass'n for Logic Programming), May 24, 2011, at 1, *available at* http://www.cs.nmsu.edu/ALP/wp-content/uploads/2011/03/PrologAndWatson1.pdf (describing the software, known as "DeepQA").

136. IBM SYS. & TECH. GRP., WATSON—A SYSTEM DESIGNED FOR ANSWERS 3 (2011), *available at* ftp://public.dhe.ibm.com/common/ssi/ecm/en/pow03061usen/POW03061USEN.pdf.

137. *See id.* at 4.

138. *See id.*

139. *See A Computer Called Watson*, IBM, http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/watson (last visited Mar. 5, 2014).

The specialized modules in Watson have a natural analogue in the specialized sections of the human brain. Like Watson, the answers stemming from human minds are thought to emerge from the harmonization of these different sections.[140] Indeed, after learning about the process by which Watson determines answers, Ken Jennings, the famous game show champion, remarked that "[t]he computer's techniques for unraveling *Jeopardy!* clues sounded just like mine."[141]

Watson defeated Ken Jennings and Brad Rutter (*Jeopardy!*'s all-time money leader) in February of 2011, more than doubling the score of either human contestant.[142] IBM is currently adapting Watson's natural language abilities to create a system for improved medical diagnosis.[143] Also, IBM states that Watson's technology can be deployed to parse through "vast tracts of legal documents."[144]

Like Watson, much of the genius of Apple's Siri lies in deciphering the meaning of language. Siri is a virtual assistant that is built into Apple's iPhone.[145] It receives simple natural language commands, searches the Internet, and ultimately responds to the natural language command with an answer.[146] It can also transcribe and send text messages and can even make restaurant reservations.[147] Unlike Watson, however, Siri must

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140. As noted by neuroscientist Antonio Damasio:

> Conscious minds result from the smoothly articulated operation of several, often many, brain sites. The ultimate consciousness product occurs from those numerous brain sites at the same time and not in one site in particular, much as the performance of a symphonic piece does not come from the work of a single musician or even from a whole section of an orchestra.

Pamela Weintraub, *Art and Science Peer into the Mind*, DISCOVER MAG. (July 7, 2011), http://discovermagazine.com/2010/dec/17-art-science-peer-into-the-mind.

141. Ken Jennings, *My Puny Human Brain*, SLATE (Feb. 16, 2011, 11:04 PM), http://www.slate.com/articles/arts/culturebox/2011/02/my_puny_human_brain.html.

142. Betsy Cooper, *Judges in Jeopardy!: Could IBM's Watson Beat Courts at Their Own Game?*, 121 YALE L.J. ONLINE 87, 87, 93 (2011), http://yalelawjournal.org/the-yale-law-journal-pocket-part/legislation/judges-in-jeopardy!:-could-ibm%E2%80%99s-watson-beat-courts-at-their-own-game?; Seth Borenstein & Jordan Robertson, *IBM 'Watson' Wins: 'Jeopardy' Computer Beats Ken Jennings, Brad Rutter*, HUFFINGTON POST (Feb. 17, 2011, 1:24 AM), http://www.huffingtonpost.com/2011/02/17/ibm-watson-jeopardy-wins_n_824382.html (Watson: $77,147; Ken Jennings: $24,000; Brad Rutter: $21,600).

143. *IBM's Watson Heads from 'Jeopardy!' to Columbia University Medical Center*, CBS N.Y. (Feb. 17, 2011, 8:30 AM), http://newyork.cbslocal.com/2011/02/17/ibms-watson-heads-from-jeopardy-to-medical-ward/.

144. IBM SYS. & TECH. GRP., *supra* note 136, at 5.

145. Steve Lohr, *Siri and Apple's Future*, N.Y. TIMES BITS (Oct. 5, 2011, 5:59 PM), http://bits.blogs.nytimes.com/2011/10/05/siri-and-apples-future.

146. *Id.*

147. David Pogue, *New iPhone Conceals Sheer Magic*, N.Y. TIMES (Oct. 11, 2011), http://www.nytimes.com/2011/10/12/technology/personaltech/iphone-4s-conceals-sheer-magic-po

accomplish these tasks using the limited resources available on a smartphone, rather than a supercomputer.[148] The key advantage that Siri has, and the reason it is so important to the improvement of natural language algorithms, is its immense user base from which Siri and its subsequent iterations can learn.[149] Apple is currently storing the raw data of each Siri interaction in a massive computer database in North Carolina.[150] Its engineers will be able to mine this database to correct Siri's errors and add new capabilities for understanding.

By improving the level of accuracy and breadth of response, technologies like Siri and Watson change the very nature of search. As Gary Morganthaler, an early backer of the technology behind Siri, put it, the future of search is "to deliver the information you want, not in a million blue links, but in one correct answer."[151]

Given the future importance of understanding natural language, it is not surprising that both Lexis and Westlaw are making serious efforts to improve their natural language searches. Westlaw felt confident enough in its technology to make natural language search the default search choice in WestlawNext.[152] Lexis's new search product "Lexis Advance" will include an upgraded natural language search.[153] The goal of this search is to understand the semantic value of the search query, rather than just trying to find the exact words being searched for.[154] If working properly, this search should be able to pull up a result that does not contain any of the words that were used in the search, but is nonetheless on topic.

However, while legal search companies are making large strides in this area, the big breakthroughs are likely to initiate in other fields and then

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gue.html?pagewanted=all (noting Siri's ability to read text messages aloud for the user and to respond to the user's text messages, all by voice); *see also* Jason Cipriani, *How to Use Siri's New Features in iOS 6*, CNET (Sept. 19, 2012, 11:09 AM), http://www.cnet.com/how-to/how-to-use-siris-new-features-in-ios-6 (describing how a software update gave Siri the ability to make reservations).

148. When a spoken command is given to Siri, the speech is both analyzed locally on the smartphone and sent to Apple's servers for evaluation. Andrew Nusca, *Say Command: How Speech Recognition Will Change the World*, SMARTPLANET (Nov. 2, 2011, 9:01 PM), http://web.archive.org/web/20130825081645/http://www.smartplanet.com/blog/smart-takes/say-command-how-speech-recognition-will-change-the-world/19895 (archived copy). Regardless of which analysis (local or server-side) is eventually accepted by the program before it acts, Siri is limited by either the computational power or the Internet connectivity of the smartphone. *See id.*

149. *See* Eric Jackson, *Why Siri Is a Google Killer*, FORBES (Oct. 28, 2011, 10:20 AM), http://www.forbes.com/sites/ericjackson/2011/10/28/why-siri-is-a-google-killer/.

150. *Id.*

151. *Morgenthaler Says iPhone Siri Is 'Seriously Underrated,'* at 3:02 (Bloomberg television broadcast Oct. 20, 2011), *available at* http://www.youtube.com/watch?v=byIgpVZ9xzw.

152. *See* Wheeler, *supra* note 115, at 360–61 (describing WestlawNext's new WestSearch search engine).

153. Interview with Clemens Ceipek, Ian Koenig, Steve Mann, LEXISNEXIS (Dec. 14, 2011).

154. *Id.*

transfer to the legal field because the market for general natural language search is so much larger than that for legal search. Once a company such as IBM, Apple, or Google has created the proper algorithms, there is very little marginal cost in applying those algorithms to legal search.[155] As a result, the advancements in general natural language understanding will quickly improve legal search.[156]

### 2. The Practical Effects of Accurate Natural Language Search

These new algorithms and additional computing power will likely improve legal search in two broad phases. The two phases are broken apart by the function of the lawyer. In Phase I, the lawyer spots the issues and looks to the search engine to identify the relevant cases. In Phase II, the search engine itself identifies the issues implicated within a given set of facts, and then suggests the case law likely to be on point for the issues it identified. This second phase will substantially reduce the role of the lawyer in legal research.

Legal search engines during Phase I of search improvement will build upon the process that lawyers use to interact with search engines by adding the capability of accurate natural language understanding. Legal search engines have incorporated a natural language search option for twenty years, but its effectiveness has been limited. Unlike keyword searches, where the search engine simply scans for the keywords in documents, natural language search attempts to understand what the search query is asking for.[157] As an example, a search for "boat accidents" using a keyword search engine would cause the search engine to simply look through documents to find those that contained the words "boat" and "accident." Documents might then be ranked higher if the words appeared more often or closer together. A natural language search would try to understand the search query on a more fundamental level. For instance, the search engine could pull documents that dealt with a "ship" accident or a "sailboat" accident, knowing those words were synonyms for the word "boat." More sophisticated algorithms would understand longer,

155. Improved algorithms may also migrate over from the field of legal discovery search. The need for automated search in that field may be even greater than the need within the case law search field. The cost of a thorough discovery search can often exceed the value of the case. The leading journal on e-discovery issues has specifically advocated that lawyers cooperate in developing improved artificial intelligence as a necessary component for future legal cases. *See* The Sedona Conference, *The Sedona Conference® Best Practices Commentary on the Use of Search and Information Retrieval Methods in E-Discovery*, 8 SEDONA CONF. J. 189, 212 (2007).

156. Analogously, improvements in the analysis of big data for predictions will be applied to predict the outcome of pending cases. *See* Daniel Katz, *supra* note 131, at 912–13, 936–42, 948–49.

157. Interview, *supra* note 107; *see* Judith M. Stinson, *Why Dicta Becomes Holding and Why It Matters*, 76 BROOK. L. REV. 219, 253 n.164 (2010) (describing and distinguishing natural language and Boolean search methods).

more complicated natural language queries that include verbs and adjectives, but this level of understanding is still in its infancy.

Today, despite some advances in semantic understanding, legal search engines still work as a searchable index. Lawyers searching the index play a guessing game, trying to come up with the magical combination of terms that will get the search engine to return the relevant case law. The guessing game takes time, energy, and money. In Phase I of search improvement, legal search engines will eliminate the guessing game by understanding, at a human level, the legal question being posed. Instead of typing in a search term like "conspiracy /s (cover-up getaway escape) /p join!" the lawyer will simply ask "find case law where the court discusses whether helping to cover up a conspiracy means you are responsible for the acts of the conspiracy."

It is unlikely that these search engines will be able to determine *the one* case that is most on point. Instead, following Watson, the search engine will likely use competing algorithms to "score" each possible case for how well it lines it with the search query and come up with a short list of the top-ranked cases. The algorithm could then also take into account nonlanguage related factors, such as whether the opinion was heavily cited to or searched for. WestlawNext already implements this feature by altering its search results depending on actions made by its users, such as how often a given source has been downloaded or viewed.[158]

When natural language understanding and case ranking algorithms are implemented, the search engine operates as an Automated Legal Encyclopedia (ALE). Legal encyclopedias such as American Jurisprudence (AmJur) and Corpus Juris Secundum (CJS) ideally work like a good legal researcher. If a lawyer has a question on how the statute of repose works in the state of Illinois, a look at that topic section in the encyclopedia should give him a good overview of the relevant case law, just as a legal researcher would do if they were given a research task. While legal encyclopedias often work exactly as planned, they are far from perfect. Three flaws in legal encyclopedias are dated citations, the failure to gauge the relative weight of precedent, and inflexibility.

Many of the cases cited in the legal encyclopedias are too old to include in a strong legal brief. In encyclopedias such as AmJur, CJS, or their state law equivalents, citations to cases from the 1800s are far from rare.[159] An ALE search will not have this limitation. The database it is based on will be refreshed whenever a new case is published. When a lawyer gives the computer a topic to research, the computer will access that database and use it to compile a fresh list of cases that are on point for that topic. Essentially, the encyclopedia topic is recreated with every

158. Wheeler, *supra* note 115, at 365.

159. *See, e.g.*, 6 AM. JUR. 2D *Assignments for Benefit of Creditors* § 60 (2008); 74 C.J.S. *Railroads* § 585 (2013).

search. This development will eliminate the problem of overturned and stale case law.

As ALE search advances it also can deal with the reality that cases do not have equal precedential value: their persuasiveness depends on the court that decided the case and the force that the precedent acquired over time. They may also have different weights depending on the kind of argument in which they are used and the court and judge to whom they are presented. Thus, even when lawyers find precedents by means of a computer, they rely on their own judgment in deploying it. But machine intelligence will also make judgments about the strength of precedent. Network analysis can now evaluate the strength of a precedent by considering how much other cases rely on it.[160]

Indeed, the process of legal search itself may actually help us gauge weights. If more people click on a precedent, that suggests they find it more persuasive. More generally, one new area for legal search, as with other search, is to discover information from the patterns of search itself.[161]

By creating each research topic from scratch, the search engine will also overcome another flaw of legal encyclopedias: lack of flexibility. Legal encyclopedias are very detailed and often have four or more levels of subheadings under a single topic. No matter how detailed, however, no encyclopedia can possibly have a heading for every available combination of law and fact. If the particular case law that the lawyer is looking for is not contained in the encyclopedia, then it serves as merely a starting point for further research on an issue. An ALE will be able to provide customized results that highlight the exact cases that the lawyer is looking for. A lawyer using ALE search will therefore have instant access to the case law that is in his favor. ALE search will also be able to pull up secondary sources that can support the case law and contextualize the legal issues in the case.

### C. *Information Theory and Advanced Legal Search*

ALE search will represent the next installment in the push/pull relationship of case law growth and increased legal synthesis that has taken place throughout legal history. However, its effects will be more profound than any previous step in the history of legal technology. In fact, the capability of ALE legal search could develop into the law itself. To

160. *See* James H. Fowler et al., *Network Analysis and the Law: Measuring the Legal Importance of Precedents at the U.S. Supreme Court*, 15 POL. ANALYSIS 324, 335 (2007) (noting that the relevance of a given case can be determined objectively by the extent to which judges and justices cite to them in future cases).

161. *See, e.g.*, *Google Searches Track Flu Spread*, BBC NEWS (Nov. 12, 2008, 1:18 PM), http://news.bbc.co.uk/2/hi/technology/7724503.stm (discussing a famous example in which early warnings of flu epidemics are generated by Google searches).

understand why this will be the case, this Article now examines how legal information fits into the framework provided by information theory.[162] Despite the potential synergy between information theory and law, there has been a surprisingly small body of scholarship on this subject.[163]

There are two concepts in particular that apply to this Article's thesis: the signal to noise ratio and the algorithm theory of information content. Information theory is both conceptual and mathematical. In this early application of information theory to law, this Article does not seek to apply information theory to law in a rigorous mathematical sense. Instead, it looks to how the concepts suggested by information theory are applicable to law and legal search.

Mathematician Claude Shannon founded information theory in 1948 when he published his article, *A Mathematical Theory of Communication*.[164] Among other things, Shannon showed that the maximum amount of information that can be reliably carried through a signal is limited by the amount of noise in the channel.[165] In telecommunication, this noise would show itself as the hisses and pops that inevitably accompanied a signal and altered the message that was transmitted.

Shannon showed that the sender of a message had to make the message redundant to ensure that it was received accurately, despite the noise.[166] The greater the amount of noise, the more redundancy had to be built into the signal. By requiring more redundancy, which takes time and energy to produce, noise reduces the potential of a system to communicate.[167]

A message sent through a telegraph wire illustrates the uses of redundancy. The noise in the wire could alter the signals sent so that the letter "a," sent at one telegraph station, is received at another station as the letter "b." A natural amount of redundancy in the English language provides a counterweight to such errors.[168]

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162. For an underappreciated explanation of information theory as a potential framework for understanding law, see Martin Shapiro, *Toward a Theory of* Stare Decisis, 1 J. LEGAL STUD. 125, 125 (1972) (describing his new theory of stare decisis involving communications theory to be developed).

163. For examples of legal scholars using concepts from information theory, see Barton Beebe, *An Empirical Study of U.S. Copyright Fair Use Opinions 1978–2005*, 156 U. PA. L. REV. 549, 596 & n.146 (2008) (criticizing the fair use doctrine as syntactic rather than cybernetic feedback); Randy E. Barnett, *The Virtues of Redundancy in Legal Thought*, 38 CLEV. ST. L. REV. 153, 153–55 (1990) (explaining how redundancy in law leads to increased jurisprudential certainty and discovery).

164. Erico Marui Guizzo, The Essential Message: Claude Shannon and the Making of Information Theory 2 (June 16, 2003) (unpublished M.S. thesis, Massachusetts Institute of Technology), *available at* http://dspace.mit.edu/bitstream/handle/1721.1/39429/54526133.pdf.

165. C.E. Shannon, *A Mathematical Theory of Communication* (pts. 1 & 2), 27 BELL SYS. TECH. J. 379, 623 (1948).

166. *Id.* at 410.

167. *See id.*

168. *See* Guizzo, *supra* note 164, at 36–38.

For instance, you might be able to understand *whn we wrt ths wrds wtht ny vwls*. However, while such communication can potentially be more efficient, the lack of redundancy would make the message more vulnerable to noise.[169] For instance, if a telegraph operator sent the word "where" down the telegraph line and noise turned the "r" into a "t," there is a decent chance that the receiver of the message would understand "whete" to have been a scrambled version of the word "where." In that case, there would be no loss of information, despite the noise. However, if the word "where" is sent without any vowels as "whr" and the "r" is turned into a "t," leaving the word "wht," the receiver will likely view the message as the word "what." Because of the lack of redundancy, the same amount of noise caused a loss of information.

To ensure that a message is received accurately, a sender can go beyond the redundancy inherent to language and add repetition.[170] For instance, picture a young salesperson in the 1870s meeting an unfamiliar business contact. The salesman knows that his manager has met with this contact before, so he telegraphs a question, asking his manager to describe the contact's character. If the manager was concerned about noise in the transmission, and wanted to be sure the salesperson got the right message, he could incorporate redundancy by sending the message "bad bad bad."

But redundancy is broader than simple repetition or additional letters. For instance, let us change the above scenario slightly. First, we will change the telegraph system so that there is no longer any noise in actual wire signal. Any message sent will be the exact message delivered to the other side. However, we will also change the salesperson into someone who has a very limited grasp of English. In this scenario, the manager would likely feel the need to be redundant, just in a different way. He might write with a semantic redundancy, "bad evil liar," in the hopes that the salesperson would recognize at least one of the words as negative.[171]

This same sort of noise occurs in legal search. The noise is the lack of intellectual convergence between the searcher of law and the search engine responder. Legal search fights this lack of intellectual convergence through redundancy. Since the legal search engine does not have the intelligence to actually understand legal search queries the way a human being would, legal search is used to download massive amounts of case law. For instance, legal search can bring up all cases where the discovery rule is mentioned, but not all the cases where the rule is applied in ways applicable to particular fact pattern. Like the manager writing to his salesperson, the legal search process is predicated on the hope that some of the cases produced line up with the understanding of the questioner.

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169. *See id.* at 38–39.

170. *See id.* (noting that under Shannon's theory, by adding redundancy to a given message, thereby adding repetitive patterns, the message could be better protected from errors).

171. For a fascinating example of how African tribes overcame this kind of noise in drum signals, see GLEICK, *supra* note 96, at 22–25.

Intelligent search engines allow us to reduce the level of noise inherent to this process. Instead of returning hundreds of cases of marginal importance, such a search returns a few, highly relevant cases. Seen through the prism of information theory, the legal information system will have improved its ability to communicate. Naturally, this improvement in capability should lead to changes in how the law is created and disseminated. Legal actors will not have to spend a great deal of energy looking through irrelevant case law, and will instead either focus their energies on crafting better arguments or simply reduce the cost of their services. If noise is wholly eliminated it will have a dramatic effect: the legal search engine will become the law itself. To understand why this is the case, it is necessary to first understand a different part of information theory: the algorithm theory of information.

This theory was conceived by Gregory Chaitin.[172] Mathematicians wanted to understand how much information was carried within a given message. Chaitin determined that the proper way to measure the amount of information contained in a message is to determine the smallest possible algorithm that could describe the message.[173] For instance, think of the binary string "01" repeated one million times. In order to transmit that information, it is not necessary to send one million copies of the "01" string. Instead, the information could be captured in the shorter and simpler message "repeat '01' one million times." The amount of information contained in the "01" string, therefore, is actually rather small. On the other hand, for a truly random string of numbers, there is no way to compress the message into an algorithm. Instead, the entire message must be sent. The information contained in a random string of numbers is therefore exactly equal to its length.

The English common law, as it existed before synthesis, can be viewed as being in a random or "uncompressed" form. Since there were no guideposts, one would have to go through each case in the case law records to determine what the law was on a particular issue. Synthesis, such as that provided by Blackstone,[174] provided a series of algorithms that compressed the information contained in the case law. Blackstone would state that the law on issue *X* stems from the decisions in cases *A*, *B*, and *C*.[175] West Publishing's Key Digest system had a similar effect, but had the additional benefit of providing an exponential leap in the number of algorithms available to the legal researcher.[176] However, these

172. Gregory Chaitin, *Algorithmic Information Theory*, 21 IBM J. RES. & DEV. 350, 350 (1977).

173. *See* GLEICK, *supra* note 96, at 332.

174. *See supra* notes 42–45 and accompanying text.

175. *E.g.*, 3 WILLIAM BLACKSTONE, COMMENTARIES *216–17 (discussing nuisance actions regarding "corporeal inheritances" and citing many cases).

176. *See* Berring, *supra* note 6, at 25.

algorithms were still inevitably limited since they could not capture every legal scenario.[177] Thus, these summaries and digests were rough approximation of the law, rather than the law itself.

Modern legal search refines the process that Blackstone and West began. By allowing researchers to design their own queries, legal search opened up an infinite amount of potential algorithms. As described above, however, this communication signal is currently reduced by the noise inherent in the lack of intellectual convergence between sender and receiver. If this noise can be severely reduced to the point that legal search becomes highly accurate, then this problem goes away.[178]

The question of "what is the case law on the discovery rule in X situation" will not be scattered among random case numbers or found in legal encyclopedias, but will instead be entirely contained within the phrase itself (placed into a legal search engine). Since the researcher will be free to pose any question of law to the search engine, then the search engine itself will effectively become the law.

We use the term "law" here the same way Justice Oliver Wendell Holmes did when he said "[t]he prophecies of what the courts will do in fact, and nothing more pretentious, are what I mean by the law."[179] We are speaking positively, not normatively, about what the law is, not what it should be. For simplicity, this Article assumes, like Holmes, that judges enforce and interpret the law, rather than other officials.[180] And Holmes's term "prophecies" is very relevant here. So long as human judges decide the law in the future, what the law is at present is always only an informed prediction. But the best prediction available is in effect the positive law until the judges make their decision. There is no better way for citizens to take account of law than to take account of the best prediction of the law and plan their lives accordingly. Thus, the algorithm becomes the law until judges add data that changes the algorithm.

One objection to this view is that law is more complicated than mathematics and therefore the algorithm analogy is inapt. In many legal areas there are conflicting decisions. Thus, the argument would run in

177. *See* Russ VerSteeg, *Rethinking Originality*, 34 WM. & MARY L. REV. 801, 859 (1993) (noting that West does not publish every legal opinion submitted to them).

178. A critic may counter this proposition by pointing out that the noise between the legal search engine and the researcher can never be completely reduced since the intellectual convergence between the two parties can never be complete. This is true. However, the same can be said of a researcher and a legal encyclopedia. It will never be the case that the researcher's understanding of the topics in the encyclopedia line up perfectly with the author's understanding, but we accept that they can be close enough to allow for efficient communication.

179. O.W. Holmes, *The Path of the Law*, 10 HARV. L. REV. 457, 461 (1897).

180. *See* Schauer, *supra* note 19, at 883 (noting that Holmes "fully appreciated that common law judges made law in the process of deciding cases"). But if officials other than judges have effectively unreviewable authority to interpret and apply the law, there is no reason that the algorithm could not predict the decisions of those officials as well.

many areas, no algorithm can compress all the decisions into a predictive algorithm because some of the decisions conflict in a variety of ways, creating future uncertainty.[181] Moreover, even the best legal search engine, like lawyers today, may lack substantial amounts of relevant information. For instance, settlements may tell us about the law because they are made in light of what lawyers think the law will be, not simply what it was in the past. And many, if not most, settlements remain private. However, the analysis in this Article does not require that search engines will have more information than is publicly available, let alone perfect information.

Complexity and lack of perfect information certainly lead to uncertainty, but algorithms can work in a world of probabilities as well as certainties.[182] Algorithms can be statistically based and thereby sift the likely prediction of the law from a variety of possibilities that are more or less strongly supported by case law or other data points. One can think of this process as not different in kind from a regression analysis.[183] Not all the data need to be on a line for a line to be fit to the data. Moreover, computers can be programmed to treat decisions from higher courts or more persuasive judges as having more generative force. These weights can be readjusted as the ALE gathers more information about decisions in all areas of law, thus ever refining the weights it assigns decisions for their predictive value. Thus, in time, machine intelligence can provide the probabilities of what the legal answer will be, just as the computer program that recently won at *Jeopardy!* not only gave the solution it deemed most probable to problems posed on that game show but also displayed its confidence levels in a variety of plausible solutions.[184]

To be sure, uncertainty reduces the attractiveness of standards as opposed to rules, as Part III discusses. Nevertheless, so long as the uncertainty can be approximated, it permits those subject to standards to

181. In contrast, it might be thought that if outcomes could be perfectly predicted, there would be no litigation and thus no case law from which to update algorithms. But even in the absence of real uncertainty, some litigants are not rational because they are distracted by grudges or overflowing with confidence. Thus, while better search is likely to reduce litigation, it will surely not eliminate it.

182. Thus, we believe that computers can help guide law even when the law is not determinate, so long as the computer can give better or at least as good predictions as any person about the law. In that sense, legal search provides benefits even when the law is indeterminate so long as it can provide an array of probabilities about what the law is likely to be. Thus, this view of legal search is based on Holmes' predictive view. It does not depend on a view that law is determinate in the sense that formal logic compels a legal conclusion. For an excellent discussion of the possibilities and limits of computation under this latter view of law, see Harry Surden, *The Variable Determinacy Thesis*, 12 COLUM. SCI. & L. REV. 1 (2011).

183. For discussion of regression analysis, see Jae-On Kim & Frank J. Kohout, *Multiple Regression Analysis: Subprogram Regression*, *in* STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES 320, 320–23 (2d ed. 1975).

184. *See* IBM, *supra* note 139.

better calculate their compliance risks. It thus will still make standards relatively more attractive than they would be in the absence of powerful search.

Another objection may be that while an algorithm could capture relatively settled law, it would be unable to anticipate revolutions in law, such as a modern day *McPherson v. Buick Motor Co.*,[185] which completely overturn settled legal doctrine. But in the long run, a more sophisticated ALE should be able to give some sense of the likelihood of such an eventuality. In the modern world, radical change in legal rules is almost always accompanied by previous criticism of the old rule, whether the criticism is academic, judicial, or political. Thus, information would in principle be available both about difficulties with an old rule and the sitting Court's likelihood of revising rules. Again, this element would introduce uncertainty but would not destroy the value of the ALE because it would nevertheless be better than previous predictions. Moreover, it is important to note that in any given case, a substantial change in law, like *McPherson*, is not at all likely.[186] Indeed, such transformative changes are possible only with certain sorts of judges, and ALE will likely capture the jurisdictions and courts that are possible game changers and those that are not.

There may also be an interesting dynamic between law's algorithm and law reform. In principle, an ALE could consider any factor culled from available information that turned out to be a good predictor of a decision, even if it were not a factor that legislators and judges thought legitimate. If potent but illegitimate factors became widely known, legislators could change the law to try to prohibit such factors from being taken into account. But judges might also reform themselves by consciously reacting against such factors.[187] The greater transparency of what factors are actually guiding judicial decisions must be counted as another advantage of more powerful search.

It is true that in some areas of law, however, this self-referential process might create some uncertainty. While self-referential uncertainty is of theoretical interest, for the vast majority of legal search it will not be of great practical significance. But in principle this uncertainty itself could be reflected in the confidence levels.

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185. 111 N.E. 1050, 1053 (N.Y. 1916) (introducing the rule that manufacturers of a product could be liable for its defects even if not in privity with the consumer).

186. The principle of stare decisis should, at least in theory, make radical change in legal doctrine a rarity. *See* Thomas R. Lee, *Stare Decisis in Economic Perspective: An Economic Analysis of the Supreme Court's Doctrine of Precedent*, 78 N.C. L. REV. 643, 650 (2000) (noting that rules of stare decisis serve to enhance certainty and stability in law).

187. It is possible that judges might just make different decisions than they are predicted to make simply to proclaim their autonomy. But this possibility is not very likely. Judges still retain the autonomy to offer their own distinctive reasons, even if the result is what was predicted by a computer.

A final point of interest is the effect of competition by multiple ALEs. One might think that such competition could further raise the level of uncertainty because citizens would have to choose which ALE to credit. However, the effects of competition are likely to be relatively modest. First, ALEs will be judged by results and thus likely converge. The best will likely have the largest market share, like Google. If there is a substantial lack of convergence, one may expect ALE aggregators to try to aggregate results, perhaps discounting them in light of past performance.

## III. THE MOVE TO STANDARDS AND DYNAMIC RULES

This Part considers how increased information capacity affects the form of law. First, we show how the capacity makes standards relatively attractive compared to rules because improved legal search can make the legal effects of standards more accessible to the community. Second, it shows how increased information capacity makes dynamic rules relatively attractive compared to static rules because more information is available to automatically update complex rules. It ends by comparing standards and dynamic rules, showing that the choice between them will often come down not to a question of technological capacity but human fallibility—how much trust society has in judges and other decision makers charged with applying the law.

### A. *Informational Capability and Its Effect on the Rules Versus Standards Debate*

This section discusses how increased informational capability, and ALE search in particular, allows people to take advantage of the many benefits of standards-based law. First, it outlines the rules-versus-standards debate in general terms. It then applies the informational capability framework to show how ALE search will improve the use of standards-based law. The improvements will stem from ALE's greater capacity to find the law, which will help the judiciary more rapidly mold more efficient standards and will increase citizens' accessibility to the content of those standards. The section then considers Montana's "reasonable and prudent" speed limit to show how ALE search can make this standard attractive, even though it was previously thought unworkable and inconsistent with the notice requirements of law. The section ends by noting that ALE search will also make it less likely that rules will replace standards in the manifold areas where standards are now used because ALE search will make such standards more transparent and accessible.

#### 1. Background of the Rules Versus Standards Debate

This section's analysis of the rules versus standards debate begins with an explanation of what it means for a law to be a "rule" or a "standard."

This Article defines a rule, in its purest form, as "a directive to an official that requires him to respond to the presence together of each of a list of easily distinguishable factual aspects of a situation by intervening in a determinate way."[188] The prototypical example of a rule-based law is a speed limit that holds that a driver must drive at sixty-five miles per hour or less. In contrast, a standard "requires the judge both to discover the facts of a particular situation and to assess them in terms of the purposes or social values embodied in the standard."[189] A standards-based speed limit, for example, would hold that a driver must drive at a "reasonable" speed.[190]

In outlining these differences, this Article recognizes that in the real world, rules and standards rarely exist as perfect Platonic forms.[191] It is possible to consider a rule that is sufficiently open to interpretation that it becomes a standard, or a standard that is so fixed in its interpretation that it becomes a de facto rule.[192] It is beyond the scope of this Article to define exactly when a law crosses the rule/standards boundary. For this Article, it is enough that some laws are more rule-like or standard-like than others. Those laws will contain the benefits and drawbacks of rules or standards to such degree as they are more like the ideal rule or standard.

The fundamental benefit of standards is their ability to take advantage of distributed decision-making. As discussed in Part I, distributed decision-making is the process by which multiple parties converge on an optimal solution by each contributing a portion of the answer.[193] While the creation of a rule often involves multiple parties in a legislature, once a rule is written its meaning is fixed even as it applied to different facts. In contrast, a standard is more mutable, because its application varies not only with the changing facts but with a judge's determination of what legal considerations should be relevant to achieve the standard's broad objectives. While this process means the development of standards-based

188. Duncan Kennedy, *Form and Substance in Private Law Adjudication*, 89 HARV. L. REV. 1685, 1687–88 (1976).

189. *Id.* at 1688; *see also* Russell B. Korobkin, *Behavioral Analysis and Legal Form: Rules vs. Standards Revisited*, 79 OR. L. REV. 23, 30 (2000) ("Under rules, outcomes are determined by the presence or absence of triggering facts that can be specified *ex ante*; under standards, outcomes require situation-specific factual inquiries and/or balancing of competing factors.").

190. Korobkin, *supra* note 189, at 23.

191. *See* Pierre Schlag, *Rules and Standards*, 33 UCLA L. REV. 379, 410 (1986) (arguing that rule-like directives can become "contaminated" with standard-like qualities and *vice versa*). Even a rule-based speed limit will generally permit exceptions. *See id.* at 428–29 ("Rules tend to yield specific exceptions that are generated by appeal to other standards [as they evolve].").

192. *See id.* at 410–11 (arguing that rules that require flexibility to attain their underlying directive tend to blur with standard-like qualities, and standards that require some rigidity to retain their meaning tend to blur with rule-like qualities); Colin S. Diver, *The Optimal Precision of Administrative Rules*, 93 YALE L.J. 65, 68–69 (1983).

193. *See supra* notes 16–17 and accompanying text.

law is more chaotic, it can lead to a better legal framework in the long run through two processes of natural selection.

Of the two processes, one is conscious while the other is not. The conscious process of judicial natural selection is straightforward. The first judge to reach a decision on a given set of facts may make a good decision or a bad decision. If it is a good decision, it is more likely to be held up by higher courts on appeal.[194] It is also more likely to be followed by sister courts. On the other hand, a bad decision is more likely to wither on the judicial vine.

The other process of natural selection requires no ability whatsoever from the judicial branch. It occurs because bad decisions are more likely than good decisions to be relitigated in the courts.[195] For instance, suppose a judge interprets a standard in an inefficient manner. The party that lost the decision will have more to gain from overturning it than the party that won will have to gain by defending it.[196] This dynamic means that parties that lose because of an inefficient decision will be more likely to take their future cases to trial.[197] Even if the subsequent decisions were to be decided by random chance, the increased pressure on inefficient decisions would cause them to be overturned with greater frequency.

While the benefits of distributed legal information are significant, the flip side to having all of this distributed information is that it makes it harder for lawyers, judges, and clients to understand and use this information.[198] This difficulty is a problem both *ex ante* and *ex post*. *Ex ante*, an actor subject to a law wants to understand what actions the law requires, so that he may avoid liability.[199] Instead of simply looking up a statute, as in the case of a rule, an actor subject to a standard would need to try and collect the relevant case law to determine the outlines of the standard and how it applies to him.[200] *Ex post*, an actor subject to a standard would have to go through the same process to determine the

194. This assumes that the judiciary is more prone to making good decisions than bad ones. Without that assumption, this entire Article is moot.

195. Paul H. Rubin, *Why is the Common Law Efficient?*, 6 J. LEGAL STUD. 51, 53–55 (1977).

196. *Id.*

197. *Id.*

198. *See* Arthur L. Corbin, *The Restatement of the Common Law by the American Law Institute*, 15 IOWA L. REV. 19, 21 (1929) (noting that among the reasons for creating the restatements was the notion that the common law created confusion and uncertainty that made it difficult for practitioners to consult common law decisions).

199. For an example of this kind of behavior at work, see Lucian Ayre Bebchuk, *Ex Ante Costs of Violating Absolute Priority in Bankruptcy*, 57 J. FIN. 445, 448 (2002).

200. This may prove difficult because "under a standard, citizens cannot know with certainty *ex ante* where a legal boundary would be drawn in the event a set of specified facts come to pass." Korobkin, *supra* note 189, at 26.

likelihood of success at trial.[201] At trial, the judge has the additional burden of determining the proper application of the standard to the particular facts of the case.

Although there is a fascinating range of scholarship on the topic of standards and rules,[202] Professor Louis Kaplow offers the now canonical law and economic analysis of the benefits of rules versus standards.[203] The first factor to consider is cost.[204] Rules are generally more expensive to create, but then generally have lower enforcement costs.[205] Rules-based laws are more expensive than standards-based laws to create because of the greater level of care that must be taken when creating a rule.[206] For them to perform well, there must be a lot of information about all of their potential applications—information that standards gather over time. Rules must be designed carefully because they apply to a broad array of situations and are determinative as to outcome.[207] They also tend to be hard to change because it is costly for legislatures and administrative agencies to come to an agreement to change rules.[208] However, once a rule has been promulgated, the costs of enforcement are less than with standards.[209] The court system itself must incur a greater litigation cost when deciding standards because it must give content to the standard, which takes more energy than determining whether a rule has been

201. *See* Corbin, *supra* note 198, at 21 (noting that lawyers at the time the restatements were being created had the unenviable task of coursing through confusing and uncertain case law in order to make predictions of law).

202. Much of the scholarship frames the discussion within questions about the applicability of standards or rules to particular areas of law. *See, e.g.*, Clayton P. Gillette, *Rules, Standards, and Precautions in Payment Systems*, 82 VA. L. REV. 181, 201–03 (1996) (discussing how information asymmetries between group leaders and the public lead to the development of potentially inefficient rules rather than standards in payment system regulation because the public is more likely to appreciate rules); Joel R. Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553, 568 (1998) (explaining how flexible standards regarding information security can be promulgated and ultimately embedded into privately designed computing networks by merely becoming industry defaults rather than through governmental intervention).

203. *See generally* Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557, 562–67 (1992) (discussing his four-part analysis of rules versus standards).

204. *Id.* at 562–63.

205. *Id.* The substantiality of these advantages has recently been challenged. Given that special interests have influence with the legislatures, the rules may be of worse quality than the output of standards. *See* Stevenson, *supra* note 87, at 25–26. But even if the advantages of rules are less than they are thought to be, better legal search will also make standards more attractive.

206. Kaplow, *supra* note 203, at 562.

207. *See* Diver, *supra* note 192, at 66–67 (noting the importance of precision in rule making).

208. *See id.* at 73–74 (noting the potential costs incident to rule making).

209. *See* Korobkin, *supra* note 189, at 31–32 (noting that public costs of promulgating rules tends to be front-loaded, while the public costs of promulgating standards tend to be back-loaded).

violated.[210] Moreover, the individual subject to a standard must incur a greater cost to learn about a standard, which is contained in dispersed case law, than to learn about a rule.[211]

Another consideration for Kaplow is the likelihood actors will conform their conduct to the law.[212] If actors are able to inform themselves as to the consequences of the law beforehand, they are more likely to act in accordance with the law. Under a system of rule-based law, the legal norm is stated before an individual has the opportunity to act, giving them the chance to inform themselves about the law and act accordingly.[213] In a standards-based law, the individual does not know the exact outlines of the law until it is given content by the court.[214] This lack of information would result in less conformity with the law.[215]

As Kaplow notes, standards generally impose higher information gathering costs compared to rules because distributed systems of legal ordering require more litigation to create legal norms and because information about the law is more widely distributed (in case reports, for instance), which likely makes it harder for citizens to know how law will affect their conduct.[216] As detailed below, the thesis of this Article is that greater information capacity both reduces litigation costs of standards and makes it easier for citizens to conform to the legal requirements of a standard. By reducing these downsides of standards, information capacity makes them generally more attractive than they were in a world of greater information scarcity.

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210. *See id.* at 32 ("Dispute resolution by standards is more expensive than by rules. Adjudicators must not only investigate facts, but also determine the legal consequences of the facts because this has not been done *ex ante*."); Kaplow, *supra* note 203, at 570, 616–17.

211. *Id.* at 571–72. *But see* Ian Ayres, *Preliminary Thoughts on Optimal Tailoring of Contractual Rules*, 3 S. CAL. INTERDISC. L.J. 1, 8 (1993) (describing the possibility that standards, by expressing the law in commonsense terms, may sometimes provide an individual with easier access to the law than a rule); Korobkin, *supra* note 189, at 34 ("It would take little research for a lawyer to learn and communicate that the speed limit is 65 mph or that the speed limit is a 'reasonable speed' given road conditions."). In this example however, for the lawyer's client in this case to be truly informed of his legal position under the standard, the lawyer would need to do further research to identify case law where the "reasonable speed" standard was interpreted in cases where the facts were similar to the client's situation. Because of this additional informational burden inherent in standards-based law, it is typically easier to derive information from rule-based law.

212. *See* Kaplow, *supra* note 203, at 592.

213. *See id.* at 585 (noting that rules provide the law to individuals before they act, allowing the law to guide individuals while they act); Kennedy, *supra* note 188, at 1688 (noting that the certainty that inheres to rules assures that the citizenry can "know in advance the incidence of official intervention" and subsequently adjust their behavior in recognition of the rules).

214. *See* Kaplow, *supra* note 203, at 562–63 (asserting that standards are more difficult to predict because they require a court's *ex post* determination as to the content of the law).

215. Kaplow, *supra* note 203, at 564.

216. As Kaplow noted, the exception could be if a rule was passed that was rarely litigated. In that case, the upfront cost of creating the rule would be greater than the cost of litigated standards-based, information-rich cases, since the cases would be so rare. *Id.* at 621–22.

If information costs help reduce the characteristic flaws of standards, they put into relief an important advantage that standards enjoy over rules. Rules are seen to suffer from the problem of over- or underinclusiveness because it is impossible in advance to know all the possible situations to which a rule may apply.[217] Overinclusiveness occurs when a rule is applied to a situation that it was not intended to govern. Underinclusiveness occurs when clever legal actors identify loopholes in the rigid structure of the rule. Standards, by being more complex than rules, are able to encompass a more complete range of possible actions and thereby avoid this problem.

Kaplow disagrees with this view of the relative complexity of rules and standards.[218] He suggests that there is no inherent difference in the complexity of rules and standards (by inference suggesting that there is no inherent problem of over- or underinclusiveness with rules).[219] To prove his point, Kaplow posits an intellectual device, the "rule equivalent to the standard."[220] This rule would have the exact same content as its equivalent standard.[221] Through this device, Kaplow argues that the complexity of rules and standards is not inherent to their form, since they can both be just as simple or complex as each other.[222]

This Article disagrees with Kaplow's interpretation because to the extent that a standard has discrete factors, that standard has become more rule-like.[223] A true standard is inherently more complex in its application than a rule since the factors are given content in relation to the specific

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217. *See* Kaplow, *supra* note 203, at 588–89; Kennedy, *supra* note 188, at 1689–90, 1697; Frederick Schauer, *Rules and the Rule of Law*, 14 HARV. J.L. & PUB. POL'Y 645, 647–49 (1991).

218. *See* Kaplow, *supra* note 203, at 588–89.

219. *See id.*

220. *Id.* at 586–88 (internal quotation marks omitted).

221. *Id.* at 586.

222. If the concept of a "rule equivalent to a standard" were accepted, it would, in the end, prove too much, as it can be used to destroy the entire concept of a "rule" and a "standard." For instance, you can imagine a standard that has developed into a long-standing precedent, and this could be the "standard-equivalent" to a rule. One could then compare this to a rule that has been frequently modified, and find it is now the frequently changing rule that would be engaged in *ex post* decision-making, while someone subject to long-standing precedent would be able to confidently predict the law *ex ante*. Furthermore, the concept of the "cost" of promulgating the rule can be turned on its head as well. If the development of the "standard-equivalent" only took place after a series of costly court battles, it could be said that it required a greater up-front expenditure than the rule. And yet, if it remained precedent for a long time, it would have the low enforcement costs of a rule. Kaplow seems to recognize the latter problem. *See id.* at 577. The "rule equivalent to a standard" device proves only the widely accepted point that in the real world, rules and standards exist on a spectrum, and any individual law likely has elements of both. *See* Korobkin, *supra* note 189, at 26 ("[T]he two types of legal forms are better understood, as a descriptive matter, as endpoints of a spectrum than as dichotomous categories.").

223. *See* Korobkin, *supra* note 189, at 28 ("Multi-factor balancing tests are . . . more rule-like than requirements of 'reasonableness' because they specify *ex ante* . . . what facts are relevant to the legal determination.").

facts of each case, and the number of possible facts in a case is infinite. Thus, for instance the standard, "drive at a reasonable speed," does not provide a fixed value or hierarchy of the factors that determine reasonableness. This increased complexity creates an informational burden on any individual trying to decide how a standard will apply to the facts of her particular case. This Article refers to this difference in complexity as relating to the "substance" of the law.

In addition to this difference in the complexity between rules and standards, there is a difference in the complexity of the "medium" through which standards and rules are promulgated. The information within a rule exists in a single location. For instance, a driver passing by a 40 mph speed limit sign does not need substantially to inquire how various courts have interpreted the term "40 mph." In contrast, the actual embodiment of a standard exists in pieces of case law, which are scattered within the jurisdiction where the standard was created. Such a distributed system is inherently more complex than one with a single source.

Although this Article disagrees with Kaplow's view on complexity, this disagreement is not central to its thesis. From the perspective of Kaplow, this Article's thesis would change from advocating the greater use of standards to advocating the greater use of complexity, both in terms of substance and medium. Lower information costs generated by improved technology permit lawmakers to introduce more complexity in terms of substance through either the use of standards or dynamic rules that adjust automatically to different circumstances. While Kaplow does not compare each medium of law in terms of complexity, it is evident that distributed law is more complex than centralized law. This Article's argument is that technology will allow citizens to more directly access scattered legal information and thus permit the greater use of standards, which encourage more use of distributed law.

Some may think it will be more burdensome to continually look at the ALE rather than memorize a simple rule. But if the ALE provides the same certainty as the rule for any particular situation, there is no additional burden. Even with some uncertainty and the consequent need for a choice among possible outcomes, the existence of the ALE does reduce the cognitive burden, even if it does not eradicate it, and thus it will make standards more attractive than they previously were. And given the centrality of exponentially increasing informational capability to our time, this dimension is now central to the tradeoff between standards and rules. The greater ease in finding the law made possible by better information technology will work to limit the downsides associated with standards-based lawmaking, thereby allowing lawmakers to take advantage of the many benefits of standards-based law.

### 2. How ALE Search Makes Standards More Attractive by Decreasing the Cost of Finding the Law

An ALE search reduces the cost of finding the law, reducing both litigation costs and the difficulty individuals have in conforming their behavior to standards—the two greatest drawbacks of regulating behavior by standards rather than rules. First, ALE search allows actors to understand standards-based law with less cost and greater accuracy. ALE search lowers the cost of legal advice by substantially cutting down the amount of time the lawyer needs to gather the relevant case law on the topic. Accuracy is improved by leveraging the superior processing power of computerized search. This improved accuracy gives the actor two of the key benefits of rules—knowing how to conduct himself to avoid litigation and knowing where he stands when faced with litigation.

But ALE search also increases the ability of judges to utilize legal information when they craft their opinions, which allows them to more accurately apply precedent when they create standards. ALE search achieves these benefits by increasing the quality of the legal briefs presented to the court. Partially, the increased quality flows from the simple fact that a lawyer using ALE search is less likely to miss case law that is relevant to the proceeding. The greater improvement, however, could come from increased depth and creativity in briefs. Since the cost in time and energy of pursuing alternative legal theories is reduced, lawyers who use ALE search can take advantage of the opportunity to essentially brainstorm with the ALE. The lawyer can come up with a whole multitude of arguments for his client, the computer will quickly deliver the relevant case law, and the lawyer will be able to determine which avenues are fruitful. Garry Kasparov, the famous chess champion, points out that a similar process takes place today with humans and chess computers.[224] Although computers today are far better than humans at playing chess, a human with access to a chess computer can work with the computer to perform better than any computer can alone.[225]

The improved depth and range of legal briefing also make it more likely that the first court to interpret a standard will make a legally efficient decision. With ALE search, the court is better exposed to relevant precedents in other jurisdictions along with pertinent information from secondary sources. If a court that is the first in its jurisdiction to interpret a standard has such information, it is more likely that its decision will line up with the eventual consensus view, meaning there is less need for the court to reverse itself down the line. These developments make the process of legal natural selection, already a benefit of standards-based law, move faster.

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224. *See* Garry Kasparov, *The Chess Master and the Computer*, N.Y. REV. BOOKS (Feb. 11, 2010), http://www.nybooks.com/articles/archives/2010/feb/11/the-chess-master-and-the-computer/.

225. *Id.*

Greater information capacity reduces litigation costs because it improves the capacity of the judiciary. Economist Hans-Bernd Schäfer argues persuasively that the capability of the judiciary should influence the rules/standards debate.[226] His argument stems from the fact that standards require a highly capable judiciary to interpret properly, whereas rules are typically easier to interpret.[227] Schäfer addresses judicial capability in the context of comparing judiciaries in developed versus developing countries, and argues that developing countries should lean towards creating rules in order to ease the burden on their fledgling judiciary systems.[228]

This same dynamic arguably applies to our own judiciary as it increases in capability over time on account of improved legal search. For instance, the lower cost of finding the law allows quicker molding of established precedent. Every reported decision creates precedent of a kind. The type of precedent discussed here is a series of consistent decisions where the facts are very similar. Precedent of this kind is basically an organically created rule.[229]

Because precedent is a type of rule, the benefits of established precedent are similar to those of statutory rules. It can give actors a clear signal of the legal playing field, typically at a low cost, since a lawyer will often know of established precedent off hand or can easily find it.[230] Established precedent also makes standards more transparent. Thus, the speedier precedent can be established, the more attractive are standards.

However, a critical issue for the efficacy of precedent is the speed at which standards generate established precedent.[231] Typically, precedent develops in fits and starts. Before someone can truly rely upon it, several lower courts, or the relevant high court, must make a clear decision.[232] If courts are able to turn standards into established precedents with greater speed, it would bolster the argument for choosing standards.

ALE improves the speed at which precedent evolves by reducing the occurrence of inconsistent decisions. Inconsistent decisions impede the creation of established precedent because legal actors cannot rely upon a mixed group of opinions. ALE search reduces inconsistent decisions both within and between jurisdictions. By increasing the accuracy of legal research, ALE search reduces inconsistent decisions within jurisdictions

226. *See* Hans-Bernd Schäfer, *Rules Versus Standards in Rich and Poor Countries: Precise Legal Norms as Substitutes for Human Capital in Low-Income Countries*, 14 SUP. CT. ECON. REV. 113, 113, 120–21 (2006).

227. *Id.* at 118.

228. *Id.* at 119.

229. *See* Kaplow, *supra* note 203, at 578–79 (noting that a standard may effectively transform into a rule when a prior adjudication serves as a precedent for future adjudicatory proceedings).

230. *Id.* at 577.

231. *Id.* at 612.

232. *Id.* at 612–13.

by decreasing the likelihood of a court being unaware of important precedent, the omission of which could lead the court to make an "outlier" decision.[233] ALE search also reduces inconsistent decisions between jurisdictions by increasing the quality of briefing that courts receive. If a court is hearing a case of first impression, a higher quality brief, full of the most relevant case law and secondary sources, makes it more likely that the court will decide the case consistent with what eventually becomes the consensus view.[234]

We can compare standards-based law and rules-based law in the same way that we can compare a Ferrari and a Prius. A Ferrari is capable of very high performance, but unlike a Prius, it requires copious amounts of fuel to run its oversized engine. Standards-based law is similarly capable of very high performance, but compared to rules it requires much greater amounts of information to fuel the decision-making process. It needs a large and growing database of previous decisions to flesh out the particulars of its legal structure. It also needs the ability to sift through information and find only that particular information that applies to each case. Thankfully, unlike gasoline, our ability to produce, store, and sort through information is increasing at exponential rates. We can and should design a legal engine that produces the highest level of performance, and be confident that its demands for more sophisticated uses of information will be met.

### 3. Example: The Montana Speed Limit Experiment

As an example of how ALE might make a difference, it is illustrative to look at what happened with Montana's standards-based speed limit. In 1995, Montana changed its daytime driving speed from fifty-five miles per hour (mph) to "reasonable and prudent,"[235] a classic standards-based

233. Thus we disagree with the concerns that electronic search will ultimately lead to instability in the law by multiplying the number of precedents. *See, e.g.*, M. Ethan Katsh, *Communications Revolutions and Legal Revolutions: The New Media and the Future of Law*, 8 NOVA L.J. 631, 658–59 (1984) (arguing that the computerization of case law may threaten the stability and predictability of the common law when too many prior cases are added to a database at a more rapid rate). The increase in computer power that has accompanied the electronic medium allows the speedier sifting of precedent and is more likely to increase rather than decrease stability.

234. Another benefit of standards is that they may increase the quality of the judiciary. *See* Frank B. Cross, *Identifying the Virtues of the Common Law*, 15 SUP. CT. ECON. REV. 21, 35 (2007) (arguing that common law systems tend to have better judges because the system ascribes more importance to the judiciary and expects the judiciary to produce "a better quality of law"). Standards do this by increasing the autonomy that judges have to decide the cases that come before them. Judicial systems where judges have greater autonomy, such as common law systems, have been shown to have lower levels of judicial corruption and greater independence from other branches of government. *See id.* at 57.

235. Robert E. King & Cass R. Sunstein, *Doing Without Speed Limits*, 79 B.U. L. REV. 155, 155 (1999).

approach.[236] The new speed law was popular amongst residents, who appreciated the responsibility of determining the appropriate speed to drive.[237] Residents also noted that the wide variety of road conditions in Montana made a fixed rule unworkable.[238] Multiple attempts to repeal the standard in favor of a numerical law failed in the state legislature.[239]

However, the law was not without problems. The Montana state court system soon faced a deluge of drivers eager to argue their citations.[240] The problem of enforcement was also recognized by police officers, who admitted they had difficulty defining exactly what the standard meant.[241] In 1999, the Supreme Court of Montana found that the standard was overly vague, and overturned it in a 4–3 decision.[242] The court's opinion emphasized that the standard left "the average motorist in Montana [with] no idea of the speed at which he or she could operate his or her motor vehicle on this State's highways."[243] While the court could credibly make that statement in 1999, a similar ruling would find less support if ALE search were widely available.

With ALE search, any reasonably intelligent private citizen could obtain a list of relevant case law that described how "reasonable and prudent" applied to specific road conditions. If given a speeding ticket, the driver could compare it with cases in which the conditions were similar. For instance, if the driver was given a ticket while driving in snowy conditions on a two-lane highway, the ALE could provide a list of cases that involved snowy conditions on a two-lane highway. This structuring of information would discourage drivers from bringing cases where they were clearly on the wrong side of the case law. A similar process would discourage prosecutors from pursuing cases where the driver was clearly on the right side of the case law. Indeed, police officers might be expected to use ALE as well. On the other hand, a driver who had not been considering fighting a citation might change his mind if a quick search through the case law showed that he was in a grey area. By bringing this case, the driver would help the development of the law by adding depth to the "reasonable and prudent" standard.

ALE search could also help with the problem of enforcement that police officers deal with. A police officer on a rainy, four-lane highway would be able to get on the Internet and perform an ALE search to pull up rainy, four-lane highway decisions. This ease of access would allow him to avoid issuing citations that would likely lead to litigation.

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236. *See* Korobkin, *supra* note 189, at 23.
237. King & Sunstein, *supra* note 235, at 177 & n.144, 179, 186.
238. *Id.* at 163–64.
239. *See id.* at 185–88.
240. *Id.* at 180.
241. *Id.* at 181.
242. State v. Stanko, 1998 MT 321, ¶¶ 30–32, 292 Mont. 192, 974 P.2d 1132, 1138.
243. *Id.* ¶ 28.

Indeed, given today's information capacity, a market would eventually develop for a smart phone app that automatically combined GPS location, weather data, and court decisions into an estimated speed limit. Different companies could compete to provide the most accurate prediction and could even offer drivers insurance should the app prediction fail to provide the right speed limit.

Given all of this additional information, the distributed network of judges, prosecutors, police officers, and drivers would begin to converge on what "reasonable and prudent" means in different situations. A similar process occurred in Montana without ALE search. In the first full year after the law was enacted, speeding citations rose by more than 50%.[244] The next year, however, citations settled down to a level only 25% above the amount issued before the rule change.[245] Given the increased speed of information distribution made possible by ALE search, this process would accelerate and ultimately move toward a lower level of citations because the standard would better coincide with efficient driving speeds.

A standards-based system combined with ALE search would not be perfect. No matter how accurate the ALE search is, the existing case law will never exactly match the conditions a driver or police officer confronts on any given day. However, the variegated nature of conditions highlights the problems with a rule-based system in the first place. Given certain conditions such as icy roads or heavy traffic, driving the speed limit can be dangerous.[246] In contrast, on a perfect day, with a well-maintained, modern car, the speed limit is likely to be too low.

### 4. Applying ALE to Already Existing Standards

To be sure, speed limits are a relatively simple legal problem, but they illustrate how computerized search can begin to make standards attractive. As ALE search becomes more powerful, it will be applied to more complex areas. ALE search will make standards relatively more attractive, which will rebalance the choice between rules and standards.

Another implication is that the development of ALE will make the place of standards already in the law more secure by making them more attractive and thus less likely to be replaced by rules. The importance of this effect of ALE is potentially very large. Standards are ubiquitous in

244. King & Sunstein, *supra* note 235, at 178.

245. *Id.*

246. Reflecting this concern, many states have a "basic law" that requires drivers to drive at a speed no faster than what the conditions reasonably allow. *See, e.g.*, R.I. GEN. LAWS ANN. § 31-14-1 (West, Westlaw through 2013 Reg. Sess.). This creates a hybrid system where all speeds lower than the speed limit are judged by standards-based law, and speeds above the speed limit are automatic violations. Our argument is simply that there is no need to impose an arbitrary point to switch over to rule-based lawmaking when information is more readily accessible.

law.[247] In the common law, for instance, the reasonable person standard requires consideration of many factors in deciding whether an action is negligent.[248] In family law, the "best interests of the child" standard used for making decisions about custody is open-ended.[249] Often-invoked federal statutes incorporate standards: bankruptcy law requires fourteen factors to be weighed before deciding to remand back to state court a claim that has been put in bankruptcy court.[250]

Even constitutional law is replete with standards. For instance, the Sixth Amendment requires consideration of many factors to decide whether representation is adequate.[251] Balancing tests are essentially standards in which justices consider various factors on different sides of an issue and come down on the side of the balance with the greatest weight. In fact, commentators note that the Supreme Court in the past century has moved more to using balancing tests in constitutional law.[252]

Such standards are often criticized as unclear, sometimes so unclear as to give unclear notice of a how a citizen is to conform his conduct to the law.[253] Moreover, as the debate over codification suggests,[254] standards are also criticized because they empower lawyers at the expense of the citizenry, particularly those of modest incomes, who cannot easily afford to learn the law.

But ALE responds to such concerns. It analyzes the factors in a situation and provides an indication of what ruling a judge will make and thus what the law is likely to be. If past criminal convictions for drug abuse outweigh better education in determining where the best interests of the child lie, the algorithm will take account of this regularity. If failure to object to a faulty jury instruction carries a lot of weight in the evaluation of inadequate representation, the algorithm will give it adequate weight. Thus, ALE will make standards clearer and more predictable.

Moreover, better legal predictive tools can help equalize access to law while still permitting law to be flexible. As computers are able to better

247. Kal Raustiala, *Form and Substance in International Agreements*, 99 AM. J. INT'L L. 581, 589 (2005) (noting the ubiquity of standards in domestic law).

248. Thomas C. Galligan, Jr., *The Tragedy in Torts*, 5 CORNELL J.L. & PUB. POL'Y 139, 158 (1996).

249. Martin Guggenheim, *The Right to Be Represented but Not Heard: Reflections on Legal Representation for Children*, 59 N.Y.U. L. REV. 76, 107 (1984).

250. Paul P. Daley & George W. Shuster, Jr., *Bankruptcy Court Jurisdiction*, 3 DEPAUL BUS. & COM. L.J. 383, 426 (2005).

251. *See, e.g.*, United States v. La Monte, 684 F.2d 672, 674 (10th Cir. 1982) (considering five factors in determining whether a defendant was denied adequate representation).

252. *See* T. Alexander Aleinikoff, *Constitutional Law in the Age of Balancing*, 96 YALE L.J. 943, 952 (1987).

253. Kenneth W. Simons, *When Is Strict Criminal Liability Just?*, 87 J. CRIM. L. & CRIMINOLOGY 1075, 1126 (1997) (discussing the notice problem of open-ended and vague standards).

254. *See supra* notes 83–96 and accompanying text.

predict the law—even law that depends on various factors that are not written in a code but are hidden in thousands or even millions of cases—the law becomes more broadly available at lower cost.[255]

## B. *Dynamic Rules*

This Article argues for increased use of standards as information technology improves in part because standards allow new information to alter the law after the standard has been implemented. New information is added from the facts of each case and the legal interpretations of other judges.[256] This new information is used by judges to shape and change the interpretation of the standard. This section introduces another kind of legal mechanism that likely will also become more popular with increased computational powers—"dynamic rules."[257] Dynamic rules are rules that automatically change without intervention by the rule giver according to changes in future conditions that the rule itself comprehensively and accurately fixes. As computation increases, it becomes easier to add complex conditions, both because these conditions can be continually monitored and because the application of the new rule can be more readily calculated.

In theory, rules could also be changed by legislatures or regulatory bodies in response to new information. In practice, however, rules tend to be sticky even in the face of changing circumstances that should modify them. Legislatures tend to be reactive to crises and thus may not update rules continuously as new information becomes available.[258] The legislatures' crowded agendas often make it difficult to find time to update rules.[259] Finally, legislatures contain many veto points in the forms of committees and their chairpersons as well as legislative procedures, such as filibusters, that can easily lead to gridlock and inertia.[260]

For rules that regulatory bodies oversee, the main challenge to frequent

255. Technological innovations have been redounding to the advantages of consumers faster over the history of technology. It took a much longer time for the middle class to have refrigerators than smart phones. *See* John O. McGinnis, *Innovation and Inequality*, NAT'L AFF., Winter 2013, at 135.

256. *See* Kaplow, *supra* note 203, at 560–61.

257. Dynamic rules in our sense have not been discussed much in legal literature. One previous specific example is the suggestion of pliable rules—rules that enforce entitlements as property or liability rules according to specified conditions. *See* Abraham Bell & Gideon Parchomovsky, *Pliability Rules*, 101 MICH. L. REV. 1, 3, 5 (2002).

258. For an example of this in action, see Edward J. López, R. Todd Jewell & Noel D. Campbell, *Pass a Law, Any Law, Fast! State Legislative Response to the* Kelo *Backlash*, 5 REV. L. & ECON. 5 (2009).

259. Richard Pierce, *Institutional Aspects of Tort Reform*, 73 CALIF. L. REV. 917, 919–20 (1985).

260. Indeed, in the U.S. Senate, legislators may successfully block legislation simply by signaling an *intention* to filibuster. *See* Catherine Fisk & Erwin Chemerinsky, *The Filibuster*, 49 STAN. L. REV. 181, 203 (1997) (discussing the concept of a "stealth filibuster").

change stems from the burdensome notice and comment procedures required before making any changes.[261] Regulatory ossification is now thought to be a pervasive problem of the administrative state.[262] As previously suggested, one possible solution is for agencies to substitute regulation through adjudication under standards rather than rulemaking. Many agencies have the statutory discretion to choose between rulemaking and adjudication.[263] Thus, just as common law standards become more attractive compared to fixed rules, so does a process of regulatory standards and adjudication. But currently the culture of administration favors regulation by rulemaking and thus this section seeks to offer suggestions for improvements in those rules.[264]

Dynamic rules can provide a solution to the problem of legislative inertia or regulatory ossification.[265] Dynamic rules are rules that are tied directly to real world empirical data, so that they automatically update as the data to which they are tied changes. Dynamic rules can therefore increase the ability of rules to adapt to continuously changing circumstances rather than await another legislative decision to adapt.[266]

As with our arguments for adopting standards, our arguments regarding dynamic rules are based on technological change. While our theory on the improving case for standards is based on computers'

261. *See* David L. Franklin, *Legislative Rules, Nonlegislative Rules, and the Perils of the Short Cut*, 120 YALE L.J. 276, 303–04 (2010) (explaining three benefits associated with the use of nonlegislative rules instead of the use of the notice and comment requirement).

262. *See* Barack Obama, *Toward a 21st-Century Regulatory System*, WALL ST. J. (Jan. 18, 2011, 12:01 AM), http://online.wsj.com/article/SB10001424052748703396604576088272112103698.html (explaining the need for an executive order to conduct a "government-wide review of the rules already on the books to remove outdated regulations").

263. *See* M. Elizabeth Magill, *Agency Choice of Policymaking Form*, 71 U. CHI. L. REV. 1383, 1386 (2004).

264. *Id.* at 1398 (noting that "by the mid-1970s, rulemaking was the primary and preferred mode of making policy for many agencies" as opposed to the initial case-by-case policy making methods prominent in earlier periods).

265. For regulatory rules, one way to increase the rate of change would be to use "contemporaneous revision-planning." Lynn E. Blais & Wendy E. Wagner, *Emerging Science, Adaptive Regulation, and the Problem of Rulemaking Ruts*, 86 TEX. L. REV. 1701, 1731 (2008). Contemporaneous revision-planning involves determining the expected future course of revisions at the time of the initial rule making. *Id.* Those future revisions would fail to take place only if regulators undertook the process of changing them. This framework would shift the bias of the rulemaking machine towards continual updates, rather than towards maintenance of the status quo. This process would help increase the rate of change but not the ability of the system to process and adapt to information. If the future-looking rules turn out to be inefficient or subject to regulatory capture, the same status quo bias that contemporaneous revision-planning was designed to get around would tend to keep those improper projections fixed in place.

266. We do not mean to suggest that dynamic rules will themselves not be subject to revision. Dynamic rules eliminate one element of uncertainty by responding to real world information. However, the framework of that response, or the algorithm behind the rule, would still need to be updated periodically.

increasing ability to understand semantic values, our theory on dynamic rules is based primarily on the increasing ability of computers and electronic devices to create, store, and analyze data. At the end of 2011, the world was estimated to contain 1.8 zettabytes of electronic data.[267] A zettabyte is a trillion gigabytes, or 1,000,000,000,000,000,000,000 bytes of information.[268] This data stems from a nearly all-pervasive collection system. Google has servers containing every Internet page it has indexed, and is able to cross-reference this information with its geographical data, data on search terms, and data on the physical location of millions of Wi-Fi enabled devices.[269] We are living in the age of "Big Data."[270]

As pervasive as this system of data collection is now, it will increase dramatically in the future. As discussed above,[271] Moore's law means that the cost of computing will fall exponentially, dramatically decreasing the computing cost required to create and store data. Computing devices are now approximately 100 billion times more efficient than computers in the 1950s, and power consumption continues to fall by a factor of 100 each decade.[272] The result of this amazing improvement is that the power requirements of computing have dropped so low that computing devices can now be powered by background energy sources such as ambient heat and radio waves.[273] For instance, researchers recently created a device that collects and transmits weather readings once every five seconds, powered only by ambient radio waves.[274] Cheap, self-powering devices like these will create empirical data at a rate far beyond what we experience today.

Several commentators argue that lawmakers and regulators should take advantage of this data explosion by incorporating more empirical information into their decision-making process.[275] However, even mandatory reviews are unlikely to keep up with underlying conditions in a world with ubiquitous data collection. And it is difficult to frame rules to require legislators or even regulators to undertake a mandatory review of

267. Juan Enriquez, *The Glory of Big Data*, POPULAR SCI. (Oct. 31, 2011, 10:00 AM), http://www.popsci.com/technology/article/2011-10/glory-big-data.

268. *Id.*

269. *See* Google Inc., 27 FCC Rcd. 4012, 4012 (2012) (discussing Google's data collection initiative that collected information about Wi-Fi user locations). It is not just corporations and governments creating this data, however. Deb Roy, a researcher at MIT, used a series of cameras in his house to record every moment of his newborn son's speech development. Enriquez, *supra* note 267. In the process he created "more than 20 times [the data available in] the complete printed collection of the Library of Congress in 2000." *Id.*

270. Enriquez, *supra* note 267.

271. *See supra* Subsection II.B.1.

272. Jonathan Koomey, *The Computing Trend That Will Change Everything*, MIT TECH. REV. (Apr. 9, 2012), http://www.technologyreview.com/business/40016.

273. *Id.*

274. *Id.*

275. *See, e.g.*, John O. McGinnis, *Accelerating Regulatory Review*, *in* THE NANOTECHNOLOGY CHALLENGE 309, 309 (David A. Dana ed., 2012).

subjects they would prefer to leave unaddressed.

Rather than requiring legislators or regulators to look at empirical data, using dynamic rules could bypass regulators altogether by placing the collection and analysis of data at the heart of the regulatory system. Instead of setting up a fixed rule or a schedule of rule changes, rule makers would create an algorithm. The algorithm could be fed information from existing sources of data (such as economic information), or could be fed data from an information-gathering system set up by the rulemaking body. As the data reflecting real-world information changes, the algorithm would alter the rule. Rule makers would oversee the regulating process, but the algorithm would process and update the actual regulations. This process would fit with the trend of regulators moving towards "meta-regulation": the regulation of the regulation process itself.[276]

As an example, picture a system of pollution regulation that involved lowering the amount of mercury in coal plants. First, regulators would use available empirical information to determine the appropriate amount of pollution allowance for the current day. Regulators would then write an algorithm that changed this level based on certain factors. For instance, one factor could be the cost of reducing mercury pollution. To determine what the cost of reduction is, a computerized bidding system could be set up, wherein providers of pollution technology are free to submit bids for pollution-reduction services. If the bids on the system show that technology is outpacing the estimates of technological growth, the law would automatically be changed to reflect the new technology.[277]

This system would have the effect of encouraging advances in technology. The pollution control industry would recognize that if it could collectively improve its product, the law would automatically change to provide a market for that product.[278] By participating in the bidding process, the individual businesses would be changing the law by adding

276. For a brief explanation of the concept of "meta-regulation," see Douglas A. Kysar & James Salzman, *Foreword: Making Sense of Information for Environmental Protection*, 86 TEX. L. REV. 1347, 1357 (2008), and Christine Overdevest & Brian Mayer, *Harnessing the Power of Information Through Community Monitoring: Insights from Social Science*, 86 TEX. L. REV. 1493, 1504–05 (2007).

277. Any bidders in the system would need to be held to their bid.

278. Professors Blais and Wagner point out that a similar mechanism would work using contemporaneous revision-planning. *See* Blais & Wagner, *supra* note 265, at 1735. Predicted revisions would give technology companies a target to shoot for. Firms would have reasonable confidence that if they could produce a technology that economically achieved pollution reduction at the target revision amount, then the target revision amount would likely take effect. However, while this is possibly an improvement on regulations that would otherwise have been in a default stasis mode, a dynamic rule could encourage even more innovation by giving the industry assurance that improvements will lead to legal changes. On the other hand, if they are unable to improve, a dynamic rule could prevent implementation of uneconomical increases of regulation.

information to the rulemaking system. The more general point here is that dynamic rules make planning easier because they reduce the uncertainty that is created by the difficulty that legislatures and agencies have in creating a schedule for updating their rules in response to new factual information.

By incorporating empirical data into the law, dynamic rules may also make the process of rulemaking itself easier. Currently, when creating forward-looking legislation or rules, legislators or rule makers have to solve two types of problems: uncertainty as to what facts will exist in the future and disagreements stemming from the differing political preferences of the rule makers today. Dynamic rules can help to lessen the problem of future empirical uncertainty by simply allowing that uncertainty to exist as a variable in the dynamic rule.[279] Two sides with diametrically opposing views about what is likely to happen in the future could happily come to agreement on a legislative or regulatory framework, both thinking that the other will be proven wrong by future events.

The inaction over climate change is an example of a debate that could benefit from a dynamic rule tied to future empirical data. The debate over climate change is partly over principles (what burdens should we undertake on behalf of the environment), but is also driven by a disagreement on facts (whether human activity is changing the environment, how quickly will technology advance to mitigate the damage, etc.). Instead of continuing to disagree over the facts, legislatures could craft regulations that are dependent on empirical facts as they exist five or ten years into the future. For instance, Congress could set up a cap and trade system, but no price would be set on carbon for ten years. Once ten years passes, the price would be set based on a basket of empirical information, such as objective changes in temperature.

A technology element could be included as well. The dynamic rule could take into account a basket of renewable energy costs as a percentage of fossil fuel costs. Faster than expected breakthroughs in renewable energy technology could be a factor in reducing the fine for carbon emissions, based on the premise that these advancements will reduce the likely amount of carbon emissions going forward.

The use of a technology component shows how a dynamic rule could just as easily reduce the need for regulation, meaning that conservatives could have a reason to support it. Regulations could also become automatically less onerous if temperatures dropped or if new studies

279. *See* David Gamage, *Preventing State Budget Crises: Managing the Fiscal Volatility Problem*, 98 CALIF. L. REV. 749, 792 (2010). Professor Gamage discusses how volatility in state budgets could be reduced by setting a target for revenues and then adjusting tax rates based on that target. *Id.* at 802–10. Setting a revenue target helps remove budget disputes from the particular circumstances of the economic cycle in which legislators are debating. *Id.* at 808.

showed that climate change is a less serious problem than we assumed.

Dynamic rules could encourage a more market-driven approach to industry regulation. When faced with a dynamic rule that will create future regulation, businesses may begin to change their behavior immediately. Yet unlike a set schedule of changes, which everyone is aware of and subject to, a dynamic rule in essence allows different firms to "bet" on what regulations are going to be implemented. For instance, one firm may believe that technology advances will obviate the need for carbon pricing. That firm may choose to avoid any carbon mitigation strategy. A different firm might believe that temperatures are likely to rise faster than expected and choose to pursue an aggressive mitigation strategy. Collectively, the individual businesses may settle on a level of interim regulation (before the delayed dynamic rule takes place) that is more optimal than the level that would have been reached if the regulators simply set it right out of the gate.

There are several examples of dynamic rules that are currently in effect, many with very successful results. For instance, the Economic Recovery Tax Act of 1981 indexed tax brackets to inflation.[280] Before this change, taxpayers experienced "bracket creep" when inflation pushed them into higher tax brackets while their purchasing power remained the same.[281] This led to a period during the 1970s when tax brackets had to be frequently changed by Congress in order to keep pace with inflation.[282]

By indexing brackets, Congress eliminated the need to revisit tax policy solely due to the inevitable increase of inflation. This aspect of the law has allowed Congress to focus on the true political disputes involved in taxation rates without having to also come to agreement on an empirical fact like the future increase of inflation. In contrast to the indexing of standard tax rates, Congress did not at the same time index the brackets for the Alternative Minimum Tax (AMT).[283] The absence of indexing led to repeated fights in Congress when AMT brackets required adjustment and greater uncertainty for taxpayers.[284] For the first time this year Congress did index the AMT, making this annual legislative dance unnecessary.[285]

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280. Jerry Tempalski, *Revenue Effects of Major Tax Bills* 12 (Office of Tax Analysis, Working Paper No. 81, 2006).

281. *Id.* at 4.

282. *Id.*

283. GREGG ESENWEIN, CONG. RESEARCH SERV., RS22100, THE ALTERNATIVE MINIMUM TAX FOR INDIVIDUALS: LEGISLATIVE INITIATIVES AND THEIR REVENUE EFFECTS 2 (2005).

284. *See, e.g.*, David M. Herszenhorn, *Congress Averts Higher Tax Bill for Middle Class*, N.Y. TIMES (Dec. 20, 2007), http://www.nytimes.com/2007/12/20/washington/20cong.html.

285. Dan Kadlec, *At Long Last, A Permanent Patch for a Dreaded Tax*, TIME (Jan. 3, 2013), http://business.time.com/2013/01/03/at-long-last-a-permanent-patch-for-a-dreaded-tax/print.

Congestion price is yet another example of a dynamic rule. Congestion pricing is a method of charging motorists a price to drive or park on a road that varies depending on how busy the road typically is at certain times.[286] The most technologically interesting congestion pricing system currently being used is San Francisco's SF*park* parking meter system. The system uses sensors placed underneath parking spots to determine congestion for each block and for each hour of the day.[287] Each month, an algorithm dynamically adjusts the price, raising prices in busy areas to reach a level that leaves at least one space open, and lowering prices in empty areas until those spaces begin to fill.[288]

Although some congestion pricing systems were implemented before the computer revolution, the ability to use automated systems to collect data, charge vehicles, and distribute pricing information has vastly increased their utility. It is not surprising that successful schemes such as that in San Francisco arose along with the ability to use automated pricing and toll collections. These congestion pricing schemes can provide a model for the more complicated task of creating dynamic laws and rules that change their applications according to conditions and communicate those changes to legal actors.

### C. *Standards Versus Dynamic Rules*

This section compares the two forms of legal rules that are likely to become more prevalent in the information age of American law—standards and dynamic rules. In our world of increasingly powerful information capability, these forms of law have substantial advantages over laws that do not update on information. But how do they compare to one another? This Article contends that as information capacity increases, standards will continue to gain advantages even over dynamic rules in reconciling law's twin objectives of informing the community of norms and infusing information from the world to update norms.

This capacity of judges to use standards to make such incremental changes has advantages as information about the world may be relevant to changing law's algorithm and to applying law's algorithm to facts. Thus, standards permit the judge to tweak the algorithm by varying the weight of factors that determine how a standard is to be applied. This capacity enables judges to take account of new information, potentially making better decisions along the lines this Article has described.[289] But we may

286. For discussion of congestion pricing, see Jonathan Remy Nash, *Economic Efficiency Versus Public Choice: The Case of Property Rights in Road Traffic Management*, 49 B.C. L. REV. 673, 703–08 (2008).

287. *Sensors*, SFPARK, http://sfpark.org/how-it-works/the-sensors (last visited Apr. 5, 2014).

288. *Pricing*, SFPARK, http://sfpark.org/how-it-works/pricing (last visited Apr. 5, 2014).

289. *See* M.B.W. Sinclair, *The Semantics of Common Law Predicates*, 61 IND. L.J. 373, 391–92 (1986).

not trust judges with this kind of discretion out of fear that the costs of such discretion will outweigh the institutional advantages of greater information gathering. The costs can be of two kinds. First, judges may exercise discretion in an ideological manner.[290] Second, judges may exercise discretion in an unpredictable manner because applying standards to different facts does not result in a convergence of application.[291] This creates substantial uncertainty, no matter how efficacious the search.

Dynamic rules avoid this problem because they remove or thwart judicial discretion. But while they are better at integrating information than static rules, they do so in a more mechanical way than standards. The law's algorithm is fixed by a rule, even if its results can vary widely with new information. Even a dynamic rule once set can be changed in our system only through legislation or, in the administrative context, through rulemaking. These processes are generally more laborious, more time consuming, and less spontaneous than judicial action.[292]

The legislative or administrative responsibility for changing rules, even dynamic rules, gives legal change—changes in the algorithm itself—a more punctuated character.[293] Thus, even if increasing information capacity helps transcend the tension between comprehensibility and flexibility by allowing us to continuously update on information, it cannot transcend the enduring institutional questions of authority. And that is how it should be. However great machine intelligence becomes, the question of whom we trust with authority to change the law remains salient.

To understand this difference between standards and dynamic rules, it is useful to return to the previously discussed example—speed limits. A

290. *See* SHAPIRO, *supra* note 19, at 263 (noting the view that judges enjoy legal discretion when they engage in legal reasoning to reach a given result). For an explanation of various potential nonpolitical biases that might hinder judges as producers of efficient law, see generally Schauer, *supra* note 19, at 899. However, it seems that greater information capacity would help judges overcome these biases. *See* Stefanie A. Lindquist & Frank B. Cross, *Empirically Testing Dworkin's Chain Novel Theory: Studying the Path of Precedent*, 80 N.Y.U. L. REV. 1156, 1193–95 (2005) (finding that building precedent initially constrains judicial discretion but once there is sufficient precedent, judges more freely use ideology).

291. *Cf.* SHAPIRO, *supra* note 19, at 257–58 (noting that despite the legal indeterminacy or uncertainty inherent in providing judicial exercise of discretion, this discretion allows judges to adjust the law in light of changing circumstances, which avoids the potentially "morally monstrous results" stemming from rigid—albeit predictable—application of precise legal rules).

292. *See, e.g.*, Charles W. Joiner & Oscar J. Miller, *Rules of Practice and Procedure: A Study of Judicial Rule Making*, 55 MICH. L. REV. 623, 623 (1957) (explaining how even in the narrow field of judicial procedure, the complexity of society could not abide to wait for the legislature to update rules). Consider that Professors Joiner and Miller wrote this article in 1957, and that society has surely become even more "modern and complex" in the intervening decades. *Id.*

293. *See* Pierce, *supra* note 259, at 919 (noting that while legislatures are the preferred source of legal reform, legislatures "have developed powerful inertial forces that render them impotent to make comprehensive changes").

classic standard would be the command "drive at a reasonable speed." As information costs fall, this standard becomes more plausible than rules specifying particular speed limits. A dynamic rule, in contrast, would change the speed limit based on a calculation of factors—perhaps very complex but wholly specified. For instance, the dynamic rule could consider the road conditions, the traffic conditions, and the condition of the car at particular times. Its application would depend on a mathematical formula that would plug in different factual values for the various factors that drive the change of legal application. The dynamic rule thus would possess many of the advantages of a standard (compared to a rule with a specified speed limit) because it would vary the speed limit more efficiently. If an app was programmed with the dynamic rule and could monitor the information relevant to the conditions necessary to calculate its new form, drivers could still have ready knowledge of the rule, even if the speed limit were no longer fixed at a particular limit.

The difference between the standard and the dynamic rule governing the speed limit is that the standard would still allow judges to vary the mix of factors in determining what is reasonable because they would make decisions to which an algorithm would need to adjust. In this case the algorithm would itself evolve with judicial decisions. Thus, these decisions might posit that there is a different tradeoff between road conditions and traffic in a particular place to get the same level of safety. In short, they could modify the weight of the factors in the algorithm as well as apply the factors in the algorithm.

Thus, standards retain their advantages of capturing distributed information even vis-à-vis dynamic rules. They permit judges incrementally to gather information about the world to efficiently update the law. No legislature can perfectly foresee the future.[294] Even with dynamic rules that take account of changing factors, the world may change in a way that makes another weighting of factors achieve the legislature's original objectives. Thus, some factual change in the world—for instance the introduction of some unforeseen new technology into cars that dramatically improves safety—may mean that the rule's factors no longer capture the preferences implicit in the rule because the rule applied in the new factual context reaches results that do not accord with our preferences even at the time we made the rule. If we had known about these changes at that time we would have had a different algorithm in the first place.

In the famous Italian novel, *The Leopard*, Tancredi, the nephew of the Prince, famously says, "If we want things to stay as they are, things will

294. *See* Legislation, *The Elimination of Obsolete Statutes*, 43 HARV. L. REV. 1302, 1302–03 (1930) (discussing obsolete statutes, their ill effects, and the unfortunate result that such statutes must be deliberately repealed by the legislatures). For a more recent article on point, see Note, *Desuetude*, 119 HARV. L. REV. 2209, 2209 (2006).

have to change."[295] So too it can be with law: in a world that is changing, law must sometimes change if it is to maintain the same objectives and tradeoffs in values.[296] Determining whether to use standards or dynamic rules turns on whether the advantages of the greater capacity to update on information inherent in standards are outweighed by danger of ideological abuse and unpredictability that they can facilitate.[297]

Thus, as information costs fall, standards will become more clearly better than rules, even dynamic rules, in any area in which we can trust judges to update according to the preferences of the community. For areas where we want to give judges less discretion, dynamic rules will gain advantages in the information age over the more static rules in previous ages.[298] Their openness to change within determinate bounds allows for substantial updating on information and yet permits citizens to better plan around the foreseen consequences of the rules, because the updating depends on transparent factors. Within the constraints of trust and tractability, dynamic rules also reflect the legal form of our information age.

## CONCLUSION

Grant Gilmore famously divided American law into three eras.[299] The Age of Discovery was marked by the new nation's finding its own social

295. GIUSEPPE DI LAMPEDUSA, THE LEOPARD 28 (Archibald Colquhoun trans., 1st rev. paperback ed. 2007).

296. For a compelling example arguing that the advent of the Internet has created such a disconnect between the public's perception of copyright infringement and that of the law, that a reconceptualization of copyright norms must realign both public perception and legal rules in order to accomplish the goals of copyright policy, see Christopher Jensen, Note, *The More Things Change, the More They Stay the Same: Copyright, Digital Technology, and Social Norms*, 56 STAN. L. REV. 531, 533–34 (2003).

297. It might be argued that this tension too can be tempered if we can create a system of adjudication that not only updates on information but does so in a manner that creates efficient algorithms. That promise lies behind the claim that the common law is efficient. *See* Rubin, *supra* note 195, at 51. This Article has previously shown that greater information capacity should help the forces of efficiency by giving judges better access to precedent and making litigation against inefficient precedents more likely to succeed. But the claim that common law tends toward efficiency is contested. For an empirical study evaluating whether common law indeed tends toward efficiency, see Thomas J. Miceli, *Legal Change: Selective Litigation, Judicial Bias, and Precedent*, 38 J. LEGAL STUD. 157, 166 (2009) (concluding that selective litigation will lead the common law towards efficiency if precedent is overturned at random, but a large fraction of biased judges could disrupt this result). In any event, not everyone agrees that efficiency should be the touchstone of all legal norms. *See, e.g.*, James M. Buchanan, *Good Economics—Bad Law*, 60 VA. L. REV. 483, 485 (1974).

298. As discussed above, this Article assumes that judges govern the application of law. Where other decision makers exercise substantial discretion, society's trust in their exercise of discretion will also be relevant to the choice between standards and dynamic rules.

299. *See* GRANT GILMORE, THE AGES OF AMERICAN LAW 11–12 (1977). However, Gilmore himself acknowledged that he was adopting the view of Karl Llewellyn. *Id.* at 11.

norms and creating precedents that differed from Britain's.[300] The Age of Faith of the later nineteenth century forged a coherent set of rules from the precedents of the former age.[301] The twentieth century's Age of Anxiety reflected concern about the adequacy of these rules to reflect the law, in part because the increasing complexity of the world and the multiplication of precedents made it harder to find the law.[302]

Today we inhabit the Age of Information and this age is creating a new synthesis for the structure of law. If the Age of Faith required formalism to regulate the legal world, the Age of Information, like the Age of Anxiety, accepts that many factors may influence the law. But the Age of Information, like the Age of Faith, has greater confidence in creating legal clarity. Both the Age of Information and the Age of Faith have their gods of legal order, but if the god of the Age of Faith was formalism, today's god is computable realism. The rise of computable standards and dynamic rules will be this age's contribution to legal expression.

Computation is not yet quite capable of creating this order, but its exponential nature is likely to usher in that age sooner than we think. Exponential growth is not very noticeable at first. An investment of a dollar that grows at 50% per year yields $38 in the tenth. A person living through those ten years and looking only at the gross gains in value would hardly think anything was happening at all. Years thirty through forty, however, take that person from $125,000 to over $7,000,000. The same growth rate becomes more noticeable when it operates on larger numbers. If placed on a linear graph, the line charting this growth would start to turn dramatically upwards. This point is known as the "knee of the curve."[303]

We are likely in the knee of the curve when it comes to the growth of legal information technology. Looking back through the history of legal information, we see very slow changes at first. The practice of law in England changed little from the Magna Carta until Blackstone's Commentaries. Another two hundred years or so passed until West Publishing came up with a detailed, topic-based breakdown of the law. Ninety years later, we had the first electronic legal search. In the intervening thirty-seven years we have witnessed tremendous changes in how legal search is used. It has gone from an expensive, slow, limited process that took place on a single, fixed terminal, to something that can often be done for free using a cell phone.

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300. *See id.* at 19–21.

301. *See id.* at 43–47.

302. *Id.* at 70.

303. KURZWEIL, *supra* note 130, at 10 ("[E]xponential growth is seductive, starting out slowly and virtually unnoticeably, but beyond the knee of the curve it turns explosive and profoundly transformative.").

There is every reason to believe this process will continue to accelerate. Moore's law will continue to dramatically lower the costs of computation (in terms of money and energy), just as it has in the past. Legal search will also benefit from the technology industry's interest in natural language search. By hitching its star to the improvement of search in general, and riding the wave of increasing computational power, legal search is experiencing a revolution in capability. This Article has suggested that law should respond to the improvements in information capacity to move towards a more flexible, nimble legal framework through either standards-based law or dynamic rules.

There's an old Silicon Valley joke that goes "if GM had kept up with technology like the computer industry has, we'd all be driving cars that got 1,000 mpg and cost $25."[304] Unfortunately, the laws of physics prevent the car industry from improving the way computers have. Likewise, enduring issues of trust—a matter imbedded in human nature itself—prevent the law from improving at the exponential rates of growth that the technology industry achieves. Nonetheless, given that law is an information technology, the information revolution can substantially improve our ability to find the law and with that greater capacity can mold a law that better serves its objectives of both providing information to society and gathering information from the world.

304. This quote is often misattributed to Bill Gates. *Car Balk*, SNOPES, http://www.snopes.com/humor/jokes/autos.asp (last updated Oct. 14, 2010).