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INTRODUCTION

Our society thrives on new technology and technological advance. We enjoy the internet, clothes that do not wrinkle or stain, and the wonders of medical biotechnology. A century of innovation has improved our lives in myriad ways. We are healthier, wealthier, and, if not necessarily happier, have a vastly greater variety of options for how to spend our leisure time.

The marvels of technological advance are not always risk-free. The risks presented by new technologies can take varying forms: deleterious effects on human health or the environment, concerns about individual autonomy and privacy, or concerns relating to community or moral values. Such risks and perceived risks often create new issues and disputes to which

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the legal system must respond. Are various means of copying information via the internet copyright infringement? Do the nanofibers that confer beneficial properties to clothing pose health or environmental risks? Is it acceptable to conduct embryonic stem cell research?

The new legal issues created by technological advance frequently are quite challenging. Such issues often raise questions that are at the forefront of scientific knowledge, and therefore may not only be incomprehensible to the average person, but also not fully (or even well) understood by scientific experts in the relevant field. In addition, the issues often present new variations that challenge current understandings of the law, even where the limits of scientific knowledge are not critical to the issue's resolution. In the face of this limited knowledge and understanding, generally lay legislative, executive, administrative, and judicial actors must continue to establish and rule on laws that govern and decide such uncharted disputes.

My contribution to this symposium, concerning whether and to what extent there can be a general theory of law and technology, focuses on lessons that can be learned from past responses to once-new legal issues created by technological advance. Studying how prior law and technology issues were handled, and particularly how they were sometimes mishandled, provides valuable lessons for responding to current and future law and technology issues as they arise.

The history lessons do not produce a complete road map for responding to each new law and technology issue — such a guide is not achievable considering the vast variety of technological change. But the lessons do provide a number of useful guidelines for how to confront novel law and technology challenges. In this symposium article, I propose three lessons: (1) that preexisting legal categories may no longer apply for new law and technology issues; (2) that decision-makers be careful to avoid being blinded by the marvels of new technology in deciding law and technology cases; and (3) that the types of new law and technology disputes can be unforeseeable. These are just three examples of useful lessons; they are not intended to be a comprehensive list, and more suggestions are welcome. Critically for any discussion of a general theory of law and technology, I contend that these guidelines are applicable across a wide variety of technologies, even those that we cannot conceive of presently.

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I. OLD CATEGORIES MAY NO LONGER APPLY

The claim that lessons from one technology can be exported to another technology is supported by examining the legal system's reaction to historic technological advances. Lessons learned from these analyses are applicable today, even though the technologies to which we would apply them now were inconceivable in the periods from which the lessons are derived.

Perhaps the most important lesson to be learned from the history of legal responses to technological advance is that a decision-maker must be careful when compartmentalizing a new law and technology issue into a preexisting category. Lawyers and judges are trained to work in a system of precedent that depends on categorizing cases according to existing legal rules. The routine response to new issues, not surprisingly, is to try to analogize them to existing legal categorization. Such a response is often rational. But, where the new issue arises as a result of technological change, the old categories may no longer apply. In order to handle a new technology issue, one often must delve deeper, into the basis for the existing system of legal categorization. Examples from the Nineteenth century illustrate this point.

A. THE TELEGRAPH

Before fiber optics and Wi-Fi, the first means of contemporaneous long-distance communication was the telegraph. On May 24, 1844, Samuel Morse sent the world's first telegraph message, "What Hath God Wrought."[1] Telegraph infrastructure rose hand-in-hand with the railroads, and in a short time (on a nineteenth century technological diffusion scale), both criss-crossed the country and were in heavy use.[2]

Unsurprisingly, the advent of the telegraph also brought new legal disputes. One such type of dispute was contract disputes concerning miscommunicated telegraph messages.[3]

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1. *See* Library of Congress, American Memory, Today in History: May 24, http://memory.loc.gov/ammem/today/may24.html (last visited Apr. 7, 2007). This message was taken from the *Bible, Numbers* 33:23. It was suggested to Morse by Annie Ellworth, daughter of a friend. Library of Congress, *supra*.

2. *See* Inventors.About.com, History of the Telegraph and Telegraphy, http://inventors.about.com/library/inventors/bltelegraph.htm (last visited Apr. 07, 2007).

3. *See, e.g.*, Parks v. Alta Cal. Telegraph Co., 13 Cal. 422 (Cal. 1859).

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At first glance, this may appear to present a standard contract issue, but analysis of a pair of cases reveals otherwise.

Parks v. Alta California Telegraph Co.[4] concerned a contract under which Alta was to send a telegraph message for Parks.[5] Alta failed to send the message in a timely manner, causing a loss for Parks, and Parks sued Alta to recover for the loss.[6] The outcome of the case hinged on whether a telegraph company was a common carrier.[7] Common carriers, such as companies that transported goods, were automatically insurers of the delivery of the goods.[8] If Alta was a common carrier, it necessarily insured delivery of Parks' message, and would be liable for Parks' loss.[9] In contrast, if Alta was not a common carrier, it did not insure delivery of the message, and would only be liable for the cost of the telegraph.[10]

The court held that telegraph companies were common carriers.[11] Companies that delivered goods, prior to telegraphs, also delivered letters.[12] These companies, therefore, automatically insured delivery of the letters they were carrying, and were liable for any delivery failures.[13] The court reasoned, "[t]here is no difference in the general nature of the legal obligation of the contract between carrying a message along a wire and carrying goods or a package along a route. The physical agency may be different, but the essential nature of the contract is the same."[14] Other than this relatively circular reasoning about the "essential nature" and there being "no difference," the court did not further explain the basis for its conclusion. In the *Parks* court's view, "[t]he rules of law which govern the liability of Telegraph Companies are not new.

4. *See id*. at 424.
5. *See id*.
6. *See id*.
7. *See id*. at 423-24.
8. *See id*. at 424-25.
9. *See id*. at 423.
10. *See id*.
11. *See id*. at 424.
12. *See, e.g.*, Gordon Stimmell, *U.S. Carrier, Locals, & Independent Mails,* http://www.uspcs.org/uspcsCarriers_Locals.html (last visited, Apr. 07, 2007) (a history of private mail services). *See also* United States Postal Service, *History of the US Postal Service, 1779-1993*, http://www.usps.com/history/his2.htm (last visited Apr. 07, 2007).
13. *See Parks*, 13 Cal. at 424-25.
14. *Id*. at 424.

They are old rules applied to new circumstances."[15] The court analogized the delivery of a message by telegraph to the delivery of a message (a letter) by physical means, and since letter-carriers were common carriers, it concluded that telegraph companies must be as well.[16]

Breese v. U.S. Telegraph Co.[17] also concerned a dispute over a telegraph message. Breese contracted with U.S. Telegraph to send a telegraph message to buy $700 worth of gold.[18] The message received was to buy $7,000 in gold.[19] Unfortunately, the price of gold dropped, and Breese sued U.S. Telegraph for the loss.[20] Here, U.S. Telegraph's form for sending a telegraph included a notation that, for important messages, the sender should always have the message sent back, at an additional charge, to ensure that there were no errors in delivery.[21] The form stated that if the message was not repeated, U.S. Telegraph was not responsible for any error.[22]

Like *Parks, Breese* hinged on whether a telegraph company was a common carrier.[23] If telegraph companies were common carriers, U.S. Telegraph was necessarily an insurer of delivery of the message, and could not limit its liability as it attempted on the telegraph form.[24] The court concluded that telegraph companies are not common carriers.[25] It did not offer a reasoned explanation for its conclusion, beyond stating that the law of contract governs,[26] a point irrelevant to the issue of whether telegraph companies are common carriers.

Though *Parks* and *Breese* reached different conclusions, both courts based their decisions on whether telegraph companies were common carriers.[27] The *Parks* court believed

15. *Id*.
16. *See id*. at 425 ("The process of ascertainment is the same in this as in other cases of carriers.").
17. Breese v. U.S. Telegraph Co., 48 N.Y. 132 (N.Y. 1871).
18. *See id*. at 136.
19. *See id*. at 137.
20. *See id*.
21. *See id*. at 133.
22. *See id*. at 133-34.
23. *See id*. at 132.
24. *See id*. at 141.
25. *See id*. at 142.
26. *See id*. at 139.
27. *See id*. at 142; Parks v. Alta Cal. Telegraph Co., 13 Cal. 422, 425 (Cal. 1859).

that telegraph messages were not relevantly different from previous methods of message delivery, and therefore that telegraph companies were common carriers.[28] The *Breese* court, on the other hand, considered telegraph messages to be a new form of message delivery, distinguishable from prior systems, and therefore not bound by the old common carrier rules, but only by contract.[29] Our analysis need not determine which court had the better view.[30] The comparison, however, reveals two important points: (1) neither court engaged in the appropriate analysis to determine whether telegraph companies should be held to be common carriers, and (2) neither court engaged in the appropriate analysis to determine whether a telegraph company should be liable for an error in delivery of a telegraph message.

New legal issues created by technological advance often raise the question of whether the technology is similar enough to the prior state of the art such that the new technology should be governed by similar, existing rules, or whether the new technology is different enough such that it should be governed by new or different rules. This question cannot be resolved simply by comparing the function of the new technology to the function of the prior technology. Rather, a decision-maker must consider the rationale for the existing legal categories in the first instance, and then determine whether that rationale applies to the new technology. Legal categories (such as common carrier) are only that — legal constructs. Such constructs may need to be revised in the face of technological change.

The relevant metric by which the extension of the common carrier category should have been evaluated was not the physical activity involved (message delivery) but the basis for the legal construct. The rationale for common carrier liability, for instance, may have been to institute a least-cost avoider

28. *See Parks*, 13 Cal. at 425.

29. *See* Breese v. U.S. Telegraph Co., 48 N.Y. 132, 139 (N.Y. 1871).

30. This is not a simple doctrinal question. A common carrier is one who holds themselves out to the public as engaged in the business of transportation of persons or property for compensation. BLACK'S LAW DICTIONARY 226 (8th ed. 2004) ("A commercial enterprise that holds itself out to the public as offering to transport freight or passengers for a fee."). To determine whether a telegraph company is a common carrier under this definition, one would have to determine whether a telegraph message is property.

regime and reduce transaction costs (likely among other reasons).[31] Prior to the advent of the telegraph, there was little a customer could do to insure the proper delivery of her package or letter once handed to a carrier. Telegraphs, however, offered a new, easy, cheap method of self-insurance, as revealed in *Breese*—having the message returned to ensure that it had been properly delivered.[32] It is possible that this change in technology was substantial enough that the old legal rules should no longer apply. But, this is an analysis that neither court reached.

That preexisting legal categorization might not apply to new technologies may appear to be a simple error that we would not expect today's courts to make. Chalking up this legal error to archaic legal decision-making, however, is too dismissive, as cases concerning modern message delivery reveal.

B. THE INTERNET

The growth of the internet and email usage in the 1990s resulted in a dramatic increase in unsolicited email messages. These messages became known as "spam," apparently after a famous Monty Python skit in which spam is a disturbingly ubiquitous menu item.[33] Spam was (and is) a significant annoyance for email users. However, it is potentially an even greater problem for internet service providers who are forced to make additional investments to process and store extra messages or face the prospect of losing customers annoyed by spam filling their in-boxes.[34]

One internet provider, CompuServe, brought suit against a

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31. *See* Eli M. Noam, *Principles for the Communications Act of 2034: The Superstructure of Infrastructure*, 47 FED. COMM. L.J. 317, 320 (1994).

32. *See Breese*, 48 N.Y. at 134.

33. *See* Dictionary.com, Definition of "Spam," http://dictionary.reference.com/browse/spam (last visited Apr. 07, 2007).

34. Although private solutions to the spam problem (email message filters) would eventually work with some degree of success, they were not particularly well developed in the early days of spam. *See, e.g.*, CompuServe Inc. v. Cyber Promotions, Inc., 962 F. Supp. 1015, 1017-19 (S.D. Ohio 1997). The current generation of spammers, however, have now figured out how to evade these email filters, making spam more of a problem than it has been in several years. *See* Dan Woog & Carolynn Ananian, *Spam, Spam, Everywhere*, N.Y. TIMES, Dec. 9, 2006, at A18.

particularly persistent spammer.[35] CompuServe had attempted to technologically block the spam, but had not been successful.[36] CompuServe, however, had a problem in developing a legal theory for its lawsuit. Use of the CompuServe email system by a non-client did not create an obvious cause of action in contract, tort, property, or other area of law. In fact, such use, as a general matter, was highly desired and necessary for the email system to operate—CompuServe's clients needed to be able to receive email from others.

CompuServe developed a somewhat ingenious claim—that the spammer was trespassing on CompuServe's personal property (its computers) violating an ancient doctrine known as trespass to chattels.[37] Trespass to chattels is a common law doctrine prohibiting the unauthorized use of another's personal property.[38] Trespass to chattels, however, requires physical contact with the chattel, that the plaintiff was dispossessed of the chattel permanently or for a substantial period of time, and that the chattel was impaired in condition, quality or value, or that bodily harm was caused.[39] Application of these elements to spam is not straight-forward. Spam does not physically contact a computer, does not appear to dispossess a computer, and does not appear to harm the computer. CompuServe argued, and the court held, however, that the electronic signals by which the email was sent constituted physical contact with the chattel, that the use of band-width dispossessed the computer, and that the value of CompuServe's computers was diminished by the burden of the mass spamming.[40]

While one can understand the court's sympathy for CompuServe's plight, the *CompuServe* court committed the same error as the courts in *Parks* and *Breese*—it did not consider the basis for legal categorization before extending a category to new disputes created by new technology. Clear extensions of the *CompuServe* holding make evident that the court's categorization was problematic. All unsolicited email, physical mail, and telephone calls would constitute trespass to

35. *CompuServe*, 962 F. Supp. at 1015.
36. *Id*. at 1019.
37. *Id*.
38. BLACK'S LAW DICTIONARY 1542-43 (8th ed. 2004).
39. RESTATEMENT (SECOND) OF TORTS § 218 (1965).
40. *Compuserve,* 962 F. Supp. at 1022.

chattels under this reasoning, a holding that would surprise many. This result would create a common law cause of action against telemarketers and companies sending junk mail.[41] Even more surprising, advertisements on broadcast radio and television would also constitute trespass to chattels. Under the court's reasoning, individuals would have a cause of action against ABC, CBS, and NBC for airing commercials, which physically contact the television through electronic signals, dispossess the television to at least the same extent as spam affects a computer, and diminish the value of the television by carrying the extraneous material.[42] An argument that a television viewer should expect or implicitly consents to commercials would apply equally to a computer user expecting or implicitly consenting to spam as a result of connecting to the internet.

The problem with the *CompuServe* decision lies in its failure to recognize the difference between use of an (ethereal) email system and use of physical property. This technological difference makes a difference for the legal categories into which the disputes should be placed. The dispute in *CompuServe* was not really over the use of physical property (computers), but over interference with CompuServe's business and customers. The legal solution to this new type of problem would have been better served by recognizing this difference.

In sum, courts should not expect that common law, often developed centuries earlier, will be well-suited for handling new law and technology issues. The preexisting categories may be applicable in some cases, but the only way to determine this is to examine the basis for the categories in the first instance, and whether that basis is satisfied by extension of the doctrine. This analysis will vary for different disputes and technologies, and often will require consideration of the impact of the decision on the development and dissemination of the technology, as well as on the economy and social welfare.

II. DO NOT BE BLINDED BY THE TECHNOLOGY

A second history lesson for law and technology concerns the need for decision-makers to look beyond the technology

41. Many, presumably, would welcome such a cause of action, but this is a different question from whether it is appropriate or was intended.

42. Trespass to chattels arguably would not apply to cable providers, who have entered a contract with the cable customer, and therefore presumably have received implicit consent to transmit the commercials.

involved in a dispute to focus on the legal issues in question. Sometimes decision-makers have a tendency to be blinded by spectacular technological achievement.

People v. Jennings[43] was the first case in the United States in which fingerprint evidence was admitted to establish identity. Jennings was charged with murder. Critical to the case against Jennings was the testimony of four fingerprint experts matching Jennings' fingerprints to the prints of four fingers from a left hand found at the scene of the crime.[44]

The fingerprint experts were employed in police departments and other law enforcement capacities.[45] They testified, in varying manners, to certain numbers of points of resemblance between Jennings' fingerprints and the crime scene prints, and each concluded that the prints were made by the same person.[46] The court admitted the testimony as expert scientific evidence. The bases for admission identified in the opinion were that fingerprint evidence was already admitted in European countries, reliance on encyclopedias and treatises on criminal investigation, and the experience of the expert witnesses themselves.[47]

Upon examination, the bases for admission are weak and fail to establish the critical evidentiary requirement of reliability. None of the encyclopedias or treatises cited discussed scientific support for the use of fingerprints to establish identity, let alone demonstrating its reliability.[48] In a similar vein, the court identified that the four expert witnesses each had been studying fingerprint identification for several years, but never mentions any testimony or other evidence concerning the reliability of fingerprint analysis itself. Identification of a number of points of resemblance between prints (an issue on which the expert testimony varied) provides little evidence of identity without knowing how many points of resemblance are needed for a match, how likely it is for there to be a number of points of resemblance between different people, or how likely it is for experts to incorrectly identify points of resemblance. No evidence on these matters was provided.

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43. 252 Ill. 534 (Ill. 1911).
44. *Id.* at 548-49.
45. *Id.* at 547-48.
46. *Id.*
47. *Id.* at 546-47.
48. *Id.*

Reading the *Jennings* opinion, one is left with the impression that the court was simply very impressed with the idea of fingerprint identification. Fingerprinting was perceived to be an exciting new scientific ability and crime-fighting tool. The court, for instance, provides substantial description of the experts' qualifications and their testimony, despite its failure to discuss the reliability of fingerprint identification.[49] It is not surprising, considering the court's amazement with fingerprint identification, that the court deferred to the experts in admitting the evidence, despite the lack of evidence of reliability and the experts' obvious self-interest in having the testimony admitted—this was, after all, now their line of employment.

Jump forward from fingerprint identification at the beginning of the twentieth century to DNA identification at the end of the century. *Oregon v. Lyons*[50] concerned the admissibility of a new method of DNA typing, the "PCR replicant method," a process for determining the probability of a match between a defendant's DNA and DNA obtained at the scene of a crime.[51]

Despite almost a century gap separating the opinions, the similarity in deficiencies between the *Jennings* and *Lyons* courts' analyses of the admissibility of a new form of scientific evidence are remarkable. In *Lyons*, the court similarly relies on the use of the method in question in other fields as a basis for its reliability in a criminal case. The PCR method had been used in genetics, but only in limited ways in the field of forensics.[52] No evidence was provided concerning the reliability of the PCR replicant method under crime scene conditions. The *Lyons* court also relied on the expert witness's own testimony that he followed proper protocols as evidence that there was no error and, even more problematically, that the method itself was reliable.[53] Finally, the PCR replicant method expert also had a vested interest in the test being considered reliable—again, this was his line of employment. In both cases the courts appear simply impressed and excited by the technology. The *Lyons* decision includes not only a lengthy description of the PCR replicant method process, but also an

49. *Id.* at 546-49.
50. 863 P.2d 1303 (Or. Ct. App. 1993).
51. *See id.* at 1306.
52. *Id.* at 1309.
53. *Id.* at 1309-10.

extended discussion of DNA, all of which turns out to be irrelevant to the issue of reliability or the case.[54]

In fairness to the courts, there was an additional similarity between *Jennings* and *Lyons*: in both cases the defense failed to introduce competing experts to challenge the reliability of the identification evidence.

In DNA typing cases, defense attorneys learned to introduce their own experts to challenge the admissibility of new forms of DNA typing.[55] These experts challenged proffered DNA evidence on numerous grounds, from problems with the theory of DNA identification (such as assumptions about population genetics) to problems with the method's execution (such as the lack of laboratory standards or procedures).[56] These challenges led geneticists and biologists to air disputes concerning DNA typing in scientific journals, and eventually to the National Research Council convening two distinguished panels on the matter.[57] A number of significant problems were identified concerning methods of DNA identification, and courts in some instances held DNA evidence inadmissible.[58] Eventually, new procedures were instituted and standardized, and sufficient data was gathered such that courts now routinely admit DNA evidence.[59]

The challenges to DNA identification methods actually led, in turn, to challenges to the admissibility of fingerprint identification evidence, an issue which still had not been adequately addressed despite its long use and mythical status in crime-solving lore.[60] The bases for these challenges included the lack of objective and proven standards for establishing that two prints match, the lack of an established error rate,[61] and

54. *Id*.

55. Jennifer L. Mnookin, *Fingerprint Evidence in an Age of DNA Profiling*, 67 BROOK. L. REV. 13, 51-56 (2001).

56. *See, e.g.*, People v. Mohit 579 N.Y.S.2d 990, 991-93 (N.Y. Crim. Ct. 1992) (challenging DNA based on an uncommon ancestry); People v. Castro, 545 N.Y.S.2d 985, 986-97 (N.Y. Sup. Ct. 1989) (challenging the procedures used in the testing laboratory); Mnookin, *supra note 55*, at 51-56.

57. *See* JAMES F. CROW ET AL., COMMITTEE ON DNA FORENSIC SCIENCE, NAT'L RESEARCH COUNCIL, THE EVALUATION OF FORENSIC DNA (NAT'L ACAD. PRESS 1996), *available at* http://newton.nap.edu/html/DNA/.

58. *See, e.g.*, *Castro*, 545 N.Y.S.2d at 999.

59. *See* Mnookin, *supra* note 56, at 54-56.

60. *Id.* at 57-70.

61. A 1995 proficiency test of fingerprint examiners, for instance, found that slightly less than half of them received a perfect score; 22% made an

the lack of statistical information concerning the likelihood that two people would have fingerprints with a given number of corresponding features.[62] In 2002, a district court judge held that evidence of identity based on fingerprints was inadmissible because it was unreliable.[63] This holding led to somewhat of an uproar and the Unites States filed a motion to reconsider. The court held a hearing on the accuracy of fingerprint identification, at which two FBI agents testified. The court reversed its earlier decision and admitted the fingerprint testimony.[64]

The lesson learned from these cases for law and technology is relatively straight-forward: decision-makers must not get blinded by the wonder or promise of new technology when judging the new legal issues created by impressive technological advance. It is a lesson that is easy to state, but clearly more difficult to apply in practice, particularly when a decision-maker is confronted with the new technology for the first time and a cadre of experts testifies to its spectacular abilities.

III. NEW TECHNOLOGY DISPUTES ARE UNFORESEEABLE

The final history lesson for a general theory of law and technology offered in this article is the most difficult to implement: decision-makers must remain cognizant of the limits of their knowledge and ability to foresee new technology issues. It is inevitable that legal disputes concerning the new technology will be handled under the preexisting legal scheme in early stages of technological development. At this stage, there often will not be enough information and knowledge about nascent technologies to develop or modify appropriate legal rules, or there may not have been enough time to establish new statutes, regulations, or common law for managing the technology.

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erroneous identification, identifying a match where none existed. *Id.* at 59-60.

62. *Id.* at 57-70.

63. United States v. Llera-Plaza, Nos. CR. 98-362-10, CR. 98-362-11, 98-362-12, 2002 WL 27305, at *517-18 (E.D. Pa. 2002), *vacated and superseded*, 188 F. Supp. 2d 549 (E.D. Pa. 2002). The court, in perhaps a Solomonic twist, held that experts could testify to the similarities and differences between fingerprints, though the experts were not permitted to present evaluation testimony as to their opinion that a particular latent print was or was not the print of a particular person. *Id.*

64. U.S. v. Llera Plaza, 188 F. Supp. 2d 549, 549 (E.D. Pa. 2002).

In addition, there often appears to be an inclination to handle new technology disputes under existing rules.[65] This response is usually the easiest, both administratively and psychologically. Not surprisingly, however, the preexisting legal structure may prove a poor match for new technology. Often there will be gaps or other problems with applying the existing legal system to a new technology issue. The regulation of biotechnology serves as a useful example.

A. BIOTECHNOLOGY

As the biotechnology industry developed in the early 1980s, the federal government determined that bioengineered products generally would be regulated under the already-existing statutory and regulatory structure.[66] The basis for this decision, established in the Coordinated Framework for Regulation of Biotechnology, was a determination that the process of biotechnology was not considered inherently risky, and therefore that only the products of biotechnology, not the process itself, required oversight.[67]

This decision was questionable. As a result of the Coordinated Framework, biotechnology products are regulated under a dozen statutes and by five different agencies and services.[68] Experience with biotechnology regulation under the Coordinated Framework has revealed gaps in biotechnology regulation; inefficient overlaps in regulation; inconsistencies among agencies in their regulation of similarly situated biotechnology products; and instances of agencies acting outside of their areas of expertise.[69]

The most significant gap in biotechnology regulation is likely the lack of Environmental Protection Agency (EPA) involvement in the review and approval of numerous genetically modified plants and animals that could have a

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65. *See* Gregory Mandel, *Gaps, Inexperience, Inconsistencies, and Overlaps: Crisis in the Regulation of Genetically Modified Plants and Animals*, 45 WM. & MARY L. REV. 2167, 2257-58 (2004).

66. Coordinated Framework for Regulation of Biotechnology, 51 Fed. Reg. 23,302-09, 23,313-14, 23,336 (June 26, 1986).

67. *See id.* at 23,302-03. *See also* NAT'L RESEARCH COUNCIL, GENETICALLY MODIFIED PEST-PROTECTED PLANTS: SCIENCE AND REGULATION 25-26 (2000) [hereinafter NRC 2000 REPORT].

68. Mandel, *supra* note 65, at 2228.

69. *See*, *supra* note 65, for a comprehensive discussion of the regulation of genetically modified products and related issues.

significant impact on the environment, and in certain instances the lack of sufficient review of the environmental impacts of such products by any agency.[70] As another example, it is unclear whether any agency has regulatory authority over transgenic animals not intended for human food or to produce human biologics.[71]

Regulatory inconsistencies have created difficulties as well. The Coordinated Framework identified two priorities for the regulation of biotechnology by multiple agencies: that the agencies regulating genetically modified products "adopt consistent definitions" and that the agencies implement scientific reviews of "comparable rigor."[72] As a result of constraints created by primary reliance on preexisting statutes, however, the agencies involved in the regulation of biotechnology define identical regulatory constructs differently.[73] Similarly in violation of the Coordinated

70. *See id.* at 2234-36.

71. *See* OFFICE OF SCI. & TECH. POLICY, EXECUTIVE OFFICE OF THE PRESIDENT, CASE STUDY NO. IV: FARM ANIMAL (GOAT) THAT PRODUCES HUMAN DRUGS 14 (2001), *available at* http://www.ostp.gov/html/ceq_ostp_study5.pdf. It is possible that the Animal and Plant Health Inspection Service (APHIS) could exercise authority pursuant to the Animal Health Protection Act (AHPA) of 2002, 7 U.S.C. §§ 8301-8320 (2000 & Supp. 2003), to regulate genetically modified animals to the extent such animals may affect the health of livestock (in much the same manner as APHIS regulates genetically modified plants based on their potential to pose threats to plants). *See* Tadlock Cowan & Geoffrey S. Becker, CRS REPORT FOR CONGRESS, BIOTECHNOLOGY IN ANIMAL AGRICULTURE: STATUS AND CURRENT ISSUES (2006) (noting this potential). APHIS authority here would turn on the meaning of "disease" under the AHPA, a term to be defined by the Secretary of Agriculture. 7 U.S.C. § 8302(3). The Secretary may be able to define disease in such a manner as to include genetic modification of animals, although this would not be consistent with how the Secretary has defined the term previously, so whether such a definition would survive judicial review is not clear. *See, e.g.*, 7 C.F.R. § 319.59-1 (2004) (defining "disease" in another agricultural context to include "its common meaning [and] a disease agent which incites a disease"). In addition, the legislative history of the AHPA is quite sparse and does not indicate that such a broad interpretation was intended.

72. Coordinated Framework for Regulation of Biotechnology, 51 Fed. Reg. 23,302-03 (June 26, 1986).

73. Genetically modified pest-protected plants, for example, are regulated by three different agencies, each of which identify the regulated product and define the regulated substance differently, as the following table reveals:

	EPA	USDA	FDA
Regulated Product	Plant-Incorporated protectant.	Plant pest, regulated article.	Food, feed, food additive.

Framework priorities, the National Research Council has specifically noted that the data on which different agencies base comparable analyses, and the scientific stringency with which they conduct their analyses, are not comparably rigorous.[74]

Regulatory overlap also has been a problem for biotechnology. Multiple agencies have authority over similar issues, resulting in inefficient duplication of regulatory resources and effort.[75] In certain instances, different agencies request the same information about the same biotechnology product from the same firms, but do not share the information or coordinate their work.[76] The worst case scenario for overlap is for agencies to reach differing conclusions concerning the same product. This occurred for two agencies reviewing the potential for transgenic cotton to cross with wild cotton in parts of the United States. One agency concluded that "[n]one of the relatives of cotton found in the United States . . . show any definite weedy tendencies,"[77] while another found that there would be a risk of transgenic cotton crossing with species of wild cotton in southern Florida, southern Arizona, and Hawaii.[78]

Agency inexperience also has proven problematic in the regulation of biotechnology. In 1998 the EPA approved a registration for StarLink, a variety of corn genetically modified

Regulated Substance	Pesticidal substance and genetic material necessary for its production.	Organism engineered to contain sequences from plant pests.	Human food (whole or processed), animal feed.

See NRC 2000 REPORT, *supra* note 67, at 159 (the table reproduced above has been modified to reflect changes to agency definitions since the table was originally published).

74. *See* NRC 2000 REPORT, *supra* note 67, at 170-71.

75. Mandel, *supra* note 65, at 2243-44.

76. *See id.* at 2244.

77. JOHN H. PAYNE, USDA /APHIS PETITION 97-013-01P FOR DETERMINATION OF NONREGULATED STATUS FOR EVENTS 31807 AND 31808 COTTON: ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT 6 (1997), *available at* http://web.archive.org/web/20010702230537/http://www.aphis.usda.gov/biotech/dec_docs/9701301p_ea.HTM.

78. ENVIRONMENTAL PROTECTION AGENCY, BIOPESTICIDES REGISTRATION ACTION DOCUMENT IIC9-IIC10 (2000), *available at* http://www.epa.gov/oscpmont/sap/meetings/2000/october/brad3_enviroassessment.pdf.

to be pest-resistant.[79] StarLink corn was only approved for use as animal feed and non-food industrial purposes, such as ethanol production; it was not approved for human consumption because it carries transgenic genes that express a protein containing some attributes of known human allergens.[80]

In September 2000, StarLink corn was discovered in various brands of taco shells and later in many other human food products, eventually resulting in the recall of over three hundred products.[81] Several of the United States' largest food producers were forced to stop production at certain plants due to concerns about StarLink contamination, and there was a sharp reduction in United States corn exports.[82] The owner of the StarLink registration agreed to buy back the year's entire crop of StarLink corn, at a cost of about $100 million.[83] It was anticipated that StarLink-related costs could end up running as high as $1 billion.[84]

It turned out that the same harvesting, storage, shipping, and processing equipment are often used for both human and animal food.[85] Corn from myriad farms is commingled as it is gathered, stored, and transported.[86] In fact, due to recognized commingling, the agricultural industry regularly accepts about 2-7% of foreign matter in bulk shipments of corn in the United States.[87] In addition, growers of StarLink corn had been inadequately warned about the need to keep StarLink corn segregated from other corn, leading to further commingling in grain elevators.[88]

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79. *See* Sutter v. Aventis CropScience USA Holding, Inc., 145 F. Supp. 2d 1050, 1052 (S.D. Iowa 2001).

80. *See In re* StarLink Corn Prods. Liab. Litig., 212 F. Supp. 2d 828, 834 (N.D. Ill. 2002); *Sutter*, 145 F. Supp. 2d at 1052.

81. Mandel, *supra* note 65, at 2204.

82. *Id.*

83. Andrew Pollack, *European Company Will Buy Entire Crop of Corn in Recall*, N.Y. TIMES, Sept. 30, 2000, at C14.

84. James Cox, *StarLink Fiasco Wreaks Havoc in the Heartland: Developer Wants EPA To Approve Seed for Food Supply*, USA TODAY, Oct. 27, 2000, at 1B.

85. *See In re StarLink Corn*, 212 F. Supp. 2d at 834.

86. *See id.*

87. Andrew Pollack, *Labeling Genetically Altered Food Is Thorny Issue*, N.Y. TIMES, Sept. 26, 2000, at A1.

88. *See* Barnaby J. Feder, *Farmers Cite Scarce Data In Corn Mixing: Companies' Warnings Are Called Inadequate*, N.Y. TIMES, Oct. 17, 2000, at C1. *See also In re StarLink Corn*, 212 F. Supp. 2d at 838.

Someone with working knowledge of the country's agricultural system would have recognized from the outset that it was inevitable that once StarLink corn was grown, produced, and processed on a large-scale basis, some of it would make its way into the human food supply.[89] According to one agricultural expert, "[a]nyone who understands the grain handling system . . . would know that it would be virtually impossible to keep StarLink corn separate from corn that is used to produce human food."[90] The EPA, however, lacked the relevant expertise to recognize this problem, and failed to realize the limits of their experience in regulating pesticides when applied to a new technology.

B. NANOTECHNOLOGY

The admonition "to be aware of what you do not know and to recognize the limits of foresight" is clearly a difficult one to follow. This lesson does, however, provide important guidance for handling new technology. Most critically, it highlights the need for legal regimes governing new technologies to be flexible and reveals that it should be anticipated that preexisting legal regimes may run into problems when being used to govern technology that did not exist when the legal regimes were created.

A leading current candidate for application of these understandings is the management of nanotechnology. Nanotechnology concerns the ability to build matter atom by atom. This capability has only recently been scientifically realized, and will increasingly impact a vast array of industries, including medicine and health care, materials science, electronics and computers, and optics.[91] Nanotechnology development and commercialization already is raising, and will continue to raise, concerns regarding risks to human health, safety, and the environment.[92] Knowledge

89. George Anthan, *OK Sought for Corn in Food*, DES MOINES REG., Oct. 26, 2000, at 1D. The EPA later acknowledged "that the limited approval for StarLink was unworkable." *Id.*

90. *Id.*

91. *See* National Nanotechnology Initiative, Nanotech Facts, http://www.nano.gov/html/facts/home_facts.html (last visited Apr. 07, 2007).

92. *See generally* Gregory Mandel, *Governing Nanotechnology* (unpublished manuscript). Some potential risks of nanomaterials include toxicity due to inhalation, ingestion, or dermal contact with nanomaterials. *Id.*

concerning these risks is extremely limited because of the nascent stage of the technology.[93] In addition, the risks are extremely difficult to characterize because matter behaves differently at the nanoscale.[94] Due to differences that result from nanomaterials' low weight, high surface-area-to-weight ratio, and potential indestructibility, a compound that is innocuous at the macroscale may have a significantly different risk profile when it is only several atoms in size.[95] As the ability to manufacture engineered nanomaterials is a recent technological achievement, research into the health and environmental effects of nanomaterials is in its infancy and is permeated by uncertainty.[96]

Undoubtedly, nanotechnology development will raise new legal issues, some of which are beginning to be perceived, others of which are entirely unforeseeable at this time.[97] As the legal system evolves to handle nanotechnology issues, it is important to remember the lessons learned from past technology development. A legal system that is flexible, recognizes the unpredictability of new issues, realizes that new issues may not fit well into preexisting legal constructs, and which is operated by legal actors who take a measured view of the technology will operate far better in managing nanotechnology than a system that fails to learn these lessons.

CONCLUSION

This article presents several lessons concerning the legal system's adaptation to new legal issues brought about by technological advance, and explains how these lessons can be applied to future law and technology issues. One critique of these lessons as a theory of law and technology is that the theory is actually a general legal theory, not one limited to law and technology. The suggestions to consider the legal basis for existing doctrines before extending them to new application, for instance, is appropriate for all manner of legal decisions, not just law and technology. This critique has some merit, but also

93. Rick DelVecchio, *Berkeley Considering Need for Nano Safety*, S. F. CHRON., Nov. 24, 2006, at A1.

94. *See* Mandel, *supra* note 92.

95. *Id.*

96. *Id.*

97. For example, many health and environmental statutes are based on the assumption that chemical uses or releases below certain mass or quantity thresholds do not present a significant risk. Nanomaterial toxicity may not adhere to these previous assumptions and understandings. *Id.*

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is limited. There are two overarching reasons why the theory presented here is one of law and technology in particular. First, certain of the lessons offered are applicable only to law and technology issues—for example, that legal decision-makers should not let their amazement with new technology overrun their legal analysis, or that legal regimes developed prior to the advent of a technology often reveal gaps and other problems when applied to new technology issues. Second, for those lessons that have significant applicability outside of law and technology, the interaction of technological development and the legal system renders the lessons particularly pertinent for resolving new technological disputes. Determining the basis for legal constructs before extending them applies in many situations. But, the nature of technological advance means that recognition of this consideration is a ubiquitous concern for handling new legal disputes caused by technological advance, not just the occasional concern presented in other areas.

Despite the indescribably diverse manners of technological advance, and the correspondingly diverse range of new legal issues that arise in relation to such advance, the legal system's response to new law and technology issues reveals important similarities. These similarities provide lessons for a general theory of law and technology. Each lesson will not apply equally to every new law and technology dispute, but the lessons do provide valuable guidance for adapting law to a wide variety of future technological advances.