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I. Introduction

If a tree falls in Cambridge, Massachusetts and there is no one nearby to hear it, but it is detected by a supersensitive monitor near a hospital in Princeton, New Jersey, does it make a sound? If so, does that sound violate a Princeton ordinance that prohibits making a "detectable sound" in a hospital zone?

The interpretation of such an ordinance is committed to the judiciary; the creation of new laws is committed to the legislature and the judiciary. Although there is legislative power to delegate certain aspects of this authority, it is circumscribed, both by the Constitution and the Administrative Procedure Act ("APA").

A third mechanism for changing law emerged without fanfare in the middle of the twentieth century and has taken on increasing importance as the pace of technological development accelerates: advances in technology may change the meaning of a law even though the words of a statute remain unchanged. A vehicle law which limits vehicle speeds to miles per hour ("mph") depends on the definitions of miles and of hour, both of which have undergone change since the first vehicle speed limits were adopted in the early twentieth century. An environmental law which limits "detectible emissions" depends on the sensitivity of available detection equipment, a characteristic which has changed since the first modern environmental laws were adopted in the mid-twentieth century.

This technological development is not overseen by any government entity, yet it has the consequence of redefining the

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meaning of existing laws. Although such changes in the meaning of a statute can have a profound economic impact, legislatures rarely consider it.

This Article examines the question of when this is problematic. It begins by identifying and drawing the outline of this previously unrecognized source of law: technology-made law. It then focuses on one paradigmatic case: changes in the meaning of "zero" and the closely related concept of a mathematical limit (for example a speed limit). It defines "zero" and demonstrates its explicit and implicit uses in law. It then posits that there are two ways to interpret a law involving a technological limit: a technology-static approach, in which comparisons are made using the technology available at the time the law was enacted, and a technology-dynamic approach, in which comparisons are made using the technology available at the time compliance is determined. It then sets the stage for a comparison of these approaches by surveying the sources of authority for making law. The approaches are then compared using examples of the type of law which should be interpreted under the technology-static rubric (vehicle speed limits) and the type of law which should be interpreted under the technology-dynamic rubric (environmental law). The analyses are then compared so as to extract a set of principles that should aid in resolution of the question (static or dynamic interpretation) in other cases. Finally, it offers a generalized theory of how problems of technology-made law can be minimized and how they should be addressed in circumstances where they have not been avoided.

II. Zero: Meaning and Consequence

Zero is an unusual number. Mathematically it is the number that can be added to any other number and result in the original number; it is the dividing line between positive and negative numbers; it is the average of any number and its negative.

From the perspective of daily life, it stands out from the other natural numbers—it is rarely necessary to count how

many of something exist where there are none. As a result, zero is a late entrant to the world of numbers.[1] Think back to grade school and try to recall the symbol for the Roman numeral zero. You don't, because there is none. Early mathematicians dealt with positive real numbers because their world experience was limited to positive real numbers: a prehistoric hunting party may have considered the wisdom of attacking a herd of a dozen wooly mammoths, but it is doubtful that any considered the question of what to do in the face of negative three wooly mammoths.[2] Without the concept of negative numbers, zero's role as the dividing line between positive and negative does not arise.

Likewise, in a pre-technological society, where measurement is done purely by human eyes, mathematical experience deals with the world on a macro scale, so the "nothingness" of zero makes little difference. The concept of "no wooly mammoths" has a fixed and definite meaning. The introduction of measurement technology changes the concept in an important way.

"Zero" really means "below detectable limits"—in a pre-technological society "no wooly mammoths" means "no wooly mammoths close enough to be seen or heard." Development of a

1. Mathematically, zero serves two functions: as a number (the whole number between -1 and +1) and as a placeholder (distinguishing 1 from 10). Historically, there have been at least two recognitions of the numerical zero, one developing between 400 and 300 B.C. in Babylon, developing in India, "wending its way through northern Africa and . . . crossing into Europe via Italy" circa 1200, the other arising independently in the New World, in Mayan culture, likely in the first few centuries A.D. John Matson, *The Origin of Zero*, SCI. AM. (Aug. 21, 2009), *available at* http://www.scientificamerican.com/article.cfm?id=history-of-zero (citing CHARLES SEIFE, ZERO: THE BIOGRAPHY OF A DANGEROUS IDEA (Viking 2000)). Jolanta Swiderek argues that Aristotle was the first to recognize the number zero. Jolanta Swiderek, Section Paper presented at Twentieth World Congress of Philosophy held at Boston University: *A Notion of* μηδέν *in the Philosophy of Aristotle* (Aug. 10-15, 1998), *available at* http://www.bu.edu/wcp/Papers/Anci/AnciSwid.htm ("The first notion of an abstract zero, that is a number zero, in the history of human thought appeared in Aristotle's philosophy in the 4th c. [sic] BC . . . [t]he Philosopher could not accepted [sic] it since it would lead him to contradiction. The basic principles of his metaphysics demanded the rejection of this notion just as they demanded the rejection of a notion of nothingness or actual infinity.").

2. Arguably, it might have been important for prehistoric people to know "no saber tooth tigers around," but that isn't really a counting exercise.

telescope changes the inquiry. Now the answer to the question of "how many wooly mammoths are around?" depends on how good the telescope is.[3] As measurement technology improves, the answer changes and becomes a function of the precision of the measuring instrument. The concept of precision is implicit in all systems of measurement, but it is not an important consideration in early systems. Prior to the eighteenth century, there was no international standard weight, and agreements based on weight needed to include a definition of the reference weight. The scientific definition of a kilogram has evolved from the eighteenth century (the mass of a cubic decimeter of water) to the more precise definition adopted by the General Conference on Weights and Measures ("CGPM") in 1889 as the mass of a specific platinum-iridium bar maintained by the International Bureau of Weights and Measures under conditions specified by the 1st CGPM in 1889.[4]

3. Galileo faced a similar problem in 1610 when he built a telescope which enabled him to see several of Jupiter's moons and to observe the phases of Venus, leading him to believe that the earth revolved around the sun. GALILEO GALILEI, SIDEREUS NUNCIUS 28 (Peter Barker trans., Byzantium Press 2004) (1610). This led to an inquiry by the Inquisition, which (not having as good a telescope) concluded: "That the sun is the center of the world and motionless is a proposition which is philosophically absurd and false . . . ;That the earth is neither the center of the world nor motionless . . . is philosophically equally absurd and false . . . ." MAURICE A. FINOCCHIARO, THE GALILEO AFFAIR: A DOCUMENTARY HISTORY 288 (Maurice Finocchiaro ed. & trans., Univ.Cal. Press, 1989).

4. *Unit of Mass (Kilogram)*, NAT'L INST. SCI. & TECH., http://physics.nist.gov/cuu/Units/kilogram.html (last visited Jan. 2, 2014). Accuracy in measuring time has also advanced dramatically. In the late sixteenth century, astronomer Tycho Brahe's observatory used some of the earliest mechanical clocks capable of displaying seconds, but the agreement between the clocks was only plus or minus four seconds. With the advance of the science of physics in the late nineteenth and twentieth centuries, the ability to measure small quantities improved dramatically. By the mid-twentieth, time was no longer being measured by the period of the revolution of the earth around the sun (which varies from year to year) but was measured using atomic transitions (the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom), with an accuracy to 10^{-10}. However, even atomic clocks have undergone recent redefinition to account for the time-dilation effect of distance from the earth's gravitational center (1980) and to account for temperature (1997). *NIST-F1 Cesium Fountain Atomic Clock, The Primary Time and Frequency Standard for the United Stated*, NAT'L INST. SCI. & TECH., http://www.nist.gov/pml/div688/grp50/primary-frequency-standards.cfm (last

Once it is recognized that the meaning of "zero" is, in effect, "below detectable limits"[5] the legal issue becomes apparent. A statute that uses the term zero (or a variant, discussed below) means "so close to nothing that we can't detect it"—and, therefore, becomes closer and closer to mathematical zero as the detection technology improves. As the ability to detect improves, the legal standard changes—without the intervention of a court or legislature.[6] Moreover, there are two types of legal zero: explicit and implicit. An example of an explicit zero is an environmental statute which calls for "zero" visible emissions.[7] An example of an implicit zero is a speeding statute. Although the speeding statute sets a non-zero benchmark, this is equivalent to "zero above" the benchmark—for example, a thirty mph speed limit translates into "zero more than thirty mph." Viewed this way, the use of zero in legislation is common.

It may, at first glance, appear that it is simple to conclude that better detection translating into tighter standards is a good result; better detection means better enforcement and better compliance. A few examples will illustrate why this is not necessarily the case.

Imagine a rational legislature, attempting to balance

updated Feb. 4, 2013). Current cesium clocks are accurate to within about one second in thirty million years. *Id.*

5. It follows from this definition that the meaning of "no" is "not detectable" or, arguably, "not detected."

6. As the ability to measure more precisely improves, the meaning of a number changes. If it is only possible to measure in increments of .5, then a statute or agreement requiring "1" means between .5 and 1.5—anything in that range will be detected as "1". If a detector is developed which permits measurement in increments of 0.1, the meaning of "1" will be narrowed to between 0.9 and 1.1. Things that were previously permissible under the statute or agreement have now become violative, even though the statute (or agreement) has not changed, nor has the thing being done.

7. An example of such a statute is the standard authorized by 42 U.S.C. § 7412 (2012) and implemented by regulations published in 40 C.F.R. § 63.302 (2013). Interestingly, as discussed at *infra* Part IV.B, the standard was originally based on whether emissions were observed for more than a specified period of time by a "certified observer" (i.e., a person) but modified as the technology became available, to allow 24/7 machine detection. In effect, the standard was tightened without amending the regulations or providing public notice as required by the Administrative Procedure Act ("APA"). *See infra* Part III.B for a more detailed discussion of the notice requirements.

environmental health with economic health. After careful analysis, it concludes that if a particular industry spends $1 on pollution control, there will be $2 in environmental benefits, that the industry can afford the extra $1 cost, and that this level of control will be achieved by a statutory standard of zero emissions of a particular pollutant. At the time, the best available detection technology can detect one part per thousand of the pollutant.[8] After the standard is set, however, detection technology improves so that it is now possible to detect one part per million. In effect, the standard for control technology has been made a thousand times more stringent. The cost of reducing pollution to less than one part per thousand (the old standard) was $1 and the legislature concluded this was a reasonable cost for the anticipated benefits. Suppose, however, that the cost to reduce the pollution to one part per million (the new standard) is not $1 but $100. The justification for the standard—the determination that the environmental benefit exceeded the cost of compliance—is no longer valid.[9] Instead of a $2 benefit for every $1 spent, the statute imposes a $100 cost for every $2 in benefit.

Imagine that the same legislature decided to build a new superhighway. Although the cost is high, it is justified by the time that will be saved in commuting and the economic development that will result from expanding the area from which people can commute. Suppose the highway engineers report that the safe speed on the road is eighty mph and the economics of the road project are based on travel at a constant speed of seventy-five mph (to allow a margin of safety). At that speed, the cost of the road is justified by a cost-benefit analysis showing a return of 200% of the cost. When it comes time to set the speed limit on the road, one legislator observes that people often exceed the speed limit and assume that being a "little bit"

8. This detection level means that a company will be out of compliance with the standard if it emits more than one molecule of the pollutant in every thousand molecules of sample. Below that level, the company may be emitting the pollutant but there is no way to know that.

9. If the legislature's original determination, that the value of the reduction was $2, is correct, then the new standard will cause $100 of economic damage for every $2 of environmental benefit. This is not to say that a legislature could not reach the conclusion that this is still desirable—it is simply that the legislature has not reached that conclusion.

over will not lead to a citation, so that to get traffic moving at between seventy-five mph and eighty mph, the speed limit needs to be lower than seventy-five mph. How much lower? If the then-existing detection technology is a speedometer calibrated in five mph increments, then a seventy mph limit is appropriate: drivers can travel at up to seventy-five mph without being detected as violating the limit[10] and the cost-benefit analysis is sound. Suppose, however, that detection technology improves so that one mph increments can be detected. Now traffic must move at no more than seventy-one mph to avoid violating the speed limit.[11] This would not be a problem if the legislature had considered and approved it. Legislatures are empowered to make cost-benefit decisions.[12] However, in the absence of an examination of the issue and an analysis of the costs and benefits of this new limit, a problem is presented: the cost-benefit analysis that was done, under then existing technological assumptions, is no longer valid.

Thus, better measurement technology does not always lead to an improvement in the underlying law.

Accepting that zero[13] takes on a new meaning, which

10. This is based on the simplifying assumption that the speedometer indicator changes when the next level is reached—i.e., that when a vehicle goes from sixty-nine mph to seventy mph, the speedometer reading goes from sixty-five mph to seventy mph.

11. Improved detection does not necessarily lead to increased regulation. For example, suppose a legislature wants to remove X units of a pollutant per year, as required for example under the federal non-attainment regulations, discussed *infra* Part IV.B. If the limit of detection is Y, then the standard must be set to remove $X + Y$ units in order to meet the requirement. If the detection limit improves to $.5Y$, the limit can be lowered to $X + .5Y$, thus allowing the possibility of a more relaxed standard (and presumably less costly controls). In either case, however, if the legislation was based on a cost/benefit analysis, that analysis will become unbalanced by virtue of the improved detection technology.

12. "The decision whether the law of diminishing returns should have any place in the regulation of toxic substances is quintessentially one of legislative policy." Indus. Union Dep't, AFL-CIO v. Am. Petrol. Inst., 448 U.S. 607, 686 (1980) (Rehnquist, J., concurring). It would also likely not be a problem if an administrative agency—for example, a state motor vehicles administration—had made the decision pursuant to the exercise of a proper delegation of authority.

13. The same analysis applies to any number. Zero provides a convenient way to re-conceptualize a variety of problems so that the same analysis can be applied. For example, a speed limit of thirty mph may be

varies according to the ability to distinguish something from nothing, technological advances that increase the precision of any measurement in effect rewrite the law relating to that which is measured. Is this an acceptable result? Laws are changed all the time, by legislatures and courts—does it matter if the change is, instead, wrought by a private party and is controlled by the ingenuity of inventors and the economics of the marketplace?

III. The Power to Make Law

A. *Direct Lawmaking—Legislatures and Courts*

According to classical theory, there are two ways in which laws are created:[14] legislative enactment[15] and common law judicial development.[16] Both legislature-made law and judge-made law involve explicit decisions by public officials,[17] both

thought of as a requirement that speed not exceed thirty mph by more than zero.

14. *See* Eisenhuth v. Moneyhon, 119 N.E.2d 440, 443 (Ohio 1954) ("[S]tandard of conduct . . . may be specifically established by legislative enactment; by judicial decisions . . . ; or, in the absence of legislative enactment or judicial decision, by a consideration . . . of the facts and circumstances of the particular case."); ANTHONY D'AMATO, JURISPRUDENCE: A DESCRIPTIVE AND NORMATIVE ANALYSIS OF LAW 118-41 (1984); LON FULLER, ANATOMY OF THE LAW 59 (1968); Anthony D'Amato, *Can Legislatures Constrain Judicial Interpretation of Statutes?*, 75 VA. L. REV. 561, 561 (1989). There is some debate as to the scope of the power of the Executive to make laws by treaty. *See, e.g.*, Max Stul Oppenheimer, *Harmonization through Condemnation: Is New London the Key to World Patent Harmony?*, 40 VAND. J. TRANSNAT'L L. 445, 483-88 (2007). In any event, that power requires action by at least one branch of the legislature. U.S. CONST. art. II, §2.

15. U.S. CONST. art. I. Legislatures may delegate certain types of rulemaking authority to administrative agencies (e.g., APA), arguably creating a third form of lawmaking. Validly adopted agency rules have the force of statute. W. Oil & Gas Ass'n v. EPA, 633 F.2d 803 (9th Cir. 1980); Bd. of Educ. v. Harris, 622 F.2d 599 (2d Cir. 1979), *cert. denied*, 449 U.S. 1124 (1981). Thus, considering agency-made law a separate category from legislation would not change the analysis.

16. U.S. CONST. art. III.

17. While legislative laws are enacted and common law is announced, it is convenient to use the term "post-enactment" to describe technology which is developed after the law in question has been established—whether by legislative enactment or judicial creation.

are the result of a deliberative process informed by some degree of attention to public policy, both produce public records, and both are subject to established processes of review and, ultimately, accountability to the public.

Legislatures and, to a greater extent courts, have traditionally dealt with the problem of applying existing laws to new circumstances, including circumstances which were unforeseen at the time the law was originally created.[18]

In particular, past technological advances have required interpretation and application of laws to new circumstances. Copyright law is a good example, having faced several waves of interpretation in response to such changes in the technology available for copying and expressing the content of copyrightable works. For example, when piano music rolls and the phonograph were invented in the late nineteenth century, courts were challenged to interpret and apply existing copyright law to these new technologies, unforeseen at the time the statute was enacted. Producers of music rolls and records sold physical objects capable of reproducing sounds that embodied works copyrighted as sheet music. In *White-Smith Music v. Apollo,* the Supreme Court held that these "pianola rolls" were not copies (within the meaning of the then-current copyright statute) of the sheet music composition which they reproduced and, therefore, did not infringe the author's copyright.[19] One year later, Congress amended the copyright statute to address the issue and provided that record companies could embody musical compositions in pianola rolls and records by paying a statutory fee.[20]

Likewise, early cable operators captured over-the-air television broadcast signals and retransmitted them to subscribers without compensating the owners of the copyrights in the original broadcast. In *Fortnightly Corp. v. United Artists*

18. In response to the emergence of personal computers, Congress enacted section 117 of the Copyright Act, which provided for "interim" rules regarding copyright protection for computer software, pending further study. More than thirty years later, section 117 remains unchanged. Courts have been more active in resolving the issues posed by computers. 17 U.S.C. § 117 (2012); *See, e.g.*, cases cited *infra* notes 19, 21-27.

19. White-Smith Music Publ'g Co. v. Apollo Co., 209 U.S. 1, 14-18 (1908).

20. Copyright Act § 1(e) (1909) (current version at 17 U.S.C. §§ 401-412 (2012)).

Television, Inc., the Court held that cable retransmission was not public performance under the then-existing copyright statute, and thus did not infringe on copyright owners' rights.[21] In *Teleprompter Corp. v. CBS*, the Court held that cable television's importation of remote signals was also non-infringing.[22]

Another set of copyright interpretative issues arose in connection with the advent of the new technology of photocopiers. Publishers sued the National Institute of Health and the National Library of Medicine for systematic photocopying of journals they published.[23] An equally divided Supreme Court affirmed the Court of Claims' finding that this constituted fair use and therefore did not infringe the publishers' copyrights.[24]

A series of cases has tested the application of existing copyright law to the storage and transfer of files over the internet. Courts first found that centralized file storage and sharing violated the copyright on the stored files,[25] then reached the same conclusion, but as to decentralized management of stored files.[26] In both cases, courts found that a substantial portion of the files involved were infringing.[27]

The problems dealt with in these cases, however, differ

21. Fortnightly Corp. v. United Artists Television, Inc., 392 U.S. 390, 398-401 (1968).

22. Teleprompter Corp. v. CBS, 415 U.S. 394, 410-15 (1974).

23. *See* Williams & Wilkins Co. v. United States, 487 F.2d 1345, 1346-47 (Ct. Cl. 1973), *aff'd per curiam*, 420 U.S. 376 (1975).

24. *Id.* at 1359. While the majority in Court of Claims decision found that this constituted fair use, the dissent characterized the ruling as "the Dred Scott decision of copyright law." *Id.* at 1387 (Nichols, J., dissenting). For the current codification of the Fair Use Doctrine, *see* 17 U.S.C. § 107 (2012).

25. *See* A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004, 1012-17 (9th Cir. 2001).

26. *See* MGM Studios, Inc. v. Grokster, Ltd., 545 U.S. 913, 937-41 (2005).

27. *See id.* at 923 ("MGM's evidence gives reason to think that the vast majority of users' downloads are acts of infringement . . . [meaning that] the probable scope of copyright infringement is staggering."); *Napster*, 239 F.3d at 1012-17; *see also* A&M Records, Inc. v. Napster, Inc., 114 F. Supp. 2d 896, 911 (N.D. Cal. 2000) ("[V]irtually all Napster users engage in the unauthorized downloading or uploading of copyrighted music; as much as eighty-seven percent of the files available on Napster may be copyrighted . . . ."), *aff'd in part*, *rev'd in part* 239 F.3d 1004 (9th Cir. 2001).

from the problem of new technology changing the meaning of existing law. These cases involve applying a known rule to a new problem, a classic judicial task, even if the new problem was one unforeseen at the time the rule was adopted. In the case of technology-made law, the challenge is applying a known rule to a known problem, with the complication that the meaning of the rule itself has changed, which is of potentially far broader impact and which poses the possibility of disappointing settled expectations.[28]

In order to answer the question of whether the introduction of private actors into the formulation of law is a problem, one additional concept—that of delegation—needs to be considered.

B. *Delegated Lawmaking—Administrative Agencies*

There is at least one category of governmental action that arguably changes law[29] and falls outside the two areas (legislative and judicial) described above.

Legislatures frequently create administrative agencies and delegate to them the task of developing procedures and rules for implementing legislation**.** These agencies are called on to adjudicate matters or to provide generalized guidance on the interpretation and enforcement of statutes. This power is constrained, however, by the Constitution[30] and by the Administrative Procedure Act[31] ("APA).

28. Of course, if a legislature changed the meaning of a rule, the problem would not arise. The issue is posed when the change in meaning takes place outside the classic law-making process.

29. As discussed in this section, there are types of agency actions that create rights or obligations. Presumably, however, any interpretations or adjudications by an agency are consistent with the statute that the agency operates under. Furthermore, in the legislation creating the agency, Congress may place constraints on the agency, and it often "legislatively limit[s] the factors an agency may consider." David M. Driesen, *Distributing the Costs of Environmental, Health, and Safety Protection: The Feasibility Principle, Cost-Benefit Analysis, and Regulatory Reform*, 32 B.C. ENVTL. AFF. L. REV. 1, 82 (2005).

30. *See generally* U.S. CONST. art. I-III. The analysis focuses on federal agencies. Most states have similar statutes governing state administrative agencies.

31. 5 U.S.C. §§ 551-559 (2012).

Among the provisions of the APA are requirements that an agency give public notice of proposed rulemaking and that the agency solicit and consider public comments on its proposed rules.[32] The APA distinguishes between agency rulemaking, which is merely interpretative (and does not require notice and comment),[33] and that which is substantive.[34] Substantive rulemaking, which establishes rights and duties, requires public notice, while interpretative rulemaking does not require public participation and is merely a statement of how an agency intends to act.[35] Although the line between the two has been described as "murky,"[36] legislative rules may be thought of as those that create new laws granting rights or imposing obligations,[37] while interpretative rules clarify existing law or regulations, state how an agency will interpret existing law or regulations,[38] or deal with internal agency matters such as

32. 5 U.S.C. § 553(b) (2012) requires that "[g]eneral notice of proposed rule making [sic] shall be published in the Federal Register" unless affected parties are given actual notice and that the notice include the legal authority for the rule and the proposed rule. Interested parties must also be given the opportunity to participate in the rule making and the agency must consider relevant matter presented. § 553(b)(3).

33. § 553(b)(3)(A).

34. The APA does not define the distinction between substantive and interpretative rules. Courts generally draw the distinction between rules that clarify and those that create rights or duties. *See, e.g.*, White v. Shalala, 7 F.3d 296, 303-04 (2d Cir. 1993); Metro. School Dist. of Wayne Twp. v. Davila, 969 F.2d 485, 488-93 (7th Cir. 1992). The Attorney General's Manual on the APA describes substantive rules as "rules . . . issued by an agency pursuant to statutory authority and which implement the statute," and interpretative rules as "rules . . . issued by an agency to advise the public of the agency's construction of the statutes and rules which it administers." U.S. DEP'T OF JUSTICE, ATTORNEY GENERAL'S MANUAL ON THE ADMINISTRATIVE PROCEDURE ACT 30 n.3 (1947).

35. *See* New Jersey v. Dept. of Health & Human Servs., 670 F.2d 1262, 1281-82 (3d Cir. 1981).

36. Erringer v. Thompson, 371 F.3d 625, 631 n.12 (9th Cir. 2004).

37. *See, e.g.*, SBC Inc. v. FCC, 414 F.3d 486, 497-98 (3d Cir. 2005); *White*, 7 F.3d at 303-04; Animal Legal Def. Fund v. Quigg, 932 F.2d 920, 926-31 (Fed. Cir. 1991); Friedrich v. Sec'y of Health & Human Servs., 894 F.2d 829, 833-37 (6th Cir. 1990); Citizens to Save Spencer Cnty. v. EPA, 600 F.2d 844, 894-99 (D.C. Cir. 1979).

38. Haas v. Peake, 525 F.3d 1168, 1186-95 (Fed. Cir. 2008); Fed. Labor Relations Auth. v. U.S. Dep't of Navy, 966 F.2d 747, 761-65 (3d Cir. 1992); Avoyelles Sportsmen's League, Inc. v. Marsh, 715 F.2d 897, 909-16 (5th Cir. 1983).

organization.[39]

In addition to providing a source of information to the agency, the requirement to follow a notice and comment procedure when creating rights and obligations has at least two important justifications. Such public participation introduces an element of accountability in what is, after all, an unelected body and comports with notions of fairness to any affected parties by providing an opportunity to influence the agency by making concerns known.[40]

If the legislature has provided the necessary power and the agency has provided adequate public notice, delegation of law making power is permissible. More is needed, however, to reach the conclusion that delegation to private parties is also permissible.

C. *Technological Lawmaking—Inventors and the Marketplace*

In addition to the classical mechanisms for creating law,[41] there is an additional mechanism for changing law. This mechanism emerged without fanfare in the middle of the twentieth century and takes on increasing importance as the pace of technological development accelerates. Advances in technology may change the meaning of a law even though the words of a statute remain unchanged. While there is explicit constitutional authority for legislative enactment[42] and common law judicial development,[43] there is no constitutional

39. *Erringer*, 371 F.3d at 630.

40. Elizabeth Williams, Annotation, *What Constitutes "Interpretative Rule" of Agency so as to Exempt Such Action from Notice Requirements of Administrative Procedure Act (5 U.S.C.A. § 553(b)(3)(a))*, 126 A.L.R. FED. 347, §§ 2(a), 13(a) (1995).

41. Legislative enactments, judicially created common law, judicial interpretation, and, arguably, delegated rulemaking by administrative agencies are discussed *supra* Part III.A.

42. U.S. CONST. art. I. Legislatures may delegate certain types of rulemaking authority to administrative agencies, arguably creating a third form of lawmaking. *See e.g.*, Administrative Procedure Act, 5 U.S.C. § 500 (2012). Validly adopted agency rules have the force of statute. *See* W. Oil & Gas Ass'n, 633 F.2d at 807-13; Bd. of Educ., 622 F.2d at 613, *cert. denied*, 449 U.S. 1124 (1981). Thus, considering agency-made law a separate category from legislation would not change the analysis.

43. U.S. CONST. art. III.

authority for private parties to make laws.[44] Unlike the classical mechanisms for changing law, this mechanism is not dependent on the decision of a public official, need not even be explicitly intended to change existing law, rarely results from considerations of public policy, is not generally the subject of published deliberations and is subject to review only in the sense that companies respond to market failures and legislatures have the power to amend statutes if they determine that developments subsequent to enactment warrant such response. Although it can have a profound economic impact,[45] legislatures rarely consider it.

Although this technological development is not overseen by any government entity, it can have the consequence of changing the meaning of existing laws by a process that would not pass muster even if it were adopted by an administrative agency. As discussed in Part III(B), an administrative agency would, at a minimum, need to provide notice of its intended action and consider public comments on the proposal. Further, the administrative agency would be accountable to Congress and therefore, at least indirectly, to the public.

Certainly, once statutes have been enacted, there is a role for private parties. Although the government can set the rules, independent actors can decide how to operate within those rules. For example, in the case of federal income taxation, Congress can establish tax rates, rules for determining taxable income, and the dates on which taxes are due. The Internal Revenue Service can establish rules for reporting taxes and resolving issues in interpreting the tax code. However, the actual amount of tax revenue collected is not determined by

44. Private parties can, of course, enter contracts (which may be thought of as a sort of private "law"), but contracts only bind the contracting parties and certain third party beneficiaries.

45. While national data is not available, the economic impact of the use of speed cameras must be in the hundreds of millions of dollars per year. When the accuracy of its speed cameras forced the City of Baltimore (a city with a population of less than a million people) to suspend their use, the city lost $90,000 per weekday in revenues. Scott Calvert, *City Gives No Restart Data for Camera Tickets*, BALT. SUN (June 13, 2013), http://articles.baltimoresun.com/2013-06-13/news/bs-md-speed-cam-june-meeting-20130613_1_speed-cameras-brekford-corp-camera-tickets. Pollution control costs are easily in the billion-dollar range each year.

Congress[46]—that depends on the actions of others (how much money taxpayers earn, how they arrange their finances, and the general state of the economy, among others.)[47]

However, there are important distinctions that preclude bringing technology-made law within the authority granted to legislatures and courts, or within the authorization of administrative delegation.

The most obvious distinction is that legislatures are elected and directly accountable to the public. Judges are either elected (in some jurisdictions) or appointed by elected officials, and senior administrative officials are appointed by elected officials and therefore indirectly accountable to the public. Technology-made law is created by inventors and companies, who are accountable (if at all) to stockholders.[48]

Legislators, judges and administrative agencies are not only publicly accountable, but in most cases act in public and create publicly accessible records. Except in rare cases,[49] companies developing new technologies are under no obligation to disclose their plans (and, in fact, generally are motivated to keep such plans confidential).

While subject to lobbying and persuasion, legislators presumably make decisions based on their evaluations of public interests, while private companies generally make decisions based on their evaluation of profit potential. Moreover, Congress is the one body empowered to impair contracts—state

46. The amount of revenue expected is certainly a factor in setting tax rates.

47. This constraint on legislative power is not necessarily unwelcome to the legislature. For example, states with property taxes are able to keep the tax rate constant while receiving rising revenue when property values rise, and thus can raise tax revenues while claiming not to have raised taxes. *See* Mark Perry, *Tax Rates (%) X Tax Base = Tax Revenue ($)*, DAILYMARKETS (May 17, 2011), http://www.dailymarkets.com/economy/2011/05/17/tax-rates-x-tax-base-tax-revenue.

48. It would be rare for a decision to invest in development of a new technology to rise to the level where it would require stockholder approval.

49. Examples would include companies that are required to file reports with the Securities and Exchange Commission ("SEC") and transactions which either required stockholder approval (and therefore triggered the SEC's proxy rules), or which were material (and therefore required disclosure under SEC's reporting rules.) 17 C.F.R. §§ 240.13a-1, 240.14a-2 (2013). These situations would be rare.

legislatures and private individuals are constitutionally prohibited from doing so.[50]

Thus, technological law making cannot be justified as an extension of traditional law making.[51] If technological law making does not have the force of law, the question remains how it should impact legitimate laws: how should courts use post-enactment technological advances in deciding cases under those enactments?

If courts use post-enactment technology in interpreting and applying laws, then technological advances have been incorporated in the law and the result is as though, in effect, technology-made law rises to the same level as classical-made law. On the other hand, ignoring technological advances may produce less than optimal results, without any offsetting benefit.

Given that the meaning of zero is not constant, but is a function of available technology, how should laws setting an explicit or implicit zero standard be interpreted?[52] Two options are available: interpret the law using the meaning of zero at the time the law was created (technology static interpretation), or allow the meaning of zero to evolve and apply the meaning of zero at the time of application (technology dynamic interpretation), in effect leaving the meaning of the law in the hands of inventors.

Two examples will help develop a process for determining when to ignore post-enactment technological advances and when to consider them in interpreting and applying the law.

50. Such action by the federal government would be prohibited by U.S. CONST. art. I § 10 and the Fifth Amendment, by a State government would be prohibited by the Fourteenth Amendment, and by private party would constitute breach of contract or inducement, depending on whether the private party was a party to the contract or not.

51. Without having conducted a survey, it would seem intuitive that there would be general outrage if one were to propose that an anonymous private party should have the power to make law.

52. Of course, under standard rules of interpretation, legislative intent is relevant. Legislatures rarely consider the issue of measurement precision. Two arguable exceptions are the fields of occupational safety and environmental control, discussed at *infra* notes 77-78.

IV. Illustrative Examples

The following examples illustrate an analytic approach suitable for determining whether post-enactment technological development should affect the interpretation of a law. One would seem to lead to the conclusion that the interpretation should be technology-static and should be based on the technology that existed at the time the law was created. The other would seem to be suitable for a technology-dynamic interpretation, based on the state of technology at the time the law is being applied to particular circumstances.

The distinctions are then distilled into a set of principles that should govern resolution of the question (static or dynamic interpretation) in other cases.

A. *Speeding and Technology Freezing Interpretation*

The technology for measuring vehicle speeds, and determining whether a speed limit violation has taken place, has improved dramatically in the last hundred years. Speeds can now be measured to within tenths of a mile per hour using inexpensive and widely available equipment. Notwithstanding the availability of this precision measurement, the majority of courts apply the law in a manner that acknowledges much of the imprecision of early twentieth century measuring techniques. While judicial justifications vary, this may be seen as an example of a technology-static law.

In the early twentieth century, speeds were measured by a police officer following the suspect vehicle, matching its speed, and reading the speedometer in the officer's car.[53] The precision of the evidence of speed depended, among other things, on the accuracy of the police car speedometer, and tickets were rarely issued for speeds less than five miles over the speed limit.[54]

53. *See, e.g.*, Commonwealth v. Parish, 10 A.2d 896, 896-97 (Pa. Super. Ct. 1940) (officer followed vehicle for 1.9 miles and measured speed of sixty mph in a fifty mph zone—statute required tracking for at least .25 mile.); City of Spokane v. Knight, 165 P. 105, 105-06 (Wash. 1917) (motorcycle officer followed vehicle and measured speed of twenty-seven mph to thirty mph in a twenty mph zone).

54. United States v. Sowards, 690 F.3d 583, 595 n.13 (4th Cir. 2012) ("It

There have been two dramatic changes in speed limit enforcement. Radar and laser technology now enable measurement of vehicle speeds to within a fraction of a mile per hour, and these new technologies also make their measurements instantaneously[55] rather than requiring monitoring a vehicle over a significant distance. Furthermore, incorporating a recording device with the speed-measuring device allows violations to be detected without the presence of a police officer—a remotely monitored system can operate 24/7 and detect all violations, not just those that occur in the presence of a human observer.

Note how the definition of a speeding violation has changed, without the intervention of a legislature or a court. Originally, "exceeding thirty-five mph" meant "traveling at a speed of at least forty mph, if a police officer happened to see you, and continuing this behavior (notwithstanding the fact that a police car was following you) for a period of several seconds." Now, that same language ("exceeding thirty-five mph") can mean "traveling at a speed of at least 35.1 mph for a fraction of a second."

Several states (and the federal government)[56] have explicitly addressed this, and have chosen to preserve something of the historic meaning by statute. Florida requires warnings for exceeding the speed limit by five mph or less (except in school zones).[57] Georgia limits citations to exceeding

is worth noting that the dissent has not cited—nor have we found—a single case issued by any court at any time, whether state or federal, finding probable cause exists to initiate a traffic stop for speeding on the sole basis of an officer's unaided visual estimate that a vehicle was exceeding the speed limit by five mph or less."). Some states, by statute, limit the assessment of points or grade the severity of the offense (for example, requiring that only a warning be issued) for speeds within five or ten miles of the limit. *See infra* note 55-62 and accompanying text.

55. Sticklers will complain that an instantaneous measurement is not possible—it is just very fast compared to the pacing method—and possibly summon Heisenberg in support of the argument that a police officer could not specify both where the violation occurred and how fast the vehicle was going. Such people probably should not try traffic cases.

56. The Federal Highway Administration recommends at least five mph tolerance. *See* Discretionary Cooperative Agreements To Support the Demonstration and Evaluation of Setting and Enforcing Rational Speed Limits, 66 Fed. Reg. 29855-02 (June 1, 2001).

57. FLA. STAT. ANN. tit. 23, § 318.18(3)(b) (LexisNexis 2013).

the speed limit by more than five mph.[58] Kansas does not assess points on a driver's record for exceeding the speed limit by less than ten mph where the speed limit is fifty-five to seventy-five mph.[59] Oklahoma does not assess points on a driver's record for exceeding the speed limit by less than ten mph.[60] Pennsylvania authorizes measuring vehicle speed by pacing, but only if the speed is measured for at least 0.3 miles,[61] and by radar and other electronic devices but only if the speed is six mph or more in excess of the legal speed limit (ten mph or more in an area where the legal speed limit is less than fifty-five mph) except in school and work zones.[62]

Most state legislatures, however, have not addressed the issue. While rare,[63] most courts faced with the question of "how fast is too fast" reach the same conclusion as the above-mentioned states, and require a "significant" speed differential. Though none of these decisions rest on an explicit recognition of the technology-dynamic/technology-static issue, they are consistent with the principle.

In Missouri, courts have affirmed a speeding conviction based upon a fifteen mph differential[64] while reversing a speeding conviction based upon a ten mph differential,[65] based on the rationale that the results were required by "the margin of error of accuracy within which an experienced person can discriminate between the two speeds."[66]

58. GA. CODE ANN. tit. 40, § 40-6-1 (LexisNexis 2013).

59. KAN. STAT. ANN. § 8-1560(d)-(c) (LexisNexis 2013).

60. OKLA. STAT. ANN. tit. 47, § 11-810(A) (LexisNexis 2013).

61. PA. STAT. ANN. tit. 75, § 3368(a) (West 2013).

62. § 3368(c)(4).

63. The rarity of appellate decisions regarding speeding probably has to do with the relatively low cost of a speeding violation compared to the cost of a trial and appeal. Many of the cases dealing with speeding involve the question of whether there was probable cause to suspect speeding as a predicate for a vehicle stop which led to a search and discovery of a more serious offense.

64. *See* State v. Kimes, 234 S.W.3d 584, 589-90 (Mo. Ct. App. 2007).

65. *See* Kansas City v. Oxley, 579 S.W.2d 113, 115-16 (Mo. 1979).

66. *Kimes*, 234 S.W.3d at 589; *see also* State v. Graham, 322 S.W.2d 188, 197 (Mo. Ct. App. 1959) (sustaining a speeding conviction, even though there was a question as to the accuracy of the measurement, because the radar unit had indicated that the defendant was driving in excess of fifteen mph over the limit).

The Fourth Circuit has recently held that an officer's visual speed estimate of seventy-five mph in a seventy mph zone did not provide probable cause to initiate a traffic stop for speeding.[67] This case was complicated by the officer's difficulty in explaining how he estimated speed. After reviewing the following testimony:

> Q. [Government counsel] And how many feet are in a hundred yards?
> A. [Deputy Elliott] There's 12 [sic] feet in a yard.
> Q. So 300 feet?
> A. Correct.
> . . . .
> THE COURT: And how many feet are in a yard?
> [Deputy Elliott]: How many feet? There's 12 [sic] feet in a yard.
> THE COURT: Well, do you know what a yardstick is?
> [Deputy Elliott]: Yes, sir.
> THE COURT: How many inches in a yardstick?
> [Deputy Elliott]: Well, on a yardstick there's 12 [sic] inches. Well, it depends on the yard stick that . . . you have.[68]

The Fourth Circuit held that for "the district court to find that Deputy Elliott's 'difficulty with measurements is immaterial to his estimate of speed as that did not depend on time or distance' . . . . rings in the absurd . . . ."[69]

These decisions are consistent with (and arguably influenced by) the degree of accuracy associated with human observation of speed. *Sowards* explicitly makes the comparison, citing several cases to make the point, comparing acceptable estimations[70] with unacceptable estimations.[71]

67. Sowards, 690 F.3d at 594..

68. *Id.* at 586.

69. *Id.* at 589.

70. *Id.* at 591-92; *See* United States v. Banks, No. 2:08-cr-19-FtM-29SPC, 2008 WL 4194847, at *1 (M.D. Fla. Sept. 11, 2008) (probable cause where officer estimated speed to be fifty to sixty mph in a thirty mph zone);

Thus, enforcement of speed limits appears to be an example of a technology-static law from the perspective of the meaning of "miles per hour" in the definition of speeding.

This conclusion comports with notions of fairness and perhaps a lingering sense that the right to confront one's accusers is somehow diminished when the accuser is a machine, and a fallible machine at that.[72] When the average motorist's speedometer is rarely tested for accuracy and may, as in many vehicles still on the road, be an analog device with speeds marked in five mph increments, holding that motorist (who must divide attention between monitoring speed and other important tasks while driving) to the current technologically feasible standard of a fraction of a mile per hour measured instantaneously does not seem fair, and the great weight of authority agrees.

B. *Pollution and Technology Forcing Interpretation*

As with the technology for measuring vehicle speeds, the technology for measuring emissions of pollutants has improved dramatically in recent years. An example is the measurement

State v. Butts, 269 P.3d 862, 871-74 (Kan. Ct. App. 2012) (reasonable suspicion where officer estimated speed to be forty-five mph in a thirty mph zone); People v. Olsen, 239 N.E.2d 354, 355 (N.Y. 1968) (sustaining conviction where officer estimated speed to be fifty to fifty-five mph in a thirty mph zone).

71. *See* Oxley, 579 S.W.2d at 116 (estimate of forty-five mph speed in a thirty-five mph zone insufficient); *Olsen*, 239 N.E.2d at 355 (estimate of thirty-five to forty mph in a thirty mph zone might "for obvious reason" be insufficient); *Kimes*, 234 S.W.3d at 589 (estimate of sixty mph speed in a fifty-five mph zone insufficient, "because the accuracy of human estimation of speed cannot easily, readily, and accurately discriminate between such small variations in speed.").

72. A recent audit of Baltimore's speed camera citations disclosed one vehicle clocked at thirty-eight mph – despite the fact that it was stopped at a red light (as shown by the City's own photographs) at the time. Scott Calvert, *City Issued Speed Camera Ticket to Motionless Car*, BALT. SUN (Dec. 12, 2012), http://articles.baltimoresun.com/2012-12-12/news/bs-md-speed-camera-stopped-car-20121212_1_potential-citation-xerox-state-camera-ticket ("The Baltimore City speed camera ticket alleged that the four-door Mazda wagon was going 38 miles per hour in a 25-mph zone . . . But the Mazda wasn't speeding. It wasn't even moving. The two photos printed on the citation as evidence of speeding show the car was idling at a red light with its brake lights illuminated.")

of "visible emissions." When the first modern environmental laws governing visible emissions were passed, a violation required observation by a human observer. The observer had to be a person who had passed a certification program and had to observe the visible emission for a specified period of time (which varied depending on the type of facility being observed). Thus, in order to be in violation, a facility needed not only to be emitting a visible pollutant, but needed to be doing so in daylight (the observer could not see the emissions at night) and needed to be doing so when the certified observer was present.[73] Clearly this standard allowed significant visible emissions to go undetected. Detection technology improved to the point where mechanical sensors could be installed and could monitor a facility twenty-four hours a day and could detect much slighter emissions than a human observer could see.[74]

In effect, this equates to a dramatic reduction in amount of pollution without a change in the statutory language. Similar reductions have, in effect, taken place under the Clean Air Act,[75] the Clean Water Act,[76] and the Occupational Safety and Health Act,[77] all of which set technology based standards.

73. 40 C.F.R. § 63.302 (2013).

74. The technology is similar to the "electric eye," which can automatically open a door when someone approaches, or keep an elevator or subway door from closing when there is a passenger in the way.

75. 42 U.S.C. § 7401 (2012).

76. The Clean Water Act and the Occupational Safety and Health Act require plants to operate at control levels achievable by the industry's best-controlled plant. *See* 33 U.S.C. § 1251 (2012); 29 U.S.C. § 651 (2012); EPA v. Nat'l Crushed Stone Ass'n, 449 U.S. 64, 76-77 (1980) (holding that economic considerations are inappropriate factors in setting Best Practicable Technology standards); Kennecott v. EPA, 780 F.2d 445, 448 (4th Cir. 1985) (holding that Best Available Technology standards should be set at the level an optimal plant can achieve); Indus. Union Dep't v. Hodgson, 499 F.2d 467, 477-78 (D.C. Cir. 1974) (holding that the Occupational Safety and Health Administration could set standards that put a company out of business, if it is deemed necessary to protect the health and safety of the company's workers).

77. Driesen, *supra* note 29, at 8.

> In *American Textile Manufacturers Institute, Inc. v. Donovan*, the Supreme Court addressed an industry claim that the Occupational Safety and Health Administration

Within the Clean Air Act, Congress has set different control technology standards that vary according to the quality of ambient air.[78] For areas in which air quality is already acceptable, Prevention of Significant Deterioration (PSD) standards impose a requirement, known as Best Available Control Technology (BACT), which subjects new sources of pollution to the best control technology that is economically feasible—"the maximum degree of reduction . . . which the permitting authority, on a case-by-case basis, taking into

> (OSHA) must assure that the cost of standards for toxic pollutants in the workplace bear a reasonable relationship to the benefits such a standard provides. The Court rejected the argument. The statutory provision at issue in the case required OSHA to set the standard which most adequately assures, to the extent feasible . . . that no employee will suffer material impairment of health or functional capacity . . . . The Court concluded that Congress had already considered cost and decided to put the health and safety of workers above all other considerations, save that of feasibility. The Court, relying upon a dictionary definition, defined feasibility in terms of what one is capable of doing.

Id.

78. Commentators either see gradations in the degree of control required, often discernible by analyzing the superlatives which Congress used, or are guided by the tense of the verbs chosen by Congress. *See Id.* at 22.

> Congress signals this less demanding approach to technology-based regulation by leaving superlative words like best, maximum, or lowest out of the statutory provision or by qualifying the superlatives to diminish their force. A good example of the absence of superlatives comes from the Clean Air Act, which requires states to apply limits achievable through application of reasonably available control technology to major stationary sources in areas not meeting air quality standards. The provisions for best practicable technology effluent limits offers a good example of qualification usually leading to laxer standards.

Id. at 14 n.77 ("Congress sometimes clearly indicates a technology-forcing intent through employment of the future tense in articulating the feasibility principle."). If either of these approaches is accepted, they could be equally applied to determining whether the statute should be viewed as technology-static or technology-dynamic.

account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of . . . available methods . . . including . . . innovative fuel combustion techniques . . . ."[79] For areas in which air quality is not acceptable, the standard requires that proposed new sources meet a lowest achievable emission rate.

> The term lowest achievable emission rate [(LAER)], [which] means for any source, the rate of emission which reflects—(A) the most stringent emission limitation which is contained in the implementation plan of any State for such class or category of source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable, or (B) the most stringent emission limitation which is achieved in practice by such class or category of source, whichever is more stringent.[80]

The PSD requirements "are designed to ensure that the air quality in attainment areas or areas that are already 'clean' will not degrade."[81]

In construing EPA's authority to review a state agency's determination, the Supreme Court held that the statute required consideration of costs in determining BACT, noting that the statute's purpose included "to insure that economic growth will occur in a manner consistent with the preservation of existing clean air resources."[82]

The Supreme Court has observed that compliance with environmental laws is always possible—shutting down a plant reduces emissions to zero (by any measure, however precise).[83]

79. 42 U.S.C. § 7479(3) (2012).

80. *Id.* § 7501(3).

81. Alaska Dep't of Envtl. Conserv. v. EPA, 540 U.S. 461, 470 (2004).

82. *Id.* at 485; *see* 42 U.S.C. § 7470(3). Although the majority and minority both agreed on the definition of BACT, they disagreed on whether the state had reached a rational conclusion. Alaska Dep't of Envtl. Conserv., 540 U.S. at 502-18.

83. Union Elec. Co. v. EPA, 427 U.S. 246, 265 n.14 (1976). *accord,* AFL-CIO v. Brennan, 530 F.2d 109, 121 (3d Cir. 1975) ("[T]he most certain way to

This does not translate into an inflexible requirement that environmental laws be interpreted as technology-dynamic; however, when coupled with a standard that is set based on a perception of significant risk of public harm, it is a powerful argument in that direction.

Taken together, environmental laws, unlike speeding prosecutions, appear to be ones that should be viewed as technology-dynamic in making determinations of violations of environmental standards.

Several differences in the genesis and purpose of these two categories of law justify this distinction. Using the Clean Air Act as an example, note the following distinctions.

1. In enacting the Clean Air Act,[84] Congress made the following finding.

> [T]hat the growth in the amount and complexity of air pollution brought about by urbanization, industrial development, and the increasing use of motor vehicles, has resulted in mounting dangers to the public health and welfare, including injury to agricultural crops and livestock, damage to and the deterioration of property, and hazards to air and ground transportation.[85]

Congress further stated that one of the purposes of the law was "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population."[86] At least some members of Congress believed that most pollutants cause some harm at any level.[87]

Therefore, an important public interest, which is

eliminate industrial hazards is to eliminate industry."). These observations must assume that other laws, such as the Workers Notification Act, have already been complied with—otherwise, it might be unlawful to shut down a plant without prior notice. *See* 29 U.S.C. § 2101 (2012).

84. 42 U.S.C. § 7401 (2012).

85. *Id.* § 7401(a)(2).

86. *Id.* § 7401(b)(1).

87. *See, e.g.*, 123 CONG. REC. 18,463-64 (1977) (statement of Sen. Edmund Muskie).

established by specific scientific evidence and which would be furthered by more stringent enforcement, is involved. In contrast, although excessive speed is certainly dangerous, it is hard to defend particular speed limits as anything but arbitrary. For example, a hypothetical speed limit of twenty-five mph was probably set at that level not because twenty-six mph would be too fast, while twenty-four mph would be too slow but because all speed limits are set at speeds ending in "5" or "0" (and thirty mph was thought too fast).

2. Congress has provided guidance suggesting that it wanted to err on the side of control: in enacting the Clean Air Act, Congress declared that its purposes included "initiat[ing] and accelerat[ing] a national research and development program to achieve the prevention and control of air pollution."[88] Given its findings as to the importance of pollution control and the adverse effects of even small amounts of pollution, this bias seems rational. On the other hand, it would be hard to justify the argument that a small deviation from a speed limit would have an adverse effect. As the cases described above appear to recognize, traveling even five or ten miles above the speed limit, by itself, is not viewed as a serious offense.[89] Given the comparative lack of precision of automobile speedometers, it is unimaginable that a prosecution for traveling at 30.1 mph in a 30 mph zone would succeed.

3. The determination of environmental standards is subject to an explicit statutory safety net. Although subject to controversy as to its application from its inception,[90] the Clean Air Act, as well as most environmental statutes, requires a cost/benefit analysis in setting standards. As long as a cost/benefit analysis is made, any changes in measurement technology that result in stricter standards will be balanced against costs of the more stringent standard. Thus, an

88. 42 U.S.C. § 7401(b)(2) (2012).

89. *See* United States v. Sowards, 690 F.3d 583, 595 n.13 (4th Cir. 2012).

90. *See* C. Boyden Gray, *The Clean Air Act Under Regulatory Reform*, 11 TUL. ENVTL. L.J. 235, 235 (1998) ("For years, one of the most vigorously debated issues in regulatory reform is whether the Clean Air Act . . . should be amended to require the Environmental Protection Agency . . . to consider costs and benefits in setting ambient air quality standards."). *See generally* Stephen Fotis, *Private Enforcement of the Clean Air Act and the Clean Water Act*, 35 AM. U. L. REV. 127 (1985).

accountable agency, after public notice, will be making a decision on the record and subject to judicial review. This process overcomes the objections to private technology-made law.

The conclusion that environmental laws should be interpreted as technology-dynamic, comports with notions of fairness and, even, with the right to confront one's accusers. Environmental laws principally apply to corporations with manufacturing facilities. Unlike the typical motorist, corporations with manufacturing facilities are generally well positioned to install their own monitoring equipment and to check the accuracy of any findings regarding alleged violations. They are also well positioned to monitor proposed legislative or administrative changes and present their views as to the appropriate level of precision in determining violations. Thus, the elements of unfairness and unequal access to exculpatory data which are argued, in a purely visceral way, in favor of a technology-static approach to speeding laws, argue at the same basic level in favor of a technology-dynamic approach to environmental laws.

V. Principled Approach to the Problem

As noted above, there are two options available for interpreting laws. First, there is a technology-static approach, interpreting the law's meaning and effect using the technology available at the time the law was created. Second, there is a technology-dynamic approach, interpreting the law's meaning and effect using the technology available at the time the law is being applied, in effect allowing inventors to rewrite law.

The approach to the problem depends on whether the law in question is already in effect or is under consideration. The simpler case is that of a pending proposal for future legislation.

A. *Future Legislation*

Once the problem of interpretation created by advances in measurement technology has been recognized, it can be addressed legislatively. Future legislation should therefore explicitly recognize the areas in which technological

development is likely to have an effect on the meaning and enforcement of the law.[91] There are fundamentally two choices: declare that the law is to be enforced according to the capabilities as of the date of enactment, or that it is to be enforced according to the best measurement technology available at the time of enforcement. Environmental laws provide examples of legislation where Congress has indicated that post-enactment technological advances should be considered.[92] Note that this is not the same as the technology-forcing aspect of the environmental laws discussed above. Those statutes were designed to encourage use of the most current control technology. It is a different matter—and a separate legislative determination—to decide whether also to encourage use of the most current detection technology.

B. *Existing Legislation*

This leaves the much more difficult problem of existing legislation. Where the legislature has declared a policy (as for example the Clean Air Act), that policy should be analyzed to determine whether it leads clearly to one approach or the other. However, even in cases where there is legislative history, it will not necessarily be specific to the point at issue and even if on point will not necessarily be consistent and unambiguous or beyond dispute.[93]

Where the legislature has been silent, the above two examples suggest factors which should be considered in determining which approach is appropriate:

1. In situations where life is at stake and the outcome will be affected by the precision of a measurement, the law should be interpreted using the most current available technology—it should be technology-dynamic. This is the case with respect to environmental laws and is not the case with respect to speed

91. This is not a radical suggestion. Congress has taken comparable action in indexing tax brackets to account for future inflation.

92. *See supra* notes 76-80 and accompanying text.

93. *See generally* Mont. Power Co. v. EPA, 608 F.2d 334 (9th Cir. 1979) (observing that when legislative history contains conflicting, inconclusive views, the court must divine the intent of Congress from the overall purpose of the statute).

limits

2. In situations where the state of mind of an individual is a critical element, especially where the detection equipment available to one party is less precise than that available to the other, interpretation should not take into account post-enactment technology unless the individual has done so—it should be technology-static. (Speed cameras should not be more precise than vehicle speedometers, but it is acceptable for the EPA to use modern detection equipment that is also available to the industry being regulated.)

3. In situations where a law is the result of a cost-benefit analysis, the law should be frozen at the level of technology at enactment—it should be technology-static. To employ a more stringent standard upsets the cost-benefit analysis. While the environmental example might superficially seem to the contrary, it is not. Congress had made the determination that very low levels were the goal, and provided, through delegation to administrative agencies, the power to consider costs and benefits under appropriate circumstances.

4. Counter intuitively, the argument in favor of tightening standards as technology improves detection is stronger under laws that set less precise standards. Use of an imprecise or variable standard, as in the case of the environmental laws discussed above, suggests that the legislature was aware of, though perhaps not in those terms, the possibility of future improvements in detection technology and did not want to tie the law to contemporary limits. On the other hand, when a legislature uses a term such as "thirty miles per hour," it shows no such awareness that the term may have an imprecise or potentially changing meaning.