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SOFTWARE AS A PROFESSION

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I. INTRODUCTION

When a glitch in the Boeing 737 MAX flight control software pushed two brand-new airplanes into fatal nosedives, killing 189 and 157 passengers, respectively, headlines were dominated by questions of how the software error had escaped notice.[1] Initially, the explanation was that a developer oversight had allowed the software to rely on a single point of failure — an angle-of-attack sensor with a track record of poor reliability.[2] Later reports complicated the narrative: Boeing's team had expanded the scope of the software at a late stage in the design process, allowing the software greater control over the flight path than the initial design specified, but Boeing's management had failed to disclose that change to regulatory officials at the Federal Aviation Administration ("FAA") or to airline pilots.[3] Boeing defended itself by maintaining that it had complied with appropriate safety certification processes.[4] In the aftermath, as Boeing attempted to fix the software

1. *See* Dominic Gates, *Flawed Analysis, Failed Oversight: How Boeing, FAA Certified the Suspect 737 MAX Flight Control System*, SEATTLE TIMES (Mar. 21, 2019, 9:46 AM), https://www.seattletimes.com/business/boeing-aerospace/failed-certification-faa-missed-safety-issues-in-the-737-max-system-implicated-in-the-lion-air-crash [https://perma.cc/2QB7-CJEX].

2. *See* Mike Baker & Dominic Gates, *Lack of Redundancies on Boeing 737 MAX System Baffles Some Involved in Developing the Jet*, SEATTLE TIMES (Mar. 27, 2019, 3:01 PM), https://www.seattletimes.com/business/boeing-aerospace/a-lack-of-redundancies-on-737-max-system-has-baffled-even-those-who-worked-on-the-jet [https://perma.cc/U2JC-SM5H]; Todd C. Frankel, *Sensor Cited as Potential Factor in Boeing Crashes Draws Scrutiny*, WASH. POST (Mar. 17, 2019, 7:47 PM), https://www.washingtonpost.com/business/economy/sensor-cited-as-potential-factor-in-boeing-crashes-draws-scrutiny/2019/03/17/5ecf0b0e-4682-11e9-aaf8-4512a6fe3439_story.html [https://perma.cc/DX3C-MLNV].

3. *See* Jack Nicas et al., *Boeing Built Deadly Assumptions into 737 Max, Blind to a Late Design Change*, N.Y. TIMES (June 1, 2019), https://nyti.ms/2WCoTHk [https://perma.cc/T5US-8P4E] (describing Boeing engineers' expansion of the scope of Maneuvering Characteristics Augmentation System ("MCAS")); *see also* W. Bradley Wendel, *Technological Solutions to Human Error and How They Can Kill You: Understanding the Boeing 737-Max Products Liability Litigation*, 84 J. AIR L. & COM. 379, 400 (2019) (noting Boeing's silence about the presence of the new version of MCAS).

4. *See* Natalie Kitroeff et al., *The Roots of Boeing's 737 Max Crisis: A Regulator Relaxes Its Oversight*, N.Y. TIMES (July 27, 2019), https://nyti.ms/2K0xdd7 [https://perma.cc/GE3F-M36J] (quoting Boeing's official statement that "the 737 Max met the F.A.A.'s stringent standards and requirements as it was certified through the F.A.A.'s processes"); Andrew Tangel et al., *The Four-Second Catastrophe: How Boeing Doomed the 737 MAX*, WALL ST. J. (Aug. 16, 2019, 11:59 PM), https://www.wsj.com/articles/the-four-second-catastrophe-how-boeing-doomed-the-737-max-11565966629 [https://perma.cc/XW8Y-MLU5] ("A Boeing spokesman said the design and certification of MCAS, including reliance on pilots as the ultimate safety net, were part of a methodical six-year effort that followed accepted industry practices.").

and get its aircraft recertified, additional software errors were discovered, further delaying the re-approval process.[5]

Although it is simple to say that the software did not perform as expected, or that Boeing mismanaged the regulatory process, it is more difficult to articulate whether the *software developers* acted appropriately. The legal literature remains undecided on how to define "reasonable care" for software developers.[6] Instead, most of the discussion on software liability has looked for alternative measures such as software's overall cost-benefit to society,[7] post-sale duties to warn and to fix known vulnerabilities,[8] or other ways to avoid cross-examination of the software development process itself.[9] As a result, software developers

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5. *See* David Koenig, *New Software Glitch Found in Boeing's Troubled 737 Max Jet*, SEATTLE TIMES (June 27, 2019, 11:07 AM), https://www.seattletimes.com/business/new-problem-discovered-in-boeings-troubled-737-max-jet [https://perma.cc/J648-MYV8].

6. *Compare* Gary E. Marchant & Rachel A. Lindor, *The Coming Collision Between Autonomous Vehicles and the Liability System*, 52 SANTA CLARA L. REV. 1321, 1334 (2012) ("The [software] manufacturer will almost always lose the cost-benefit argument . . . . This is because the cost of not implementing the potential improvement will usually be severe . . . compared to the relatively small cost of the marginal improvement that might have prevented the accident."), *with* Kenneth S. Abraham & Robert L. Rabin, *Automated Vehicles and Manufacturer Responsibility for Accidents: A New Legal Regime for a New Era*, 105 VA. L. REV. 127, 143–44 (2019) ("[G]iven the greatly heightened complexity and sophistication of the computerized control systems in highly automated vehicles. . . . the concept of a reasonable alternative design . . . is likely to become increasingly indeterminate."), *and* Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611, 1643–46 (2017) (noting that scholars have disagreed about how the risk-utility test will apply in software cases, and observing that machine learning introduces additional complications).

7. *See, e.g.*, Year 2000 Responsibility and Readiness (Y2K) Act § 2(a), 15 U.S.C. § 6601(a)(2), (6) (2018) ("It is in the national interest . . . to minimize possible disruptions associated with computer failures. . . . Concern about the potential for liability . . . is prompting many persons and businesses with technical expertise to avoid projects aimed at curing year 2000 computer date-change problems."); Communications Decency Act of 1996 § 509, 47 U.S.C. § 230(b)(1), (2) (2018) ("It is the policy of the United States . . . to promote the continued development of the Internet and other interactive computer services . . . [and] to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation."); Geistfeld, *supra* note 6, at 1615 ("Autonomous vehicles will save lives and prevent many more injuries, making a compelling safety case for policies that foster the widespread deployment of this technology."); Bryant Walker Smith, *Automated Driving and Products Liability*, 2017 MICH. ST. L. REV. 1, 54 (predicting that "the companies that develop and deploy automated driving systems are likely to have a bigger slice of what will hopefully be a smaller pie of total crash liability").

8. *See, e.g.*, Andrea M. Matwyshyn, *Hidden Engines of Destruction, the Reasonable Expectation of Code Safety and the Duty to Warn in Digital Products*, 62 FLA. L. REV. 109, 137 (2010) ("The reasonable expectation of code safety entails three duties: a duty to inspect, a duty to warn of digital harm, and a duty of code repair."); Bryant Walker Smith, *Proximity-Driven Liability*, 102 GEO. L.J. 1777, 1806–07 (2014) (arguing that the ease and availability of over-the-air software updates could generate a post-sale duty to update).

9. *See* Ryan Abbott, *The Reasonable Computer: Disrupting the Paradigm of Tort Liability*, 86 GEO. WASH. L. REV. 1, 29 (2018) ("[T]he negligence test [for a computer tortfeasor] should focus on whether the computer's *act* was negligent, rather than whether the computer

lack meaningful guidance as to what the law considers reasonable coding practices — the work that actually produces the software.

Software errors are pervasive and easy to second-guess after the fact, and not every software developer is employed by a leading global firm. During the 2020 primary elections, the Iowa Democratic Party commissioned a small independent team to deploy a mobile app that would allow precinct chairs to tally and report votes via the internet.[10] On the night of the caucuses, the app failed to function correctly: it crashed, it blocked access to authorized users, and it misreported vote count data.[11] Later code reviews revealed additional undiscovered security flaws.[12] Critics pointed to the fact that the software was developed by inexperienced developers on a tight budget in under two months.[13] No independent testing was performed,[14] nor did the app use vetted open-source software libraries.[15] Yet, despite the unlucky outcome, the software developers defended their efforts on the basis that

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was negligently designed or marketed. . . . [T]his paradigm would treat the computer more like a person than a product."); Bryan Casey, *Robot Ipsa Loquitur*, 108 GEO. L.J. 225, 271–72 (2020) (arguing that event data recorders allow authorities "to recreate detailed, moment-by-moment accounts of accidents" and "to assign accident fault with a degree of precision simply unimaginable in conventional contexts[,]" without having to "comb through millions of lines of source code in search of direct evidence").

10. *See* Eric Geller et al., *What Went Wrong with the Iowa App*, POLITICO (Feb. 4, 2020, 3:29 PM), https://www.politico.com/news/2020/02/04/iowa-app-caucuses-2020-election-110710 [https://perma.cc/2DUE-ZS8Y] (reporting that the "software was the handiwork of Shadow Inc.," which received $63,000 from the Iowa Democratic Party and $58,000 from the Nevada Democratic Party).

11. *See* Max Read, *The Real Problems with the Iowa Caucuses' 'Shadow' App*, N.Y. MAG. (Feb. 4, 2020), https://nymag.com/intelligencer/2020/02/the-real-problems-with-the-iowa-caucuses-shadow-app.html [https://perma.cc/55BF-8E43] ("Some precinct leaders . . . reported being kicked out of the app after logging in; others were unable to log in at all. Worse, according to Iowa Democratic Party chair Troy Price, the app was 'reporting out only partial data,' a problem he attributed to 'a coding issue in the reporting system.'").

12. *See* Jack Gillum & Jessica Huseman, *The Iowa Caucuses App Had Another Problem: It Could Have Been Hacked*, PROPUBLICA (Feb. 5, 2020, 4:16 PM), https://www.propublica.org/article/the-iowa-caucuses-app-had-another-problem-it-could-have-been-hacked [https://perma.cc/MS2D-G2MW] (reporting that the "IowaReporterApp was so insecure that vote totals, passwords and other sensitive information could have been intercepted or even changed" and that the app was "plagued with data-reporting problems and curious error messages").

13. *See* Matthew Rosenberg et al., *Faulty Iowa App Was Part of Push to Restore Democrats' Digital Edge*, N.Y. TIMES (Feb. 4, 2020), https://nyti.ms/2uaeZRh [https://perma.cc/HLM4-MGP4] (reporting that Shadow was "[g]iven less than two months to build the app," while "[f]ew of its employees had worked on major tech projects, and many of its employees were relatively inexperienced").

14. *See* Nick Corasaniti et al., *App Used to Tabulate Votes Is Said to Have Been Inadequately Tested*, N.Y. TIMES (Feb. 3, 2020), https://nyti.ms/2RT4QRY [https://perma.cc/VX4J-G92Q].

15. *See* Rabble (@rabble), TWITTER (Feb. 4, 2020 5:25 PM), https://twitter.com/rabble/status/1224821360897097728 [https://perma.cc/LF5M-3Y58] ("There is no way they could succeed. The problem is structural . . . . We need it to be based on open source technology . . . ."); *see also* Sunoo Park et al., Going from Bad to Worse: From Internet Voting to Blockchain

the app was very simple by design, and their efforts proportionate to the task.[16]

Frustration with bad code has been rising, along with questions of whether software developers should take greater personal responsibility for the software they create.[17] Curiously, most of the conversation occurring within the software community has focused on ethics and professionalism rather than on law.[18] Thus, in June 2018, the Association for Computing Machinery ("ACM")[19] adopted a new version of its

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Voting 8 (Feb. 20, 2020) (unpublished manuscript), https://people.csail.mit.edu/rivest/pubs/PSNR20.pdf [https://perma.cc/3BB8-4LGX] ("[S]ecurity-critical software that is closed-source carries much higher risk and uncertainty than disclosed-source alternatives. Accordingly, voting systems should favor disclosing system designs and code whenever possible.").

16. *See* Jason Koebler et al., *An "Off-the-Shelf, Skeleton Project": Experts Analyze the App That Broke Iowa*, VICE (Feb. 5, 2020, 4:59 PM), https://www.vice.com/en_us/article/3a8ajj/an-off-the-shelf-skeleton-project-experts-analyze-the-app-that-broke-iowa [https://perma.cc/YTA3-5EBK] (quoting Shadow CEO Gerard Niemira: "The point of this app was to help temporary precinct chairs do the math and get good results in the room and speed up the process, help them basically. That is a relatively simple function, it's basically a calculator, so that's the approach we took to it.").

17 . *See* U.S. CYBERSPACE SOLARIUM COMM'N, FINAL REPORT 5 (2020), https://www.solarium.gov/report [https://perma.cc/84HT-UXBB] [hereinafter CYBERSPACE SOLARIUM REPORT] ("Congress should pass a law establishing that final goods assemblers of software, hardware, and firmware are liable for damages from incidents that exploit known and unpatched vulnerabilities . . . for as long as they support a product or service." (emphasis omitted)); Jane Chong, *The Challenge of Software Liability*, LAWFARE (Apr. 6, 2020, 1:06 PM), https://www.lawfareblog.com/challenge-software-liability [https://perma.cc/9Q7R-7N5W] (noting that the past decade has seen "the slow improvisation of a disjointed movement to make software vendors pay for shoddy code" and that this movement has had "an episodic, experimental quality").

18. *See* KATE CRAWFORD ET AL., AI NOW INST., THE AI NOW REPORT: THE SOCIAL AND ECONOMIC IMPLICATIONS OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN THE NEAR-TERM 5, 20–21, 24–25 (2016), https://ainowinstitute.org/AI_Now_2016_Report.pdf [https://perma.cc/7S4U-WJUQ] (recommending that professional organizations such as ACM and IEEE update (or create) professional codes of ethics); Press Release, Ass'n for Computing Mach., World's Largest Computing Association Affirms Obligation of Computing Professionals to Use Skills for Benefit of Society (July 17, 2018), https://www.acm.org/media-center/2018/july/acm-updates-code-of-ethics [https://perma.cc/J5VZ-VUFN] ("The impetus for updating the ACM Code of Ethics stemmed from the emergence of new technologies and the impact of computing on so many aspects of daily life."); Bo Brinkman et al., *Making a Positive Impact: Updating the ACM Code of Ethics*, COMM. ACM, Dec. 2016, at 7, 8.

19. ACM is the leading professional community for computing practitioners. Founded in 1947, ACM claims to be the "world's largest educational and scientific society, uniting computing educators, researchers and professionals," with over 100,000 members worldwide. ACM History Committee, *ACM History*, ASS'N FOR COMPUTING MACH., https://www.acm.org/about-acm/acm-history [https://perma.cc/26DB-R33M]. ACM competes most closely with the Institute of Electrical and Electronics Engineers ("IEEE"), an older society which claims over 423,000 members internationally, but which has a broader mission. *See About IEEE*, IEEE, https://www.ieee.org/about/index.html [https://perma.cc/R4VV-NTZQ] (noting that IEEE has more than 423,000 members in over 160 countries); *History of IEEE*, IEEE, https://www.ieee.org/about/ieee-history.html [https://perma.cc/H9M6-AS68] (describing the organization's history tracing back to 1884 and its commitment to advancing innovation and technological excellence for the benefit of humanity).

Code of Ethics and Professional Conduct. This revision was the first update in more than a quarter-century since the ACM added a separate ethics component to the Code in 1992.[20] The flurry of recent activity heralds a renewed campaign to proclaim the "professional" stature of the software community.[21] In announcing the release, the president of the ACM opened with the assertion that "[t]he Code is a contract among ourselves as *professionals*, as well as a public statement of our understanding of the responsibilities the *profession* has to the larger society that it serves."[22]

Leading voices in law have lauded the move to professional ethics, calling for ad hoc imposition of fiduciary duties upon software developers by analogy to traditional professions such as doctors and lawyers.[23] To be sure, critics of the "information fiduciary" model have rightly questioned whether software developers are genuine fiduciaries

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20. *See* Don Gotterbarn et al., *ACM Code of Ethics: A Positive Action*, COMM. ACM, Jan. 2018, at 121, 121. Prior to 1992, ACM had a Code of Professional Conduct that was adopted in 1972. *See* ACM Comm. on Prof'l Ethics, *Historical Archive of the ACM Code of Ethics*, ACM ETHICS, https://ethics.acm.org/code-of-ethics/previous-versions [https://perma.cc/E3YH-6NFJ].

21. *See* Andrew A. Chien, *Computing Is a Profession*, COMM. ACM, Oct. 2017, at 5, 5 ("Common among these [professional] attributes are a deep technical expertise, an essential, valued, societal contribution, and the need to adhere to high ethical and technical standards. Professions such as medicine, law, and accounting exemplify these attributes. Computing exhibits all of the attributes of a profession.").

22. ASS'N FOR COMPUTING MACH., ACM CODE OF ETHICS AND PROFESSIONAL CONDUCT 1 (2018) [hereinafter 2018 ACM CODE] (emphasis added), https://www.acm.org/binaries/content/assets/about/acm-code-of-ethics-booklet.pdf [https://perma.cc/CTV9-ESUZ].

23. *See* Jack M. Balkin, *Information Fiduciaries and the First Amendment*, 49 U.C. DAVIS L. REV. 1183, 1208 (2016) ("[P]rofessionals like doctors and lawyers have fiduciary obligations that give them special duties with respect to personal information that they obtain in the course of their relationships with their clients. . . . We can call them *information fiduciaries*."); Jack M. Balkin & Jonathan Zittrain, *A Grand Bargain to Make Tech Companies Trustworthy*, THE ATLANTIC (Oct. 3, 2016), https://www.theatlantic.com/technology/archive/2016/10/informationfiduciary/502346 [https://perma.cc/3PL4-3SQT] (proposing a grand bargain whereby "[c]ompanies could take on the responsibilities of information fiduciaries," and "[i]n return, the federal government would preempt a wide range of state and local laws"); Kiel Brennan-Marquez, *Fourth Amendment Fiduciaries*, 84 FORDHAM L. REV. 611, 649 (2015) ("Although Balkin's analysis has focused specifically on ISPs, the logic extends beyond that realm. . . . Whereas traditional fiduciaries manage financial assets, and their duties tend to concern financial transactions, information fiduciaries manage the 'asset' of information, and their duties primarily concern security and confidentiality."); Urs Gasser & Carolyn Schmitt, *The Role of Professional Norms in the Governance of Artificial Intelligence* (exploring "the possibility of the emergence of what might be labeled 'AI professions,'" in conjunction with "a flourishing of initiatives aimed at developing principles specifically for ethical AI"), *in* THE OXFORD HANDBOOK OF ETHICS OF AI (Markus D. Dubber et al. eds., forthcoming May 2020) (manuscript at 7) (on file with author); *see also* Data Care Act of 2018, S. 3744, 115th Cong. (2018) (proposing imposition of duties of care, loyalty, and confidentiality on online service providers); New York Privacy Act, S. 5642, 2019–2020 Leg., Reg. Sess. (N.Y. 2019) (proposing "data fiduciary" concept).

of their customers, let alone the public at large.[24] But the potency of the analogy raises the question whether the practice of software development is indeed like the practice of medicine or law — and if so, how.

Complicating the matter, courts have uniformly rejected attempts by tort plaintiffs to hold software developers to a professional malpractice standard.[25] Although software developers are free to call themselves professionals in the colloquial sense, they receive no such designation as a matter of tort law. This dissonance reveals a profound

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24. *See, e.g.*, Lina M. Khan & David E. Pozen, *A Skeptical View of Information Fiduciaries*, 133 HARV. L. REV. 497, 504 (2019) (observing that software developers might owe fiduciary duties to corporate stockholders that conflict with any fiduciary duties owed to end users).

25. *See* Superior Edge, Inc. v. Monsanto Co., 44 F. Supp. 3d 890, 911–14 (D. Minn. 2014) ("Computer programmers commonly define themselves as 'professionals.' Yet, despite the complexity of the work, computer programming and consultation lack the indicia associated with professional status for purposes of imposing higher standards of reasonable care." (quoting RAYMOND T. NIMMER, THE LAW OF COMPUTER TECHNOLOGY § 9.30 (4th ed. 2012))); Avazpour Networking Servs., Inc. v. Falconstor Software, Inc., 937 F. Supp. 2d 355, 364 (E.D.N.Y. 2013) ("New York State law does not 'recognize a cause of action for professional malpractice by computer consultants.'" (citation omitted)); Atrium Cos. v. ESR Assocs., Inc., No. H-11-1288, 2012 WL 5355754, at *11 (S.D. Tex. Oct. 29, 2012) (dismissing professional negligence claim because information technology services do not involve a "special" confidential relationship establishing a fiduciary duty); Ferris & Salter, P.C. v. Thomson Reuters Corp., 819 F. Supp. 2d 667, 671 (E.D. Mich. 2011) (concluding that "no professional negligence action will lie against computer engineers and technicians" under either Minnesota or Michigan law); Heidtman Steel Prods., Inc. v. Compuware Corp., No. 3:97CV7389, 2000 WL 621144, at *14 & n.2 (N.D. Ohio Feb. 15, 2000) (refusing to recognize a professional malpractice claim against computer consultants under either Michigan or Ohio law); Hosp. Comput. Sys., Inc. v. Staten Island Hosp., 788 F. Supp. 1351, 1361 (D.N.J. 1992) (holding that computer consultants do not meet "the requirements under New York law to give them the status of professionals," because they are not bound by "higher standards of care," "state licensing requirements," or a "higher code of ethics"); UOP v. Andersen Consulting, No. CV 950145753, 1997 WL 219820, at *6 (Conn. Super. Ct. Apr. 24, 1997) ("The services of a computer consultant are more like those of an architect, rather than those of an accountant, lawyer, or insurance broker."); Racine Cty. v. Oracular Milwaukee, Inc., 767 N.W.2d 280, 286–89 (Wis. Ct. App. 2009) (citing eight "characteristics of a profession" to conclude that "computer consultants are not professionals"), *aff'd on other grounds*, 781 N.W.2d 88 (Wis. 2010); *cf.* Rockport Pharmacy, Inc. v. Dig. Simplistics, Inc., 53 F.3d 195, 199 (8th Cir. 1995) (dismissing argument that a computer maintenance agreement was a contract for professional services); Triangle Underwriters, Inc. v. Honeywell, Inc., 604 F.2d 737, 745–46 (2d Cir. 1979) (refusing to "cloth[e] sellers or manufacturers of [computer] machinery in the garb of members of the learned professions"); *In re* All Am. Semiconductor, Inc., 490 B.R. 418, 431–32 (S.D. Fla. 2013) (refusing to recognize computer consultants as professionals because "[a] vocation is not a profession if there is any alternative method of admission that omits the required four-year undergraduate degree or graduate degree, or a state license is not required at all"). *But cf.* Diversified Graphics, Ltd. v. Groves, 868 F.2d 293, 295–97 (8th Cir. 1989) (affirming as harmless error a jury verdict based on a professional, rather than an ordinary, standard of care); Data Processing Servs., Inc. v. L.H. Smith Oil Corp., 492 N.E.2d 314, 319–20 (Ind. Ct. App. 1986) (suggesting in dicta that computer programmers are analogous to lawyers or doctors in the sense that they "hold themselves out to the world" as possessing the skills and qualifications of well-informed members of the trade or profession).

confusion regarding the significance of the word "professional"[26] and its relationship to software ethics and software liability. One view has been that the software community must meet a higher standard of care in order to receive legal recognition as a profession.[27] The contrary view holds that it is the legal recognition as a profession that is needed in order to enforce a higher standard of care.[28]

This Article takes the different view that professional malpractice serves simply as legal shorthand that software liability should be determined by reference to the software community's customary practices, rather than by the ordinary reasonable person standard of liability.[29] In other words, *non-professionals* are subject to the prescriptive "reasonable care" standard, which is determined by reference to the ordinary reasonable person.[30] Evidence of industry custom can be persuasive,

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26. *See* Richard A. Posner, *Professionalisms*, 40 ARIZ. L. REV. 1, 1 (1998) ("The terms 'profession' and 'professionalism' have an incredibly large and vaguely bounded range of meanings, the despair of sociology, the discipline that has done most to study the professions."); *see also* John C.P. Goldberg & Benjamin C. Zipursky, *Seeing Tort Law from the Internal Point of View: Holmes and Hart on Legal Duties*, 75 FORDHAM L. REV. 1563, 1581 (2006) (arguing that "tort duties are legal duties, and legal duties obligate for different reasons, and under different circumstances, than moral duties").

27. *See* Michael L. Rustad & Thomas H. Koenig, *The Tort of Negligent Enablement of Cybercrime*, 20 BERKELEY TECH. L.J. 1553, 1590–91 (2005) ("Courts will not apply the professional standard of care to software engineers and other professionals until they can reliably assess the skill and expertise required of software engineers."); *cf.* Deborah L. Rhode, *Moral Character as a Professional Credential*, 94 YALE L.J. 491, 496 (1985) ("Within the American bar, moral character requirements have been a fixed star in an otherwise unsettled regulatory universe.").

28. *See* Patricia Haney DiRuggiero, *The Professionalism of Computer Practitioners: A Case for Certification*, 25 SUFFOLK U. L. REV. 1139, 1149 (1991) ("Proponents [of the notion that professional status ought to apply to the computer industry] contend professionalism will protect public health, safety, and welfare."); Michael D. Scott, *Tort Liability for Vendors of Insecure Software: Has the Time Finally Come?*, 67 MD. L. REV. 425, 473–74 (2008) ("[I]t may be time to rethink the logic behind these earlier cases and to establish a framework within which software vendors could be held liable as professionals for distributing insecure software.").

29. *See* DAN B. DOBBS ET AL., HORNBOOK ON TORTS § 21.6, at 506 (2d ed. 2016) ("The professional standard asks the trier only to determine whether the defendant's specifically identified conduct conformed to the medical standard or medical custom in the relevant community with respect to the particular acts alleged to be negligent."); RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 7 cmt. a (AM. LAW INST. 2010) ("[T]he modified duty applicable to medical professionals, which employs customary rather than reasonable care, reflects concerns that a lay jury will not understand what constitutes reasonable care in the complex setting of providing medical care and the special expertise possessed by professionals.").

30. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 7(a) (AM. LAW INST. 2010) ("An actor ordinarily has a duty to exercise reasonable care when the actor's conduct creates a risk of physical harm."). Confusingly, "reasonable care" is sometimes used interchangeably with "ordinary care," and "ordinary care" is sometimes used interchangeably with "customary care." *See id.* § 13 cmt. a ("[N]egligence is often defined as the lack of 'ordinary care.' Because complying with custom confirms that the actor has behaved in the ordinary way, one might suppose that proof of compliance with custom would be a complete defense against an allegation of negligence. In this respect, however, the

but juries are free to override it based on their general sense of reasonableness.[31] By contrast, *professionals* are judged under the descriptive "customary care" standard, which is determined according to the internal norms of the professional community.[32] Juries still play a role in factually determining what that professional custom is, but adherence to professional custom creates a strong presumption of due care.[33]

This Article argues further that this switch is needed where the practice is not a precise science but an inexact art, and thus there is a great need for the exercise of professional judgment.[34] By forcing the

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negligence standard, concerned with 'reasonable care,' is more demanding than a standard understood solely in terms of ordinary care."). This Article will follow the convention of the Third Restatement and use "reasonable care" to denote the usual rule of negligence, and it will use "customary care" to denote a deviation from that usual rule.

31. *See* Kenneth S. Abraham, *Custom, Noncustomary Practice, and Negligence*, 109 COLUM. L. REV. 1784, 1791 (2009) ("[T]he custom rule does not require that [custom] evidence be 'taken into account,' but only permits the jury to consider custom evidence if it wishes to do so. The jury may wholly disregard custom evidence without violating the custom rule."); Richard A. Epstein, *The Path to* The T. J. Hooper*: The Theory and History of Custom in the Law of Tort*, 21 J. LEGAL STUD. 1, 25, 37–38 (1992) [hereinafter Epstein, *The Path*] (observing that in products liability law "[i]t is always open season on an established practice, as the cost-benefit approach can be used, without rudder or compass, to override the established custom").

32. *See* RESTATEMENT (SECOND) OF TORTS § 299A (AM. LAW INST. 1965) ("One who undertakes to render services in the practice of a profession or trade is required to exercise the skill and knowledge normally possessed by members of that profession or trade in good standing in similar communities."); Claudia E. Haupt, *Professional Speech*, 125 YALE L.J. 1238, 1286 (2016) ("It is thus the knowledge community that determines the standard of care. Moreover, only the knowledge community's specific insights matter. Deference is thus awarded to the core knowledge, not to peripheral interests."); Maxwell J. Mehlman, *Professional Power and the Standard of Care in Medicine*, 44 ARIZ. ST. L.J. 1165, 1182 (2012) [hereinafter Mehlman, *Professional Power*]. *But see* DOBBS ET AL., *supra* note 29, § 21.5, at 504 (noting criticisms that "courts do not ordinarily survey actual behavior or customs of physicians" and that "the medical standard is often established by conclusory testimony of an expert that specified conduct simply is 'the standard'").

33. *See* Clark C. Havighurst, *Altering the Applicable Standard of Care*, LAW & CONTEMP. PROBS., Spring 1986, at 265, 266–67 ("[A]dherence to prevalent professional standards creates an almost irrebuttable presumption of due care."); Page Keeton, *Medical Negligence — The Standard of Care*, 10 TEX. TECH L. REV. 351, 358–59 (1979) ("Under the 'customary practices standard of the local community,' the jury's only function was to determine whether the physician did something that was not customary or failed to do something that was."); John W. Wade, *An Overview of Professional Negligence*, 17 MEM. ST. U. L. REV. 465, 471 (1987) ("Acting in accordance with an established professional custom is ordinarily treated as safe conduct, not productive of negligence liability.").

34. *See* Stephen R. Latham & Linda L. Emanuel, *Who Needs Physicians' Professional Ethics?* ("Nonphysicians cannot normally answer these questions . . . [because] good medical outcomes do not dependably follow from good medical care, nor bad outcomes from bad care."), *in* THE AMERICAN MEDICAL ETHICS REVOLUTION 192, 196 (Robert B. Baker et al. eds., 1999); Havighurst, *supra* note 33, at 266 ("The impossibility of precisely articulating in advance the performance required of a health care provider under all possible circumstances explains why professional custom has been widely used as a benchmark for evaluating a professional's work."); Wade, *supra* note 33, at 470 (comparing "the reluctance of courts to impose liability on a legal or medical professional for a judgmental decision" to the desire not "to let the jury be a 'Monday morning quarterback'").

software profession to generate information about its own consensus practices, norms, and ethics, the customary care standard can generate a virtuous circle that raises standards of care in a practice area that otherwise resists standardization.

Part II opens with the question why courts have had difficulty defining a standard of reasonable care for software developers. It presents both a theoretical explanation that software complexity is orders of magnitude greater than conventional kinds of complexity, as well as real-world insight into how software complexity has forced startling and unexpected compromises in the practice of safety-critical software development, where one might expect the greatest care to be exercised.

Part III investigates why courts have refused to apply a professional malpractice standard to software developers. The case law reveals that courts have relied principally on an outmoded sociological theory of professions — based on traits such as formal education, licensure, codes of ethics, and "gentlemanly" behavior — as the reason to dismiss these claims. Looking at more recent sociological literature suggests that the trait-based test should be rejected.

Part IV defends a functionalist theory of professionalization centered on the customary care standard and the need for professional judgment.[35] It argues that this need arises not because the professional possesses requisite traits, but instead because the science of the field is inexact. This Part sets out a three-factor test to determine when the customary care standard is appropriate and, by extension, when an occupation should be designated a profession as a matter of tort law. That test is met where (1) bad outcomes are endemic to the practice, (2) those bad outcomes are attributable to inherent uncertainties in the science of the field; and (3) the practice is socially vital even where bad outcomes are especially likely to occur. This framework also shows that a profession can outgrow the label if any of those factors subsides.

Part V presents the case that software should be viewed as a profession like medicine or law. The uniform consensus of experts in the field is that software developers cannot avoid producing bad code as a matter of ordinary course. Moreover, software has become ubiquitous and affects our daily well-being in a way that sets it apart from ordinary goods and services.[36] This Article concludes by returning to the question of software ethics and argues that a professional code of ethics

35. *See* Richard A. Epstein, *Big Law and Big Med: The Deprofessionalization of Legal and Medical Services*, 38 INT'L REV. L. & ECON. (SUPPLEMENT) 64, 66 (2014) [hereinafter Epstein, *Big Law*] ("[T]he notion of a profession carries with it the implication that the professional is someone who can bring critical judgment to solve a problem that has never quite been presented in that form before."); Wade, *supra* note 33, at 468, 470 (focusing on the concept of "enlightened professional judgment" and explaining that courts have been reluctant "to impose liability on a legal or medical professional for a judgmental decision that turns out not to have attained the desired result").

36. *See generally* LAURA DENARDIS, THE INTERNET IN EVERYTHING (2020).

should be understood not as an emblem of social status, but as a guide for fellow professionals grappling with the arcane dilemmas of their chosen art.

II. THE LIMITATIONS OF SOFTWARE STANDARDS

The root puzzle of software liability scholarship is why a "reasonable care" standard has failed to emerge even after decades of rapid maturation and mainstream success.[37] It is not enough to proclaim that software development is a complex enterprise where error is inevitable. After all, many human endeavors are complex and imperfect. Driving safely is a formidable task of coordination riddled with compliance errors.[38] Industrial product design involves polycentric interdependencies that thwart discovery of all possible defects.[39] In these conventionally difficult cases, a basic negligence or negligence-like rule has eventually been found to be a workable solution.[40]

Yet, software liability has remained a pocket of tort exceptionalism. Since the 1990s, the *de facto* reality for software developers has been general immunity from tort liability.[41] Early commentators had worried that a flood of software liability lawsuits could be "catastrophic"

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37. *See* Rustad & Koenig, *supra* note 27, at 1591 (noting that "[n]o court has held a software company liable for failing to meet professional computer security standards" and hypothesizing that the reason is because "[s]oftware engineering is a relatively new field without the well-established professional standards that are found in more developed professions such as law and medicine"); Scott, *supra* note 28, at 448 ("In the area of secure software, no accepted tests currently exist for determining when a particular software vendor has breached its duty, although many have been proposed."); Jane Chong, *Bad Code: The Whole Series*, LAWFARE (Nov. 4, 2013, 12:46 PM), https://www.lawfareblog.com/bad-code-whole-series [https://perma.cc/2N8V-U9GX] (attributing the lack of software liability to myriad reasons, including the fact that "courts tend to treat certain user security expectations as inherently unreasonable").

38. *See* Mark F. Grady, *Res Ipsa Loquitur and Compliance Error*, 142 U. PA. L. REV. 887, 900 (1994) ("It is impossible to drive a car for any period of time without missing a required precaution.").

39. *See* James A. Henderson, Jr., *Judicial Review of Manufacturers' Conscious Design Choices: The Limits of Adjudication*, 73 COLUM. L. REV. 1531, 1539–40 (1973).

40. *See* Aaron D. Twerski & James A. Henderson, Jr., *Manufacturers' Liability for Defective Product Designs: The Triumph of Risk-Utility*, 74 BROOK. L. REV. 1061, 1073 (2009) (asserting that there is "overwhelming judicial support" for the risk-utility balancing test for design defect products liability cases); *see also* Nora Freeman Engstrom, *An Alternative Explanation for No-Fault's "Demise,"* 61 DEPAUL L. REV. 303, 312–13 (2012) (arguing that the tort system and no-fault system have converged and "become progressively more and more alike").

41. *See* Rustad & Koenig, *supra* note 27, at 1563, 1566 (observing that software licensors "typically disclaim warranties" and that "contract law has failed to provide consumers and other users with meaningful remedies to redress [injuries] caused by defective software design").

to software developers.[42] Building error-free software systems had proved to be far more difficult than anyone had anticipated,[43] and software developers successfully persuaded lawmakers that broad legal protections were needed to save the industry against claims of defective software.[44] As a result, software development has been spared the kind of second-guessing of quality control to which most other work is subject.[45]

Today, a standard of "reasonable" software development remains as elusive as ever, even as software's reach has metastasized to connect "vehicles, wearable devices, home appliances, drones, medical equipment, currency, and every conceivable industry sector . . . blurring boundaries between material and virtual worlds."[46] Efforts by regulators to promulgate software standards have been anemic, speaking in broad generalities that permit nearly all software practices to pass muster.[47] Little concrete guidance has emerged as to what constitutes *unreasonable* coding practices sufficient to trigger tort liability.

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42. *See* Lawrence B. Levy & Suzanne Y. Bell, *Software Product Liability: Understanding and Minimizing the Risks*, 5 BERKELEY TECH. L.J. 1, 1–2 (1989) ("[S]oftware vendors are likely to face increasing exposure to lawsuits alleging that software did not perform as expected. The consequences of such lawsuits to software vendors could be catastrophic.").

43. *See* UNIFORM COMPUT. INFO. TRANSACTIONS ACT ("UCITA") § 403 cmt. 3(a) (NAT'L CONF. OF COMM'RS ON UNIF. STATE LAW 2000) (observing that it is "often literally impossible or commercially unreasonable to guarantee that software of any complexity contains no errors that might cause unexpected behavior or intermittent malfunctions").

44. *See* ProCD, Inc. v. Zeidenberg, 86 F.3d 1447, 1452 (7th Cir. 1996) (worrying that refusal to enforce software license terms would mean "the [software] seller has made a broad warranty and must pay consequential damages for any shortfalls in performance, two 'promises' that if taken seriously would drive prices through the ceiling or return transactions to the horse-and-buggy age"); Bryan H. Choi, *Crashworthy Code*, 94 WASH. L. REV. 39, 75–76 (2019) (describing Congress's willingness to enact legislative immunities for software developers, including Section 230 and the Y2K Act). *But see* Step-Saver Data Sys. Inc. v. Wyse Tech., 939 F.2d 91, 104–05 (3d Cir. 1991) (rejecting defendant's "public policy" arguments that "requiring software companies to stand behind representations concerning their products will inevitably destroy the software industry").

45. *See* Chong, *supra* note 37 ("Bruce Schneier, perhaps the most prominent decrier of the current no-liability regime for software vendors, puts it simply: 'there are no real consequences for having bad security.' The result is a marketplace crammed with shoddy code.").

46. *See* DENARDIS, *supra* note 36, at 3 ("The Internet is no longer merely a communication system connecting people and information. It is a control system connecting vehicles, wearable devices, home appliances, drones, medical equipment, currency, and every conceivable industry sector. Cyberspace now completely and often imperceptibly permeates offline spaces, blurring boundaries between material and virtual worlds.").

47. *See* FDA, GENERAL PRINCIPLES OF SOFTWARE VALIDATION; FINAL GUIDANCE FOR INDUSTRY AND FDA STAFF 1 (2002) (recommending that "software validation and verification activities be conducted throughout the entire software life cycle" but declining to "recommend any specific life cycle model or any specific technique or method"). *Compare* FTC, START WITH SECURITY: A GUIDE FOR BUSINESS 9–10 (2015) (advising software developers to train engineers in secure coding practices, follow platform guidelines for security, verify that privacy and security features work, and test for common vulnerabilities), *with* James C. Cooper & Bruce H. Kobayashi, An Unreasonable Solution: Rethinking the FTC's Current Approach to Data Security 2 (Dec. 10, 2019) (unpublished manuscript) (on file with author)

Instead, scholarly proposals aimed at reviving software liability gravitate heavily toward strict liability or no-fault compensation schemes.[48] For example, leading tort scholars encountering the problem of fully autonomous vehicles have championed theories of enterprise liability, which would require developers of said vehicular software systems to assume responsibility for all resulting injuries.[49] Likewise, the U.S. Cyberspace Solarium Commission has proposed that Congress should enact legislation holding "final goods assemblers of software, hardware, and firmware" liable for all known vulnerabilities that are not fixed within a reasonable amount of time.[50] The primary virtue of such proposals is that they seemingly avoid the need to draw difficult lines regarding reasonable care during the actual stages of software development.[51] Instead, the common hope is that forcing software developers to internalize the accident costs of bad code will "promote deterrence and compensation more effectively" than other tort approaches.[52] But that calculus holds only if software developers

(expressing doubts about the FTC's ability to define a standard of reasonable cybersecurity or to articulate why a company's practices fall short of that standard).

48. *See, e.g.*, Michael C. Gemignani, *Product Liability and Software*, 8 RUTGERS COMPUTER TECH. L.J. 173, 199–200 (1981) ("If an injury from a wheel made of defective wood or from a fan blade made from impure steel can subject the maker to strict liability in tort, it is difficult to understand why harmful and erroneous data produced by an incorrect [software] program should not subject its maker to comparable liability."); Donald G. Gifford, *Technological Triggers to Tort Revolutions: Steam Locomotives, Autonomous Vehicles, and Accident Compensation*, 11 J. TORT L. 71, 71 (2018) (proposing a no-fault compensation system modeled on the workers' compensation system).

49. *See* Abraham & Rabin, *supra* note 6, at 147 (proposing a system of "Manufacturer Enterprise Responsibility" for injuries caused by highly automated vehicles); Geistfeld, *supra* note 6, at 1668–69 (arguing that "[d]ue to the safety problems that would be predictably created by an under-enforced rule of negligence liability, the failure of an operating system to perform in its intended manner due to either a computer bug or third-party hacking provides an inference of defect — a product malfunction — that justifies strict liability"); *see also* Michael A. Froomkin & Zak P. Colangelo, *Self-Defense Against Robots and Drones*, 48 CONN. L. REV. 1, 12–14 (2015) (wrestling with potential applicability of ultrahazardous liability against robots and autonomous vehicles); *cf.* David Vladeck, *Machines Without Principals: Liability Rules and Artificial Intelligence*, 89 WASH. L. REV. 117, 146–50 (2014) (proposing a strict liability regime that requires autonomous vehicles to carry adequate self-insurance policies).

50. *See* CYBERSPACE SOLARIUM REPORT, *supra* note 17, at 76.

51. *See* Mark A. Geistfeld, *Protecting Consumer Information Entrusted to Others in Business Transactions: Data Breaches, Identity Theft, and Tort Liability*, 66 DEPAUL L. REV. 385, 400 (2017) ("The rationale for strict liability is based on the difficulty of adequately enforcing the manufacturer's obligation to adopt reasonable quality-control measures."); *see also* Gemignani, *supra* note 48, at 190 ("[I]t is difficult, if not impossible, to define a 'standard minimum of special knowledge and ability' in the field of computing.").

52. Kenneth S. Abraham & Robert L. Rabin, *The Future Is Almost Here: Inaction Is Actually Mistaken Action*, 105 VA. L. REV. ONLINE 91, 91 (2019); *see also* Steven Shavell, *On the Redesign of Accident Liability for the World of Autonomous Vehicles* 2–3 (Nat'l Bureau of Econ. Research, Working Paper No. 26220, 2019), https://ssrn.com/abstract=3450246 [https://perma.cc/UST5-7ZSS] (proposing a strict liability scheme with damages paid to the state, and defending it as "instill[ing] perfect incentives to reduce accident risks").

are realistically capable of curbing accident risks; otherwise, fairness and efficiency considerations cut against a strict liability approach for truly unavoidable risks.[53]

This Part offers a descriptive account that explains why software experts generally disagree with the lay assumption that software developers can meaningfully reduce the incidence of bad code. The explanation proceeds in two parts: one grounded in the *theory* of software complexity, and a second corroborating account drawn from the *practice* of safety-critical software development. Although the theory of complexity applies to all software, this case study of safety-critical software offers a proof-of-concept that even the highest levels of expenditure are not expected to yield safer code.[54] The takeaway from both discussions is that software defies the standard risk-benefit calculus that characterizes much of modern negligence analysis.[55]

A. The Theory of Software Complexity

Perhaps the crispest articulation of why software development is uniquely hard is found in Fred Brooks' famous 1987 article, "No Silver Bullet."[56] In explaining the nature of software's complexity, Brooks helpfully distinguished "essential complexity" from "accidental complexity."[57] Essential complexity arises from the minimum conceptual

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53. *See* Robert L. Rabin, *The Ideology of Enterprise Liability*, 55 MD. L. REV. 1190, 1205 (1996) ("To put it simply, there is a strong inherent perception of injustice in holding a company responsible for risks that it had no reason to know about at the time that it put a product on the market."); Gary T. Schwartz, *The Beginning and the Possible End of the Rise of Modern American Tort Law*, 26 GA. L. REV. 601, 689–90 (1992) (arguing that enterprise liability did not take off in part because of the "unexpected consequences of expanded liability" including the "heavy cost burden of modern tort liability").

54. As Fred Brooks famously summarized this lesson: "Adding manpower to a late software project makes it later." FREDERICK P. BROOKS, JR., THE MYTHICAL MAN-MONTH: ESSAYS ON SOFTWARE ENGINEERING 25 (1975).

55. *See* Joshua C. Teitelbaum, Computational Complexity and Tort Deterrence 17–19 (Oct. 25, 2019) (unpublished manuscript), https://ssrn.com/abstract=3480709 [https://perma.cc/4XE8-2VKW] (asserting that when the marginal cost function is discrete rather than convex, "neither strict liability nor negligence can achieve socially optimal deterrence" because the problem is "neither computationally tractable nor reasonably approximable"); *see also* Charles C. Mann, *Why Software Is So Bad*, MIT TECH. REV., July/Aug., 2002, at 33, 36 ("If a bridge survives a 500-kilogram weight and a 50,000-kilogram weight, [Shari] Pfleeger notes, engineers can assume that it will bear all the values between. With software, she says, 'I can't make that assumption — I can't interpolate.'").

56. Frederick P. Brooks, Jr., *No Silver Bullet: Essence and Accidents of Software Engineering*, COMPUTER, Apr. 1987, at 10, 10.

57. *Id.* at 11 ("Following Aristotle, I divide them into *essence*, the difficulties inherent in the nature of software, and *accidents*, those difficulties that today attend its production but are not inherent."). Brooks also enumerated three other qualities of software — conformity, changeability, and invisibility — that amplify the difficulties of working with software's essential complexity. *Id.*

constructs necessary to represent the intended thing: the data sets, algorithms, function calls, and interrelationships among all those elements.[58] Accidental complexity refers to all the unnecessary difficulties — such as cumbersome design choices and other conceptual errors — that could be eliminated through better programming tools and practices.[59]

Brooks' message was that, for software, even if all the accidental complexity were eliminated, the essential complexity would remain orders of magnitude more complex than most other human constructs.[60] Automobiles, buildings, and even computer hardware rely on many repeated elements to simplify the task of construction; but software systems differ profoundly in that any repeated element becomes a single subroutine.[61] Thus "a scaling-up of a software entity is not merely a repetition of the same elements in larger sizes, it is necessarily an increase in the number of different elements."[62] As the number of different elements increases, the interactions among those elements increase at an exponential rate, which causes the complexity of the system to balloon quickly beyond human comprehensibility.[63] That essential complexity cannot be simplified — after all, it is essential to the purpose of the software design.[64] The double-edged sword of software is that it facilitates the abstract representation of concepts more complex than is ordinarily manageable in the physical realm.[65] Accordingly,

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58. *Id.*

59. *Id.*

60. *Id.* ("Software entities are more complex for their size than perhaps any other human construct . . . . Software systems have orders-of-magnitude more states than computers do."); Steven Fraser & Dennis Mancl, *No Silver Bullet: Software Engineering Reloaded*, IEEE SOFTWARE, Jan./Feb. 2008, at 91, 91 ("The premise of [Brooks'] paper was that unless the remaining accidental complexity is 90 percent of all the remaining complexity, shrinking all accidental complexity to zero still would not result in an order-of-magnitude improvement.").

61. *See* Brooks, *supra* note 56, at 11; *see also* Herbert D. Benington, *Production of Large Computer Programs*, 5 IEEE ANNALS HIST. COMPUTING 350, 352 (1983) ("Many of our government procurement documents act as if one produces software in the same way that one manufactures spacecraft or boots. . . . This attitude can be terribly misleading and dangerous."); David Lorge Parnas, *Software Aspects of Strategic Defense Systems*, 28 COMM. ACM 1326, 1328 (1985) ("There is seldom a good reason to construct software as highly repetitive structures. The number of states in software systems is orders of magnitude larger than the number of states in the nonrepetitive parts of computers. . . . It is a fundamental difference that will not disappear with improved technology.").

62. Brooks, *supra* note 56, at 11.

63. *See* Benington, *supra* note 61, at 350 ("With SAGE, we were faced with programs that were too large for one person to grasp entirely . . . . One might think that with today's technology, SAGE-like software would be easier to build. Unfortunately, this seems not to be so.").

64. *See* Brooks, *supra* note 56, at 11 ("The complexity of software is an essential property, not an accidental one. Hence, descriptions of a software entity that abstract away its complexity often abstract away its essence.").

65. *See* NANCY G. LEVESON, SAFEWARE: SYSTEM SAFETY AND COMPUTERS 36 (1995) [hereinafter LEVESON, SAFEWARE] ("In the design of physical systems, such as nuclear power

Brooks concluded, "building software will always be hard. There is inherently no silver bullet."[66]

A simple way to grasp the exponential growth of software complexity is to consider all possible control paths that a software program could take.[67] Consider a basic "if-then" statement, "If x is true, then perform y." This simple instruction allows only two possible paths: one if x is true and another if x is false. Adding a second and third if-then statement multiplies the number of paths to four, then eight. Even a very simple program consisting of twenty-five consecutive if-then statements "could have as many as 33.5 million distinct control paths, only a small percentage of which would probably ever be tested."[68] Nesting subroutines within subroutines — the basic technique by which software developers eliminate repeated elements of code — generates additional complexity.[69] As the program logic becomes more layered, the software system rapidly accumulates more potential control paths, any one of which could prove arbitrarily fatal to the system.[70]

It is thus well understood within the software industry that it is impossible for any person to properly conceptualize any software system of non-trivial size.[71] Accordingly, during the planning and design

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plants or cars, the physical separation of the system functions provides a useful guide for effective decomposition into modules. Equally effective decompositions for software are hard to find.").

66. Brooks, *supra* note 56, at 11.

67. This metric, "cyclomatic complexity," is a quantitative measure of the number of linearly independent paths through a software system. *See* Thomas J. McCabe, *A Complexity Measure*, [SE-2] IEEE TRANSACTIONS ON SOFTWARE ENGINEERING 308, 308 (1976); *see also* Christof Ebert, *Cyclomatic Complexity*, IEEE SOFTWARE, Nov./Dec. 2016, at 27, 28 ("It's no surprise that CC [cyclomatic complexity], unlike many other metrics that have been proposed over the past decades, is still going strong and is used in almost all tools for criticality prediction and static code analysis."). *But see* Martin Shepperd, *A Critique of Cyclomatic Complexity as a Software Metric*, 3 SOFTWARE ENGINEERING J. 30, 30 (1988) (setting forth the academic consensus that McCabe's cyclomatic complexity metric is "based upon poor theoretical foundations and an inadequate model of software development" that is unsupported by empirical evidence and is no better at estimating software complexity than a simple count of lines of code).

68. McCabe, *supra* note 67, at 308.

69. *See* Shepperd, *supra* note 67, at 32–33 (noting the "bizarre result" that the cyclomatic complexity of a program increases "as a program is divided into more, presumably simpler, modules," even as "complexity may be reduced in a situation where modularisation eliminates code duplication").

70. *See* Nasib Gill & Sunil Sikka, *New Complexity Model for Classes in Object Oriented System*, ACM SIGSOFT SOFTWARE ENGINEERING NOTES, Sept. 2010, at 1, 2 ("Many unique features mainly inheritance and polymorphism of object oriented software are not considered by traditional software complexity metrics, therefore, traditional complexity metrics are not suitable for measuring complexity of object oriented software.").

71. *See* Brooks, *supra* note 56, at 12 ("In spite of progress in restricting and simplifying the structures of software, they remain inherently unvisualizable, and thus do not permit the mind to use some of its most powerful conceptual tools."); Arbi Ghazarian, *A Theory of Software Complexity*, 4 SEMAT WORKSHOP ON GEN. THEORY SOFTWARE ENGINEERING 29, 29 (2015) ("To arrive at an accurate measure of the essential complexity contained in software

phases, conceptual errors of commission and of omission are accepted as routine.[72] Likewise at the verification and validation phases, software testing is necessarily inadequate for the same reason. Because comprehensive testing cannot be completed in a finite amount of time, the tester must artfully select which tests are performed.[73] To be sure, a large firm like Boeing has more resources than an independent developer or a small firm.[74] But software complexity dwarfs those relative differences. During the critical phases of planning, designing, and testing software, many decisions made by the software developer are little more than subjective judgment calls.

B. The Practice of Safety-Critical Software Development

An examination of certification standards for safety-critical software helps corroborate the theoretical discussion above by showing how startlingly weak protection such software standards are able to provide. The safety-critical software community is a useful benchmark because it is the sector with the highest incentive — and backed by the power of military spending — to push the limits of possibility for software quality. Even under those peak conditions, experts in the field have found it impossible to achieve conventional measures of quality assurance and have been forced instead to redefine what quality assurance means for software. The implications are dismaying: if safety-critical software standards cannot offer much assurance, there is even less hope for other, run-of-the-mill forms of software.

Conventional safety-critical engineering achieves quality assurance by certifying process standards, performance metrics, or both. Process standards require the engineer to adhere to an approved method of construction, with the expectation that obeying a consistent process

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systems would be a very ambitious, if not impractical, goal. This is because software systems are capable of implementing problems from an infinitely large number of problem domains . . . .").

72. *See* Parnas, *supra* note 61, at 1330 ("How can it be that we have so much software that is reliable enough for us to use it? The answer is simple: programming is a trial and error craft. People write programs without any expectation that they will be right the first time."); LEVESON, SAFEWARE, *supra* note 65, at 34 ("Another trap of software flexibility is the ease with which partial success is attained, often at the expense of unmanaged complexity. . . . The software works correctly most of the time, but not all the time.").

73. *See* PAUL AMMANN & JEFF OFFUTT, INTRODUCTION TO SOFTWARE TESTING 19 (2016) ("Instead of looking for 'correctness,' wise software engineers try to evaluate software's 'behavior' to decide if the behavior is acceptable . . . . Test case design can be the primary determining factor in whether tests successfully find failures in software.").

74. *See* Dirk van der Linden & Awais Rashid, *The Effect of Software Warranties on Cybersecurity*, 43 ACM SIGSOFT SOFTWARE ENGINEERING NOTES, Oct. 2018, at 31, 31 (acknowledging that major firms such as Microsoft have greater engineering resources to respond to public scrutiny than smaller developers do).

will yield consistent results.[75] For example, a certified bridge builder must follow approved methods of placing and curing concrete to ensure structural integrity.[76] Performance metrics work in reverse by setting a target goal without dictating the means by which to achieve that measure.[77] Thus, a bridge builder can start with the expected load limits and resistance factors that the bridge must be able to tolerate, and then use scientific measurements and calculations to evaluate whether a new bridge design will be able to perform as needed.[78]

Software certification standards mimic the form but not the function of conventional engineering standards.[79] First, while software process standards check that particular stages have been performed during the development process, they do little to ensure consistency in how each stage should (or should not) be performed. Second, software safety performance metrics have failed to gain traction because objectively quantifiable metrics have been elusive. Taken together, the best available software certification standards afford the veneer of safety compliance but only brittle assurances of actual software safety.

1. Process Standards

The gold standard of conventional engineering process is the "waterfall" method: a project cascades from a top-level planning phase

75. *See* Aaron D. Twerski et al., *Shifting Perspectives in Products Liability: From Quality to Process Standards*, 55 N.Y.U. L. REV. 347, 358 (1980) ("Our contention is that a structured, well-articulated, and highly visible standard-setting process performed by private industry or private consensus standard-setting groups can provide greater assurance of product safety than does the present system, which reviews only the quality of a manufacturer's decision on a particular product feature.").

76. *See generally* 23 C.F.R. § 625.4(b) (2019); AM. ASS'N OF STATE HIGHWAY & TRANSP. OFFICIALS, AASHTO LRFD BRIDGE CONSTRUCTION SPECIFICATIONS § 8 (4th ed. 2017).

77. *See* Todd A. DeLong et al., *Dependability Metrics to Assess Safety-Critical Systems*, 54 IEEE TRANSACTIONS ON RELIABILITY 498, 498 (2005) ("Metrics are commonly used in engineering as measures of system performance for a given attribute. Typically, metrics are computed based on an analytical model that describes the behavior of a system as a function of parameters associated with these attributes.").

78. *See, e.g.*, MOHAMMAD AYUB, OCCUPATIONAL SAFETY & HEALTH ADMIN., U.S. DEP'T OF LABOR, INVESTIGATION OF MARCH 15, 2018 PEDESTRIAN BRIDGE COLLAPSE AT FLORIDA INTERNATIONAL UNIVERSITY, MIAMI, FL 18, 79, 106–12 (2019), https://www.osha.gov/doc/engineering/pdf/2019_r_03.pdf [https://perma.cc/DYF3-4ZEH] (detailing measurements of structural design deficiencies).

79. *See* LEVESON, SAFEWARE, *supra* note 65, at 25 ("Proven system safety engineering techniques do not include software, and, because of the unique characteristics of this new technology, are not easily adapted to software."); Wolfgang Emmerich et al., *Software Process — Standards, Assessments and Improvement*, *in* SOFTWARE PROCESS: PRINCIPLES, METHODOLOGY, AND TECHNOLOGY 16 (Jean-Claude Derniame et al. eds., 1999) ("ISO 9000 has been specialised for software production because it has been recognised as different from general purpose production processes.").

where the project's requirements are fully mapped out and defined.[80] In subsequent phases of the project, those requirements are converted into a preliminary design, implemented as a working model, and then tested to ensure that the final product meets all the initial requirements. The waterfall model has been very effective in many contexts, and it is encoded in popular certification standards such as ISO 9001[81] or MIL-STD-882E[82] that offer high-level frameworks for system safety. Those standards are not specific to software,[83] but they offer a starting platform for risk planning and management in any complex engineering project.

This basic "waterfall" model was a stunning disappointment in the world of software development.[84] When the military turned its attention from computer hardware to computer software in the 1970s and 1980s, it assumed that traditional waterfall methods could be readily adapted to software development.[85] Thus, in 1985, in an effort to procure software of more uniform quality, the military issued DOD-STD-2167,

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80. *See* ADAM BARR, THE PROBLEM WITH SOFTWARE: WHY SMART ENGINEERS WRITE BAD CODE 196 (2018) ("What was implicit in that guidance was the one-way flow of the development process: first you plan, then you code, then you test each component, and then you test the whole thing together. This is where the word *waterfall* comes from, since the process is like water going over a fall. You don't reopen the planning process after coding has started, nor do you begin coding before the planning is complete."); *see also* NANCY G. LEVESON, ENGINEERING A SAFER WORLD 69–72 (2011) [hereinafter LEVESON, ENGINEERING A SAFER WORLD] (describing systems-based approach to safety engineering pioneered by military programs in the 1950s and 1960s).

81. ISO 9001 was first published in 1987 by the International Organization for Standardization ("ISO"), based on older government procurement standards. It remains one of the most important standards ISO publishes. *See* ISO 9001:2015 QUALITY MGMT. SYS. — REQUIREMENTS (INT'L ORG. FOR STANDARDIZATION 2015); *see also* Jeroen Singels et al., *ISO 9000 Series: Certification and Performance*, 18 INT'L J. QUALITY & RELIABILITY MGMT. 62, 62–63 (2001) ("A common misconception is that ISO would mandate higher levels of product quality. . . . [I]t is better to say that ISO is aimed at the assurance of quality consistency instead of a higher quality of the products or services of an organization.").

82 . U.S. DEP'T OF DEF., MIL-STD-882E, DEPARTMENT OF DEFENSE STANDARD PRACTICE: SYSTEM SAFETY 9 (2012), https://www.dau.edu/cop/armyesoh/DAU%20Sponsored%20Documents/MIL-STD-882E.pdf [https://perma.cc/M6Y9-W2KJ] (depicting the linear sequence of the eight elements of the system safety process).

83. In 1991, ISO published ISO 9000-3, a software-specific version of ISO 9001. *See* ISO 9000-3:1991, ISO, https://www.iso.org/standard/16532.html [https://perma.cc/7FMM-YW2A]. In 2004, the standard was renumbered and reissued as ISO/IEC 90003. *See* ISO/IEC 90003:2004, ISO, https://www.iso.org/standard/35867.html [https://perma.cc/F9R3-L57G].

84. *See* Alan M. Davis et al., *A Strategy for Comparing Alternative Software Development Life Cycle Models*, 14 IEEE TRANSACTIONS ON SOFTWARE ENGINEERING 1453, 1453–54 (1988) (observing that under the waterfall model, "software is almost always more expensive and delivered later than expected, and to make matters worse, it is often unreliable and fails to meet the ultimate users' needs").

85. *See* Benington, *supra* note 61, at 351 ("[W]e were all engineers and had been trained to organize our efforts along engineering lines. . . . In other words, as engineers, anything other than structured programming or a top-down approach would have been foreign to us."); *see also* Paul V. Shebalin, *Software Development Standards and the DoD Program Manager*,

which required all contractors building "mission-critical" military software to document their compliance with the waterfall method.[86]

DOD-STD-2167 proved to be both expensive *and* ineffective, resulting in massive delays, mounting expenses, and abandoned projects.[87] The principal problem was that the waterfall method hinged on being able to properly identify the risks and requirements at the outset.[88] All subsequent work flowed from the assumptions formed at step one. If risks or requirements were missed at the planning stage, they were unlikely to be discovered at the testing stage. Compared with conventional projects, software projects were uniquely prone to missing critical risks and requirements at the initial planning stage.

A 1987 task force report commissioned by the Department of Defense ("DoD") concluded that the "document-driven, specify-then-build approach" of Standard 2167 had caused "so many of DoD's software problems," and it recommended that Standard 2167 be revised "to remove any remaining dependence upon the assumptions of the 'waterfall' model and to institutionalize rapid prototyping and incremental development."[89] The same report concluded that the civilian software market offered cheaper, faster access to more robust and better maintained software, and it recommended that the military avoid developing its own custom-built solutions unless a unique need could be proved.[90] Ultimately, the military adopted the task force's recommendations in full, embracing commercial software and demilitarizing its defense standards.[91]

1994 ACQUISITION REV. Q. 202, 206 (describing the evolution from MIL-STD-1679, issued in 1978, to DOD-STD-2167A, issued in 1988, to MIL-STD-498 in 1994).

86. *See* U.S. DEP'T OF DEF., DOD-STD-2167, MILITARY STANDARD: DEFENSE SYSTEM SOFTWARE DEVELOPMENT 11 (1985) (requiring six phases: (1) analysis of system requirements, (2) preliminary design, (3) detailed design, (4) code implementation, (5) component integration, and (6) configuration testing); *see also* Richard Armstrong Beutel, *Software Engineering Practices and the Idea/Expression Dichotomy: Can Structured Design Methodologies Define the Scope of Software Copyright?*, 32 JURIMETRICS J. 1, 8–16 (1991) (describing the DOD-STD-2167 software development methodology).

87. *See* Craig Larman & Victor R. Basili, *Iterative and Incremental Development: A Brief History*, COMPUTER, June 2003, at 47, 52–53 (describing the "failure in acquiring software based on the strict, document-driven, single-pass waterfall model that DoD-Std-2167 required"); Daniel E. Schoeni, *Long on Rhetoric, Short on Results: Agile Methods and Cyber Acquisitions in the Department of Defense*, 31 SANTA CLARA HIGH TECH. L.J. 385, 398–401, 408 (2015) (explaining the ineffectiveness of the waterfall methods which have high costs).

88. *See* LEVESON, ENGINEERING A SAFER WORLD, *supra* note 80, at 69 (pointing out that there could be interface and component interaction problems unnoticed until later stages under the traditional waterfall model).

89. DEF. SCI. BD., U.S. DEP'T OF DEF., REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON MILITARY SOFTWARE 33–34 (1987) [hereinafter 1987 DEF. SCI. BD. REPORT].

90. *Id.* at 24, 28.

91. *See generally* DEF. SCI. BD., U.S. DEP'T OF DEF., REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON ACQUIRING DEFENSE SOFTWARE COMMERCIALLY (1994). DOD-STD-2167 was revised to DOD-STD-2167A in 1988, then superseded by the more flexible

The commercial sector succeeded not through greater expertise or skill, but by diluting the certification requirements. Aviation led the way: in January 1982, the Radio Technical Commission for Aeronautics ("RTCA") published the landmark "DO-178" document, which proposed a new framework for certifying avionics software.[92] The key strategic move was that DO-178 defined three levels of system criticality — critical, essential, and nonessential — so that different components of a safety-critical software system could be approved at decreasing levels of scrutiny.[93] Thus, the strict waterfall model would be required only for "critical" (Level 1) software, while less critical (Level 2 and 3) software could be developed in a looser manner more akin to ordinary commercial software.[94] At the time, it was understood that software techniques were "obviously unsatisfactory for flight control systems."[95] But the gambit paid off: in September 1982, the Federal Aviation Administration ("FAA") endorsed DO-178 as an appropriate means for obtaining FAA certification of avionics software.[96]

MIL-STD-498 in 1994, and ultimately replaced by the demilitarized version EIA J-STD-016 in 1998. *See* Larman & Basili, *supra* note 87, at 53; Sarah A. Sheard, *Evolution of the Frameworks Quagmire*, COMPUTER, July 2001, at 96, 96; Reed Sorensen, *Software Standards: Their Evolution and Current State*, CROSSTALK, Dec. 1999, at 21, 23–24.

92. *See* RADIO TECH. COMM'N FOR AERONAUTICS, DO-178C, SOFTWARE CONSIDERATIONS IN AIRBORNE SYSTEMS AND EQUIPMENT CERTIFICATION app. A (2011) [hereinafter DO-178C] (describing the historical background of the DO-178 document); Leslie A. (Schad) Johnson, *DO-178B: "Software Considerations in Airborne Systems and Equipment Certification*," CROSSTALK, Oct. 1998, http://www.dcs.gla.ac.uk/~johnson/teaching/safety/reports/schad.html [https://perma.cc/KA48-D5CY] (explaining that DO-178 was developed as "an alternative means for software design integrity from the classical statistical method of determining system integrity[,]" after "it became clear that the classical statistical methods of safety assessment for flight critical software based systems were not possible").

93. *See* Johnson, *supra* note 92 (explaining that DO-178 "established that a system's software development rigor could vary by the system failure condition categories (criticality)"). The three levels of criticality matched the FAA's categorizations. *See* FAA, U.S. DEP'T OF TRANSP., ADVISORY CIRCULAR 25.1309-1, at 2–3 (1982) (stating that fault conditions must be "extremely improbable" for "critical" functions, must be "improbable" for "essential" functions, and may be "probable" for "nonessential" functions).

94. *See* J.P. Potocki de Montalk, *Computer Software in Civil Aircraft*, 17 MICROPROCESSORS & MICROSYSTEMS 17, 21 (1993) ("Level 1 . . . standards are extremely severe, and require the structure of the software to be simple and deterministic . . . . The standards [for Level 2] are comparable with Level 1, but less documentation is required. Level 3 . . . is the least stringent of the three levels, and is similar to good commercial software."); *cf.* LEVESON, SAFEWARE, *supra* note 65, at 24 ("Often the argument that software providing information or advice to humans is not safety critical is used to avoid the difficult task of ensuring the safety of the software.").

95. James J. Treacy, *Flight Safety Issues of an All-Electric Aircraft*, [AES-20] IEEE TRANSACTIONS ON AEROSPACE & ELECTRONIC SYS. 227, 232 (1984).

96. *See* FAA, U.S. DEP'T OF TRANSP., ADVISORY CIRCULAR 20-115 (1982) ("An applicant . . . may use the considerations outlined in RTCA Document DO-178 as a means . . . to secure FAA approval of the digital computer software."). That approval has been renewed through three subsequent revisions. *See* FAA, U.S. DEP'T OF TRANSP., ADVISORY CIRCULAR 20-115D (2017).

In subsequent years, as RTCA sought to expand the scope of avionics software, it concluded that it needed to soften the DO-178 standard even further. Early versions of DO-178 were criticized for being still too restrictive, and for permitting only the simplest software functions to be certified.[97] In response, RTCA undertook a major revision effort beginning in 1989, resulting in the adoption of DO-178B in 1992.[98] Not only did DO-178B expand the number of criticality levels from three to five, but it also relaxed the rigid waterfall requirement at *all* levels in favor of a more flexible "iterative lifecycle" model, whereby the software always remains a work-in-progress and is never finalized. The raison d'être of the iterative model is that it promotes less upfront planning at the design stage.[99] This adjustment was viewed as necessary to allow software developers to build rapid prototypes, reassess design requirements on the fly, and release incrementally updated versions on a continual, rolling basis. The shift to an ad hoc iterative methodology was a grudging concession to the unique challenge of software's essential complexity and the inability to manufacture software in a single, linear progression like conventional products.

The central frailty of the iterative approach is that it makes it difficult if not impossible to determine consistency of software quality. Because each iteration of software design must be arbitrarily cut short, DO-178B offers no set guidance on how much or how little planning is required at each iteration. For example, a vigorous debate has emerged in recent years on whether leaner, more aggressive software development methods — such as "Agile" development methods[100] — should be approved for DO-178 certification. Conventional voices worry that Agile methods cut too many corners and cannot possibly be as safe as

97. *See* de Montalk, *supra* note 94, at 21 (observing that DO-178A standards are "extremely severe, and require the structure of the software to be simple and deterministic").

98. *See* DO-178C, *supra* note 92, app. A, at A-1 (explaining that FAA "formally requested" in 1989 that RTCA establish a special committee to review and revise DO-178A in light of "rapid advances in software technology," and that those efforts "culminated in the publication of RTCA document DO-178B in December 1992").

99. *See* Brooks, *supra* note 56, at 17–18; 1987 DEF. SCI. BD. REPORT, *supra* note 89, at 33.

100. The Agile method emerged in 2001 out of an informal gathering at Snowbird ski resort to discuss "the need for an alternative to documentation driven, heavyweight software development processes." *See* Jim Highsmith, *History: The Agile Manifesto*, AGILE MANIFESTO, https://agilemanifesto.org/history.html [https://perma.cc/7X4Y-VXPT]; *see also* BARR, *supra* note 80, at 195, 198 ("Scrum is the Agile Manifesto mapped onto software project management. . . . [O]ne key assertion behind Scrum is that there exists no solid process or technique to develop software, but that's OK . . . . Scrum focuses aggressively on delivering new functionality to the user as often as possible."); Noura Abbas et al., *Historical Roots of Agile Methods: Where Did "Agile Thinking" Come from?*, 9 INT'L CONF. ON AGILE PROCESSES SOFTWARE ENGINEERING & EXTREME PROGRAMMING 94, 95–96 (2008) (defining Agile as an adaptive, iterative and incremental, and people-oriented process that started to take form in the 1970s).

more conservative methods.[101] But proponents argue, counterintuitively, that Agile methods are safer precisely *because* they are cheaper and faster — extolling the virtues of ever-shorter increments.[102]

To allay safety concerns, RTCA emphasized other improvements in quality control. For example, DO-178B authorized the use of automatic code generators and code analyzers, which was aimed at minimizing errors caused by manual labor.[103] Additionally, DO-178B created a mandate of code "traceability," meaning that every requirement in the design document must be traced to the actual lines of code implementing that requirement.[104] Vice versa, every line of code must be traced back to a requirement in the design document, to avoid the risks caused by "dead code" or "orphan code."[105] To be sure, automated

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101. *See* BARR, *supra* note 80, at 215 ("Agile tends to peter out just as the engineering gets complicated . . . . While Agile may make easy problems a bit easier, it doesn't help with the hard problems."); *see also* LEVESON, SAFEWARE, *supra* note 65, at 34–36 (explaining that the flexibility of software is a "curse," because "the apparent low cost is deceptive" and "the ease of change encourages major and frequent change, which often increases complexity rapidly and introduces errors"). *See generally* Hanne-Gro Jamissen, The Challenges to the Safety Process When Using Agile Development Models (June 29, 2012) (unpublished Master's thesis, Østfold University College), https://hiof.brage.unit.no/hiof-xmlui/bitstream/handle/11250/148044/Jamissen1.pdf [https://perma.cc/4HTC-9UF9]; Martin McHugh et al., *Barriers to Adopting Agile Practices When Developing Medical Device Software*, 12 INT'L CONF. ON SOFTWARE PROCESS IMPROVEMENT & CAPABILITY DETERMINATION 141 (2012).

102. *See* BRUCE POWEL DOUGLASS & LESLIE EKAS, IBM CORP., ADOPTING AGILE METHODS FOR SAFETY-CRITICAL SYSTEMS DEVELOPMENT 10 (2012) ("Agile methods are a set of practices that can help improve both quality and productivity and can be employed in the development of safety-critical systems as well. The common agile practices apply well to safety-critical systems, but they must be tailored and customized to ensure that safety objectives are met."); *see also* Geir K. Hanssen et al., *An Assessment of Avionics Software Development Practice: Justifications for an Agile Development Process*, 18 INT'L CONF. ON AGILE SOFTWARE DEV. 217, 221–22 (2017) (observing that the common interest in Agile methods stems from increases in "avionic system complexity," frequent "cost and schedule overruns," and a desire for "a more flexible development process with less emphasis on complete and detailed up-front design"); Steven H. VanderLeest & Andrew Buter, *Escape the Waterfall: Agile for Aerospace*, 28 IEEE/AIAA DIGITAL AVIONICS SYS. CONF. 6.D.3-1, 6.D.3-1 (2009) (documenting successful integration of Agile methods into a traditional DO-178B process and concluding "with a call for a collaborative effort to further explore Agile as an answer to the urgent need for new approaches to complex systems").

103. *See* Andrew J. Kornecki & Janusz Zalewski, *The Qualification of Software Development Tools from the DO-178B Certification Perspective*, CROSSTALK, Apr. 2006, at 19, 20. The latest trend in this direction has been the application of neural network techniques to code generation. *See* Andrej Karpathy, *Software 2.0*, MEDIUM (Nov. 11, 2017), https://medium.com/@karpathy/software-2-0-a64152b37c35 [https://perma.cc/P2MZ-Y5YH] (arguing that a neural network optimization "can find much better code than what a human can write").

104. *See* Johnson, *supra* note 92, at 7–8 ("Traceability was added as an integral feature of software development. . . . This was to demonstrate that no additional functionality was present (*unintended function*); that all requirements had been implemented; and, that the system was fully tested.").

105. Orphan code is considered dangerous because it represents an unknown contingency that could be activated at any wrong moment. *See, e.g.*, Jean-Marc Jezequel & Bertrand Meyer, *Design by Contract: The Lessons of Ariane*, COMPUTER, Jan. 1997, at 129, 129 ("The

code generation and traceability checks are helpful in reducing syntax errors and logical errors that might otherwise go overlooked. Nevertheless, as beneficial as such requirements are, they are targeted only at accidental complexity, not essential complexity.[106]

The most recent revision in 2011, DO-178C, was only a minor update.[107] The committee specifically rejected calls for major revisions, citing the satisfactory safety record of DO-178B.[108] Yet, the Boeing 737 MAX incidents expose that safety record as troublingly brittle. The ease with which Boeing's software scope was modified, without full recertification of those changes, was not a misuse but arguably a core "feature" of the DO-178 framework.

If DO-178 offers little protection against software malfunctions, there can be only two explanations for the aviation industry's long streak of luck. One is that extraneous factors — such as pilot "airmanship"[109] or the safety design of non-software elements — have tended to save avionics software from itself. The other is an intrinsic explanation, namely, that the avionics software development community has adopted a voluntary norm of more conservative practices than DO-178 formally requires.[110] Neither explanation is especially comforting when

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explosion, the report says, is the result of a software error, possibly the costliest in history . . . . Particularly vexing is the realization that the error came from a piece of the software that was not needed.").

106. *See* LEVESON, SAFEWARE, *supra* note 65, at 30 ("[P]ractical experience and empirical studies have shown that most safety-related software errors can be traced to the requirements and not to coding errors (which tend to have less serious consequences in practice).").

107. *See* Won Keun Youn et al., *Software Certification of Safety-Critical Avionic Systems: DO-178C and Its Impacts*, IEEE AEROSPACE & ELECTRONIC SYS. MAG., Apr. 2015, at 4, 6 (explaining that the "main structure and content of DO-178C are essentially the same as those seen in DO-178B"); *see also* FRÉDÉRIC POTHON, ACG SOLUTIONS, DO-178C/ED-12C VERSUS DO-178B/ED-12B: CHANGES AND IMPROVEMENTS 5 (2012), https://www.adacore.com/uploads/technical-papers/DO178C-ED12C-Changes_and_Improvements-Sep2012.pdf [https://perma.cc/VMD7-XDVR] ("Since DO-178B/ED-12B has struck an appropriate balance between the effort required to demonstrate compliance with its objectives and the resulting confidence in the correctness and safety of the software, there was no perceived need to make it more difficult to achieve compliance.").

108. *See* POTHON, *supra* note 107, at 6 ("It was also recognized that DO-178B/ED-12B's basic principles have demonstrated their relevance and value, and should remain unchanged."); Youn et al., *supra* note 107, at 4 (citing studies that software developed under DO-178B has caused "no hull-loss accidents" and "has been a significant contributing factor in only a small number of accidents and in-flight upsets," but noting that "the effectiveness of DO-178B has become questionable as the size and complexity of modern avionic software increase").

109. *See* William Langewiesche, *What Really Brought Down the Boeing 737 Max?*, N.Y. TIMES MAG. (Sept. 18, 2019), https://nyti.ms/34Ro3b7 [https://perma.cc/Q7RL-UMQP] ("'Airmanship' . . . includes a visceral sense of navigation, an operational understanding of weather and weather information, the ability to form mental maps of traffic flows, fluency in the nuance of radio communications and, especially, a deep appreciation for the interplay between energy, inertia and wings.").

110. *See* John Marsden et al., *ED-12C/DO-178C vs. Agile Manifesto: A Solution to Agile Development of Certifiable Avionics Systems*, EUR. CONGRESS EMBEDDED REAL TIME

looking ahead to ambitious expansions of software use in aviation and beyond.

In other safety-critical contexts, such as automotive vehicles, medical devices, and nuclear power plants, the relevant certification standards have been modeled closely after the example of the avionics sector.[111] The best recognized examples have been those issued jointly by the International Electrotechnical Commission ("IEC") and the International Organization for Standardization ("ISO").[112] In particular, IEC 61508 has become the de facto certification standard for safety-critical software systems.[113]

SOFTWARE & SYS., Jan. 31–Feb. 2, 2018, at 1, 5 (noting that Airbus, a leading developer of avionics software, continues to follow a conservative "Requirements-Based Engineering" paradigm that closely resembles the classical waterfall method); *see also* BARR, *supra* note 80, at 199 (explaining the author's experience working at Microsoft: "although we did not follow a strict waterfall process during each milestone, we definitely back-loaded the testing, and only toward the end of any given milestone was the software reliable enough to release externally").

111. Some automakers have attempted to build consensus around ISO 26262, which is an adaptation of IEC 61508 to Road Vehicles. *See* QI D. VAN EIKEMA HOMMES, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., ASSESSMENT OF SAFETY STANDARDS FOR AUTOMOTIVE ELECTRONIC CONTROL SYSTEMS 2, 7, 14 (2016); *see also* Robert Palin & Ibrahim Habli, *Assurance of Automotive Safety —A Safety Case Approach*, 29 INT'L CONF. ON COMPUTER SAFETY RELIABILITY & SECURITY 82, 83–84 (2010) (describing the initiative by German and French automakers to create ISO 26262). For medical devices, the U.S. Food and Drug Administration recognizes IEC 62304, another adaptation of IEC 61508, as an acceptable consensus baseline. *See* Ken Wong & Christine Callaghan, *Managing Requirements Baselines for Medical Device Software Development*, 6 IEEE INT'L SYS. CONF. 479, 480 (2012). Nuclear power plants have the option of using IEC 60880 or IEC 61508 depending on the application context. Jussi Lahtinen et al., *Comparison Between IEC 60880 and IEC 61508 for Certification Purposes in the Nuclear Domain*, 29 INT'L CONF. ON COMPUTER SAFETY, RELIABILITY & SECURITY 55, 56 (2010).

112. *See* James W. Moore, *An Integrated Collection of Software Engineering Standards*, IEEE SOFTWARE, Nov./Dec. 1999, at 51, 52 (highlighting the work of Joint Technical Committee, ISO/IEC JTC1, which has led the field in "manag[ing] a collection of about two dozen [software engineering] standards, the most popular being ISO/IEC 12207, Software Life Cycle Processes"). *But see id.* at 51 (observing that "uptake of the available standards has been somewhat disappointing").

113. *See* Ron Bell, *Introduction and Revision of IEC 61508* ("[IEC 61508] has been used to develop standards for the process, nuclear and railway industries and for machinery and power drive systems. It has influenced, and will continue to influence, the development of E/E/PE safety-related systems and products across all sectors."), *in* ADVANCES IN SYSTEMS SAFETY 274 (Chris Dale & Tom Anderson eds., 2011); *see also* Hartmut von Krosigk, *Functional Safety in the Field of Industrial Automation: The Influence of IEC 61508 on the Improvement of Safety-Related Control Systems*, COMPUTING & CONTROL ENGINEERING J., Feb. 2000, at 13, 17 ("Up to now there has been no international standard which treated the whole safety-related system generally. With the publication of IEC 61508 the situation has changed.").

Similar to DO-178, the IEC 61508 standard defines multiple tiers of "safety-integrity levels" that correspond to different levels of criticality.[114] Level 1 applies to the lowest risk components and requires minimal process to satisfy the 61508 standard. Level 4 addresses the most critical safety risks and requires additional precautionary burdens, and it is therefore avoided to the extent possible.[115] Moreover, the 61508 standard allows the same iterative methods that the DO-178 standard does.[116] Like RTCA, IEC has also concluded that a flexible, qualitative metric is needed because software risks cannot be quantified.[117]

But here, the same frailties found in DO-178 are more exposed, because IEC 61508 addresses a much broader audience than the close-knit avionics software community.[118] Norms that persist in an industry dominated by two major manufacturers (Boeing and Airbus) are less likely to prevail in other industries fragmented across a dozen — or even hundreds of — manufacturers.

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114. *See* DAVID J. SMITH & KENNETH G.L. SIMPSON, SAFETY CRITICAL SYSTEMS HANDBOOK 8–9 (3d ed. 2011) (discussing the multiple tiers of safety-integrity used in IEC 61508).

115. *See id.* at 9–10 ("There is a considerable body of opinion that [Safety-Integrity Level] 4 should be avoided . . . ."); *id.* at 81 ("The authors (as do many guidance documents) counsel against [Safety-Integrity Level] 4 targets.").

116. IEC 61508 requires an initial concept stage that defines the project's scope and performs a safety risk analysis. Thereafter, the project moves through an iterative loop of design, implementation, validation, and maintenance. *Id.* at 11.

117. *Id.* at 5 ("The proliferation of software during the 1980s, particularly in real time control and safety systems, focused attention on the need to address systemic failures since they could not necessarily be quantified. In other words . . . software failure rates were generally agreed not to be predictable."); *see also* John Brazendale, *IEC 1508: Functional Safety: Safety-Related Systems*, 2 IEEE INT'L SOFTWARE ENGINEERING STANDARDS SYMP. 8, 13–14 (1995) (explaining that "[t]he [IEC] standard does not set risk targets, because this is a social and political issue as much as a technical one" given that "there is no known way to prove the absence of faults in reasonably complex safety-related software").

118. *See* Rashidah Ksauli et al., *Safety-Critical Systems and Agile Development: A Mapping Study*, 44 EUROMICRO CONF. ON SOFTWARE ENGINEERING & ADVANCED APPLICATIONS 470, 470 (2018) (noting that "the situation has changed through potentially disruptive trends that significantly increase the need for short development cycles and quick time to market," and that "companies developing [safety-critical systems] realize the competitive advantages that agility can provide"); Mary Walowe Mwadulo, *Suitability of Agile Methods for Safety-Critical Systems Development: A Survey of Literature*, 5 INT'L J. COMPUTER APPLICATIONS TECH. & RES. 465, 470 (2016) (arguing that the low adoption of Agile methods for safety-critical systems development is because developers of such systems are "too conservative" and want to use "traditional methods . . . they are familiar with").

2. Performance Metrics

In contrast to the process-based approach, a performance-based engineering approach seeks to achieve "rational and measurable quantitative indicators" that provide objective standards of quality.[119] Ideally, having independently verifiable quality metrics would provide a valuable workaround to the challenges of standardizing the processes of software development.[120]

Software researchers have made some strides to define performance metrics by which software quality could be certified.[121] But unlike the quality of physical *hardware* components, the quality of *software* components has been exceedingly difficult to formulate in precise, mathematical terms.[122] Accordingly, a consensus definition of software quality has remained elusive.[123]

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119. A. Emin Aktan et al., *Performance-Based Engineering of Constructed Systems*, 133 J. STRUCTURAL ENGINEERING 311, 312 (2007).

120. *See* Witold Suryn et al., *ISO/IEC SQuaRE. The Second Generation of Standards for Software Product Quality*, 7 IASTED INT'L CONF. ON SOFTWARE ENGINEERING & APPLICATIONS 807, 808 (2003) ("The objective of software product quality engineering is to achieve the required quality of the product through the definition of quality requirements and their implementation, measurement of appropriate quality attributes and evaluation of the resulting quality.").

121. *See* Steffen Becker, *Performance-Related Metrics in the ISO 9126 Standard* (detailing several basic metrics relating to time behavior and resource utilization, such as response time, throughput, load balancing, and memory consumption), *in* DEPENDABILITY METRICS 204–06 (Irene Eusgeld et al. eds., 2007). *But see* Hiyam Al-Kilidar et al., *The Use and Usefulness of the ISO/IEC 9126 Quality Standard*, 2005 INT'L SYMP. ON EMPIRICAL SOFTWARE ENGINEERING 126, 130 (criticizing ISO/IEC 9126 for relying on overly simplistic counting techniques, while providing "no guidance, heuristics, rules of thumb, or any other means to show how to trade off measures, how to weight measures or even how to simply collate them").

122. *See* Irene Eusgeld et al., *Software Reliability* (explaining that "the largest part of hardware failures is considered as a result of physical wearout or deterioration," which is "well-described by exponential equations in the relation to time," whereas software is "pure design" and design failures are "typically only usage dependent and time independent"), *in* DEPENDABILITY METRICS, *supra* note 121, at 104, 105; *see also* ALAIN ABRAN, SOFTWARE METRICS AND SOFTWARE METROLOGY 4, 5 (2010) (noting that "[o]ne of the peculiarities of software engineering relative to other scientific and engineering disciplines is its lack of general use of quantitative data for decision making," and reporting "a very low rate of acceptance and use [of software metrics] by either researchers or practitioners").

123. *See* DAVID FLATER, NAT'L INST. OF STANDARDS & TECH., QUANTITIES AND UNITS FOR SOFTWARE PRODUCT MEASUREMENTS 7 (2020) ("In current practice, many of the elementary quantities of software measurement are multiply-defined and/or ill-defined."); Anas Bassam al-Badareen et al., *A Suite of Rules for Developing and Evaluating Software Quality Models*, 2015 INT'L WORKSHOP ON SOFTWARE MEASUREMENT & INT'L CONF. ON SOFTWARE PROCESS & PRODUCT MEASUREMENT 1, 3 (noting that "there is no commonly accepted model for software quality"); Shari Lawrence Pfleeger et al., *Evaluating Software Engineering Standards*, COMPUTER, Sept. 1994, at 71, 73 ("Software engineering standards are heavy on process and light on product, while other engineering standards are the reverse."). *See generally* DANIEL GALIN, SOFTWARE QUALITY 25–40 (2018) (discussing the

Challenges to defining software performance metrics are at least twofold. The first is one of taxonomy: what is the appropriate set of software quality characteristics? The leading certification model for software product quality is based on ISO/IEC 9126,[124] which has been updated and reissued under the ISO/IEC 25000 series.[125] The 9126 standard defines software product quality as comprising six characteristics: functionality, reliability, usability, efficiency, maintainability, and portability.[126] *Functionality* is defined as the ability of the software to "satisfy stated or implied needs"; *reliability* as the capability of the software "to maintain its level of performance under stated conditions for a stated period of time"; *usability* as "the effort needed for use, and on the individual evaluation of such use" by the software's users; *efficiency* as the balance between "level of performance" and "amount of resources used"; *maintainability* as "the effort needed to make specified modifications"; and *portability* as "the ability of software to be transferred from one environment to another."[127]

Commentators have long criticized the 9126 taxonomy — and others like it — for being arbitrary and underinclusive.[128] Thus the 9126 standard was updated in 2001 to include two additional characteristics: compatibility and security. Commentators have also asked why the

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differences in software quality factors across various standards and the difference in the underlying business needs and process requirements as partly responsible for this lack of uniformity).

124. ISO/IEC 9126:1991 SOFTWARE ENG'G — PROD. QUALITY (1991) (INT'L ORG. FOR STANDARDIZATION & INT'L ELECTROTECHNICAL COMM'N, withdrawn 2001); *see also* R. Geoff Dromey, *A Model for Software Product Quality*, 21 IEEE TRANSACTIONS ON SOFTWARE ENGINEERING 148 (1995) (claiming that ISO 9126 "appears to have gained wide acceptance and consensus").

125. ISO/IEC 25010:2011 SYS. & SOFTWARE ENG'G — SYS. & SOFTWARE QUALITY REQUIREMENTS & EVALUATION (SQUARE) — SYSTEM AND SOFTWARE QUALITY MODELS (INT'L ORG. FOR STANDARDIZATION & INT'L ELECTROTECHNICAL COMM'N 2011) [hereinafter SQuaRE].

126. Gualtiero Bazzana et al., *ISO 9126 and ISO 9000: Friends or Foes?*, 1 IEEE INT'L SOFTWARE ENGINEERING STANDARDS SYMP. 79, 80 (1993). These factors were derived from older models of software quality developed for the military. *See* Rafa E. Al-Qutaish, *Quality Models in Software Engineering Literature: An Analytical and Comparative Study*, J. AM. SCI., Mar. 2010, at 166, 167 (describing McCall's quality model structure as presenting three major perspectives: product revision (maintainability, flexibility, testability), product operations (correctness, reliability, efficiency, integrity, usability), and product transition (portability, reusability, interoperability)). SQuaRE added two additional characteristics: compatibility and security. *See* SQuaRE, *supra* note 125, § 4.2.

127. Bazzana, *supra* note 126, at 80.

128. *See* Al-Kilidar et al., *supra* note 121, at 126–27 (noting early criticisms that ISO/IEC 9126 "was not comprehensive, was difficult to understand, and arbitrary with respect to the selection of characteristics and sub characteristics some of which were unverified and perhaps unverifiable").

standard ignores other values such as modularity, validity, or safety.[129] Even among the six (now eight) characteristics included in the 9126 standard, there are deep conflicts.[130] For example, the redundancy needed to achieve reliability will often cut against goals of efficiency and security.[131] And the history of computing is littered with examples where excess software functionality has interfered with its ease of usability.[132] More counterintuitively, even seemingly compatible qualities such as reliability and safety can work at odds with one another.[133] While some efforts have been made to harmonize or systematize the many taxonomies that have been proposed,[134] none has resolved the contradictions that cut across the many desired attributes of software quality.

The second difficulty is measurement.[135] The 9126 standard has been repeatedly criticized as being subjective, ambiguous, and imprecise.[136] Some software quality researchers have attempted to adapt standard engineering metrics to the software context.[137] But as those

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129. *See id.* at 131 (noting the absence of validity and modularity); *see also* LEVESON, ENGINEERING A SAFER WORLD, *supra* note 80, at 7 ("Safety and reliability are *different* properties. One does not imply nor require the other: A system can be reliable but unsafe. It can also be safe but unreliable.").

130. *Cf.* Alan Z. Rozenshtein, *Wicked Crypto*, 9 U.C. IRVINE L. REV. 1181, 1189 (2019) (describing software security as a "wicked" problem, namely one belonging to that "class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing" (quoting C. West Churchman, *Wicked Problems*, 14 MGMT. SCI. B-141, B-141 (1967))).

131. *See* Felix C. Freiling & Max Walter, *Reliability vs. Security: A Subjective Overview*, *in* DEPENDABILITY METRICS, *supra* note 121, at 255, 255.

132. *See generally* SECURITY AND USABILITY, at ix–x (Lorrie Faith Cranor & Simson Garfinkel eds., 2005) (discussing the role of excessive software safety functionality in reduced software usability); Nancy C. Goodwin, *Functionality and Usability*, 30 COMM. ACM 229, 232 (1987) (discussing academic statistical analysis software, military resource planning applications, and banking consumer databases as examples of excessive and complex functionality leading to loss of usability).

133. LEVESON, ENGINEERING A SAFER WORLD, *supra* note 80, at 11 ("Not only are safety and reliability not the same thing, but they sometimes conflict: Increasing reliability may decrease safety and increasing safety may decrease reliability.").

134. *See generally* al-Badareen et al., *supra* note 123 (outlining a proposal to harmonize software quality characteristics).

135. *See* Al-Kilidar et al., *supra* note 121, at 126 (noting that software "quality as a concept is difficult to define, describe, and understand" because it "has a strong subjective element").

136. *See id.* at 129 (complaining that the standard is "subjective and open to ambiguity," and that users are "able to construct a number of different interpretations, implying that ISO/IEC 9126 is not a *standard* at all"); Rafa E. Al-Qutaish, *An Investigation of the Weakness of the ISO 9126 International Standard*, 2 INT'L CONF. ON COMPUTER & ELECTRICAL ENGINEERING 275, 277–78 (2009) (collecting multiple studies reporting that the characteristics contain ambiguities and are imprecise).

137. *See* Alain Abran et al., *ISO-Based Models to Measure Software Product Quality* (explaining that ISO already has a "very mature measurement terminology" that is "widely accepted and used in most fields of science"), *in* SOFTWARE QUALITY MEASUREMENT: CONCEPTS AND APPROACHES 61, 64 (Ravi Kumar Jain B ed., 2008). *See generally* NORMAN

software metrics researchers have acknowledged, most of the factors associated with software quality do not use "a reference scale typical of measures in the sciences or in engineering," and "no specific method is proposed for [assessing the factors] in a consistent manner across measurers and organizations."[138]

In sum, unlike other engineering disciplines, the software discipline has proved unable to develop equivalently robust process standards or performance metrics, even in those safety-critical sectors where there have been the highest incentives and greatest means to do so. Upon closer inspection, the best standards in software certification turn out to be but faint imitations of their engineering predecessors. They are not true certifications in the sense of being able to assure the quality or safety of a software system.

III. THE SHINING PROFESSIONAL ON A HILL

The exceptionalism of software complexity explains why courts and other lawmakers have hesitated to assign liability to software developers.[139] As long as there are no good ways to manage software complexity, all software will continue to be developed through iterative processes that demand grim acceptance of piecemeal designs, incomplete testing, and a plethora of undiscovered errors.[140] And because

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FENTON & JAMES BIEMAN, SOFTWARE METRICS (3d ed. 2014) (offering a basic primer on the methodology of software metrics).

138. Abran et al., *supra* note 137, at 64; *see also* ABRAN, *supra* note 122, at 216–17 (criticizing the ISO 25021 quality characteristics — inherited from ISO/IEC 9126 — as being "presented only at a fairly abstract level" and "lacking detailed descriptions," which "leaves each of them highly susceptible to individual interpretation"); *cf.* FLATER, *supra* note 123, at 7 (expressing hope that international standardization will improve "[a]s software metrology becomes a mature discipline").

139. *See* Peter A. Alces & Aaron S. Book, *When Y2K Causes "Economic Loss" to "Other Property*,*"* 84 MINN. L. REV. 1, 3 (1999) ("To a surprising extent, the developers of software and software systems have avoided liability for the failures of their products. The reasons for this are not immediately obvious . . . . The law has not provided the victims of software failure the redress that contract and tort theories have generally provided disappointed transactors."); Frances E. Zollers et al., *No More Soft Landings for Software: Liability for Defects in an Industry That Has Come of Age*, 21 SANTA CLARA COMPUTER & HIGH TECH. L.J. 745, 766 (2005) ("To date, there have been no reported cases holding a software manufacturer strictly liable for defects in the software."). *But see* Ryan M. Calo, *Open Robotics*, 70 MD. L. REV. 571, 599 (2011) (asserting that lawsuits "can and do gain traction" where software glitches lead to physical harms).

140 . *See* Ellen Ullman, *The Myth of Order*, WIRED (Apr. 1, 1999, 12:00 PM), https://www.wired.com/1999/04/y2k [https://perma.cc/B7CD-ZMA6] (observing that software developers have "develop[ed] a normal sense of failure, an everyday relationship with potential disaster," and have learned to cope by "ignor[ing] all thoughts about the consequences" or by "develop[ing] an odd sort of fatalism, a dark, defensive humor in the face of all the things you know can go wrong").

each iterative cycle is necessarily makeshift and patchy, then it is difficult to identify a non-arbitrary basis for holding certain matters of inattention to be "reasonable" and others to be "unreasonable."[141] Thus it is understandable that so many discussions of software liability have gravitated toward all-or-nothing treatments such as strict liability or general immunity — and that of those two, public policy has favored the latter option. For example, the pure economic loss rule is often invoked as a reason to summarily dismiss software liability claims.[142] But its application to software sweeps beyond the usual normative justifications for the rule[143] — suggesting that courts have stretched early economic loss cases to avoid adjudicating more difficult questions of reasonable care in software development.[144]

In the absence of effective legal interventions, many of those seeking to hold software developers responsible for harmful code have flocked instead to professional ethics.[145] A dominant theme in recent years has been that software developers should be governed by ethical

141. *See* Marchant & Lindor, *supra* note 6, at 1334 (describing the futility of applying marginal cost-benefit analysis to software development).

142. *See, e.g.*, Rockport Pharmacy, Inc. v. Dig. Simplistics, Inc., 53 F.3d 195, 198–99 (8th Cir. 1995) (reversing jury verdict awarding $56,000 in damages for negligent provision of software and maintenance services, because loss of data is a purely economic loss).

143. Some commentators have pointed to unexplained discrepancies in the application of the economic loss rule to software versus non-software cases. *See* Alces & Book, *supra* note 139, at 49 (questioning the scope of the economic loss doctrine to preclude recovery for harm caused by software to "other property"). Other commentators have explained that the justifications for the economic loss rule are narrower when contracting parties are involved, and that courts have misapplied the rule by disregarding the fact that software users are contracting parties. *See* Geistfeld, *supra* note 51, at 393, 395 (stating that "the availability of tort recovery for pure economic losses depends on whether the ordinary consumer has the requisite information to protect the relevant set of interests by contracting," and arguing therefore that the economic loss rule should not bar users who are unable "to evaluate the risk or degree to which [software] is vulnerable to hacking and other types of cyberbreaches"); Catherine M. Sharkey, *Can Data Breach Claims Survive the Economic Loss Rule*, 66 DEPAUL L. REV. 339, 361, 378–79 (2017) (explaining that courts use the contracting parties paradigm to carve out exceptions to the economic loss rule for professionals such as lawyers, doctors, and accountants, and arguing that courts should likewise "embrac[e] the contracting parties paradigm as the starting point" in data breach cases).

144. *Cf.* Kyle Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Incentives*, 52 SANTA CLARA L. REV. 1241, 1248, 1252 (2012) (observing that, in the automobile liability context, early "frightened-horse" cases produced "automobile-friendly rules with staying power" that persisted "even as time passed and the number of automobiles and the associated body count both soared").

145. *See, e.g.*, Ipek Ozkaya, *Ethics Is a Software Design Concern*, IEEE SOFTWARE, May/June 2019, at 4, 4; Cade Metz, *Is Ethical A.I. Even Possible?*, N.Y. TIMES (Mar. 1, 2019), https://nyti.ms/2Xyg7b9 [https://perma.cc/L4RC-KSA6].

standards comparable to other "professionals" such as doctors and lawyers.[146] The implied connotation is that doctors and lawyers hold themselves to a standard *higher* than other ordinary occupations, and that software developers should likewise raise the bar for their own practices.[147]

Yet, a closer examination of this syllogism raises at least two incongruities. The first is that courts have consistently refused to recognize software developers as "professionals" like doctors and lawyers.[148] This raises the question of what the entry conditions are for legal recognition as a profession. The second is that — even if the professional label were apt — professional ethics are not necessarily correlated with a heightened standard of care.[149] To the contrary, critics have long attacked the professional designation as a protectionist scheme that shields unacceptably *lax* standards of conduct.[150]

Those contradictions complicate the story as to whether and how software ethics could improve the quality of software development practices. That confusion can be traced to the conflation of professional standards and heightened standards. As elaborated below, that error not only impedes application of the professional designation where it would be useful, but also sets unrealistic expectations of what professional ethics can achieve in lieu of legal enforcement. The professional standard of care should be understood as neither a heightened threshold nor a lowered one, but instead as a *tertium quid*.

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146. *See* CRAWFORD ET AL., *supra* note 18, at 25 ("In professions such as medicine and law, professional conduct is governed by a code of ethics that dictates acceptable and unacceptable practices."); Balkin, *supra* note 23, at 1208; Chien, *supra* note 21, at 5.

147. *See* Rustad & Koenig, *supra* note 27, at 1590 ("The common law imposes a higher duty of care upon professionals such as doctors or lawyers." (citing RESTATEMENT (SECOND) OF TORTS § 299A (AM. LAW INST. 1965))); *see also* Hizey v. Carpenter, 830 P.2d 646, 649, 654 (Wash. 1992) (finding that while codes of ethics "do not create standards of civil liability," expert witnesses may base their opinion of a professional's legal duty of care on a professional's "failure to conform to an ethics rule").

148. *See supra* note 25 (collecting representative cases interpreting the laws of Connecticut, Florida, Michigan, Minnesota, Missouri, New York, Ohio, Texas, and Wisconsin). No cases on point were found in other jurisdictions. *Accord* Rustad & Koenig, *supra* note 27, at 1590 ("[T]o date, no court has held that a software engineer's failure to develop reasonably secure software constituted professional negligence.").

149. *See* Nadia N. Sawicki, *Character, Competence, and the Principles of Medical Discipline*, 13 J. HEALTH CARE L. & POL'Y 285, 296–97 (2010) ("[P]rofessional licensure and discipline standards are established to ensure a minimal level of competence, rather than to identify aspirational standards of professional conduct. . . . The appropriate view of professional licensure, then, is as a floor beyond which practitioners may not drop, rather than an ideal towards which they must strive.").

150. *See, e.g.*, RICHARD L. ABEL, AMERICAN LAWYERS 38 (1989) ("[T]he goal of self-regulation often appears to be to protect the inept members of the profession rather than the society they ostensibly serve."); MILTON FRIEDMAN, CAPITALISM AND FREEDOM 157 (1962) (arguing that licensure "tend[s] to render standards of practice low" by "making it much more difficult for private individuals to collect from physicians for malpractice").

A. Professionalism as Personal Traits

The idea of holding software developers to the same standard as doctors and lawyers is not a novel one.[151] From the earliest days of commercial software, resourceful plaintiffs have attempted to assert professional malpractice claims against software developers.[152] Uniformly, courts have held that software developers are not professionals because they do not walk, talk, and act like other professionals. The few courts that have considered this question in depth have begun and ended their analysis by reciting a long list of traits that the "professional" possesses, and that the software developer lacks. A prototypical example is *Hospital Computer Systems, Inc. v. Staten Island Hospital*,[153] a case involving failed delivery of a custom-built accounting and billing software system. There, the court declared:

> A profession is not a business. It is distinguished by the requirements of extensive formal training and learning, admission to practice by a qualifying licensure, a code of ethics imposing standards qualitatively and extensively beyond those that prevail or are tolerated in the marketplace, a system for discipline of its members for violation of the code of ethics, a duty to subordinate financial reward to social responsibility, and, notably, an obligation on its members, even in non-professional matters, to conduct themselves as members of a learned, disciplined, and honorable occupation.[154]

Likewise in a more recent case, *Superior Edge, Inc. v. Monsanto Co.*,[155] the court rejected a computer malpractice claim in part because,

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151. *See* Susan Nycum, *Liability for Malfunction of a Computer Program*, 7 RUTGERS J. COMPUTERS TECH. & L. 1, 9–11 (1979) (weighing whether computer programmers could be held to a professional standard of care); Rustad & Koenig, *supra* note 27, at 1590 ("In the future, it is possible that courts will hold internet security professionals to a higher professional standard of care, similar to those currently imposed on doctors, lawyers, accountants, and other established professionals."); Scott, *supra* note 28, at 473 (arguing that it is time to hold software vendors liable as professionals for distributing insecure software).

152. *See* Chatlos Sys., Inc. v. Nat'l Cash Register Corp., 479 F. Supp. 738, 740–41 n.1 (D.N.J. 1979) ("The novel concept of a new tort called 'computer malpractice' is premised upon a theory of elevated responsibility on the part of those who render computer sales and service. . . . In the absence of sound precedential authority, the court declines the invitation to create a new tort.").

153. 788 F. Supp. 1351 (D.N.J. 1992).

154. *Id.* at 1361 (quoting Lincoln Rochester Trust Co. v. Freeman (*In re* Estate of Freeman), 311 N.E.2d 480, 483 (N.Y. 1974)).

155. 44 F. Supp. 3d 890 (D. Minn. 2014).

unlike traditional professions, the ability to practice computer programming "is not restricted or regulated at present by state licensing laws," and "there is no substantial self-regulation or standardization of training within the programming or consulting professions."[156] Courts are in clear agreement that the mere fact that computer programming is "complex" or requires great skill or knowledge is insufficient as a marker of professionalism.[157] Formal educational requirements are not a meaningful barrier to entry in the software industry.[158] No state requires software developers to be licensed, and no disciplinary mechanism exists that would prohibit any individual from writing and distributing software programs to the general public.[159]

Most commentators on software liability have simply recited this trait-based test without critical examination, and have turned their attention instead to whether software developers could meet that test. Thus, Michael Scott and others have suggested a tiered approach whereby the most highly trained and skilled software practitioners could be elevated above others for purposes of malpractice claims.[160] Advocates like Michael Rustad and Thomas Koenig have homed in on

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156. *Id.* at 912 (quoting RAYMOND T. NIMMER, THE LAW OF COMPUTER TECHNOLOGY § 9.30 (4th ed. 2012)); *accord* Racine Cty. v. Oracular Milwaukee, Inc., 767 N.W.2d 280, 286 (Wis. Ct. App. 2009) (quoting RAYMOND T. NIMMER, THE LAW OF COMPUTER TECHNOLOGY § 9.30 (3d ed. 2008)).

157. *See* Ferris & Salter, P.C. v. Thomson Reuters Corp., 889 F. Supp. 2d 1149, 1152 (D. Minn. 2012) ("Yet, despite the complexity of the work, computer programming and consultation lack the indicia associated with professional status for purposes of imposing higher standards of reasonable care."); *Chatlos Sys.*, 479 F. Supp. at 740 n.1 ("Simply because an activity is technically complex and important to the business community does not mean that greater potential liability must attach."); *cf.* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 12 (AM. LAW INST. 2010) ("If an actor has skills or knowledge that exceed those possessed by most others, these skills or knowledge are circumstances to be taken into account in determining whether the actor has behaved as a reasonably careful person.").

158. *See* Graham Wilson, *Building a New Mythology: The Coding Boot-Camp Phenomenon*, ACM INROADS, Dec. 2017, at 66, 66 (noting that the gap between the number of graduates and positions available generates opportunities to bypass university degree programs).

159. Although there was some brief momentum to require state licensure for software engineers who work on systems affecting public health, safety, and welfare, *see* Phillip A. Laplante, *Licensing Professional Software Engineers: Seize the Opportunity*, COMM. ACM, July 2014, at 38, 38–39, that movement has since abated, *see* Press Release, Nat'l Council of Exam'rs for Eng'g & Surveying, NCEES Discontinuing PE Software Engineering Exam (Mar. 13, 2018), https://ncees.org/wp-content/uploads/Software-Engineering-exam-news-release.pdf [https://perma.cc/KYK5-J2T8] ("NCEES will discontinue the [PE] Software Engineering exam after the April 2019 exam administration. Since the original offering in 2013, the exam has been administered five times, with a total population of 81 candidates. Only 19 candidates registered for the April 2018 administration.").

160. *See* Scott, *supra* note 28, at 474 ("[T]hose who develop operating systems and security software are generally at the higher end of the profession in terms of education, training, and experience. . . . [I]t is certainly possible to hold programmers who write critical software . . . to a higher standard than those who write less critical code such as word processors and videogames.").

the absence of a licensure-and-disbarment scheme as the single most critical obstacle to judicial recognition of software developers as professionals.[161] Some members of the software community have taken the approach of adopting and touting codes of ethics as a marker of responsible self-regulation.[162]

Yet, a closer study of the trait-based approach shows that it harks back to an outmoded theory of professionalism,[163] which in turn calls into doubt the judicial authority that relies on it.[164] Beginning in the early-twentieth century, the sociology literature sought to define the "professional" by studying a few canonical professions — such as medicine, law, and the clergy[165] — and distilling a taxonomy of essential attributes.[166] Those studies yielded a range of now-familiar descriptors, including but not limited to specialized intellectual expertise, formal education, licensure systems, disciplinary mechanisms, and an overall "gentlemanly" culture.[167]

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161. *See* THOMAS H. KOENIG & MICHAEL L. RUSTAD, GLOBAL INFORMATION TECHNOLOGIES: ETHICS AND THE LAW 55 (2018) ("[C]ourts do not recognize computer malpractice because this field does not have a governing body (such as a state bar association), an enforceable code of professional ethics or licensing laws.").

162. *See* Gasser & Schmitt, *supra* note 23, at 8 (observing that "individual and powerful technology companies are publishing formal expressions of norms as a mode of self-regulation," which "function as an articulation of ethical guidelines or principles," and that "initiatives for ethical AI principles are stemming from third party organizations" as well).

163. *See* ANDREW ABBOTT, THE SYSTEM OF PROFESSIONS 3–9 (1988) (reviewing older approaches in the sociology literature); Bernard Barber, *Some Problems in the Sociology of the Professions*, 92 DÆDALUS 669, 671–73 (1963) (discussing the evolution of the definition of a profession); *see also* Haupt, *Professional Speech*, *supra* note 32, at 1249 n.35 (collecting a sample of major works in the field).

164. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. b (AM. LAW INST. 2020) ("In defining which occupational groups are 'professionals,' courts consider whether the practice of the occupation requires formal training and a license issued by a public body, whether the occupation has an internal code of conduct and discipline, and whether there is a need for complex discretionary judgments in carrying out the work."); Posner, *supra* note 26, at 3–4 (listing a typology of nine factors that cultivate "professional mystique").

165. *See* Haupt, *Professional Speech*, *supra* note 32, at 1248 nn.31–32 (noting that the three classic learned professions were theology, law, and medicine); Wade, *supra* note 33, at 465 ("Traditionally, there have been four 'learned professions' — law, medicine, ministry, and teaching."); ELLIOTT A. KRAUSE, DEATH OF THE GUILDS: PROFESSIONS, STATES, AND THE ADVANCE OF CAPITALISM, 1930 TO THE PRESENT 11 (1996) (observing that the medieval universities created a scholarly professoriate, as well as "a medical profession and two kinds of legal professional — experts in civil or administrative law and canon lawyers destined for legal careers in the growing international bureaucracy of the church itself").

166. *See, e.g.*, A.M. CARR-SAUNDERS & P.A. WILSON, THE PROFESSIONS 294 (1933); A.M. CARR-SAUNDERS, PROFESSIONS: THEIR ORGANIZATION AND PLACE IN SOCIETY 3–31 (1928); Ernest Greenwood, *Attributes of a Profession*, SOC. WORK, July 1957, at 45, 45 (1957) (listing the systematic attributes of professional careers); Talcott Parsons, *The Professions and Social Structure*, 17 SOC. FORCES 457, 457–59 (1939) (discussing the main attributes of professionals in a market economy).

167. Other factors that have been mentioned include high pay, autonomy, unstandardized work, essence to society, and historic social status. *See* Julius A. Roth, *Professionalism: The*

The motivation for these sociological case studies was not merely academic. The turn of the twentieth century had seen a sudden onrush of new licensure schemes, peddled by numerous trade groups for the purpose of socioeconomic protectionism.[168] These new occupational licensing statutes were generally sustained by courts.[169] Thus, the movement to define the "professional" was an effort to preserve some meaningful distinction of the venerable occupations from the *nouveaux métiers*.

By mid-century, the professionalism literature had matured and was under attack for being elitist. A new generation of scholars argued that the trait-based approach lacked any rigorous theory other than to elevate arbitrarily favored groups at the expense of others.[170] To redress such problems, the new wave of professionalism scholars turned their attention instead to constructing a *process theory* of professionalization.[171]

B. Professionalism as a Process

The process school sought to recast professionalism as a formula that any occupation could perform.[172] Though opinions differed as to

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Sociologist's Decoy, 1 SOC. WORK & OCCUPATIONS 6, 6–15 (1974) (collecting various taxonomies); *see also* Sande L. Buhai, *Profession: A Definition*, 40 FORDHAM URB. L.J. 241, 244 (2012) (attempting to identify the "common characteristics" of the professions, such as specialized education, expert knowledge, trust, and an ethos other than maximizing profit).

168. *See* Lawrence M. Friedman, *Freedom of Contract and Occupational Licensing, 1890–1910: A Legal and Social Study*, 53 CALIF. L. REV. 487, 497, 500 (1965) (explaining that "friendly" occupational licensing legislation, suggested and drafted by the affected occupation, "was a relatively novel phenomenon which grew rapidly between 1890 and 1910," and that "[a]lmost all of these groups were troubled by 'competition.'"); Robert B. Reich, *Toward a New Consumer Protection*, 128 U. PA. L. REV. 1, 7 (1979); Douglas A. Wallace, *Occupational Licensing and Certification: Remedies for Denial*, 14 WM. & MARY L. REV. 46, 46 n.1 (1972) ("[T]he period from 1906–35 represented a peak in the enactment of new licensing legislation."); *see also* BURTON J. BLEDSTEIN, THE CULTURE OF PROFESSIONALISM 84 (1976) (describing the rapid growth of professional associations, societies, and schools in the last quarter of the nineteenth century).

169. *See* Friedman, *supra* note 168, at 511.

170. *See* GEOFFREY MILLERSON, THE QUALIFYING ASSOCIATIONS 3–4 (1964) (levying three major critiques: first, that authors are biased by their own group affiliations and roles, such that "the measures are presented with their own occupations in mind"; second, that many authors "rely upon the same formulae, containing slight additions" without considering "the problem afresh"; and third, "characteristics and definitions have been moulded to fit arguments"); Mike Saks, *A Review of Theories of Professions, Organizations and Society: The Case for Neo-Weberianism, Neo-Institutionalism and Eclecticism*, 3 J. PROFESSIONS & ORG. 170, 172 (2016) (describing the trait approach as "essentially atheoretical").

171. *See* ABBOTT, *supra* note 163, at 5–20 (discussing more recent developments in the study of professionalization).

172. *See, e.g.*, THEODORE CAPLOW, THE SOCIOLOGY OF WORK 139–40 (1954) ("Indeed, it may be asserted that virtually all non-routine white-collar professions are in the process of being professionalized to some extent."); Harold Wilensky, *The Professionalization of Everyone?*, 70 AM. J. SOC. 137, 137 (1964) ("Yet there is a recurrent idea among the students of

the substantive content of that process, all agreed on the general premise that "professional" should be a dynamic label, not a static one reserved for only a fixed set of groups. Yet, while the sociological critique of the traditional trait-based test has been widely accepted, its impact on legal doctrine has been surprisingly limited. That lacuna strongly suggests that the professional designation performs some function other than to hail ordinary improvements in standards of care or trust.

Some thinkers tied professionalism to the higher degree of skill, training, and education required for certain occupations.[173] According to this view, professionalization arises out of the need to guard against charlatans and fraudsters who would tarnish the reputation of honest practitioners.[174] As knowledge accumulates, the path to expert competence demands ever-increasing investments of time, labor, and capital. Inevitably, there are efforts to undercut or cheat those requirements.

A competing view focused on the cultivation of shared group ethos through codes of conduct and licensure schemes.[175] Some scholars went a step further, arguing that elevation to professional status depended on the group placing the public interest above its own self-interest.[176] Thus, the adoption of a code of ethics came to be seen as a

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occupations that the labor force as a whole is one way or another becoming more professionalized."). *But see* ELIOT FREIDSON, PROFESSIONALISM REBORN 15 (1994) ("[A]n emphasis on process rather than structure, on professionalization rather than on the attributes of professions, does not really solve the problem of definition. . . . Without *some* definition of profession the concept of professionalization is virtually meaningless, as is the intention to study process rather than structure.").

173. *See* Wilensky, *supra* note 172, at 138 (arguing that the job of a professional is based on "systematic knowledge or doctrine"); *see also* Claudia E. Haupt, *Unprofessional Advice*, 19 U. PA. J. CONST. L. 671, 679–80 (2017) (claiming the "key defining feature" of the learned professions is that they are "knowledge communities"); Rebecca Roiphe, *A History of Professionalism: Julius Henry Cohen and the Professions as a Route to Citizenship*, 40 FORDHAM URB. L.J. 33, 48 (2012) ("Because they were organized around merit and skill rather than privilege and wealth, the professions provided a radically egalitarian way of seeking status.").

174. *See Introduction* to THE AMERICAN MEDICAL ETHICS REVOLUTION, *supra* note 34, at xiii, xxiv–xix; FREIDSON, *supra* note 172, at 157–63.

175. *See* CAPLOW, *supra* note 172, at 139–40; Mark S. Frankel, *Professional Codes: Why, How, and with What Impact?*, 8 J. BUS. ETHICS 109, 110 (1989) (likening a profession to a "moral community," members of which "'are distinguished as individuals and as a group by widely shared goals, beliefs about the value of those goals, . . . about the appropriate means for achieving them, and about the kinds of relations which in general should prevail among themselves, and in many cases between themselves and others.'" (quoting PAUL F. CAMENISCH, GROUNDING PROFESSIONAL ETHICS IN A PLURALISTIC SOCIETY 48 (1983))).

176. *See* TALCOTT PARSONS, THE SOCIAL SYSTEM 435 (1951) ("The 'ideology' of the [medical] profession lays great emphasis on the obligation of the physician to put the 'welfare of the patient' above his personal interests . . . ."); Geoffrey C. Hazard, Jr., *The Future of Legal Ethics*, 100 YALE L.J. 1239, 1243 (1991) ("The narrative of the American legal profession conveys a similarly clear ideal: that of the fearless advocate who champions a client threatened with loss of life and liberty by government oppression.").

crucial component of the process of professionalism.[177] Many trade organizations renamed and expanded their "codes of professional conduct" to become "codes of ethics."[178] The new codes of ethics added broad statements of public interest advising members to perform public service, to protect public safety, health, and welfare, and to uphold human rights.[179]

Critics quickly emerged: not all agreed as a normative matter that the professional classes should be expanded.[180] The economic crises of the 1970s reinforced fears that professional licensure was merely a self-serving form of monopolistic protectionism, without concomitant public benefit.[181] Thinner profits also led to fierce competition and infighting among licensed members, leading to heavy-handed efforts to

177. *See* Greenwood, *supra* note 166, at 49–51 (discussing the role of professional code of ethics in development of law as a profession); *see also* R.M. MacIver, *The Social Significance of Professional Ethics*, 297 ANNALS AM. ACAD. POL. & SOC. SCI. 118, 118 (1955) (describing professional codes of ethics as a key differentiator of businesses and professions).

178. IEEE modernized its code of ethics in 1974 in response to a dramatic rise in unemployment among electrical engineers. *See* Arthur P. Stern, *IEEE Code of Ethics*, IEEE SPECTRUM, Feb. 1975, at 65, 65 (announcing adoption of "an IEEE Code of Ethics for Engineers at its meeting of December 4, 1974"); *see also* A. MICHAL MCMAHON, THE MAKING OF A PROFESSION: A CENTURY OF ELECTRICAL ENGINEERING IN AMERICA 263–64 (1984). The American Institute of Architects revised its standards of professional practice in 1977 to include a much broader code of ethics. *See* CODE OF ETHICS & PROF'L CONDUCT (AM. INST. ARCHITECTS 1977), http://ethics.iit.edu/ecodes/node/3029 [https://perma.cc/P92L-S8AR].

179. *See, e.g.*, Stern, *supra* note 178 ("Engineers shall . . . . [p]rotect the safety, health and welfare of the public and speak out against abuses in these areas affecting the public interest"); CODE OF ETHICS & PROF'L CONDUCT Canon 1 (AM. INST. ARCHITECTS 1977) ("Members of The American Institute of Architects should serve and promote the public interest in improving the human environment.").

180. *See* FRIEDMAN, *supra* note 150, at 150 (critiquing the medical profession as "perhaps the strongest trade union in the United States" and noting the disadvantages of allowing a trade union "to restrict the number who may engage in a particular occupation"); Note, *Counterrevolution in State Constitutional Law*, 15 STAN. L. REV. 309, 311 (1963) (describing the "wave of trade regulation" as "economically objectionable"); *see also* Philip C. Kissam, *Antitrust Law and Professional Behavior*, 62 TEX. L. REV. 1, 11 (1983) (describing a shift in analysis of professionalization in the 1960s from the "functionalist" theory to the "Chicago school" critique of professions).

181. *See* ABEL, *supra* note 150, at 143 ("The suspicion that professional associations promulgate ethical rules more to legitimate themselves in the eyes of the public than to engage in effective regulation is strengthened by the inadequacy of enforcement mechanisms."); JEFFREY BERLANT, PROFESSION AND MONOPOLY 1–3 (1975) (discussing the role of professionalization of medicine in dominating the market and dealing with external stakeholders); MAGALI SARFATTI LARSON, THE RISE OF PROFESSIONALISM, at xiii–xviii (1977) (arguing that classical arguments about disinterest of professionals in profit ignores the historical role of professional associations and guilds in monopolizing profits); *see also* Claudia E. Haupt, *Licensing Knowledge*, 72 VAND. L. REV. 501, 515–18 (2019) (describing standard economic critiques of state licensing of professions); Kissam, *supra* note 180, at 19–21, 30–32 (theorizing that courts are more likely to strike down professional rules aimed at enforcing economic standards, but more likely to defer to rules aimed at setting technical standards).

stamp out "unethical" practices such as advertisement and direct solicitation.[182]

Moreover, if the professional title could be gained, then it could also be lost. At its intellectual height, "professional" was viewed as a title that could lift all boats.[183] In part, there was the expectation that professionalization could provide job security, higher pay, and better living standards to a broader swath of workers. But there was also a loftier hope that the ethical mandate might catalyze a rise in public service by professionals to redress more challenging societal inequities.[184] When it became clear that professionalization was not fulfilling either of those two great hopes,[185] the academy turned sour.[186] Much of the most recent literature on professionalism has lamented the "decline" of professionalism in the most venerable professions,[187] and has questioned whether the title of professional can be retained when individual profit and self-interest are pursued at the expense of moral duty.[188]

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182. *See* Ohralik v. Ohio State Bar Ass'n, 436 U.S. 447, 457–68 (1978) (upholding state discipline of a lawyer for engaging in direct solicitation); Nat'l Soc'y of Prof'l Eng'rs v. United States, 435 U.S. 679, 692–99 (1978) (striking down an engineering code of ethics ban on competitive bidding); Bates v. State Bar of Ariz., 433 U.S. 350, 363–84 (1977) (striking down a state bar association ban on attorney advertising); Va. State Bd. of Pharmacy v. Va. Citizens Consumer Council, Inc., 425 U.S. 748, 761–73 (1976) (striking down a state ban on advertising of prescription drug prices); Goldfarb v. Va. State Bar, 421 U.S. 773, 780–93 (1975) (invalidating minimum-fee schedule); Bhd. of R.R. Trainmen v. Virginia *ex rel.* Va. State Bar, 377 U.S. 1, 4–8 (1964) (invalidating Virginia's injunction against a lawyer referral service).

183. *See* FREIDSON, *supra* note 172, at 106 (collecting scholarly discussions of the benefits of professionalization).

184. *See, e.g.*, Marc Galanter, *Why the "Haves" Come Out Ahead: Speculations on the Limits of Legal Change*, 9 L. & SOC'Y REV. 95, 150–51 (1974) ("The contribution of the lawyer to redistributive social change, then, depends upon the organization and culture of the legal profession.").

185. *See, e.g.*, Tigran W. Eldred & Thomas Schoenherr, *The Lawyer's Duty of Public Service: More than Charity*, 96 W. VA. L. REV. 367, 369–74 (1993) (lamenting the insufficient provision of legal services for the poor); William H. Rehnquist, Dedicatory Address, *The Legal Profession Today*, 62 IND. L.J. 151, 154, 156–57 (1987) (questioning whether law has gone too far in becoming like a business, and less like a professional calling, and whether this shift has caused a loss in professionalism and ethics).

186. *See* FREIDSON, *supra* note 172, at 149, 154–57 ("[S]cholarship concerned with the professions is in an intellectual shambles. . . . The tone of most of this literature is hostile to the professions, but, because it is essentially unanalytic, much of it remains on a level of criticism so diffuse that one is at a loss to understand its implications."); Roth, *supra* note 167, at 17 ("Sociologists . . . have become the dupe of established professions (helping them justify their dominant position and its payoff) and arbiters of occupations on the make . . . .").

187. *See* Warren E. Burger, *The Decline of Professionalism*, 61 TENN. L. REV. 1, 2–7 (1993); William H. Simon, Comment, Babbitt v. Brandeis*: The Decline of the Professional Ideal*, 37 STAN. L. REV. 565, 571–84 (1985).

188. *See* Carl T. Bogus, *The Death of an Honorable Profession*, 71 IND. L.J. 911, 922–28 (1996); Thomas L. Shaffer, *Lawyer Professionalism as a Moral Argument*, 26 GONZ. L. REV. 393, 402–04 (1990); *see also* Gerard Hanlon, *Professionalism as Enterprise: Service Class Politics and the Redefinition of Professionalism*, 32 SOCIOLOGY 43, 43 (1998); William M. Sullivan, *Markets vs. Professions: Value Added?*, DÆDALUS, Summer 2005, at 19, 21–23.

Those who retain optimism have called for a "rekindling" of the public service role of professionals.[189] Other scholars have doubled down, arguing that the failure of the professions as a whole to meet their public service obligations to the needy implies that the social contract is broken, and the practice should be re-opened to non-professionals.[190] These calls for de-professionalization bring us full cycle back to the Jacksonian mood of anti-elitism.[191]

In sum, modern sociological theory correctly recast the professions as a dynamic set of changing members, rather than as a static class of fixed members. Yet, the judicial case law on professional malpractice has remained tethered to the trait-based test, which effectively preserves the status quo on unreasoned grounds.[192] Under that old precedent, even the adoption of higher standards of training, licensure, or ethics by the software community is unlikely to lead to judicial recognition of the software community as a profession, or to offer reliable

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But cf. Deborah L. Rhode, *The Professionalism Problem*, 39 WM. & MARY L. REV. 283, 303–07 (1998) (observing that complaints about professionalism are age old).

189. *See, e.g.*, COMM'N ON PROFESSIONALISM, AM. BAR ASS'N, ". . . IN THE SPIRIT OF PUBLIC SERVICE:" A BLUEPRINT FOR THE REKINDLING OF LAWYER PROFESSIONALISM 12–54 (1986), *reprinted in* 112 F.R.D. 243, 263–304 (1986); Allen R. Dyer, *Ethics, Advertising and the Definition of a Profession*, 11 J. MED. ETHICS 72, 76 (1985) (calling for "old ethics" to be "taken more seriously"). *But see* Nancy J. Moore, *Professionalism Reconsidered*, 12 AM. B. FOUND. RES. J. 773, 782 (1987) (critiquing the myth of the "golden age of professionalism"); Norman W. Spaulding, *The Practice of Law as a Useful Art: Toward an Alternative Theory of Professionalism*, 40 FORDHAM URB. L.J. 433, 444 (2012) ("[T]he ultimate object of nostalgic recollection is a patrician ideal. . . . But the material conditions for this patrician ideal never existed for most American lawyers.").

190. *See* THOMAS D. MORGAN, THE VANISHING AMERICAN LAWYER 55–56 (2010); CLIFFORD WINSTON ET AL., FIRST THING WE DO, LET'S DEREGULATE ALL THE LAWYERS 82 (2011); Leslie C. Levin, *The Monopoly Myth and Other Tales About the Superiority of Lawyers*, 82 FORDHAM L. REV. 2611, 2630 (2014) (arguing that deregulation is needed to increase access to justice); Deborah Jones Merritt & Daniel C. Merritt, *Responsibility-Rights in the Legal Profession*, 43 ARIZ. ST. L.J. 1257, 1270–71 (2011) (arguing that "[g]iven lawyers' longstanding failure to satisfy their responsibility-rights," society should "open law practice to competition by replacing lawyers' broad responsibility-rights with a nonexclusive right to practice law").

191. *See* Marie R. Haug, *The Deprofessionalization of Everyone?*, 8 SOC. FOCUS 197, 211–12 (1975) (arguing that the increased dissemination of esoteric knowledge and the erosion of trust are "rendering the concept of profession obsolete"); *see also* Mehlman, *Professional Power*, *supra* note 32, at 1171–72 ("The Jacksonians opposed licensure on the ground that the laws merely created professional monopolies . . . . The Thomsonians objected that licensure impermissibly interfered with individual liberty."); Jed Handelsman Shugerman, *The Creation of the Department of Justice: Professionalization Without Civil Rights or Civil Service*, 66 STAN. L. REV. 121, 138–40 (2014) (describing criticisms of the Jacksonian era "for opening up the bar too broadly," and subsequent efforts "to restore a measure of honor or prestige to the legal profession by making it more exclusive").

192. *See* Wade, *supra* note 33, at 477 ("For some time now, people engaged in activities other than the traditional professions have been regarding themselves as participating in a profession. . . . On this issue, the courts have been slower to act and the decisions somewhat unpredictable.").

guidance in resolving disputes over software liability. The next Part operationalizes the dynamic theory of professions by rejecting the trait-based test and offering instead a functionalist test based on the need for professional judgment.

IV. ONE VIEW OF THE PROFESSIONAL

As a matter of tort law, this Article argues, the main function of the "professional" label has been to shift the standard of care from reasonable care to customary care.[193] Injuries committed by a professional are judged by a different legal standard than injuries committed by a non-professional. When a non-professional is sued for negligence, the defendant's conduct is compared against that of the "ordinary reasonable person."[194] By contrast, when the defendant is a professional, the relevant metric is the custom of the profession — not the ordinary reasonable person or even the ordinary reasonable professional.[195] Instead of asking jurors to apply their own opinion of reasonable conduct, the customary care standard restricts the jury inquiry to assessing compliance with the profession's internal custom.[196]

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193. *See* DOBBS ET AL., *supra* note 29, § 21.1, at 494 ("[T]he traditional duty to patients is not the familiar duty of reasonable care, but rather the duty to comply with medical customs . . . ."); *see also* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. c (AM. LAW INST. 2020) ("Courts often speak of this as a 'customary' or 'professional' standard of care.").

194. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 3 cmt. a (AM. LAW INST. 2010) ("Because a 'reasonably careful person' (or a 'reasonably prudent person') is one who acts with reasonable care, the 'reasonable care' standard for negligence is basically the same as a standard expressed in terms of the 'reasonably careful person' (or the 'reasonably prudent person')."); David G. Owen, *The Five Elements of Negligence*, 35 HOFSTRA L. REV. 1671, 1677 (2007) (explaining that "negligence law normally compares the defendant's conduct to an external standard of good behavior, an 'objective' standard").

195. *See* DOBBS ET AL., *supra* note 29, § 21.6, at 506 ("As long as a doctor followed the medical standard or custom, he is not legally negligent under the medical standard, regardless of how risky the custom might be. Conversely, if he failed to follow the medical standard of care, he would be negligent under that standard even in the absence of scientific studies establishing the need for the precaution customarily taken."); Vincent R. Johnson, *Legal Malpractice in a Changing Profession: The Role of Contract Principles*, 61 CLEV. ST. L. REV. 489, 516 (2013) ("The standard of care for a malpractice suit can be articulated only by reference to practices and principles so well established that they form a dependable guide for the exercise of judgment by a jury."); Phillip G. Peters, Jr., *The Quiet Demise of Deference to Custom: Malpractice Law at the Millennium*, 57 WASH. & LEE L. REV. 163, 165 (2000) [hereinafter Peters, *Quiet Demise*] ("Under a custom-based standard of care, the relevant inquiry is not whether the defendant behaved like a reasonable person or even whether she behaved as a reasonable physician, but instead whether the defendant conformed with customary practices."); *see also* Kirsch v. Duryea, 578 P.2d 935, 939 (Cal. 1978) (holding that the attorney's action "must be shown to have been so manifestly erroneous that no prudent attorney would have done so," and that "it is not sufficient to show that some or many prudent attorneys would not have made the mistake").

196. *See* Osborn v. Irwin Mem'l Blood Bank, 7 Cal. Rptr. 2d 101, 128 (Cal. Ct. App. 1992) ("[P]rofessional prudence is defined by actual or accepted practice within a profession, rather

Various justifications have been offered for the shift from reasonable care to customary care. One set of theories focuses on professional *traits* such as heightened competence or trust.[197] Thus, professionals are learned and capable of dealing with complex matters, whereas jurors are portrayed as incapable of evaluating professional skill and knowledge.[198] Moreover, professionals are said to be deserving of special deference because they occupy positions of heightened trust, due to the need for special confidences during intimate counseling settings,[199] power asymmetries between professionals and those they

than theories of what 'should' have been done."); Theodore Silver, *One Hundred Years of Harmful Error: The Historical Jurisprudence of Medical Malpractice*, 1992 WIS. L. REV. 1193, 1212 (1992) ("[A] physician's duty is not measured by the ordinary rule of reasonableness, but rather by professional custom. The doctor is bound to do no more than follow ordinary practice within the profession."); *see also* ABA Comm. on Ethics & Prof'l Responsibility, Formal Op. 97-407, at 4 (1997), https://www.americanbar.org/content/dam/aba/events/professional_responsibility/2017%20Meetings/Conference/conference_materials/session10_ethics_issues_relating_to_the_use_of_expert_witness/aba97_407.pdf [https://perma.cc/KA7R-DUTN] (explaining that the role of a testifying expert in a legal malpractice case is to provide an opinion as to the "requirements of law or standards of legal practice").

197. *See* RESTATEMENT (SECOND) OF TORTS § 299A (AM. LAW INST. 1965) (stating that a professional has a duty "to exercise the skill and knowledge normally possessed by members of that profession or trade in good standing in similar communities"); *id.* § 299A cmt. c ("This undertaking is not necessarily a matter of the requirements of the particular task undertaken . . . . It is a matter of the skill which [the professional] represents himself to have . . . ."); PAUL C. WEILER, MEDICAL MALPRACTICE ON TRIAL 20 (1991) ("The justification for the exceptional treatment that tort law reserves for doctors must consist . . . in the tacit assumption that the medical profession can generally be trusted to adopt on its own the appropriate level of care for its patients."); Mehlman, *Professional Power*, *supra* note 32, at 1226 ("Not surprisingly, the rationales that doctors have special expertise and that they act in the public interest are the primary justifications offered in support of the medical profession controlling its standard of care."); Posner, *supra* note 26, at 2 ("The hallmark of a profession is the belief that it is an occupation of considerable public importance, the practice of which requires highly specialized, even esoteric, knowledge that can be acquired only by specialized formal education or a carefully supervised apprenticeship . . . .").

198. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. c (AM. LAW INST. 2020) ("[A] professional's methods, nearly by definition, will be difficult for jurors to evaluate from scratch. It is more practicable for them to say whether the professional's acts were consistent with standard practice in the profession than to say whether the acts were reasonable.").

199. *See* Caroline Forell & Anna Sortun, *The Tort of Betrayal of Trust*, 42 U. MICH. J.L. REFORM. 557, 567 (2009) (stating that the central role of professionals such as doctors, lawyers, and clergy is "to provide services to people who are faced with personal problems that require both undivided loyalty and the maintenance of confidentiality).

serve,[200] or other public-service aspects.[201] This approach of "professional knows best" has generated a confusing list of plausible candidates that generally includes doctors, lawyers, and accountants, but casts an uncertain net around many other disparate occupations.[202] It

200. *See* Canterbury v. Spence, 464 F.2d 772, 780 (D.C. Cir. 1972) ("The average patient has little or no understanding of the medical arts, and ordinarily has only his physician to whom he can look for enlightenment with which to reach an intelligent decision."); Haupt, *Professional Speech*, *supra* note 32, at 1249 & n.37 (noting commentary that "the professional-client relationship is asymmetric"); *see also* Gary A. Munneke & Anthony E. Davis, *The Standard of Care in Legal Malpractice: Do the Model Rules of Professional Conduct Define It?*, 22 J. LEGAL PROF. 33, 42 (1998) ("Agency concepts are at the heart of the attorney-client relationship, and the duty of care owed by lawyers to clients frequently can be described in terms of the responsibilities of agents to principals. Viewed in this light, the [ethics codes] and malpractice law have common roots.").

201. *See* Wade, *supra* note 33, at 466 ("[S]ome of the earliest cases, historians tell us, were actions brought against persons who held themselves out as practicing a 'public calling.' Public callings included a blacksmith or a gunsmith, and also a surgeon or an attorney.").

202. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. b AM. LAW INST. 2020) ("Lawyers, doctors, and accountants are invariably regarded by courts as professionals. Insurance agents and architects are examples of additional parties this Restatement would so recognize, whereas construction contractors and tradesmen are on the other side of the line."); *see also* 29 C.F.R. § 541.301 (2019) (defining "learned professionals" as those with advanced knowledge in "law, medicine, theology, accounting, actuarial computation, engineering, architecture, teaching, various types of physical, chemical and biological sciences, pharmacy, and other similar occupations that have a recognized professional status as distinguished from the mechanical arts or skilled trades"); RESTATEMENT (SECOND) OF TORTS § 299A cmt. b (AM. LAW INST. 1965) (listing professions "such as that of physician or surgeon, dentist, pharmacist, oculist, attorney, accountant, or engineer" and extending equivalent treatment to skilled trades "such as that of airplane pilot, precision machinist, electrician, carpenter, blacksmith, or plumber"); DOBBS ET AL., *supra* note 29, § 21.2, at 496 (listing medical professionals as well as non-medical professionals "such as architects, engineers, lawyers, social workers and even sports coaches").

also has sparked trenchant critiques that professional expertise is suspect,[203] that jurors are fully competent to evaluate complex evidence,[204] and that professional exceptionalism itself is a conceptual error.[205]

Instead, a more compelling set of theories looks to the unique aspects of professional *work*. Here, the leading explanation links the need for discretionary professional judgment to the fact that professional work is of a kind that produces outcomes and results that defy standardization.[206] In other words, rather than assume professionals have superior knowledge compared to laypersons, this latter approach treats professionals as equally lacking in certain knowledge. Building on that

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203. *See* Philip G. Peters, Jr., *The Role of the Jury in Modern Malpractice Law*, 87 IOWA L. REV. 909, 953 (2002) [hereinafter Peters, *Role of the Jury*] ("[C]linical 'routines are based not just on clear data and careful reasoning, but also on habit, hunch, current fashion, and the profession's folk wisdom.' As a result, medical customs have a veneer of scientific validity that is too often undeserved." (citation omitted)); Silver, *supra* note 196, at 1213 ("With professional custom as the standard, the nation's physicians may lawfully adopt and follow practices that are patently negligent and unreasonable under the standard of ordinary care to which all others are held."); Alex Stein, *Toward a Theory of Medical Malpractice*, 97 IOWA L. REV. 1201, 1204–05 (2012) ("Courts, however, also realize that medical opinions are not institutionally superior when it comes to cost-benefit tradeoffs that accord preference to one medical setup over another. . . . [D]octors have a self-serving motivation to reduce malpractice liability.").

204. *See* Mehlman, *Professional Power*, *supra* note 32, at 1228 ("Not only do physicians possess less knowledge than at first blush, but lay persons seem [to] be able to properly evaluate the quality of medical care, at least when they are jurors presented with evidence by medical experts."); Richard N. Pearson, *The Role of Custom in Medical Malpractice Cases*, 51 IND. L.J. 528, 535 (1976) ("[J]uries are often required to consider difficult scientific matters which are beyond the knowledge of typical laypersons. . . . Thus, the esoteric quality of the practice of medicine does not in itself seem to be a sufficient justification for the medical custom rule."); *see also* Kathleen M. O'Malley, *Trial by Jury: Why It Works and Why It Matters*, 68 AM. U. L. REV. 1095, 1101 (2019) ("American jurors have historically been called upon to decide complex cases, including those involving detailed scientific inquiry. . . . [T]he Supreme Court has shown no willingness to find a 'complexity exception' based on the text of the Seventh Amendment or its historical underpinnings.").

205. *See* Peters, *Quiet Demise*, *supra* note 195, at 192 ("Over the second half of this century, courts appear to have lost their faith that physicians are sufficiently different from engineers, truck drivers, product manufacturers and other businesses to justify the many special legal privileges previously accorded physicians."); Silver, *supra* note 196, at 1219 ("How then did the professional custom rule arise? The limited existing record indicates that it arose through conceptual confusion, compounded by the law's propensity toward 'lazy repetition.'").

206. *See* Wade, *supra* note 33, at 468 ("There is still a third element to be considered, although it is somewhat difficult to analyze because it is not as thoroughly identified or as fully developed as the 'requirements' of care and competence. This element is the exercise of an enlightened professional judgment."); *see also* 29 U.S.C. § 152(12)(a) (2018) (defining "professional employee" to mean one engaged in work that is (i) "predominantly intellectual," (ii) involves "the consistent exercise of discretion and judgment in its performance," (iii) produces output or results that "cannot be standardized," and (iv) requires "knowledge of an advanced type" acquired by "specialized intellectual instruction"); RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. b (AM. LAW INST. 2020) ("In defining which occupational groups are 'professionals,' courts consider . . . whether there is a need for complex discretionary judgments in carrying out the work.").

model, the following discussion expounds that the need for a customary care standard is especially acute where (1) bad outcomes are endemic to the practice of an art or trade, (2) those bad outcomes are caused by inherent uncertainties and imprecisions in the science of that art, and yet (3) the continued practice of the art is vital even (or especially) where outcomes are expected to be worst. To the extent that those factors fade or are no longer present, courts may be justified in transitioning back to the ordinary reasonable care standard.[207] This conception of professionalism incorporates the modern view that professionalism is a dynamic process with a member set that evolves over time. But it ties the threshold condition for professionalization to scientific uncertainty rather than to personal character or nobility.[208]

A. Two Approaches to Professional Malpractice

The doctrine of professional malpractice liability has come to comprise two main types of claims: professional negligence and breach of fiduciary duty.[209] Those two frameworks are typically assumed to be

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207. *See* Epstein, *Big Law*, supra note 35, at 66 ("At one point in the cycle, professionals are critical to the development of new fields and disciplines that would otherwise be outside the circle of human knowledge. . . . But later on in the cycle, that form of innovation is no longer needed . . . ."); Posner, *supra* note 26, at 4 ("[O]ne can imagine computerized diagnostic techniques and artificial intelligence eventually eroding the positions of the physician and of the lawyer, respectively."); William Meadow & Cass R. Sunstein, *Statistics, Not Experts*, 51 DUKE L.J. 629, 631 (2001) (proposing that the legal system should rely "on statistical data about doctors' performance rather than on the opinions of experts about doctors' performance . . . for the simple reason that [this statistical evidence] is becoming increasingly available"). *But see* Michelle M. Mello, *Using Statistical Evidence to Prove the Malpractice Standard of Care: Bridging Legal, Clinical, and Statistical Thinking*, 37 WAKE FOREST L. REV. 821, 825 (2002) (arguing "in favor of a cautious approach in moving towards greater empiricism in establishing the malpractice standard of care"); Mark A. Hall & Michael D. Green, *Introduction*, 37 WAKE FOREST L. REV. 663, 673 (2002) (expressing pessimism "about any hopes that proponents may have" for using empirical data sources to "fundamentally alter[] longstanding methods for proving the medical standard of care").

208. This knowledge-based test of professionalism is consistent with the theory of professions as knowledge communities. *See* Haupt, *Professional Speech*, *supra* note 32, at 1250–51 ("Because the professions are knowledge-based, I contend that they should be thought of as knowledge communities[,] . . . a network of individuals who share common knowledge and experience as a result of training and practice.").

209. *See* DOBBS ET AL., *supra* note 29, § 21.1, at 494 ("Medical malpractice actions sound in negligence. . . . [T]he traditional duty to patients is not the familiar duty of reasonable care, but rather the duty to comply with medical customs . . . ."); *id.* § 45.1, at 1164 ("A lawyer's core duties, often implicated in legal malpractice cases, include the duties of professional care and competence, but also includes the special duties of fiduciaries . . . ."). While professional negligence can be characterized either as a tort claim or as an "implied duty" under a breach-of-contract theory, the two forms are treated as essentially equivalent. *See id.* § 45.1, at 1164 ("[W]here the breach of contract claim is based on the same facts as a tort claim for legal malpractice, the former may be stricken as redundant."); Roy Ryden Anderson & Walter W. Steele, Jr., *Fiduciary Duty, Tort and Contract: A Primer on the Legal Malpractice Puzzle*, 47

harmonious. After all, malpractice claims arise most often in the context of medical and legal services; the natural presumption is that doctors and lawyers should act both as professionals and as fiduciaries, and that those twin duties are complementary if not symbiotic.[210]

In fact, there is a fundamental tension between the two approaches to professional malpractice. One framework defers to the profession's internally constructed norms and practices, while the other framework is an avenue for outside observers to hold the profession to higher ideals of acceptable care.[211] Where the two approaches clash, there is little clarity as to which one should prevail.[212] The reason for confusion is that the choice depends on one's theory of why professionals are "professionals." If one believes the main differentiating feature is that professionals have heightened obligations relative to non-professionals, then the fiduciary framework is the more attractive fit. By contrast, if the principal reason to set professionals apart is that they practice in areas of great scientific uncertainty, then the customary care framework should preempt.

SMU L. REV. 235, 235 (1994); Wade, *supra* note 33, at 467 (noting that a professional negligence action could be brought in tort or contract but that the "tort remedy . . . is now the usual vehicle"); *see also* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 reporter's note a (AM. LAW INST. 2020) ("Whether a claim of professional negligence proceeds in tort or in contract affects the outcome only occasionally.").

210. *See* Tim Cramm, Arthur J. Hartz & Michael D. Green, *Ascertaining Customary Care in Malpractice Cases: Asking Those Who Know*, 37 WAKE FOREST L. REV. 699, 703 (2002) (offering two possible justifications for reliance on custom: (1) "the specialized and complex nature of medical care is such that a lay jury is unlikely to have knowledge or experience that would enable it to determine what is, in some sense, objectively reasonable," and (2) "physicians are professionals whose first priority is dedication to the interests of their patients").

211. Although the fiduciary duty is primarily a duty of loyalty, it is possible to characterize bad care as a breach of loyalty. *See, e.g.*, Maxwell J. Mehlman, *Why Physicians Are Fiduciaries for Their Patients*, 12 IND. HEALTH L. REV. 1, 2–3 (2015) [hereinafter Mehlman, *Why Physicians*] (arguing that physicians are fiduciaries of their patients, because physicians "have greater knowledge and experience, and because they often have control over patients, especially when the patients are unconscious or so ill, afraid, or in pain that they cannot adequately fend for themselves"); Michelle Oberman, *Mothers and Doctors' Orders: Unmasking the Doctor's Fiduciary Role in Maternal-Fetal Conflicts*, 94 NW. U. L. REV. 451, 488 (2000) ("The patient has a right not only to be free from unwanted touching, but also to rely upon her doctor as a fiduciary — as 'the advocate and champion of his patient, upholding the patient's interest *above all others*.'").

212. *See* Mehlman, *Why Physicians*, *supra* note 211, at 30 (noting that physicians "can breach their fiduciary duty even if the care that they provided meets the standard of care for negligence"); Oberman, *supra* note 211, at 459 ("[A]lthough the issue of fiduciary duty occasionally arises in the context of medical negligence actions, it is used only as a vehicle for evaluating the physician's technical clinical competence, generally as it relates the duty to obtain an informed consent.").

1. Professional Negligence

Professional negligence has long been associated with the customary care standard, which evolved in the common law as an alternative to the reasonable care standard.[213] Under the customary care standard, "the only question is what in fact the standard of care is and whether or not the [professional] fulfilled it, not whether the standard is too high or low to produce socially desirable results."[214] That factual inquiry stands in contrast to the normative reasonable care inquiry applied to non-professionals.[215]

The content of a profession's custom is determined by expert witness testimony. An expert's opinion must speak to the actual standard of care; the expert cannot simply second-guess the defendant's conduct.[216] But the expert may rely on personal experience, practice guidelines, codes of ethics, or other relevant indicia to opine on what the professional custom is.[217] Professional norms can be generated within

213. *See* DOBBS ET AL., *supra* note 29, § 21.6, at 506 ("The professional standard of care is not identical to the reasonable person standard used in most negligence cases."); Page Keeton, *Professional Malpractice*, 17 WASHBURN L.J. 445, 455 (1978) ("[T]he standard of care required by a physician was the care *customarily* or ordinarily exercised by a physician of like kind in the *same community*. . . . Custom established the standard, and so the profession established the standard."); *see also* Silver, *supra* note 196, at 1225 (tracing the origin of the customary care rule to *Hawthorn v. Richmond*, 48 Vt. 557 (1876)).

214. Mehlman, *Professional Power*, *supra* note 32, at 1186; *see also* Cramm et al., *supra* note 210, at 702–03 ("For custom, though, the jury is asked . . . whether [the defendant-physician] adhered to the custom employed by other physicians. The jury's assessment of whether the custom is reasonable or unreasonable is irrelevant — the only question is whether the defendant followed that custom in treating the patient."); Peters, *Role of the Jury*, *supra* note 203, at 913 ("[T]he custom-based standard of care 'gives the medical profession . . . the privilege, which is usually emphatically denied to other groups, of setting their own legal standards of conduct, merely by adopting their own practices.'" (quoting W. PAGE KEETON ET AL., PROSSER AND KEETON ON TORTS § 32 (5th ed. 1984))).

215. *See* Cramm et al., *supra* note 210, at 699–700 ("[T]he duty applied to medical professionals is a purely factual one, unlike the normative 'reasonable care' standard invoked for non-professionals."). Some commentators have been skeptical that this jury factfinding role functions well. *See* Mark A. Hall, *The Defensive Effect of Medical Practice Policies in Malpractice Litigation*, LAW & CONTEMP. PROBS., Spring 1991, at 119, 129 ("This breakdown between theory and practice essentially allows the jury to impose, based on its own independent judgment, the governing standard of care — the very result malpractice law attempts to avoid.").

216. *See* DOBBS ET AL., *supra* note 29, § 21.8, at 509–10 ("If the plaintiff's expert witness can testify only that he was medically trained not to use the procedure used by the defendant, that in his own judgment the defendant's treatment was wrong, that he himself would not have used the procedure or would have used a better one, or that all the doctors he knows agree that the treatment was wrong, his testimony has not necessarily established a standard.").

217. *See* Hizey v. Carpenter, 830 P.2d 646, 654 (Wash. 1992) ("[E]xperts on an attorney's duty of care may still properly base their opinion . . . on an attorney's failure to conform to an ethics rule. In so testifying, however, the expert must address the breach of the *legal* duty of care, and not simply the supposed breach of the ethics rules."); Cramm et al., *supra* note 210, at 710 ("Physicians' opinions about medical practice come from their own training (including continuing education) and their own patient care.").

institutional bounds such as professional associations, but they can also be generated within less formal settings as well.[218]

Where there is no established professional custom, professionals are given latitude, since there can be no deviation from a custom that does not exist.[219] That deference allows for the coexistence of multiple schools of thought regarding the appropriate course of action.[220] Historically, the most prominent example of such heterogeneity was the locality rule, which exhibits sensitivity to the need for differences among regional norms as well as across urban versus rural practices subject to different resource constraints.[221] Additionally, the multiple schools doctrine encompasses situations where knowledge may be highly uncertain, hotly contested, or newly evolving.[222] This view of custom's role stands in contrast to the view that a custom must be clearly established in order to have value.[223]

At the opposite end, certain matters of "common knowledge" are decidable by a jury without expert testimony on professional custom.[224]

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218. *See* Haupt, *Professional Speech*, *supra* note 32, at 1252 ("But professional norms are generated outside of these associations as well. Conferences and the professional literature, for example, are sites of professional knowledge formation, even though they are not necessarily embodied in specific institutions or professional associations.").

219. *See* DOBBS ET AL., *supra* note 29, §21.8, at 509–10 (explaining that where "it is difficult to say that there is a customary standard or that anyone knows what it is . . . the plaintiff may find her case dismissed"); Schwartz, *supra* note 53, at 664 ("Traditional malpractice law has long limited the ability of the jury to resolve such disagreements among doctors; when intelligent doctors can disagree, the defendant cannot be found guilty of malpractice."); *see also* Benjamin C. Zipursky, *Legal Malpractice and the Structure of Negligence Law*, 67 FORDHAM L. REV. 649, 677 (1998) ("The parallel requirement of proof of deviation from the community norm (and related evidentiary requirements) has received little criticism or commentary, however, in legal malpractice. This is curious [given] the absence of 'scientific expertise' and 'sympathetic plaintiff' rationales in law . . . .").

220. *See* RESTATEMENT (SECOND) OF TORTS § 299A cmt. f (AM. LAW INST. 1965) ("The law cannot undertake to decide technical questions of proper practice over which experts reasonably disagree."); Cramm et al., *supra* note 210, at 704–05 (describing the "two schools of thought" doctrine).

221. *See* Russo v. Griffin, 510 A.2d 436, 437 (Vt. 1986) (explaining that the locality rule was developed to protect the rural and small town practitioner); Mehlman, *Professional Power*, *supra* note 32, at 1180 (describing the medical profession's success in "inducing the courts to adopt simultaneously the strict locality and customary care rules"); *see also* RESTATEMENT (SECOND) OF TORTS § 299A cmt. g (AM. LAW INST. 1965).

222. *See* Philip G. Peters, Jr., *Empirical Evidence and Malpractice Litigation*, 37 WAKE FOREST L. REV. 757, 772–73 (2002) [hereinafter Peters, *Empirical Evidence*] (pointing to uncertainty of patient symptoms and therapeutic responses, as well as uncertainties in the science itself, as among the reasons why "there will rarely be a 'custom' that provides a clear rule of decision").

223. *See* Jennifer E. Rothman, *The Questionable Use of Custom in Intellectual Property*, 93 VA. L. REV. 1899, 1969 (2007) ("When there are such competing customs, the custom is less certain and therefore will have substantially less value . . . . The clearer the custom and the greater the unanimity of participation in and uniformity of the description of that custom, the more likely the custom is to have value.").

224. *See* Television Capital Corp. of Mobile v. Paxson Commc'n Corp., 894 A.2d 461, 469 (D.C. 2006) ("[I]n a legal malpractice action, the plaintiff must present expert testimony

Where the professional commits "an obviously careless act, such as fracturing a leg during examination, amputating the wrong arm, dropping a knife, scalpel, or acid on a patient, or leaving a sponge in a patient's body,"[225] the jury is allowed to infer negligence based on common knowledge.[226] In general, however, the common knowledge exception has been construed very narrowly,[227] so that it does not become a way to second-guess core aspects of professional judgment.[228]

While some commentators view the professional care standard as a heightened standard,[229] others have criticized it for reducing the duty owed and for giving too much deference to professionals.[230] This split in opinion has generated substantial debate as to whether the customary care standard retains valid purpose or whether it should be replaced with the reasonable care standard.[231] Three developments are often

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establishing the standard of care unless the attorney's lack of care and skill is so obvious that the trier of fact can find negligence as a matter of common knowledge." (quoting O'Neil v. Bergan, 452 A.2d 337, 341 (D.C. 1982))).

225. Pfiffner v. Correa, 643 So.2d 1228, 1233 (La. 1994); *see also* Ault v. Hall, 164 N.E. 518, 523 (Ohio 1928) ("The subject of custom, in the technical sense of usage which has attained the force of law, is not involved in this proceeding. . . . Usage cannot avail to establish as safe in law that which is dangerous in fact.").

226. In that regard, there is a close link between "common knowledge" and res ipsa loquitur. *See, e.g.*, Pacheco v. Ames, 69 P.3d 324 (Wash. 2003) (finding no error with jury instruction on res ipsa loquitur where dentist drilled on wrong side of the mouth).

227. *See* Stein, *supra* note 203, at 1214 ("[C]ourts tend to limit the common-knowledge exception to cases in which a doctor leaves a foreign object . . . in the patient's body and cases in which a doctor injures the patient by acting in a blatantly careless way . . . . Even these categories of cases are narrowly construed.").

228. *See* Pearson, *supra* note 204, at 551 (conjecturing that "if courts expand the number of medical matters that are determined to be within the common knowledge of lay persons, juries will be able to impose liability without regard to the medical standard of care").

229. *See, e.g.*, Meredith J. Duncan, *Legal Malpractice by Any Other Name: Why a Breach of Fiduciary Duty Claim Does Not Smell as Sweet*, 34 WAKE FOREST L. REV. 1137, 1141 (1999) ("A cause of action for professional negligence differs from the typical negligence action in that a profession is held to a higher standard of care than is an ordinary member of society."); Wade, *supra* note 33, at 467 ("The doctor or lawyer is held, however, to a higher measure of competence (i.e., knowledge and skill) than the ordinary layman in conducting the activities of his profession.").

230. *See* DOBBS ET AL., *supra* note 29, § 21.6, at 507 (noting that the medical standard "reduc[es] the duty owed" and that it "has been criticized as giving too much deference to the medical profession to set its own standards"); Comment, *Professional Negligence*, 121 U. PA. L. REV. 627, 634 (1973) ("The 'professional standard,' as perceived by some, has been criticized as less demanding than the standards by which tradesmen and other laymen are evaluated."); Douglas E. Rosenthal, *Evaluating the Competence of Lawyers*, 11 LAW & SOC'Y REV. 257, 264–65 (1976) (noting that one approach evaluates performance "in terms of *minimal* standards of competence," and that "[i]n virtually all cases in which this form of incompetence has been determined, the lawyer has made some important error of omission, analogous to abandoning the client, such as letting the statute of limitations run").

231. *See* DOBBS ET AL., *supra* note 29, § 21.2, at 496 ("Some courts are now reevaluating this 'professional duty' rule in favor of a general standard of the reasonable person under the circumstances . . . ."); Peters, *Quiet Demise*, *supra* note 195, at 201 ("The weakening of support for a special standard of care for professionals also is consistent with the gradual movement of twentieth century tort law away from an array of special duties and immunities

highlighted as evidence that deference to professionals is on the decline: the demise of the locality rule, the *Helling v. Carey* holding, and the informed consent doctrine. Despite the outsized attention those reform efforts have attracted, their effect on the customary care standard has been rather modest.

Of the three, the locality rule has undergone the most palpable change. The rule, which restricts expert testimony to similar professionals practicing in the same local area, came under sharp criticism for shielding lax conduct by practitioners in rural or small communities, because it created hurdles to litigation such as lack of qualified witnesses or conspiracies of silence.[232] Pointing to improvements in communication, travel, and education, many courts declared that a uniform national standard was more appropriate for the modern era.[233] Today there is widespread consensus that the locality rule is mainly defunct.[234] That said, several commentators have observed that the need for local variances remains relevant because professional practices continue to vary a great deal by region and by resource availability.[235]

Alongside the movement toward a uniform national standard, a contemporaneous debate arose whether the customary care standard ought to be replaced by a "reasonable physician" standard. Famously, in the 1974 case *Helling v. Carey*,[236] the Washington Supreme Court overrode undisputed evidence of medical custom and held that ophthalmologists were negligent as a matter of law for failing to administer a

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tailored for specific social contexts and toward a general and more flexible obligation of reasonable care.").

232. *See* Robbins v. Footer, 553 F.2d 123, 128 (D.C. Cir. 1977) (explaining concerns that "strict adherence to the same locality requirement could completely immunize doctors who were the only practitioners in a small community and small groups of local physicians whose common lax practice fell below that ordinarily practiced in rural areas generally").

233. *See* Vergara v. Doan, 593 N.E.2d 185, 186 (Ind. 1992) ("With advances in communication, travel, and medical education, the disparity between rural and urban health care diminished and justification for the locality rule waned."); *see also* Gary T. Schwartz, *The Vitality of Negligence and the Ethics of Strict Liability*, 15 GA. L. REV. 963, 968 (1981) ("For better or worse, ignoring local practice and reducing the controlling effect of custom releases malpractice arguments from previous constraints and permits courts to consider more fully the typical negligence variables of risk magnitude and risk prevention costs.").

234. RESTATEMENT (THIRD) OF THE LAW GOVERNING LAWYERS § 52 cmt. b (AM. LAW INST. 2000) ("The locality test is now generally rejected for all professions, because all professionals can normally obtain access to standard information and facilities, because clients no longer limit themselves to local professionals, and because of the practicalities of proof in malpractice cases.").

235. *See* Peters, *Empirical Evidence*, *supra* note 222, at 772 (describing findings that "physician practices vary widely, even within narrow geographic limits" because "[p]atients vary in ways that resist standardization" and "[t]his variation in patients is matched by similar variety in possible therapeutic responses"); Nicholson Price, *Medical AI and Contextual Bias*, 33 HARV. J.L. & TECH. 65, 91–98 (2020) (arguing that medical standards of care need to be constructed differently for high-resource settings versus low-resource settings).

236. 519 P.2d 981 (Wash. 1974).

simple glaucoma test to persons under the age of forty.[237] Since then, for nearly half a century, scholars have asked whether *Helling* could be signaling an emerging trend toward a uniform reasonable care standard.[238] Most commentators, however, have concluded that *Helling* was an outlier decision that the majority of states declined to follow.[239]

The third concurrent trend was changes to the informed consent doctrine.[240] When evaluating whether physicians should have disclosed medical risks to patients, many courts have not only embraced the reasonable physician standard, but also gone further to embrace a reasonable patient standard.[241] Under the customary care standard, a physician can offer the defense that a particular disclosure is not required by medical custom. But under the reasonable physician or reasonable patient rule, liability can be found whenever the jury decides that the patient

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237. *Id.* at 983 ("The test is a simple pressure test, relatively inexpensive. There is no judgment factor involved . . . . We therefore hold, as a matter of law, that the reasonable standard that should have been followed . . . was the timely giving of this simple, harmless pressure test to this plaintiff . . . .").

238. *See* DOBBS ET AL., *supra* note 29, § 21.6, at 507 ("A number of courts have now said or implied that the standard of care for health care providers is the reasonable care standard applied in negligence law generally. Statutes also sometimes prescribe a reasonable care standard."); Peters, *Quiet Demise*, *supra* note 195, at 171–72 (arguing that "*Helling*'s rejection of customary norms was not aberrant" and that "many other courts have reached the same conclusion"). *But see id.* at 188 (cautioning that the relevant judicial opinions show "a proclivity for unclear or inconsistent language, sometimes using terms from both tests interchangeably," and that "American courts historically have believed that compliance with customary care *defined* reasonable care for professionals").

239. *See* Osborn v. Irwin Mem'l Blood Bank, 7 Cal. Rptr. 2d 101, 126 (Cal. Ct. App. 1992) ("Most of the commentary on this case has been unfavorable."); Leonard J. Nelson III, Helling v. Carey *Revisited: Physician Liability in the Age of Managed Care*, 25 SEATTLE U. L. REV. 775, 776 (2002) ("*Helling* has not been followed by courts in other states . . . . Moreover, it does not appear, that this trend toward the adoption of a reasonable, prudent physician standard has resulted in a change in the way that most malpractice cases are tried."); *see also* WEILER, *supra* note 197, at 20 ("Later analysis of *Heller* demonstrated that the decision itself is a textbook illustration of the dangers of a court's taking upon itself the responsibility for deciding which medical practices are reasonable and which are not.").

240. *See* WEILER, *supra* note 197, at 24 ("A notable and controversial change of direction was taken by a number of courts in the early seventies. Instead of asking what the reasonable *doctor* believed should be sensibly disclosed, these jurisdictions substituted the norm of what the reasonable *patient* believed would be important to learn."). *See generally* RUTH R. FADEN & TOM L. BEAUCHAMP, A HISTORY AND THEORY OF INFORMED CONSENT 86 (1986) ("'Informed consent' first appeared as an issue in American medicine in the late 1950s and early 1960s.").

241. *See* Kathy Seward Northern, *Procreative Torts: Enhancing the Common-Law Protection for Reproductive Autonomy*, 1998 U. ILL. L. REV. 489, 511–17 (describing court split between the "professional" standard, the "reasonable physician" standard under *Natanson v. Kline*, 350 P.2d 1093 (Kan. 1960), and the "reasonable patient" standard under *Canterbury v. Spence*, 464 F.2d 772 (D.C. Cir. 1972)); David M. Studdert et al., *Geographic Variation in Informed Consent Law: Two Standards for Disclosure of Treatment Risks*, 4 J. EMPIRICAL LEGAL STUD. 103, 105 (2007) (asserting that 25 states and the District of Columbia have embraced the patient standard, 23 have maintained the professional standard, and 2 states are not easily classifiable).

should have been informed of the medical risk at issue.[242] The informed consent doctrine could be characterized as a cutback of the customary care rule, but again it is unclear how extensive that repudiation has been.[243] The informed consent rule functions more like a duty to warn, rather than like a duty of care.[244] It promotes patient autonomy in *non-medical* judgments, but it does not encroach on professional judgment in the performance of medical care.[245] Where the informed consent rule has threatened to extend beyond non-professional aspects, it has been controverted.[246]

In sum, professional negligence claims continue to be governed by the customary care standard. Despite persistent questions in the academic literature whether professionals should be subject to the same

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242. *See* Studdert et al., *supra* note 241, at 114–17 (finding that the success rate increases substantially from 17% in "professional" standard states to 27% for plaintiffs in "patient" standard states).

243. *See* Harnish v. Children's Hosp. Med. Ctr., 439 N.E.2d 240, 243 (Mass. 1982) ("The patient's right to know must be harmonized with the recognition that an undue burden should not be placed on the physician."); FADEN & BEAUCHAMP, *supra* note 240, at 132–33 (reporting that "the promise and potential glory of a flourishing new doctrine of informed consent . . . quickly faded" and the "professional practice disclosure standard was not displaced in American informed consent law"); *see also* Sheldon F. Kurtz, *The Law of Informed Consent: From "Doctor Is Right" to "Patient Has Rights*,*"* 50 SYRACUSE L. REV. 1243, 1245 (2000) (observing that "the focus of the doctrine . . . is the scope of disclosure by the physician to the patient rather than the scope of the patient's understanding," resulting in physicians "inundat[ing] patients with information they may not understand and hav[ing] them sign a consent form . . . sufficient to absolve them from liability").

244. *See* Andrea Peterson Woolley, Comment, *Informed Consent to Immunization: The Risks and Benefits of Individual Autonomy*, 65 CALIF. L. REV. 1286, 1292 (1977) ("Although both federal and state governments have approached the issue of disclosure of the risks of immunization as a matter of 'informed consent,' the government's recent efforts to provide information on the risks and benefits of vaccines were largely a response to two [failure to warn] products liability cases.").

245. *See* FADEN & BEAUCHAMP, *supra* note 240, at 31 ("These courts argue that a standard of medical practice applies only to specifically medical judgments and that, ultimately, decisions for or against medical care, being *nonmedical* judgments, are reserved to the patient alone."); Sonia M. Suter, *The Politics of Information: Informed Consent in Abortion and End-of-Life Decision Making*, 39 AM. J.L. & MED. 7, 15–16 (2013) ("[T]he scope of disclosure is bound only by what is material to medical, as opposed to non-medical, interests. . . . [T]he law is reluctant to intrude too much into the medical decision-making process. Courts struggle to strike a balance that promotes autonomy while preserving some element of professional discretion for physicians."); *see also* Canterbury v. Spence, 464 F.2d 772, 785 (D.C. Cir. 1972) ("[T]he governing standard [in nondisclosure cases] is much more largely divorced from professional considerations. . . . When medical judgment enters the picture . . . , prevailing medical practice must be given its just due. In all other instances, however, the general standard exacting ordinary care applies, and that standard is set by law.").

246. *See* Caroline Mala Corbin, *Compelled Disclosures*, 65 ALA. L. REV. 1277, 1333–34 (2014) (criticizing mandatory abortion counseling laws and noting that "[t]he last time the Supreme Court found that a speech regulation distorted a profession by altering the professionals' traditional role, it struck it down" (citing Legal Servs. Corp. v. Velazquez, 531 U.S. 533, 544 (2001))); *see also Canterbury*, 464 F.2d at 789 (permitting an exception to the informed consent rule where "communication of the risk information would present a threat to the patient's well-being").

reasonable care standard that governs all other ordinary persons, that merger of treatment has not happened in practice. Thus, the functional consequence of being recognized by courts as a "profession" is that the liability threshold is dictated by the internal norms of the profession, rather than by the external views of ordinary observers.

2. Breach of Fiduciary Duty

An alternative theory of professional malpractice is breach of fiduciary duty.[247] The fiduciary concept originates from the law of trusts, and it requires the trustee to act solely in the beneficiary's interest.[248] In the law of trusts, it is well-established that the two basic principles of fiduciary administration are the duties of loyalty and prudence.[249] By contrast, judicial treatment of professionals as fiduciaries is of relatively recent provenance,[250] and the scope of fiduciary law as applied to professionals remains ill-defined.[251]

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247. *See* 2 RONALD E. MALLEN & JEFFREY M. SMITH, LEGAL MALPRACTICE § 14.1, at 227 (4th ed. 1996) ("[T]he basic fiduciary obligations are two-fold: undivided loyalty and confidentiality."); RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 16 cmt. a (AM. LAW INST. 2020) ("Some fiduciary relationships arise as a matter of law, such as the relation between attorney and client . . . ."); Mehlman, *Why Physicians*, *supra* note 211, at 3–10 & nn.5–6 (collecting exhaustive list of cases and commentary acknowledging the fiduciary nature of the patient-physician relationship); *see also* M.A. v. United States, 951 P.2d 851, 854 (Alaska 1998) ("[W]e have recognized that the unique nature of the physician-patient relationship confers upon physicians a fiduciary responsibility toward their patients."); Wiseman v. Alliant Hospitals, Inc., 37 S.W.3d 709, 713 (Ky. 2000) ("The fiduciary relationship between the parties grants a patient the right to rely on the physician's knowledge and skill.").

248. *See* Anderson & Steele, *supra* note 209, at 236 n.4 ("Like all negligence, professional negligence is failure to perform. Breach of fiduciary duty is *not* failure to perform. Breach of fiduciary duty is failure to adhere to the authority granted by the client. . . . Failure to give undivided loyalty does not necessarily mean that the attorney *performed legal services* negligently.").

249. *See* John H. Langbein, *The Contractarian Basis of the Law of Trusts*, 105 YALE L.J. 625, 655 (1995) (calling loyalty and prudence the "two great principles" of trust fiduciary law).

250. *See* Tamar Frankel, *Fiduciary Law*, 71 CALIF. L. REV. 795, 795–96, 796 n.6 (1983) (noting that "[t]rustees, administrators, and bailees are of ancient origin," but that "physicians and psychiatrists have [only] recently become members of the fiduciary group"); Oberman, *supra* note 211, at 455 ("Widespread adoption of fiduciary terminology in reference to doctors and patients began in the 1980s.").

251. *See* Anderson & Steele, *supra* note 209, at 236 ("Commentators have long noted that '[f]iduciary obligation is one of the most elusive concepts in Anglo-American law.' . . . [H]ow this standard of care plays out in the attorney-client relationship has been little explored by the courts." (citation omitted)); Oberman, *supra* note 211, at 459 ("There is no rich body of case law articulating broad fiduciary standards for physicians, the violation of which would constitute a distinct form of malpractice.").

Movements to characterize professionals as fiduciaries seem to arise from the common intuition that professionals ought to hold themselves to the highest, utmost standard of care.[252] After all, courts and commentators have long described certain professionals as holding relationships of special trust and confidentiality; from there, it seems like a short leap to exchange the word "trust" for "fiduciary."[253] Moreover, if outsiders are unable to assess directly the reasonableness of a professional's conduct, then indirect measures are needed to curb self-dealing and other potential abuses of power.[254] For those discontent to rely solely on the profession's own professions of good faith, the trustee paradigm offers a legal mechanism to force professionals to act with greater integrity than they otherwise might under the customary care standard.[255]

To be sure, codes of professional conduct have long affirmed duties of loyalty[256] and confidentiality[257] to patients and clients. But those ethical duties were viewed as separate from legal duties, not as a primary

252. *See* Hummel v. State, 196 S.W.2d 594, 595 (Ark. 1946) ("It is said that the relation of a physician to his patient is one of the highest trust and that the physician must act with the utmost good faith.").

253. *See* Mehlman, *Why Physicians*, *supra* note 211, at 15–18 (noting with puzzlement that courts and commentators often distinguish the patient-physician relationship as one merely of "trust and confidence," and not one that is "fiduciary" in nature).

254. *See* Frankel, *supra* note 175, at 109–10 ("Historically, the professions and society have engaged in a negotiating process intended to define the terms of their relationship. At the heart of this process is the tension between the professions' pursuit of autonomy and the public's demand for accountability."); Posner, *supra* note 26, at 2 ("[B]ecause the arcane skills of the professional make his performance difficult for outsiders to monitor and therefore facilitate exploitation, it is usually believed that the norms and working conditions of a profession should be such as to discourage the undiluted pursuit of pecuniary self-interest.").

255. *See* Mehlman, *Why Physicians*, *supra* note 211, at 20–21 ("Indeed, if the stronger party in a service relationship did not have conflicts of interest with the weaker party, there would be no reason for the law to make the stronger party a fiduciary to begin with.").

256. *See* CANONS OF ETHICS Canon 6 (AM. BAR ASS'N 1908) ("It is unprofessional to represent conflicting interests . . . ."); *id.* Canon 15 ("The lawyer owes 'entire devotion to the interest of the client, warm zeal in the maintenance and defense of his rights, and the exertion of his utmost learning and ability' . . . ."); CODE OF MED. ETHICS ch. I, art. I, § 2 (AM. MED. ASS'N 1847) ("Every case committed to the charge of a physician should be treated with attention, steadiness, and humanity.").

257. *See* CODE OF MED. ETHICS ch. I, art. I, § 2 (AM. MED. ASS'N 1847) ("Secrecy and delicacy, when required by peculiar circumstances, should be strictly observed; and the familiar and confidential intercourse to which physicians are admitted in their professional visits, should be used with discretion, and with the most scrupulous regard to fidelity and honor."); CANONS OF ETHICS subdiv. III (AM. BAR ASS'N 1908) ("I do solemnly swear . . . I will maintain the confidence and preserve inviolate the secrets of my client . . . .").

source of legal duties.[258] That coupling has become increasingly tightened and formalized in recent decades.[259] In turn, some commentators have sought to expand the fiduciary framework to promote the notion that professionals owe legal duties to society at large, based on the reciprocal trust that society bestows upon their professions.[260]

But the merger of professional duties and fiduciary duties is a poor fit in at least two important respects. One obvious conflict is that professional duties are owed first and foremost to the profession,[261] whereas fiduciary duties are owed exclusively to the beneficiary.[262]

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258. *See* CODE OF MED. ETHICS ch. I, art. I, § 1 (AM. MED. ASS'N 1847) ("Those [ethical] obligations are the more deep and enduring, because there is no tribunal other than his own conscience to adjudge penalties for carelessness or neglect."); CANONS OF ETHICS pmbl. (AM. BAR ASS'N 1908) ("[I]t is peculiarly essential that the system for establishing and dispensing justice be developed to a high point of efficiency and so maintained that the public shall have absolute confidence in the integrity and impartiality of its administration.").

259. *See* Hazard, *supra* note 176, at 1241 ("[O]ver the last twenty-five years or so the traditional norms . . . have become 'legalized.' The rules of ethics have ceased to be internal to the profession; they have instead become a code of public law enforced by formal adjudicative disciplinary process."); *see also* Stanley v. Richmond, 35 Cal. Rptr. 2d 1070, 1086 (Cal. Ct. App. 1995) ("The scope of an attorney's fiduciary duty may be determined as a matter of law based on the Rules of Professional Conduct . . . ."); MODEL RULES OF PROF'L CONDUCT pmbl. & scope para. 20 (AM. BAR ASS'N 2018) ("[S]ince the Rules do establish standards of conduct by lawyers, a lawyer's violation of a Rule may be evidence of breach of the applicable standard of conduct.").

260. *See* Jennifer Gerarda Brown, *Rethinking "The Practice of Law*,*"* 41 EMORY L.J. 451, 458 (1992) ("[W]e should not distinguish the responsibility to serve the public from other professional responsibilities imposed upon the practicing lawyer; we should accept it as an integral part of being a lawyer."); Gary Lawson & Tamara Mattison, *A Tale of Two Professions: The Third-Party Liability of Accountants and Attorneys for Negligent Misrepresentation*, 52 OHIO ST. L.J. 1309, 1335, 1341 (1991) (suggesting that a greater perception of professional obligations to the public could result in greater professional liability to third parties); Edmund D. Pellegrino, *One Hundred Fifty Years Later: The Moral Status and Relevance of the AMA Code of Ethics* ("Physicians, it is alleged, are too closely tied to the dyadic physician-patient relationships; they ought to focus instead on social and population ethics, on economics, and on medicine's new industrialized and institutionalized functions."), *in* THE AMERICAN MEDICAL ETHICS REVOLUTION, *supra* note 34, at 107, 114.

261. *See* Ray L. Patterson, *Legal Ethics and the Lawyer's Duty of Loyalty*, 29 EMORY L.J. 909, 917–18 (1980) ("One of the best kept secrets in American jurisprudence may be that the rules of legal ethics limit the lawyer's duty of loyalty to the client by imposing additional duties of respect for and candor to the court and fairness to others, including opposing counsel and parties."); *Introduction*, *supra* note 174, at xiii–xiv (claiming that "[t]he 1847 AMA Code of Ethics is the world's first national code of *professional* ethics . . . and the ancestor of all professional codes of ethics, medical or nonmedical," marking a "radical transition from personally interpreted 'gentlemanly' ethics to collaboratively interpreted professional ethics"); *see also* Timothy P. Terrell & James H. Wildman, *Rethinking "Professionalism*,*"* 41 EMORY L.J. 403, 409 (1992) ("The heritage of the Bar associations, like that of all trade associations, rests initially in self-interest and protectionism rather than any noble spirit of public service.").

262. *See* Khan & Pozen, *supra* note 24, at 504 n.32 (noting that "the beneficiary's 'right to [the fiduciary's] loyalty is commonly understood as being an *exclusive* claim enjoyed by the beneficiary over the exercise of discretionary power by a fiduciary.'" (alteration in original) (quoting Paul B. Miller, *Multiple Loyalties and the Conflicted Fiduciary*, 40 QUEEN'S L.J. 301, 303 (2014))); Langbein, *supra* note 249, at 655 ("The duty of loyalty requires the trustee

Thus, older codes of professional conduct discouraged the use of advertisements or direct solicitations, claiming they would diminish the profession as a collective body.[263] Moreover, the professional was cautioned not to defer to the client's demands to the detriment of the profession's interests.[264] And members of professions were advised to respect the bonds of fraternity and not to disparage one another in public venues.[265] From the client's standpoint, of course, the modern fiduciary model offers many obvious advantages. But if professionals were authentic fiduciaries, then conventional fiduciary principles should take precedence over any professional duties.[266] To say that professionals owe fiduciary duties *because* professions have codes of ethics, or even that the substantive content of those fiduciary duties should be gov-

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'to administer the trust solely in the interest of the beneficiary.'" (quoting RESTATEMENT (SECOND) OF TRUSTS § 170(1) (AM. LAW INST. 1959))).

263. *See* CANONS OF ETHICS Canon 27 (AM. BAR ASS'N 1908) ("[S]olicitation of business by circulars or advertisements, or by personal communications or interviews, not warranted by personal relations, is unprofessional."); CODE OF MED. ETHICS ch. II, art. I, § 3 (AM. MED. ASS'N 1847) ("It is derogatory to the dignity of the profession, to resort to public advertisements or private cards or handbills . . . ."); *id.* ch. II, art. V, § 9 ("A wealthy physician should not give advice *gratis* to the affluent; because his doing so is an injury to his professional brethren.").

264. *See* CANONS OF ETHICS Canon 15 (AM. BAR ASS'N 1908) ("Nothing operates more certainly to create or to foster popular prejudice against lawyers as a class, and to deprive the profession of that full measure of public esteem and confidence . . . than does the false claim . . . that it is the duty of the lawyer to do whatever may enable him to succeed in winning his client's cause."); CODE OF MED. ETHICS ch. II, art. IV, § 1 (AM. MED. ASS'N 1847) (stating that "no intelligent regular practitioner" should be "refused in consultation, when it is requested by the patient," unless that practitioner's "practice is based on an exclusive dogma, to the rejection of the accumulated experience of the profession"); *see also* Eliot Freidson, *Professionalism and Institutional Ethics* (distinguishing professionals, who "claim ultimate allegiance to some ideal goal — like health, justice, truth, or salvation — that transcends the interests of their immediate patron and even of the state," from technicians, who "serve their patrons literally as 'freelancers' or 'hired guns,' doing whatever work is asked of them within their realm of competence"), *in* THE AMERICAN MEDICAL ETHICS REVOLUTION, *supra* note 34, at 124, 133.

265. *See* CODE OF MED. ETHICS ch. II, art. VI, § 2 (AM. MED. ASS'N 1847) ("[N]either the subject matter of such differences nor the adjudication of the arbitrators should be made public, as publicity in a case of this nature . . . can hardly fail to bring discredit on the faculty."); Mehlman, *Professional Power*, *supra* note 32, at 1179–80 ("The AMA and its affiliated medical societies encouraged their members to defend their colleagues against suits by patients rather than to use malpractice liability as a club with which to beat competitors. Physicians who testified against other physicians were threatened with expulsion."). *But see* CANONS OF ETHICS Canon 29 (AM. BAR ASS'N 1908) ("Lawyers should expose without fear or favor before the proper tribunals corrupt or dishonest conduct in the profession . . . .").

266. *Cf.* Larry E. Ribstein, *Fencing Fiduciary Duties*, 91 B.U. L. REV. 899, 908–09 (2011) ("Thus, the Supreme Court has held that a doctor's duty of care did not make him the patient's fiduciary, observing that a contrary result would be an 'erroneous corruption of fiduciary obligation.'" (quoting Pegram v. Herdrich, 530 U.S. 211, 235 (2000))).

erned by a profession's idiosyncratic code of ethics, is to treat the fiduciary concept "like a nose of wax which may be turned and twisted in any direction."[267]

The other, subtler conflict, therefore, is the one between fiduciary care and customary care.[268] Where the fiduciary model is wielded expansively to impose a heightened standard of care based on what the beneficiary would want, it necessarily requires such liability to be determinable from the perspective of the beneficiaries.[269] That external second-guessing of professional judgment stands in direct contrast to the customary care model, which sets the standard of care according to the internally shared judgment of similarly situated professionals.[270] To the extent the fiduciary obligations contradict the internal practices of a profession, the two approaches are opposed.[271] At the extreme, the fiduciary concept threatens to swallow the customary care rule.[272]

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267. The term "nose of wax" is used in patent law to warn against the malleability of language. *See* White v. Dunbar, 119 U.S. 47, 51 (1886) ("Some persons seem to suppose that a claim in a patent is like a nose of wax which may be turned and twisted in any direction . . . so as to make it include something more than, or something different from, what its words express."). As an example of this malleability, Jack Balkin has argued that the "information fiduciary" framework can be applied on a "special-purpose" basis. *See* Balkin, *supra* note 23, at 1229 ("The nature of their services should guide our judgments about what kinds of duties it is reasonable to impose. We should connect the kinds of duties that information fiduciaries have to the kinds of services they provide.").

268. *See* Langbein, *supra* note 249, at 656 ("The duty of prudent administration is a reasonableness norm, comparable to the reasonable person rule of tort."). *Compare* Anderson & Steele, *supra* note 209, at 245 (noting that a professional "might breach his fiduciary duty to the client even though . . . the level of his performance has not been substandard. The fiduciary standard of care is not that of an ordinary, prudent lawyer, but a standard of 'the most scrupulous honor, good faith and fidelity to his client's interest.'" (quoting Daugherty v. Runner, 581 S.W.2d 12, 16 (Ky. Ct. App. 1978))), *with* Mark A. Hall, *Law, Medicine, and Trust*, 55 STAN. L. REV. 463, 492 (2002) ("Elevated trust merits some legal effort to justify heightened trustworthiness without imposing impossible or unrealistic requirements. The compromise struck by the law is to adopt a professional standard of care . . . .").

269. *See* Anderson & Steele, *supra* note 209, at 249, 254 ("[P]roof of legal malpractice requires expert testimony . . . . However, since an action for breach of fiduciary duty requires merely a showing of misconduct rather than violation of a standard of care, proof of a breach of fiduciary duty may be shown without resort to expert testimony.") (citing Badis v. Martinez, 819 P.2d 551 (Colo. Ct. App. 1991), and Johnson v. DeLay, 809 S.W.2d 552 (Tex. Ct. App. 1991)); Frankel, *supra* note 250, at 830 ("[O]nce a person becomes a fiduciary, the law places him in the role of a moral person and pressures him to behave in a selfless fashion, to think and act for others. In addition, the moral standard is not left to the fiduciary or to custom. . . . [I]n the last analysis, it is the courts that determine the standards.").

270. *See* Oberman, *supra* note 211, at 459 (lamenting that "only those doctors whose actions deviate from an articulated standard of care are held accountable for violating their patients' trust").

271. *See* Anderson & Steele, *supra* note 209, at 249 (observing that "fiduciary duty encompasses undivided loyalty, and a standard of solicitude that requires placing the client's interests over those of the attorney," whereas the professional negligence standard "allows an attorney to take his own interests into consideration while performing legal services").

272. *See* SUSAN SAAB FORTNEY & VINCENT R. JOHNSON, LEGAL MALPRACTICE LAW 134 (2d ed. 2015) ("The relationship between fiduciary duty law and negligence law is a source

Thus far, the customary care standard has prevailed where the conflict with fiduciary duties has been explicitly considered by courts.[273] In *Pegram v. Herdrich*,[274] for example, the Supreme Court explained that the fiduciary theory "translates into no rule readily applicable to HMO decisions or those of any other variety of medical practice," because it would interfere with the physician's discretion to give treatment sparingly or aggressively as needed.[275] "Nor would it be possible," the unanimous Court added, "to translate fiduciary duty into a standard that would allow recovery [whenever a medical decision] resulted in a bad outcome for the patient," because any such standard would convert the doctor "into a guarantor of recovery."[276] Although it is tempting to demand that trusted professionals should exercise higher and higher care, professional care is a matter best left to self-determination by the professions themselves. Professional care should not be conflated with fiduciary care.

B. The Need for Professional Judgment

If customary care is the centerpiece of the professional liability regime, as this Article has argued, then the professional designation is appropriate only when the internal opinion of professional members is a more reliable lodestar of improper conduct than the external opinion of lay jurors. That reason is unlikely to be because professionals are more knowledgeable or more trustworthy than other members of society.[277] Instead, a more fertile inquiry will be to unpack why professional work requires greater deference to expert judgment than do other types of skilled work. This Article offers an explanatory theory comprising three factors: (1) bad outcomes are endemic to the practice of the profession, (2) those bad outcomes are mainly attributable to inher-

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of potential difficulty. If fiduciary obligations are too broadly construed, they will quickly swallow the law of professional negligence.").

273. *See* Pegram v. Herdrich, 530 U.S. 211, 235 (2000) ("Thus, for all practical purposes, . . . the fiduciary standard would be nothing but the malpractice standard traditionally applied in actions against physicians."); Neade v. Portes, 739 N.E.2d 496, 502–03 (Ill. 2000) (refusing to recognize a new cause of action for breach of fiduciary duty because it "would be duplicative of the medical negligence claim"); Mehlman, *Why Physicians*, *supra* note 211, at 23 n.42 (collecting cases from ten other states holding that a patient has no cause of action for breach of fiduciary duty that is distinct from an action for medical malpractice); *see also* Hall, *supra* note 268, at 493 (observing that courts "have resisted efforts to craft legal theories based on fiduciary law that would circumvent conventional medical malpractice standards").

274. 530 U.S. 211 (2000).

275. *Id.* at 234.

276. *Id.* at 234–35. For a more extended discussion of *Pegram*, see Mehlman, *Why Physicians*, *supra* note 211, at 23–26.

277. *See supra* notes 197–205 and accompanying text.

ent uncertainties in the science of the profession, and (3) the profession's services are socially vital even where outcomes are expected to be bad.

First, by interceding in fraught areas, doctors and lawyers become lightning rods for tort claims. Left unchecked, every professional can expect to face lawsuits on a regular basis.[278] In fact, some evidence suggests that it is the most successful professionals who face highest risks of suit.[279] With high rates of individualized litigation, a reasonable care standard would jeopardize too many of those who dared to set up practice.[280] By contrast, the professional designation is less compelling where rates of injury are relatively low. For example, barbers and cosmetologists are not expected to injure their clients in the ordinary course of performing haircuts or manicures. When injuries do occur, those claims can be properly adjudicated under a reasonable care standard.

Second, the science of the profession must be sufficiently inexact such that a range of approaches or methodologies might be plausible, and any given choice cannot be easily classified as reasonable or unreasonable.[281] Even a conscientious, first-rate doctor cannot heal all patients; even a diligent, gifted attorney cannot cure all legal

278. *See* PATRICIA M. DANZON, MEDICAL MALPRACTICE: THEORY, EVIDENCE, AND PUBLIC POLICY 60 (1985) (noting that, in 1975, "one in three physicians had a pending [malpractice] claim" in California, and that the St. Paul Fire and Marine Insurance Company had "one claim per 8 physicians"); WEILER, supra note 197, at 3 ("According to even conservative estimates of claims frequency, roughly 1 in 25 doctors in the United States is now successfully sued for malpractice every year."); Anupam B. Jena et al., *Malpractice Risk According to Physician Specialty*, 365 NEW ENG. J. MED. 625, 633 (2011) ("By the age of 65 years, 75% of physicians in low-risk specialties and 99% of those in high-risk specialties were projected to face a [malpractice] claim."). *But see* WEILER, supra note 197, at 12–13 (reporting evidence that only a small fraction of potentially valid malpractice claims is actually filed, and that "a large gap obtains between the number of tort events taking place inside hospitals and those that eventually filter into the court system").

279. *See* Mehlman, *Professional Power*, *supra* note 32, at 1178 (noting that during the 1840s and 1850s, the reasonable care standard resulted in burgeoning numbers of malpractice suits being lodged "not against charlatans and amateur hacks" but against "the best-educated and most successful physicians" (quoting James C. Mohr, *American Medical Malpractice Litigation in Historical Perspective*, 283 JAMA 1731, 1732–33 (2000))); *see also* Mark F. Grady, *Better Medicine Causes More Lawsuits, and New Administrative Courts Will Not Solve the Problem*, 86 NW. U. L. REV. 1068, 1070 (1992) (book review) ("Medical malpractice claims have dramatically increased because medicine has greatly improved. . . . Paradoxically, the doctors' successful efforts to revolutionize medicine have led them into a welter of legal problems.").

280. *See* WEILER, *supra* note 197, at 86 (reporting "troubling indications" that medical services are becoming "increasingly less available to those who are poor or who live in rural areas" and attributing those reactions by physicians to "the crudity of the pricing of liability insurance" and to the cost of practicing "defensive" medicine).

281. *See* Ronald E. Mallen & David W. Evans, *Attorneys' Liability for Errors of Judgment — at the Crossroads*, 48 TENN. L. REV. 283, 316 (1981) ("[T]here are always lawyers who will disagree on almost any issue. Since law is not an exact science, no level of skill or excellence exists for which all differences of opinion or doubts will be removed from the

documents.[282] In these occupations, practitioners are expected to tolerate the likelihood of bad outcomes as a regular part of their practice. In fact, they are asked to assist even when the likelihood of failure is all but certain.[283] Where there is no objectively correct set of decisions that the professional should have taken, then it becomes problematic to have a judge or jury second-guess the judgment calls that the professional did make.[284] That uncertainty also means the cases are less likely to be simple or routine,[285] which thwarts the availability of standardized claims processing.[286] By contrast, the performance of low-level tasks — even within the field of law or medicine — may fall outside the scope of "professional" work if the tasks are rote and involve no exercise of judgment.[287]

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minds of lawyers and judges."); Mello, *supra* note 207, at 845–46 ("Clinical complexity has posed a challenge for promulgators of clinical practice guidelines. . . . Guideline developers have found the problem of clinical complexity so intractable for some clinical scenarios that they have essentially given up trying to define a detailed set of recommended behaviors.").

282. *See* City of Mounds View v. Walijarvi, 263 N.W.2d 420, 424 (Minn. 1978) ("[D]octors cannot promise that every operation will be successful; a lawyer can never be certain that a contract he drafts is without latent ambiguity . . . ."); Broyles v. Brown Eng'g Co., 151 So.2d 767, 771 (Ala. 1963) ("The practice of medicine . . . depends on factors beyond the control of the practitioner. . . . Lawyers, in the practice of their profession, are dependent on the legal pronouncements of judicial agencies of government. Interpretation of law is and cannot be an exact and accurate science."); RESTATEMENT (THIRD) OF THE LAW GOVERNING LAWYERS § 52 cmt. b (AM. LAW INST. 2000) ("The competence duty . . . does not make the lawyer a guarantor of a successful outcome in the representation. . . . The duty also does not require 'average' performance, which would imply that the less skillful part of the profession would automatically be committing malpractice.").

283. *See* CODE OF MED. ETHICS ch. I, art. I, § 5 (AM. MED. ASS'N 1847) ("A physician ought not to abandon a patient because the case is deemed incurable . . . ."); Barbara Allen Babcock, *Defending the Guilty*, 32 CLEV. ST. L. REV. 175, 180 (1983) ("From lawyers of impeccable professional integrity to those with whom we might be embarrassed to share a profession, all reiterate that innocence or guilt is of no real concern in their daily work.").

284. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. c (AM. LAW INST. 2020) ("For example, a lawyer should not be held liable for a good decision that produces a bad result, but jurors may have trouble separating those issues.").

285. *See, e.g.*, McPeak v. Vanderbilt Univ. Hosp., 229 S.W.2d 150, 152 (Tenn. Ct. App. 1950) ("The science of medicine is not an exact science. In many instances there can be no fixed rule by which to determine the duty of a physician . . . ." (quoting Blankenship v. Baptist Mem'l Hosp., 168 S.W.2d 491, 496 (Tenn. Ct. App. 1942))).

286. *Cf.* Nora Freeman Engstrom, *Sunlight and Settlement Mills*, 86 N.Y.U. L. REV. 805, 828 (2011) (observing that settlement mills work as long as settlement values are "relatively predictable" and can be determined by "formulaic 'going rates' — i.e., values worked out over time between the settlement mill and insurance adjuster").

287. *See* Michael Simon et al., Lola v. Skadden *and the Automation of the Legal Profession*, 20 YALE J.L. & TECH. 234, 245–46 (2018) (discussing Lola v. Skadden, Arps, Slate, Meagher & Flom LLP, 620 F. App'x 37 (2d Cir. 2015), which held that contract attorneys performing document review under tight constraints are not engaged in the "practice of law"). Thanks to Daniel Kluttz and Deirdre Mulligan for pointing me to this case. Such an exception could be squared with the common knowledge doctrine discussed above.

Third, the occupation must be vital to society, and especially so at the margins where bad outcomes are most likely. A reduction in medical services would diminish availability of doctors for the sickest patients, and a reduction in legal services would diminish availability of lawyers for the most vulnerable clients. Doctors and lawyers are essential for those most difficult cases, and their removal from a community can be a crippling loss.[288] Similar reasoning could be extended to clergy and educators,[289] and likely to police officers, firefighters, and other critical personnel as well.[290] The precise degree to which an occupation must be an "essential service" can be debated, but the occupation certainly should not be socially detrimental.[291]

When those three conditions are present, the reasonable care standard generates informational paralysis, except in the most egregious cases, because it becomes difficult to trust jurors to distinguish culpable acts from justifiable ones. Here, the customary care standard offers a modest way forward by forcing the profession to generate information on *worst* practices that fall below its own consensus standards.[292] By

288. *See* David L. Dranoff, Comment, *Attorney Professional Responsibility: Competence Through Malpractice Liability*, 77 NW. U. L. REV. 633, 643 & n.55 (1983) (noting the inherent tension between attempts to raise the minimum level of competence and efforts to increase access to legal services); Eli Saslow, *'Out Here, It's Just Me': In the Medical Desert of Rural America, One Doctor for 11,000 Square Miles*, WASH. POST (Sept. 28, 2019, 7:40 PM), https://www.washingtonpost.com/national/out-here-its-just-me/2019/09/28/fa1df9b6-deef-11e9-be96-6adb81821e90_story.html [https://perma.cc/PYU4-D6QB]; Austin Frakt, *A Sense of Alarm as Rural Hospitals Keep Closing*, N.Y. TIMES (Oct. 29, 2018), https://nyti.ms/2CKQTOO [https://perma.cc/66SL-AW3A].

289. *See* Wade, *supra* note 33, at 475 ("[T]he other two traditional professions — education and ministry — do not have any adequately developed case law on the liability for professional negligence. . . . [T]he relevant cases reveal[] a decided reluctance on the part of the courts to attempt to establish principles for professional negligence in these two fields."). *But see* Ethan Hutt & Aaron Tang, *The New Education Malpractice Litigation*, 99 VA. L. REV. 419, 458 (2013) ("The evolution of standards, testing, and value-added assessment measures, makes it possible for a duty of care to be fashioned without requiring courts to pass judgment on the legal acceptability of particular teaching practices.").

290. *See* Jewell v. Maynard, 383 S.E.2d 536, 546 (W. Va. 1989) ("[I]n the true professions practitioners are expected to help those in need even when those in need cannot pay. How, for example, do we pay a soldier for dying? How do we pay the clergy for the long, arduous hours they spend comforting those in despair?"); Wayne A. Logan, *Police Mistakes of Law*, 61 EMORY L.J. 69, 89 (2011) (explaining that the qualified immunity doctrine is a generous standard that protects "all but the plainly incompetent [officer] or those who knowingly violate the law," on the reasoning that police need to be shielded from "undue interference with their duties and from potentially disabling threats of liability" (alteration in original) (citations and internal quotation marks omitted)); Gerrit De Geest, *Who Should Be Immune from Tort Liability?*, 41 J. LEGAL STUD. 291, 309–10 (2012) (suggesting "some form of gross negligence for firefighters").

291. *See, e.g.*, RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 23 (AM. LAW INST. 2010) (discussing owners of abnormally dangerous animals).

292. *See* James Gibson, *Doctrinal Feedback and (Un)Reasonable Care*, 94 VA. L. REV. 1641, 1670 (2008) ("Even absent legal pressures, medicine is subject to informational cascades: the more physicians that adopt a new procedure, the greater the chance that other physicians will discount any individual misgivings and follow the herd.").

focusing the judicial inquiry on the collective practice of a profession, the customary care standard can also place public pressure on the professional community to generate new consensus in areas where there is no prior custom or norm.[293]

C. Deprofessionalization: Architects and Engineers

The professional mantle need not necessarily be a permanent one.[294] If any of the three factors described above fades sufficiently, then the judicial need for the professional designation can dissipate. Thus, a loss of societal esteem for a profession can weaken the justification for maintaining a separate professional care standard,[295] as can a sharp reduction in the rate of bad outcomes.[296] But the most compelling reason to collapse the professional designation is where the science of the field has become more exact. As long as the science remains imprecise, customary practices constitute the most reliable standard of care.[297] But once outsiders become capable of discerning objectively reasonable conduct from unreasonable conduct, then it becomes feasible to shift the standard of care from customary care back to reasonable care.

Architecture and engineering — the "design professions" — offer a prime example of that shift in judicial deference.[298] Even though some courts continue to refer to architects and engineers as "professionals," a closer examination of the case law shows that the term no longer carries the same weight of deference to their customary practices that it once did.

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293. *See* Peters, *Empirical Evidence*, *supra* note 222, at 773–74 (supporting the use of more accurate empirical evidence to determine whether multiple schools of thought exist, and whether defendant's conduct fell outside of all accepted schools of thought).

294. *See, e.g.*, ABBOTT, *supra* note 163, at 29–30 (describing rise and disappearance of psychological mediums as a spiritual profession).

295. *See supra* notes 187–91 and accompanying text.

296. For example, the real accident statistics of nuclear power plants have been much lower than predicted. *See* NUCLEAR ENERGY AGENCY, ORG. FOR ECON. CO-OPERATION & DEV., COMPARING NUCLEAR ACCIDENT RISKS WITH THOSE FROM OTHER ENERGY SOURCES 7–8 (2010) ("Comparison of real accident statistics for severe accidents . . . with the theoretically calculated accident statistics of nuclear power plants show that, contrary to many people's perception, nuclear energy presents very much lower risks.").

297. *See* John Harley Warner, *The 1880s Rebellion Against the AMA Code of Ethics: "Scientific Democracy" and the Dissolution of Orthodoxy* ("Defenders of the AMA Code [held the view that] it was precisely because science could *not* deliver exact and invariant rules for practice that the physician needed the kind of guidance the Code of Ethics provided."), *in* THE AMERICAN MEDICAL ETHICS REVOLUTION, *supra* note 34, at 52, 59.

298. *See generally* Note, *Architectural Malpractice: A Contract-Based Approach*, 92 HARV. L. REV. 1075, 1075, 1082 (1979) (noting that architects were relatively immune from malpractice suits until 1957, but that courts have since expanded the scope of architects' liability for negligent conduct).

In the U.S., early court decisions treated architects and engineers as genuine professionals.[299] The Supreme Court of Minnesota summarized the traditional rule:

> Architects, doctors, engineers, attorneys, and others deal in somewhat inexact sciences and are continually called on to exercise their skilled judgment in order to anticipate and provide for random factors which are incapable of precise measurement. The indeterminate nature of these factors makes it impossible for professional service people to gauge them with complete accuracy in every instance. Thus, doctors cannot promise that every operation will be successful; a lawyer can never be certain that a contract he drafts is without latent ambiguity; and an architect cannot be certain that a structural design will interact with natural forces as anticipated. Because of the inescapable possibility of error which inheres in these services, the law has traditionally required, not perfect results, but rather the exercise of that skill and judgment which can be reasonably expected from similarly situated professionals.[300]

This rule statement embraces the traditional view that building construction is an imprecise art rather than a science, and that safe building design relies on the use of customary techniques rather than scientific methods.[301]

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299. *See* Bayne v. Everham, 163 N.W. 1002, 1008 (Mich. 1917) ("[T]he responsibility of an architect does not differ from that of a lawyer or physician."); Coombs v. Beede, 36 A. 104, 104 (Me. 1896) ("The responsibility resting on an architect is essentially the same as that which rests upon the lawyer to his client, or upon the physician to his patient . . . ."); John C. Peck & Wyatt A. Hoch, *Liability of Engineers for Structural Design Errors: State of the Art Considerations in Defining the Standard of Care*, 30 VILL. L. REV. 403, 412 (1985) (citing early cases holding engineers to the professional standard of care); Jeffrey L. Nischwitz, Note, *The Crumbling Tower of Architectural Immunity: Evolution and Expansion of the Liability to Third Parties*, 45 OHIO ST. L.J. 217, 228–29 (1984). *But see* KRAUSE, *supra* note 165, at 60 (contending that engineers have never truly qualified as professionals).

300. City of Mounds View v. Walijarvi, 263 N.W.2d 420, 424 (Minn. 1978).

301. *See* Julia Williams Robinson, *The Form and Structure of Architectural Knowledge: From Practice to Discipline* (describing historical development of architectural theory, and the modern division between procedural theory (how to make architecture) and substantive theory (why architecture should be made a certain way)), *in* THE DISCIPLINE OF ARCHITECTURE 61, 64–71 (Andrzej Piotrowski & Julia Williams Robinson eds., 2001); David Moore, *The Renaissance: The Beginning of the End for Implicit Buildability*, 24 BUILDING RES. & INFO. 259, 260 (1996); *see also* MAGALI SARFATTI LARSON, BEHIND THE POSTMODERN FACADE: ARCHITECTURAL CHANGE IN LATE TWENTIETH-CENTURY AMERICA 5–6 (1993) ("In the face of engineering's more-established position, it was strategically easier

In more recent decades, however, courts have become increasingly willing to rely on external evidence to override the internal norms of building construction.[302] Thus, courts have allowed experts in scientific fields such as physics, chemistry, or geology to establish the architectural standard of care.[303] Courts have also relied on basic mathematical calculations to override evidence of architectural custom: in one case involving a roof built with thirty-six-inch rafter spacing rather than the customary twenty-four-inch span, the court found the defendant's reference to a stress-load formula more persuasive than an opposing architect's testimony on customary practice.[304] Likewise, in other cases where builders have made erroneous calculations regarding material quantity or strength, courts have upheld jury verdicts without requiring any testimony by expert architects or engineers.[305] Courts also have expanded the types of architectural and engineering decisions that fall

for architects to base their professional claim on the aesthetics of construction than on technological mastery or scientific methods.").

302. *See* Broyles v. Brown Eng'g Co., 151 So.2d 767, 772 (Ala. 1963) ("[A]n engineering survey of drainage requirements of a tract of land . . . is not entailed with unknown or uncontrollable topographical or landscape conditions as would prevent a drainage survey . . . from being reasonably accurate by the proper use of instruments and known formulas accepted and used by the civil engineering profession."); Tamarac Dev. Co. v. Delamater, Freund & Assocs., P.A., 675 P.2d 361, 365 (Kan. 1984) ("However, an architect and an engineer stand in much different posture as to insuring a given result than does a doctor or lawyer. The work performed by architects and engineers is an exact science; that performed by doctors and lawyers is not."); Garden Howe Urban Renewal Assocs., L.L.C. v. HACBM Architects Eng'rs. Planners, L.L.C., 110 A.3d 82, 88 (N.J. Super. Ct. App. Div. 2015) (holding that "whether an expert witness may testify in a case involving a claim of architectural malpractice will depend on the claim involved, the specific allegations made, and the opinions that the expert proposes to offer at trial.").

303. *See* Perlmutter v. Flickinger, 520 P.2d 596, 596 (Colo. App. 1974) (allowing a chemical engineer to testify to the adequacy of the architectural design of skylights); Keel v. Titan Constr. Corp., 721 P.2d 828, 831–32 (Okla. Civ. App. 1986) (allowing a physics professor to testify to defects in construction of solar energy system); Nat'l Cash Register Co. v. Haak, 335 A.2d 407, 410 (Pa. Super. Ct. 1975) (stating that reliance on "experts in the field of geology and engineering" without any testimony in the field of architecture was "not fatal" to plaintiff's case).

304. Paxton v. Alameda Cty., 259 P.2d 934, 942 (Cal. Dist. Ct. App. 1953) ("Mere deviation from 'customary practice' does not, under the circumstances of our case, prove that the resulting condition was dangerous or defective . . . in the face of the otherwise uncontradicted evidence that such use of such board was reasonably safe.").

305. *See* Laukkanen v. Jewel Tea Co., 222 N.E.2d 584, 584 (Ill. App. Ct. 1966) (affirming jury verdict finding builders negligent for using lightweight concrete instead of heavy concrete, causing a pylon to topple and strike a passerby during high-wind weather); Zontelli & Sons, Inc. v. City of Nashwauk, 373 N.W.2d 744, 754–55 (Minn. 1985) (affirming the trial court's decision holding the engineering contractor liable for "drastically underestimat[ing] the quantity of concrete and unsuitable materials to be removed" for a municipal storm sewer construction project); City of Eveleth v. Ruble, 225 N.W.2d 521, 526–27 (Minn. 1974); Bloomsburg Mills, Inc. v. Sordoni Constr. Co., 164 A.2d 201, 203–04 (Pa. 1960) (affirming jury verdict based on expert testimony by a roofing consultant).

"within the common experience or understanding of the average layman."[306]

To be sure, the judicial shift has not been uniform, and many courts continue to cite to the professional malpractice standard in building construction disputes.[307] In part, such discrepancy may be attributable to lingering inscrutabilities in the art of architecture.[308] Arguably, some questions of building safety remain beyond the ken of modern science.[309] On the other hand, some of that common-law lag may reflect a reflexive reliance on precedent.[310]

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306. Jaeger v. Henningson, Durham & Richardson, Inc., 714 F.2d 773, 776 (8th Cir. 1983) (describing error that swapped 14-gauge steel for 10-gauge steel stair pans, which caused a stairway collapse); *see also* Schreiner v. Miller, 24 N.W. 738, 738 (Iowa 1885) ("That the construction of the building was defective is clearly shown . . . . A house is not constructed with reasonable care, the foundations of which are so defective as to cause the walls to crack."); Prichard Bros. v. Grady Co., 436 N.W.2d 460, 466 (Minn. Ct. App. 1989) (finding that a technician who had worked for two architectural firms was qualified to testify to the architectural standard of care because he "essentially performs the same services provided by architects"); Yantzi v. Norton, 927 S.W.2d 427, 432 (Mo. Ct. App. 1996) ("[T]here is nothing about the engineering field which makes a professional engineer uniquely qualified to evaluate residential foundations."); Kohl v. Green, 651 N.Y.S.2d 744, 746 (N.Y. App. Div. 1997) (rejecting need for expert testimony to establish the professional standard of care an engineer must employ in conducting a structural inspection, because evidence of roof leak was "readily observable to a roofer and/or a contractor").

307. *See* SME Indus., Inc. v. Thompson, Ventulett, Stainback & Assocs., Inc., 28 P.3d 669, 678–79 (Utah 2001) (collecting cases comparing the responsibility of an architect to that of a lawyer or physician); *see also* Bartak v. Bell-Galyardt & Wells, Inc., 629 F.2d 523, 530 (8th Cir. 1980) (holding that expert testimony is required in the majority of cases involving an architect's liability for harm, "because laymen would be unable to understand highly technical architectural requirements without hearing other architects testify as to those requirements"); Donnell & Froom v. Baldwin Cty. Bd. of Educ., 599 So.2d 1158 (Ala. 1992) (holding that expert testimony by a qualified architect was required); Bartenfeld v. Chick-fil-A, Inc., 815 S.E.2d 273, 277 (Ga. Ct. App. 2018); LeBlanc v. Logan Hilton Joint Venture, 974 N.E.2d 34, 44 (Mass. 2012); Brennan v. St. Louis Zoological Park, 882 S.W.2d 271, 273 (Mo. Ct. App. 1994) ("The fact that Mr. Koestering [a licensed engineer] worked closely with architects for a number of years does not mean he is qualified to testify as to the standard of care required of architects by their own profession.").

308. *See* David Leatherbarrow, *Architecture Is Its Own Discipline* ("Although standardized elements are used in current technologies, building construction is not standardized, despite all the ambitious efforts to make it so . . . ."), *in* THE DISCIPLINE OF ARCHITECTURE, *supra* note 301, at 83, 99.

309. *See* Lesley King O'Neal et al., *Sick Building Claims*, CONSTRUCTION LAW., Jan. 2000, at 16, 16 (contesting the scientific knowability of toxic mold and other "sick building" claims alleging defective construction that sickens the building's occupants many years after the completion of the building); *cf.* E.C. Ernst, Inc. v. Manhattan Constr. Co. of Tex., 551 F.2d 1026, 1033 (5th Cir. 1977) (explaining rule of "quasi-judicial immunity" for architects when interpreting construction contracts).

310. *See* Silver, *supra* note 196, at 1235 ("[R]ules, once announced, develop lives of their own, and, even if their genesis is clearly erroneous, the law is slow to discard them."); *see also* Oona A. Hathaway, *Path Dependence in the Law: The Course and Pattern of Legal Change in a Common Law System*, 86 IOWA L. REV. 601, 626 (2001) ("As Justice Cardozo once remarked, 'the labor of judges would be increased almost to the breaking point if every past decision could be reopened in every case, and one could not lay one's own course of brick on the secure foundation of the courses laid by others who had gone before him.'");

Nevertheless, the trend in the case law underscores the point that as the science of building construction has advanced, the legal standard has shifted. Today, even when courts require expert testimony by an architect or engineer, that testimony is increasingly treated as evidence probative of reasonable care rather than as evidence of compliance with professional custom. Though the scholarly literature on the "decline" of professionalism has focused on ethics, the true culprit should be understood as scientific advance.[311]

For the software community, another implication should already be apparent. Software developers often borrow the rhetoric of architecture and engineering to describe the work of software production.[312] Yet, those hoping to find a pathway to a software *profession* must seek out a different paradigm than that of architecture and engineering. If buildings can be made reliably safe using state-of-the-art techniques, then ordinary negligence suffices. To state the case for a professional malpractice standard, the software industry must persuade courts that software cannot be made reliably safe.

V. THE CASE FOR SOFTWARE PROFESSIONALS

Software developers should be designated as professionals, not as a retrospective reward for exhibiting professional attributes, but as a prospective incentive for software communities to develop and enforce basic professional customs. The above discussion illuminates that the customary care standard is not only a mechanism for courts to acknowledge the inherent uncertainty and precariousness of a practice, but also a mechanism for courts to force a professional community to scrutinize its own internal consensus on safety standards and other codes of conduct.[313]

Applying the theoretical approach developed above, this Part states the case in favor of applying a customary care standard to software developers; explores implications of doing so for software developers,

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Roger J. Traynor, *Reasoning in a Circle of Law*, 56 VA. L. REV. 739, 743–44 (1970) (praising the "caution of the judicial process").

311. *See supra* note 207 and accompanying text.

312. *See generally* STEVE MCCONNELL, AFTER THE GOLD RUSH: CREATING A TRUE PROFESSION OF SOFTWARE ENGINEERING (1999); MARC T. SEWELL & LAURA M. SEWELL, THE SOFTWARE ARCHITECT'S PROFESSION (2002).

313. *See* Teitelbaum, *supra* note 55, at 18–19 (asserting that for computationally intractable problems, an incremental "learning-by-experimentation" process is preferable "due to its information-generating property" versus a strict liability approach); *see also* Epstein, *The Path*, supra note 31, at 24–25 (positing the Hayekian argument of customary care as a mode of decentralized information production, i.e., that "custom is both the more reliable and cheaper way to set standards of care were [sic] information is costly and juries themselves are prey to biases"); Eleanor D. Kinney, *The Brave New World of Medical Standards of Care*, 29 J.L. MED. & ETHICS 323, 324–25 (2001) (describing the work of medical professional associations beginning in the 1980s to consolidate empirically derived medical standards).

their users, their supervisors, and their insurers; and ends with some closing thoughts on how leaders in the software community should reconceptualize the role of software codes of ethics in relation to the customary care standard.

A. The Need for Software Judgment

The case for treating software developers as professionals flows from the observation that the reasonable care standard has stalled indefinitely, and that the customary care standard would move the ball forward. The three-part test developed above helps synthesize why that paradigm shift would be both effective and doctrinally appropriate. Notably, this Article argues that the professional designation should not depend on "traditional" attributes such as formal education, licensure and disciplinary systems, or social esteem. Nor does there need to be a well-established set of customs already in place; the fact that a field continues to evolve and advance should not be a disqualification. The only requirement should be the presence of conditions that make second-guessing of discretionary decisions especially imprudent for the software field.

The first factor looks to whether bad outcomes are endemic to the practice. For any non-trivial software system, the inevitability of bad code is a permanent fixture of software development practice.[314] To be sure, the prospect of physical injuries and deaths caused by bad code is still uncommon, but that "safety" record is attributable to the modesty with which software is deployed, rather than to any assurances provided by state-of-the-art software development practices.[315] As software is deployed in more ambitious ways, software crashes are likely to generate many more physical crashes.[316]

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314. *See* Mann, *supra* note 55, at 34 ("It is difficult to overemphasize the uniqueness of software's problems. . . . [W]hat's surprising — astonishing, in fact — is that many software engineers believe that software quality is not improving. If anything, they say, it's getting worse.").

315. *See* Nancy Leveson, *Are You Sure Your Software Will Not Kill Anyone?*, COMM. ACM, Feb. 2020, at 25, 25 ("With only a few exceptions, software was not used to directly control safety-critical systems until approximately 1980 . . . . [That] hesitation has now almost completely disappeared and software is used to control most systems, including physical systems that could involve potentially large and even catastrophic losses.").

316. *See, e.g.*, Homa Alemzadeh et al., *Analysis of Safety-Critical Computer Failures in Medical Devices*, IEEE SECURITY & PRIVACY, July/Aug. 2013, at 14, 14 (reporting that almost 23 percent of medical device recalls "were due to computer-related failures, of which approximately 94 percent presented medium to high risk of severe health consequences (such as serious injury or death) to patients"); Jaclyn Trop, *Toyota Agrees to Settlement in Fatal Acceleration Crash*, N.Y. TIMES (Oct. 25, 2013), https://nyti.ms/18lRU5D [https://perma.cc/5L3B-34MM] ("The Oklahoma case is extraordinary because it is the first to try the electronic and software defects that plaintiffs say existed in the Toyota models that accelerated suddenly, and because the jury rejected Toyota's driver-error defense."); Juan-

Even when code is not directly embedded in a cyber-physical system, there are still urgent reasons to extend the professional framework to those who write general libraries of code. Modern software is highly interdependent; the practice of software development depends very heavily on code reuse.[317] A software library developed for one purpose is often borrowed for other diverse and unanticipated applications. Those interdependencies strongly suggest that the problem of bad code needs to be treated on a systemic level across the entire software industry.[318]

The second factor looks to whether those bad outcomes are attributable to inherent uncertainties and imprecisions in the art of software development. Despite advances in programming languages and software development techniques, the hard problems remain hard; there is still no "silver bullet."[319] To reiterate the lessons captured by Fred Brooks' essay, improvements in software development practices can reduce accidental complexity but not essential complexity, and it is essential complexity that makes software development insolubly hard.[320] Even when software developers adhere to "best" practices, those best

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Pablo Afman et al., Towards a New Paradigm of UAV Safety 8 (Mar. 24, 2018) (unpublished manuscript), https://arxiv.org/pdf/1803.09026.pdf [https://perma.cc/E4Z6-AALQ] (describing "flyaway" problems where remote pilots lose control of their unmanned aircraft, and noting that "[m]any incidents end with devices barreling into homes, buildings, trees, bodies of water, and in some cases civilians").

317. *See* CYBERSPACE SOLARIUM REPORT, *supra* note 17, at 169 n.229 ("Open-source software forms the basis for most software written and deployed today. One survey found that 96 percent of applications contain open-source components." (citation omitted)); Brief of Microsoft Corp. as Amicus Curiae in Support of Petitioner at 3, Google LLC v. Oracle Am., Inc., No. 18-956 (U.S. Jan. 13, 2020) ("Innovation today depends on collaborative development; it is no longer the case that software is predominantly created by a single entity or individual who develops a proprietary product in isolation. Instead, developers rely on sharing, modifying, and enhancing previously developed code to create new products and develop new functionality."); Lawrence E. Hecht & Libby Clark, *Survey: Open Source Programs Are a Best Practice Among Large Companies*, NEW STACK (Aug. 30, 2018, 3:00 AM), https://thenewstack.io/survey-open-source-programs-are-a-best-practice-among-large-companies [https://perma.cc/FCJ3-5STD] ("Large technology companies are leading the way in establishing open source programs to create and nurture best practices. Their substantial developer teams heavily rely on open source components.").

318. *See* Chong, *supra* note 37 (pointing to the problem of software monoculture, namely, "the notion that system uniformity predisposes users to catastrophic attacks").

319. *See* Fraser & Mancl, *supra* note 60, at 92 (summarizing David Parnas's remarks that "progress made to date as a result of software tools and methods is a myth — suggesting that progress has been the result of hardware improvements rather than software improvements"); *see also* BARR, *supra* note 80, at 239 (observing that "[t]he history of software engineering has been a search for the silver bullet," but that every hyped solution has led to "inevitable disappointment and disillusionment").

320. *See* Brooks, *supra* note 56, at 12–16 (explaining that the "most fruitful" developments in software technology have attacked "accidental, not essential, difficulties," and extrapolating that "no technological breakthrough [in the software area] promises to give the sort of magical results with which we are so familiar in the hardware area").

practices offer little assurance of rigor or quality.[321] Instead, software developers, like doctors and lawyers, operate on the diagnosis-and-treatment model that triages problems as they arise. Many of the biggest developments in the industry — including Software-as-a-Service ("SaaS") and cloud computing — are concessions to the reality that modern software development is an iterative process that entails long-term maintenance spanning the entire lifetime of the software system.[322]

To be sure, different software fields have heterogeneous characteristics and challenges. The certification processes adopted by safety-critical software developers look much different from the practices used by cellphone app developers. Similarly, database developers have been able to achieve high degrees of reliability and fidelity in time-insensitive environments, whereas cyber-physical systems developers must grapple with the urgent demands of real-time decisions.[323] Of course, specialization is not unique to software developers. A heart surgeon follows different procedures than a pediatrician does, just as a securities litigator draws on different expertise than a family lawyer would. Nevertheless, the unifying principle across those specializations is the uncertainty of the basic science of the field. Software complexity epitomizes that essential unknowability.

The third factor requires that software development be vital to society, beyond the provision of ordinary goods or services. Here, there may be some skepticism whether software rises to the threshold of medicine, law, education, or divinity. Software is a recent entrant, and it is understandable to express doubt that software is already on par with other traditional pillars of society. Yet, modern software is ubiquitous

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321. *See* BARR, *supra* note 80, at 159 ("Beyond design patterns, what does good [software] design look like? With a lack of theoretical rigor to underpin it, this is a murky area. . . . There are books that claim to explain good design . . . but they don't present a specific approach to engineering your software.").

322. *See* Press Release, Gartner, Gartner Forecasts Worldwide Public Cloud Revenue to Grow 17% in 2020 (Nov. 13, 2019), https://www.gartner.com/en/newsroom/press-releases/2019-11-13-gartner-forecasts-worldwide-public-cloud-revenue-to-grow-17-percent-in-2020 [https://perma.cc/78VD-CJQR] (noting that "cloud adoption is mainstream" and forecasting that Software as a Service ("SaaS"), the largest market segment, will grow $116 billion in the next year); *see also* CYBERSPACE SOLARIUM REPORT, *supra* note 17, at 77 (proposing federal regulation requiring that "final goods assemblers, as well as the software and hardware component developers and manufacturers, establish a publicly accessible process for vulnerability reporting, retain records documenting when a vulnerability was made known to or discovered by the company, and maintain a vulnerability disclosure and patching policy for their products").

323. *See* Linh Thi Xuan Phan, *Towards a Safe Compositional Real-Time Scheduling Theory for Cyber-Physical Systems*, 4 ANALYTIC VIRTUAL INTEGRATION CYBER-PHYSICAL SYS. WORKSHOP 21, 21 (2013).

and interwoven with every fiber of society.[324] No one can easily opt out of the effects of bad code.[325] Much has been written about an internet "kill switch" and the disruptive effects a shutdown could have on social functions.[326] Even a partial reduction in software services and software expertise could cause great disarray.

B. Implications of Software as a Profession

The normative basis for extending the professional label to software developers is to consider whether the move from a reasonable care standard to a customary care standard could invigorate legal scrutiny of software development practices. Given that the current baseline is near zero, any increase in software liability would likely have substantial impact on software developers, their users, their supervisors, and their insurers. This Part explores possible implications of that change for each of those groups in turn.

Individual software developers: A professional malpractice cause of action would be a direct claim against an individual or individuals for deviating from customary care in the relevant area of software practice. Many software developers will likely object to the unfamiliar burden of bearing personal liability for their work. The fear of being accused of malpractice will induce much more caution before releasing new software, leading some software developers to plead harm to innovation.[327] Others will argue that software is speech shielded by the First Amendment,[328] or that individual liability is ill-suited for team-based software projects.

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324. *See generally* DENARDIS, *supra* note 36; Paul Ohm & Blake Reid, *Regulating Software When Everything Has Software*, 84 GEO. WASH. L. REV. 1672, 1672 (2016).

325. *See* Asaf Lubin, The Insurability of Cyber Risk 50–52 (Sept. 12, 2019) (unpublished manuscript), https://ssrn.com/abstract=3452833 [https://perma.cc/7HJ4-KEJD] (describing ransomware attacks on cities and municipalities costing taxpayers millions of dollars); Yang Lu & Li Da Xu, *Internet of Things (IoT) Cybersecurity Research: A Review of Current Research Topics*, 6 IEEE INTERNET THINGS J. 2103, 2103 (2019) ("In 2015, [the Internet of Things] connected 4.9 billion things and will connect 25 billion things by 2020. . . . By 2020, there will be 6.58 devices per person.").

326. *See* David W. Opderbeck, *Cybersecurity and Executive Power*, 89 WASH. U. L. REV. 795, 841 (2012) (suggesting that the U.S. President should not be able to shut down the internet, because "'[c]yberspace' in some sense transcends the physical cables and switches that make the Internet possible" and thus the internet "is not merely a 'national asset' of any state").

327. *See generally* JONATHAN ZITTRAIN, THE FUTURE OF THE INTERNET — AND HOW TO STOP IT (2008); Choi, *supra* note 44, at 71–78.

328. *See* Universal City Studios, Inc. v. Corley, 273 F.3d 429, 449 & n.24 (2d Cir. 2001) ("[W]e join the other courts that have concluded that computer code, and computer programs constructed from code can merit First Amendment protection, although the scope of such protection remains to be determined." (citations omitted)). *But see* Haupt, *Licensing Knowledge*, *supra* note 181, at 525–26, 555 (arguing that "professional licensing is indeed a prior restraint on a professional's speech, but in the professional context it is permissible,"

But those same objections would be raised against *any* software liability regime. If there must be a liability regime, there are good reasons to think that a malpractice regime would be a more apt fit than a general liability regime. While any increase in liability will deter some software activities, a customary care standard will align those increases as closely as possible with the norms of the software community. That said, it may be advisable or even necessary to contemplate an "experimental use" exception for casual hobbyists and academic researchers.[329] Additionally, many states have enacted protective legislation requiring certificates of merit to be filed for a malpractice action to proceed.[330]

As for team-based work, software is no outlier in that regard; law firm partners work with junior attorneys and paralegals, while doctors work with medical residents and nurses.[331] If there are fears of being wrongly accused for someone else's malpractice, tracing individual contributions is generally *more* feasible in software development than in either law or medicine.[332] Moreover, software developers can mitigate the financial risks of personal liability in two ways. The first is to use business entities, such as professional corporations or limited liability partnerships, that are designed specially for professionals. The second is to purchase malpractice insurance. While any exposure to legal liability would motivate the need for financial safeguards, professionals are afforded somewhat different protections than non-professionals. The potential upside of these organizational moves is that they would likely facilitate greater autonomy and independence from managerial oversight.[333]

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because "professional speech protection and professional licensing share the same goal — ensuring the availability of competent and reliable advice for clients or patients").

329. *See generally* Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 WIS. L. REV. 81.

330. *See* Benjamin Grossberg, Comment, *Uniformity, Federalism, and Tort Reform: The* Erie *Implications of Medical Malpractice Certification of Merit Statutes*, 159 U. PA. L. REV. 217, 222–25 (2010) (surveying three types of certificate of merit statutes across twenty-five states: (1) those requiring certification by the attorney, when filing the complaint, that an expert was consulted, (2) those requiring such certification to be filed by the expert, and (3) those requiring either certification to be filed within a set period of time after the complaint).

331. *See* Ybarra v. Spangard, 154 P.2d 687, 690 (Cal. 1944) ("Thus a surgeon has been held liable for the negligence of an assisting nurse who leaves a sponge or other object inside a patient, and the fact that the duty of seeing that such mistakes do not occur is delegated to others does not absolve the doctor from responsibility for their negligence."); *cf.* BROOKS, *supra* note 54, at 32 (recommending a surgical team model for large software projects).

332. *See* Andrew Begel et al., *Codebook: Discovering and Exploiting Relationships in Software Repositories*, 32 INT'L CONF. ON SOFTWARE ENGINEERING 125, 134 (2010) (describing a tool that "captures the relationships between people, code, bugs, specifications, and other work artifacts that are mined from any number of software repositories").

333. *Compare* Frankel, *supra* note 175, at 114 ("Professionals who, for example, are subjected to unreasonable demands by employers that are inconsistent with the tenets of their

Software victims: The professional malpractice claim would create a new cause of action for those harmed by bad software. As a threshold matter, one potentially significant change is that professional malpractice claims are not ordinarily limited by the economic loss doctrine.[334] Thus, much more software could be subject to malpractice suits than to ordinary negligence suits.

But the focal change would be in the standard of care. Instead of alleging that the software developer failed to exercise *reasonable care*, the plaintiff would need to allege that the software developer failed to exercise *customary care*. That switch will make the most difference in cases where the jury might be inclined to second-guess the software experts if it were deciding reasonableness in the first instance, but the jury is instead confined to determining whether the defendant software developer deviated from actual custom. If competent software developers could disagree, then no liability should be found.

To illustrate by returning to the opening example of the Boeing 737 MAX, suppose the jury were asked to review two critical decisions. First, the software developers chose to use only one sensor reading before initiating the downward flight angle correction.[335] That reliance constituted a single point of failure. Second, the software developers expanded the scope of the software requirements to include a second functionality not contemplated in the original design.[336] That change occurred at a late stage in the approval process but did not trigger a full reapproval process.

Under a *de novo* reasonableness review, a jury might well find fault with both decisions: single points of failure are troubling in any safety-critical system, and significant changes to flight control functionality should always be carefully reviewed.[337] But a verdict based on customary care might come out differently. There, the question would turn on whether the software developers adhered to the formal DO-178C standard governing avionics software, as well as to any informal norms common to the avionics software "specialty practice." It is conceivable that

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code should be able to appeal to the profession for both moral and practical support."), *with* KRAUSE, *supra* note 165, at 65 ("One thing that engineers almost never do, given their values, is to complain when they work on projects that maximize profits through cutting back on safety. . . . [W]histleblowing on the company will lead to being fired, and usually also to being ostracized by other companies working in the same field.").

334. RESTATEMENT (THIRD) OF TORTS: LIAB. FOR ECON. HARM § 4 cmt. a (AM. LAW INST. 2020) ("A prominent exception [to the economic loss rule] is the action to recover for professional negligence (also known as malpractice).").

335. *See* Wendel, *supra* note 3, at 401 ("The design of [Boeing's software] MCAS system took [angle of attack] AOA data from only one of two available sensors.").

336. *See id.* at 406 ("A design change during the development of MCAS made the system much more assertive.").

337. *See id.* at 401 ("It is a fundamental principle of aircraft design, and of engineering generally, that single points of failure are to be avoided whenever possible.").

the practices described were entirely routine to inside experts, even if surprising and offensive to lay observers. On the other hand, it is also possible that Boeing's process — which has been described as "frenetic" and "hectic"[338] — was inadequate by the experts' own standards.

In practical terms, the customary care standard already aligns with existing enforcement efforts, which have looked almost exclusively to industry practices to set the benchmark. For example, Dan Solove and Woody Hartzog have praised the Federal Trade Commission for relying on industry standards to establish a "common law" of data security.[339] Bill McGeveran has proposed a "duty of data security" that draws from industry best practices and worst practices.[340] Derek Bambauer has commended the self-audit mandate in the Gramm-Leach-Bliley Act simply for "impos[ing] greater cybersecurity obligations on financial institutions than most firms face."[341] Similarly, Peter Swire has pointed to information sharing among industry trade groups and "close-knit groups of experts" as offering the greatest cybersecurity value.[342] These

338. *See* David Gelles et al., *Boeing Was 'Go, Go, Go' to Beat Airbus with the 737 Max*, N.Y. TIMES (Mar. 23, 2019), https://nyti.ms/2UTF5jg [https://perma.cc/LTU5-N27R].

339. *See* Daniel J. Solove & Woodrow Hartzog, *The FTC and the New Common Law of Privacy*, 114 COLUM. L. REV. 583, 636 (2014) ("The FTC has come to rely on industry standards and other norms to identify a particular set of practices that, taken together, constitute adequate security practices for companies collecting personal information."); *see also* Cooper & Kobayashi, *supra* note 47, at 16 (arguing that "firms are in a better position than the FTC to weigh the marginal costs and benefits of taking additional data security precautions"); LabMD, Inc. v. FTC, 894 F.3d 1221, 1236–37 (11th Cir. 2018) (finding an FTC order requiring a "reasonably designed data-security program" to be unenforceable); Justin (Gus) Hurwitz, *Data Security and the FTC's UnCommon Law*, 101 IOWA L. REV. 955, 984 (2016) ("[I]t is unlikely that the FTC will take action in close cases . . . . Indeed, easy cases may well make bad law. Where the FTC selects cases that allow it to shape the broad contours of the law, it is misusing the adjudicatory mechanism.").

340. William McGeveran, *The Duty of Data Security*, 103 MINN. L. REV. 1135, 1188–89, 1193 (2019) ("For the most part, the fourteen frameworks do not demand specific implementations to protect data security. . . . [T]he frameworks recognize the futility of providing cookbook recipes . . . . [S]ome of the frameworks also tell data custodians exactly what they should *not* do. Instead of recommended best practices, I call these 'worst practices' . . . ."); *id.* at 1204 ("Thus, reliance on emerging industry best practices as the source for a duty of data security follows exactly the path the law has trod innumerable times before."). To be sure, some worst practices could fall within a "common knowledge" exception, but many others will depend on corroboration by expert testimony.

341. Derek E. Bambauer, *Ghosts in the Network*, 162 U. PA. L. REV. 1011, 1049 (2014) ("[E]ven the GLBA's dilute mandate increases cybersecurity for financial institutions."); *see also* Kenneth A. Bamberger, *Regulation as Delegation: Private Firms, Decisionmaking, and Accountability in the Administrative State*, 56 DUKE L.J. 377, 391 (2006) ("While the implementing regulations do include some guidance for implementation tools . . . the particular implementation is left to individual firms, and '[t]he ultimate test remains a broad one, that of "reasonable data security."'" (citation omitted)).

342. Peter Swire, *Finding the Best of the Imperfect Alternatives for Privacy, Health IT, and Cybersecurity*, 2013 WIS. L. REV. 649, 666; *see also* Amitai Aviram, *Network Responses to Network Threats: The Evolution into Private Cybersecurity Associations* (describing the establishment of Information Sharing and Analysis Centers by Presidential Decision Directive

approaches are lauded not because they are ideal, but because they raise the bar.

Some advocates of consumer safety may argue that software developers should be forced to internalize much stricter liability for the harms caused by their creations.[343] For those who mistrust current practices, a malpractice regime that defers to industry custom may seem like weak medicine. Yet, that stance challenges the very premise of the customary care standard. If software developers cannot be fairly judged by a reasonable care standard because it would lead to underprovision of essential services, then a move toward even stricter standards would exacerbate that problem.[344] Fittingly, strict liability has never been a preferred regime for professional services.[345]

Software supervisors: To say that software developers should not be subject to strict liability in their individual capacities, however, does not necessarily answer whether their employers or other supervisory entities could be held strictly liable.[346]

For example, if a medical device company employs software developers to write code for a pacemaker, and that software subsequently fails and injures a patient, what responsibility should the company

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63 under President Clinton), *in* THE LAW AND ECONOMICS OF CYBERSECURITY 143, 152–55 (Mark Grady & Francesco Parisi eds., 2006).

343. *See* Nathan Sales, *Regulating Cybersecurity*, 107 NW. U. L. REV. 1503, 1507, 1534, 1557 (2013) ("Many companies that operate critical infrastructure tend to underinvest in cyber defense . . . . The cost-benefit calculus looks very different once a products liability regime is in place . . . . The prospect [of money damages] would internalize costs that are now externalized onto others."); *see also* Michael L. Rustad, *Torts as Public Wrongs*, 38 PEPP. L. REV. 433, 548 (2011) ("The bad software problem is a byproduct of the software industry's virtual immunity from tort liability. Immunity breeds irresponsibility and tort law requires accountability.").

344. *See* Nora Freeman Engstrom, *3-D Printing and Product Liability: Identifying the Obstacles*, 162 U. PA. L. REV. ONLINE 35, 41 (2013) (observing that software democratizes product creation, which "unsettles product liability law's traditional theoretical foundation"); Frank J. Vandall, *Applying Strict Liability to Professionals: Economic and Legal Analysis*, 59 IND. L.J. 25, 27–28 (1983) ("Many of the arguments against suing physicians are economic in nature: doctors will leave the profession or move to a less risky specialty, malpractice insurance rates will become too high, and suits will raise the costs of medical treatment beyond the reach of the poor.").

345. *See* Murphy v. E.R. Squibb & Sons, Inc., 710 P.2d 247, 249 (Cal. 1985) (holding that providers of professional services cannot be held strictly liable); Vandall, *supra* note 344, at 25 ("[N]o court has held that strict liability controls in a case involving a professional."); William R. Russell, Note, *Products and the Professional: Strict Liability in the Sale-Service Hybrid Transaction*, 24 HASTINGS L.J. 111, 120 (1972) (citing cases where courts refused to apply strict liability against professionals in part because "the community need for the services of professionals, such as doctors and dentists, greatly outweighs the policy considerations favoring the imposition of liability without fault upon professionals").

346. *Compare In re* Toyota Motor Corp. Unintended Acceleration Litig., 978 F. Supp. 2d 1053, 1054 (C.D. Cal. 2013) (allowing products liability claim to proceed to trial), *with* Getz v. Boeing Co., 654 F.3d 852, 853 (9th Cir. 2011) (dismissing products liability action).

bear?[347] If the injury has an alternate cause, such as a hardware defect or a failure to warn, then the company could be held strictly liable on those alternate theories. But how should the conduct of a software professional bear on liability determinations for the supervising entity?

One seductive theory is that a court could simply apply the design defect test against the medical device software, independent of the malpractice test against the software developer.[348] The design defect analysis typically involves proving that the software manufacturer erred by not adopting a "reasonable alternative design" that would have provided a better risk-utility balance of safety, cost, and other relevant factors.[349] In the medical device example, a direct extension of products liability analysis to software design is conceptually appealing because it preserves the integrity of the medical device and its embedded software as a unitary "product." But in order to engage in that type of risk-utility inquiry, the court would need to dissect and second-guess the design decisions made by the software developers.[350] The professional judgments and the risk-utility judgments are inseparable, so it will be impossible to apply the design defect analysis independent of the malpractice analysis.

The Supreme Court has addressed a closely related question in the context of health maintenance organizations ("HMOs"), where business judgments and medical judgments are often inextricably mixed.[351] In those instances, a doctor's decisions to use diagnostic tests, seek consultations or referrals, or to perform one treatment option over another

347. *Compare* Singh v. Edwards Lifesciences Corp., 210 P.3d 337, 342–45 (Wash. Ct. App. 2009) (affirming jury verdict in favor of products liability), *with* Graves v. CAS Med. Sys., Inc., 735 S.E.2d 650, 658–59 (S.C. 2012) (affirming dismissal of products liability action).

348. *See* RESTATEMENT (THIRD) OF TORTS: PRODS. LIAB. § 2 cmt. a (AM. LAW INST. 1998) ("[Design defects] cannot be determined by reference to the manufacturer's own design or marketing standards because those standards are the very ones that plaintiffs attack as unreasonable. Some sort of independent assessment of advantages and disadvantages, to which some attach the label 'risk-utility balancing,' is necessary.").

349. *See id*. § 2 cmt. d ("Assessment of a product design in most instances requires a comparison between an alternative design and the product design that caused the injury, undertaken from the viewpoint of a reasonable person. That approach is also used in administering the traditional reasonableness standard in negligence.").

350. *See supra* note 6 and accompanying text.

351. *See* Rush Prudential HMO, Inc. v. Moran, 536 U.S. 355, 387 (2002) (observing that decisions "regulating insurance tied to what is medically necessary is probably inseparable from enforcing the quintessentially state-law standards of reasonable medical care"); Pegram v. Herdrich, 530 U.S. 211, 229 (2000) (noting that insurance eligibility decisions and medical treatment decisions are "inextricably mixed, as they are in countless medical administrative decisions every day").

are "not simple yes-or-no questions" but "when-and-how question[s]."[352] The Court concluded that, even where a medical professional's judgment might be affected by competing incentives to control cost and ration care, the malpractice regime and its corresponding tradeoffs should not be preempted by a parallel liability regime.[353] By analogy, if a software professional requires discretion to make complex judgments — about when and how to use particular tools and libraries, to create particular functions and modules, or to run particular diagnostic tests — then that professional judgment should not be preempted by a parallel risk-utility judgment.

Software insurers: An increase in malpractice actions could produce clearer guidance on how to price cyber liability insurance policies by increasing the breadth and frequency of third-party liability events.[354] To date, cyber insurance providers have "struggle[d] with evaluating how to price and evaluate the risk of loss."[355] The most commonly cited reason is that carriers and underwriters "have no historic or credible data upon which to make reliable inferences about loss expectations."[356] Moreover, much of the focus has been on a narrow class of data breach and ransomware events,[357] while coverage is often excluded for other standard losses such as physical harm and contractual liability.[358] Perhaps as a result, covered cyber losses tend to "relate to what are essentially cleanup costs" as opposed to "those directly associated with the cyber incident."[359] Malpractice liability would likely

352. *Pegram*, 530 U.S. at 228–30.

353. *See id.* at 236 (rejecting as "mischief" that "not only would an HMO be liable as a fiduciary in the first instance for its own breach of fiduciary duty committed through the acts of its physician employee, but the physician employee would also be subject to liability as a fiduciary on the same basic analysis that would charge the HMO"); *cf.* Daniel Halberstam, *Commercial Speech, Professional Speech, and the Constitutional Status of Social Institutions*, 147 U. PA. L. REV. 771, 849 (1999) ("[T]he government may fund physicians expressly for a particular specialty and thus limit the procedures that they may perform. . . . The government may not, however, prohibit a government physician from providing the truthful medical advice that a conscientious private physician . . . would nonetheless provide.").

354. *See* Tom Baker, *Back to the Future of Cyber Insurance*, PLUS J., Q3 2019, at 4, 5 (noting that first party data breach coverage is currently more significant than third party liability coverage).

355. Shauhin A. Talesh, *Data Breach, Privacy, and Cyber Insurance: How Insurance Companies Act as "Compliance Managers" for Businesses*, 43 L. & SOC. INQUIRY 417, 426 (2018).

356. Sasha Romanosky et al., *Content Analysis of Cyber Insurance Policies: How Do Carriers Price Cyber Risk?*, 5 J. CYBERSECURITY 1, 12 (2019); *see also* Lubin, *supra* note 325, at 25 (conveying the statement that carriers price cyber risk suboptimally because they "don't know," they are "guessing," or they are "using someone else's guess").

357. *See* Lubin, *supra* note 325, at 11–14 (noting that California's 2003 data breach notification law "marked an important tidal shift" and that [l]osses from ransomware events are also on the rise).

358. *See* Romanosky et al., *supra* note 356, at 7.

359. *Id.* at 8.

generate many more cases from which insurers could improve their cost models of cyber incidents.

In short, the judicial treatment of software developers as a "profession" would be a consequential change for the software industry. But it is a change that helped promote science and progress in other professions such as medicine and law. The hope is that similar advances could be achieved by professionalizing software.

C. Ethics for Professionals, by Professionals

Arguably the most significant implication of moving to a customary care standard, however, is that it could empower greater use of software codes of ethics to settle software liability determinations. Without the customary care standard to give it legal effect, a code of ethics is merely a set of advisory opinions that is persuasive, but never dispositive of legal liability. But when liability is contingent on proving deviation from professional custom, then a code of ethics can be used as positive evidence of a profession's collective norms — or lack thereof.[360]

To fully realize this legal potential, however, a code of ethics must reflect more substantial consensus of the profession's members.[361] For the software community, the disappointingly low uptake thus far of the ACM's Code of Ethics and Professional Conduct is a cautionary tale against attempting to shoehorn "aspirational"[362] ethical principles that lack authentic appeal among software developers.[363] Although academ-

360. *See* Frankel, *supra* note 175, at 111 ("As a visible pronouncement of a profession's self-proclaimed role and values, a code can function as a basis for the public's expectations and evaluation of professional performance, thus serving as a mechanism for holding the profession and individual professionals accountable.").

361. *See* Arthur Isak Applbaum, *Doctor, Schmoctor: Practice Positivism and Its Complications* (warning that a code of ethics cannot bind practitioners who "fail to identify" with "the collective judgments of a social practice that is not their own and that does not apply to them"), *in* THE AMERICAN MEDICAL ETHICS REVOLUTION, *supra* note 34, at 144, 155–56; Frankel, *supra* note 175, at 113 ("If the basic conception of the profession's values, roles, and functions as articulated by the profession is inconsistent with the reality experienced by its members, the basis of respect for the profession's ethics will erode, the profession's leadership will risk becoming isolated from the rank and file, and efforts to articulate and enforce specific provisions will be severely impaired.").

362. *See* Frankel, *supra* note 175, at 110–11 (identifying three types of professional codes: an "aspirational" code that is "a statement of ideals to which practitioners should strive"; an "educational" code that "seeks to buttress understanding of its provisions with extensive commentary and interpretation"; and a "regulatory" code that "serve[s] as a basis for adjudicating grievances").

363. *See* Ronald E. Anderson et al., *Using the New ACM Code of Ethics in Decision Making*, COMM. ACM, Feb. 1993, at 98, 98 ("ACM and many other societies have had difficulties implementing an ethics review system and came to realize that self-regulation depends mostly on the consensus and commitment of its members to ethical behavior.").

ics and accreditation boards have engaged in continuing efforts to integrate ethics modules into the computer science curriculum for three decades,[364] those efforts have been met with widespread skepticism or indifference among computer science faculty,[365] as well as among the broader software community.[366]

While the ACM Code offers a good entry point, it could be improved going forward with a clearer eye to its role of arbitrating professional customs and guiding expectations regarding professional liability risks.[367] By helping software developers make specific, informed decisions where the science of the field permits multiple schools of thought, the ACM Code would begin to provide the intrinsic authority and value that naturally wins adherence and membership.[368]

In its current incarnation, the ACM Code consists of four parts: (1) fundamental ethical considerations, (2) professional conduct, (3) leadership duties, and (4) enforcement of the Code.[369] In particular, Section 1 of the ACM Code opens with broad commandments to "avoid harm," to "be fair and take action not to discriminate," and to "contribute to society and to human well-being."[370] It also includes references to fiduciary-like duties such as "be honest and trustworthy" and "honor

364. *See* Barbara J. Grosz et al., *Embedded EthiCS: Integrating Ethics Across CS Education*, COMM. ACM, Aug. 2019, at 54, 54; David Hemmendinger, *The ACM and IEEE-CS Guidelines for Undergraduate CS Education*, COMM. ACM, May 2007, at 46, 51 (noting that the 1991 guidance added a "social, ethical, and professional issues" subject area).

365. *See* Craig Gaskell & Armstrong A. Takang, *Academic Perspectives of Professionalism* (collecting skeptical commentary from survey results of university professors), *in* THE RESPONSIBLE SOFTWARE ENGINEER 296, 303–04 (Colin Myers et al. eds., 1997). *But cf. Grosz* et al., *supra* note 364, at 59 (finding that "Embedded EthiCS modules work best with close [computer science] faculty engagement," which includes "[p]articipating fully in the design of the modules" and "being personally involved in the module class session(s)").

366. *See* Andrew McNamara et al., *Does ACM's Code of Ethics Change Ethical Decision Making in Software Development?*, 26 ACM JOINT MEETING ON EUR. SOFTWARE ENGINEERING CONF. & SYMP. ON FOUND. SOFTWARE ENGINEERING 729, 732 (2018) ("Despite its stated goal, we found no evidence that the ACM code of ethics influences ethical decision making."); Julian Webb et al., *Pressures to Behave Unprofessionally* (documenting a number of unprofessional characteristics among software developers in an investigation that took place over a period of about a year), *in* THE RESPONSIBLE SOFTWARE ENGINEER, *supra* note 365, at 265, 265.

367. *See* Frankel, *supra* note 175, at 111 ("[P]rofessionals may experience anxiety or confusion when they encounter novel situations in their practice. As a distillation of collective experience and reflection, a code can offer guidance to individual professionals by simplifying the moral universe and by providing a framework for organizing and evaluating alternative courses of action.").

368. *See generally* ROBERT C. ELLICKSON, ORDER WITHOUT LAW 167 (1991) (theorizing that "members of a close-knit group develop and maintain norms whose content serves to maximize the aggregate welfare that members obtain in their workaday affairs with one another").

369. Anderson et al., *supra* note 363, at 99. The 2018 revisions preserved the same general organization. *See generally* 2018 ACM CODE, *supra* note 22.

370. 2018 ACM CODE, *supra* note 22, §§ 1.1, 1.2, 1.4.

confidentiality."[371] Section 2 turns to matters of skill and competence,[372] professional consultations,[373] and public service.[374] Section 3 exhorts members to mentor personnel to ensure that "the public good is the central concern during all professional computing work,"[375] and that mentees have opportunities to "grow as professionals."[376] Section 4 states that members "should take actions to resolve" any ethical issues they recognize, and "should consider reporting" any violations to the ACM.[377]

The ACM Code also includes several software-specific provisions scattered throughout the document. For example, it addresses intellectual property and data privacy, two issues that have proved especially thorny for the software community over the years.[378] It cautions against hacking and unauthorized access of computer systems unless "compelled by the public good."[379] The ACM Code also notes that special care should be used when managing systems critical to the infrastructure of society and "when modifying or retiring systems."[380] And the recent 2018 revision adds new provisions advising members to "design and implement systems that are robustly and usably secure,"[381] and to take "[e]xtraordinary care . . . to identify and mitigate potential risks in machine learning systems."[382]

Going forward, at least three adjustments might help align the ACM Code more closely with the aim of constructing consensus on

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371. *Id.* §§ 1.3, 1.7.

372. *See id.* § 2.1 ("strive to achieve high quality"); *id.* § 2.2 ("maintain high standards of professional competence"); *id.* § 2.3 ("know and respect existing rules"); *id.* § 2.6 ("perform work only in areas of competence").

373. *See id.* § 2.4 ("accept and provide appropriate professional review"); *id.* § 2.5 ("give comprehensive and thorough evaluations of computer systems and their impacts")

374. *See id.* § 2.7 ("foster public awareness and understanding of computing").

375. *Id.* § 3.1.

376. *Id.* § 3.5.

377. *Id.* §§ 4.1, 4.2; *cf.* Edmund B. Spaeth, Jr., *To What Extent Can a Disciplinary Code Assure the Competence of Lawyers?*, 61 TEMP. L. REV. 1211, 1223 (1988) ("Experience has shown, however, that only a small percentage — ten to fifteen percent — of complaints to disciplinary authorities are filed by lawyers," notwithstanding the requirement of ABA Model Rule 8.3(a) that lawyers "shall inform the appropriate professional authority" of rule violations (quoting MODEL RULES OF PROF'L RESPONSIBILITY r. 8.3(a) (AM. BAR ASS'N 1983))).

378. 2018 ACM CODE, *supra* note 22, §§ 1.5, 1.6; *see also* Anderson et al., *supra* note 363, at 99–100 (elaborating potential concerns relating to intellectual property and privacy).

379. 2018 ACM CODE, *supra* note 22, § 2.8 ("access computing and communication resources only when authorized or when compelled by the public good"). This language allowing a public interest exception contrasts with the criminalization of unauthorized access of computers under the Computer Fraud and Abuse Act, which contains no such exception. *See* 18 U.S.C. § 1030 (2018).

380. 2018 ACM CODE, *supra* note 22, §§ 3.6, 3.7.

381. *Id.* § 2.9.

382. *Id.* § 2.5.

professional software customs. First, ACM should take steps to formalize the process of identifying clear violations of the ACM Code.[383] ACM has issued some educational materials based on fictionalized scenarios,[384] but it does not publish assessments of actual software systems. Published decisions, case studies, and other real-world discussions would give tangible shape to what the software community considers to be worst practices for a given type of software project. Likewise, the ACM Code should formalize expectations regarding knowledge sharing and technical consultation — such as open source code practices, or independent code reviews.[385] That information-generating function is a critical component of other professional codes, because it provides a counterweight to the inherent uncertainties involved in matters of professional judgment.[386]

Second, the ACM Code should identify and add more provisions specifically pertinent to the software community. To its credit, the ACM Code already includes some provisions regarding robustness and usable security, machine learning, retirement of systems, and special care for critical infrastructure. But there are many more areas where guidance is needed. For example, at what point do software development cycles become too short? What are necessary safeguards for open source contributions? What constitutes inadequate software testing? How long can one wait to treat known software errors? What forms of continuing education should be required to remain a member in good standing? In sum, what are the actual shared practices of responsible members of the software community?

Third, the ACM Code should amend provisions that are inapposite to the work of software developers. The fiduciary duty of confidentiality is a puzzling fit for the software setting because — unlike law and medicine — most software services do not involve intimate counseling in a confessional setting. In certain contexts, guarding the secrecy of

383. *See* Frankel, *supra* note 175, at 114 ("[Codes of ethics] are like blunt instruments; they must be sharpened by interpretation if they are to function as meaningful guides to ethical conduct. The professions must, therefore, institutionalize means for offering such interpretation and ensure that they are accessible to all interested parties.").

384. *See* 2018 ACM CODE, *supra* note 22, at 13–20 (presenting five fictionalized scenarios); Anderson et al., *supra* note 363, at 99–106 (presenting nine hypothetical case studies).

385. For example, for safety-critical software communities, these knowledge-sharing functions are currently being facilitated through Information Sharing and Analysis Centers. *See* Aviram, *supra* note 342, 152–53.

386. *See* CODE OF MED. ETHICS ch. I, art. I, § 6 (AM. MED. ASS'N 1847) ("Consultations should be promoted in difficult or protracted cases, as they give rise to confidence, energy, and more enlarged views in practice."); CANONS OF ETHICS Canon 7 (AM. BAR ASS'N 1908) ("A client's proffer of assistance of additional counsel should not be regarded as evidence of want of confidence, but the matter should be left to the determination of the client.").

code may even be against public policy.[387] Likewise, the need for a fiduciary duty of loyalty is confusing, if most software transactions tend to occur in arms-length business or commercial settings without a dedicated trustee-beneficiary relationship.[388] To the extent that such duties of confidentiality or loyalty may be warranted for software professionals, they should be tailored more narrowly to actual use cases.[389] Similar concerns of overbreadth extend to other portions of the ACM Code. While it is noble to advise members to avoid harm, not to discriminate, and to uphold the public good, these dictates are too broad to derive meaningful customs or practices.[390] Other codes of ethics have never required pure ideals such as "do no harm."[391] Professional principles must flow upward from the practices of the profession.[392]

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387. *See* Rebecca Wexler, *Life, Liberty, and Trade Secrets: Intellectual Property in the Criminal Justice System*, 70 STAN. L. REV. 1343, 1353, 1376 (2018) (criticizing the use of trade secret claims to shield against scrutiny of software used in criminal proceedings); *cf.* Peter S. Menell, *Tailoring a Public Policy Exception to Trade Secret Protection*, 105 CALIF. L. REV. 1, 9 (2017) ("[W]hile trade secrecy can foster technological innovation and economic development, it can also conceal illegal conduct and silence the most knowledgeable sources. Therein lies the tension with the foundation of civilized society.").

388. *Compare* Khan & Pozen, *supra* note 24, at 506–07 (distinguishing social media companies such as Facebook from "[d]octors, lawyers, accountants and the like [who] do not experience such acute tensions within their sets of fiduciary obligations"), *with* Donald Gotterbarn, *Software Engineering: A New Professionalism* ("Software Engineering, as a profession, is moving toward a fiduciary model of the client-professional relationship . . . ."), *in* THE RESPONSIBLE SOFTWARE ENGINEER, *supra* note 365, at 21, 31.

389. One set of exceptions might include user-facing applications that handle especially intimate data. *See* Karen E.C. Levy, *Intimate Surveillance*, 51 IDAHO L. REV. 679, 682–86 (2015) (describing dating, romance, sex, and fertility apps). Another example of a fiduciary-like duty of confidentiality in the software context might be encryption of personal cellphones. *See generally* Bryan H. Choi, Response, *The Privilege Against Cellphone Incrimination*, 97 TEX. L. REV. ONLINE 73 (2019).

390. *See* Moore, *supra* note 189, at 775 (criticizing "the vague platitudes and general exhortations once found (and since rejected) in the former Canons of Ethics" for lawyers); *see also* Catherine Flick (u/ACMComputingEthics), Response to Questions of u/book_hiker to *We Are the Team Responsible for Leading the Update of the ACM's Code of Ethics for Computing Professionals. Ask Us Anything About Computer Ethics!*, REDDIT: ASK ME ANYTHING (Aug. 16, 2018, 11:08 AM), https://www.reddit.com/r/IAmA/comments/97suot/we_are_the_team_responsible_for_leading_the/e4ao1tj [https://perma.cc/L2VW-TWXK] ("We deliberately leave the 'public good' undefined; this is so that it can be future-proofed and better contextualised in different places.").

391. *See* Howard Markel, *The Hippocratic Oath as an Example of Professional Conduct* (observing that the axiom of "First, do no harm" is "often mistakenly ascribed to the [Hippocratic] Oath, although it appears nowhere in that venerable pledge"), *in* PATIENT CARE AND PROFESSIONALISM 19, 22 (Catherine D. DeAngelis ed., 2014); *see also* Lisa R. Hasday, *The Hippocratic Oath as Literary Text: A Dialogue Between Law and Medicine*, 2 YALE J. HEALTH POL'Y L. & ETHICS 299, 304 (2002) (noting that the prevailing concern of the Hippocratic Oath "is for the reputation of physicians, specifically that they not be blamed for the deaths of patients").

392. *See* Mark Siegler, *Medical Ethics as a Medical Matter* (arguing that the main goal of medical ethics should be "not to produce junior ethicists" but rather "to improve the quality of patient care in terms of both the process and the outcome of that care"), *in* THE AMERICAN MEDICAL ETHICS REVOLUTION, *supra* note 34, at 171, 174, 178.

By rebalancing in these ways, the ACM Code would become tremendously useful to software professionals grappling with the essential complexities of software development. It would yield a wealth of shared knowledge, improve professional identity and morale, and promote greater public trust in software systems.

VI. CONCLUSION

This Article has argued that software development should be treated as a profession like medicine and law. It has looked for a functionalist theory to explain why professionals are held to a customary care standard rather than a reasonable care standard. This Article has proposed that a customary care standard is appropriate where (1) bad outcomes are endemic to the practice, (2) those bad outcomes are caused by inherent uncertainties in the science of the field, and (3) the practice is vital to society, especially where outcomes are expected to be bad. Applying those criteria, this Article has postulated that building a software system demands the exercise of inexact judgment akin to building a legal case or planning a medical course of treatment.

This theory of professions rejects the notion that a profession must mirror other characteristics of the "traditional" professions. Nor does it treat the professional designation as a licensure or exclusionary principle. The software community is a vastly heterogeneous group that has flourished precisely because it has remained open to all comers, regardless of formal training, manner of dress, or gentility. In fact, the customary care standard is a way of preserving that diversity of practice while also allowing in a modicum of legal scrutiny.

As lawmakers look for ways to raise the bar of software liability, the professional designation allows software developers to rely on existing practices and customs as stepping stones against the coming flood of tort claims. This designation is neither a privilege nor a reward, but a compromise that acknowledges both the necessity and fallibility of the services being performed.