Design for Legal Systems

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Abstract

Design has its roots in physical things, from buildings to weapons to spacecraft. It has only begun to meaningfully explore human systems. Fuzzy set theory and object-oriented design are tools that have indisputably proven their utility in physical systems; some of these utilities port over to the modeling and design of human systems.

This article operates from the point-of-view of legal pragmatism. We look at how fuzzy theory might help the designer engage and embrace uncertainty inherent in human systems generally. One of every society's most fundamental systems is the making and managing of law, policy, and their consequent norms. We explore object-oriented analysis and design as a way to see and think differently about problem domains, and how solutions created by law and policy makers might operate better within legal systems.

As sophisticated technologies swiftly embed themselves into and alter the operation of our human systems, including our legal systems, our ability to understand and manage these systemic changes faces serious challenge. This article advocates for a marked increase in interdisciplinary research and teaching in the legal academy.

I] Thinking About Thinking: Pragmatism

"At their best ... lawyers serve as society's general problem solvers ..."[1] We will accept Professor Brest's statement as generally true not just for the present, but looking back one hundred years and, more to the point, forward for another hundred years. This expands the state space, if you will, for our understanding the role of the lawyer and to ask ourselves how best to prepare lawyers for this role in human systems going forward.

"You cannot think about thinking without thinking about thinking about something."[2] Today we will think a bit about design, as a method for investigating this particular role of lawyers in society. In a heated debate between Albert Einstein and Niels Bohr, an exasperated Bohr once hollered (at Einstein!): "You are not thinking, you are merely being logical!"[3] For hundreds of years, lawyers and their teachers have used logic as a core method of teaching, thinking about and thus practicing law. For some in the legal academy, logic remains the

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[1] Paul Brest and Linda Krieger, *"On Teaching Professional Judgment"* 69 Wash. L. Rev. 527, 529 (1994). https://digitalcommons.law.uw.edu/wlr/vol69/iss3/4

[2] Seymour A. Papert, *quoted by* Nicholas Negroponte, *Being Digital* (Knopf, 1995) p. 234

[3] *Quoted by* R.P. Crease and C.C. Mann *The Second Creation* (MacMillan, 1986) p. 77.

primary if not definitive standard for 'lawyerly' thinking. It is certainly fair to wonder whether this continues to be good, or good enough. MIT Professor of Artificial Intelligence Marvin Minsky asks "[W]hen do we actually use logic in real life? We use it to simplify and summarize our thoughts … to explain arguments to other people and to persuade them that those arguments are right."[4] And this is precisely what lawyers are trained to do – understand context and analyze facts in light of formal rules, then develop arguments to persuade others. Minsky continues:

> I doubt that we often use logic actually to solve problems or to 'get' new ideas. Instead, we formulate our arguments and conclusions in logical terms *after we have constructed or discovered them in other ways*; only then do we use verbal and other kinds of formal reasoning to "clean things up." ... Logic no more explains how we think than grammar explains how we speak; both can tell us whether our sentences are properly formed, but they cannot tell us which sentences to make.[5]

This is not criticism of logic *per se*. Logic, set theory, and other formalist bases have produced powerful philosophies and schools of thought across civilizations, before and after the emergence of the scientific method. These tools have served, and continue to serve, society and humankind immeasurably. Yet they are not, and candidly have never been, the sum total of the useful arts for human thought, decision-making or problem-solving. Philosopher John Dewey: "... the possibilities of continued and rigorous inquiry do not limit access to truth to any channel or scheme of things."[6]

Dewey, along with William James, Charles S. Peirce and (lawyer) Nicholas St. John Green, developed Pragmatism, "... a philosophical movement or system … stressing practical consequences as constituting the essential criterion in determining meaning, truth, or value."[7] Certain adherents treat pragmatism as a full-blown philosophy. Others, your author included, believe its utility is better understood as analytic method.[8] Characteristics attributed to

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[4] Marvin Minsky, *The Society of Mind* (Simon and Schuster, 1988) p. 186.

[5] Marvin Minsky, *The Society of Mind* (Simon and Schuster, 1988) p. 186.

[6] John Dewey, "A Common Faith" reprinted in *Intelligence in the Modern World: John Dewey's Philosophy*, ed. Joseph Ratner, (Random House, 1939) p. 1021-1022 (emphasis added).

[7] *The Random House Dictionary of the English Language*, 2nd Edition, Unabridged, at p. 1518. It is Peirce who credits the lawyer, St. Green, as "the godfather of pragmatism." Richard A. Posner, *Overcoming Law*, (Harvard, 1995), p. 5.

[8] "'Pragmatism' is a vague, ambiguous, and overworked word. Nevertheless, it names the chief glory of our country's intellectual tradition. No other American writers have offered so radical a suggestion for making our future different from our past, as have James and Dewey." Richard Rorty, *Consequences of Pragmatism* (University of Minnesota, 1982) p. 160. "We have the advantage of historical perspective

pragmatism *qua* method: "forward-looking,"[9] "future-oriented,"[10] and "not a thing, but a way of proceeding."[11] Contemporary legal pragmatist Thomas Grey is more astute:

> Pragmatism is freedom from theory-guilt. To the pragmatist, theory can be general commentary aimed to teach or reform a practice, or it can be a separate practice itself, pursued for its own rewards. Most often, it will be some mix of the two. *So conceived, theory runs alongside rather than ruling over worldly practice*.[12]

Designers working with law and policy, and their normative consequents, will gladly embrace any license granting additional freedom from theory-guilt. It is important to note here that Grey does not say freedom from *theory*, but rather freedom from the kind of sand-in-the-gears attachment to theory that can lock up the problem-solving process in law and policy work. Moreover, the relocation of theory to the value-additive function of "run[ning] alongside rather than ruling over" practical work is, as we will come to see, particularly useful for design work in human systems.

For some old-school pragmatists, any embrace of the force and effect of theory runs hard against the grain. The extent to which these adherents reject the idea that pragmatism might need any formal touchstone or baseline ruleset is precisely the extent to which their pragmatism abandons its ownmost aim – utility, wherever it may be found. There must be a formalist component to any *meaningful* pragmatism, whether dubbed method or philosophy. And *that* pragmatism knows an immutable touchstone is the actual source of its freedoms, for it is precisely that touchstone which grounds the pragmatist in making their fundamental choice for any given domain: "sometimes one of the opposing modes of thought is appropriate, and sometimes the other, and no theory – only situated judgment – will tell us which one to adopt

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and can ... survey and select distinctive themes and phases in the formation of pragmatism, but a single definitive statement of a single thesis is not to be hoped for." H.S. Thayer, "Pragmatism" from *The Encyclopedia of Philosophy*, Volume 6; ed., Paul Edwards (MacMillan, 1972) at p. 431.

[9] Richard A. Posner, "What Has Pragmatism to Offer Law?" 63 So. Cal. L. Rev. 1653, 1657 (1990).

[10] Cornel West, *The American Evasion of Philosophy* (University of Wisconsin, 1989).

[11] Margaret Jane Radin, "The Pragmatist and the Feminist," 63 So. Cal. L. Rev. 1699, 1701. Radin's phrase is vastly preferable to Rorty's more commonly-quoted but far less instructive aphorism that "pragmatism is seeing how things hang together." Rorty, *Consequences of Pragmatism* (University of Minnesota, 1982) p. xxxviii.

[12] Thomas C. Grey, "Hear The Other Side: Wallace Stevens and Pragmatist Legal Theory" 63 So. Cal. L. Rev. 1569 (emphasis added). Grey continues: "... The pragmatist thus possesses a general antidote to statements of the form 'we cannot proceed with x until we have an adequate theory of y,' where x is a socially constituted practice and y is an academic subject or theoretical topic."

and when."[13] This idea is sometimes conveyed with a metaphoric moral compass with which to make this situated, or context-dependent judgment. And that moral compass must have a magnetic north. Thus the metaphor strengthens the case that a useful pragmatism depends on theory, as Grey embraces, to run alongside worldly practice. Indeed, it is this application of theory that frees the pragmatist to apply context-dependent judgment in an uncertain domain.

The theory selection process is not to be taken lightly. One has to refer to *something* grounded in order to make that decision. And to say merely that we refer to morals, or ethics, or conscience may not be entirely wrong, but it elides the import of the question.[14] On this idea, famed pragmatist Rorty is unconvincingly dégagé:

> Pragmatist theory about truth ... says that truth is not the sort of thing one should expect to have a philosophically interesting theory about. For pragmatists, "truth" is just the name of a property which all true statements share.[15]

In the midst of declaiming a pragmatist's disinterest in a theory of truth, Rorty in fact admits the need for just such a foundation. He tries to deny its importance by going meta, asserting that truth is merely the name one applies to a property held by all things true; a maddeningly self-referential pass. The irony is that for one to know when to apply a usefully definitive label to any such Rortian 'property' one must still have some reliable metric for said property, if for no other reason than to measure all contenders.[16] In other words, even accepting a demotion to mere property, truth still requires a paradigm to which one can look – for comparison, as a model, to see if a statement is possessed of a consensible, essential nature of said property (e.g., true*ness*). So the pragmatist <u>must</u> maintain a referent from which to calibrate context-dependent judgment scenarios.[17] That stable base is not merely useful for pragmatism, it is dispositive of success in

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[13] Margaret Jane Radin, "The Pragmatist and the Feminist" 63 So. Cal. L. Rev. 1699, 1701.

[14] We are most assuredly not mollified by the mere morality of the moment, whether Victorian England or the American Counter-Culture of the 1960s. We are discussing the classic morals: sanctity of human life *per se;* personhood; fundamental human rights – that which Posner describes thusly: "...at the bottom of a chain of premises are unshakable intuitions, our indubitables, Holmes's 'can't helps.'" Posner, *Overcoming Law*, (Harvard, 1995) at p. 5.

[15] Richard Rorty, *Consequences of Pragmatism* (University of Minnesota, 1982) p. xiii.

[16] Posner makes this point specific to his craft of judging: "We must even ... consider the possibility that the pragmatic judge would think the pragmatic thing to be would be a formalist." Richard A. Posner, *Overcoming Law* (Harvard, 1995), p. 401.

[17]Context issues are virtually everywhere, including physics: "We begin by asking whether the universe is simple or complicated. The answer: *it depends on the context you have in mind* when asking the question and the kind of answer you want." Jack Cohen and Ian Stewart, *The Collapse of Chaos: Discovering Simplicity in a Complex World* (Viking, 1994) p. 441 (emphasis in original).

coping with one of the most consistent traits of complex human systems – uncertainty.

II] Uncertainty: From Avoidance to Acceptance

> Uncertainty is the stuff of life, the world we live in. It is the subtle smile, the half-sensed pattern, the vexing decision. It is tomorrow's stock market, the best chess move, the baffling ailment. It is so ubiquitous that scholars for centuries have studied how to escape it rather than to work with it. They have preferred the solace of certainty to a grasp of uncertainty.[18]

Uncertainty in any problem domain cannot, of course, be escaped; it also ought not be ignored.[19] No theory can do away with uncertainty in human behaviour any more than theory can do away with 'friction in mechanics.' "Consider the range of social behaviours we engage in every day. In each case, there are a multitude of unknowns, reflecting the many sources of uncertainty inherent to social inference."[20] It is, just as Nikiforuk describes, verily ubiquitous.

What we *can* do is choose how we engage uncertainty in human behaviour, how we go about making that discomfiting reach for a "grasp" on uncertainty. Law, as discipline both academic and applied, works around uncertainty in various ways, some highly appropriate, some not so much. For lawyers, "[a]voiding, ignoring or misplacing uncertainty as a default response is particularly easy given the dominance of legal thinking which contains a knowledge and certainty -seeking worldview."[21] Precisely because uncertainty is peculiarly inherent in our discipline, we would do well to revisit the ways we have collectively viewed and dealt with legal uncertainty, and reconsider how we might better engage and manage it.[22]

Design can help. Designers have developed tools to address the kinds of uncertainty that

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[18] P.N. Nikiforuk quoted in *Fuzzy Automata and Decision Processes*, Gupta, Saridis, and Gaines, eds., at p. ix (Elsevier North, 1977), at p. 175. "[M]ost of us are aware that there is much uncertainty in the world, and one of our most basic choices is whether we will accept that uncertainty as a fact or try to run away from it." Robyn M. Dawes, *Rational Choice in an Uncertain World* (Harcourt, 1988) p. 273.

[19] "Vagueness, said Charles S. Peirce, is no more to be done away with in the world of logic than friction in mechanics." Heinrich Scholz, *Concise History of Logic* (N.Y. Philosophical Library, 1961) p.1.

[20] Feldman-Hall and Shenhav, "Resolving Uncertainty in a Social World" *Nat Hum Behav* 3, 426–435 (2019). https://www.nature.com/articles/s41562-019-0590-x

[21] Tang and Foley, "The Practice of Law and the Intolerance of Certainty" University New South Wales Law Journal 37(3) 1198, 1203 (2014).

[22] In an upcoming section we will look at fuzzy set theory, a way of engaging uncertainties that is profoundly multivalent, as opposed to bivalent (binary): "…uncertainty is dimensional rather than categorical. *It has the qualities of more and less, rather than all or none*." Tang and Foley, "The Practice of Law and the Intolerance of Certainty," *University New South Wales Law Journal* 37(3) 1198, 1206 (2014)(emphasis added).

arise in their problem domains. So, just what *is* design? Dominique Sciamma, Dean of the Strate School of Design in Paris and Singapore, answers it this way:

> Generally speaking, it is the process of envisioning and planning the creation of objects, interactive systems, buildings, vehicles, etc. It is user-centered; users are at the heart of the design-thinking approach. It is about creating solutions for people, physical items, or *more abstract systems to address a need or a problem*.[23]

Design has many homes in the academy, with significant grounding in engineering. This is appropriate and good, as far as it goes. But design has much more to say, and much more difficult work to do, than the making of things. In just the last decade, the "Design Thinking Approach" has developed into an active, interdisciplinary domain. For our purposes, we can start by seeing design thinking as (part of) the process by which design work gets done.[24] Apple co-founder Steve Jobs:

> Most people make the mistake of thinking design is what it looks like… . People think it's this veneer – that the designers are handed this box and told, 'Make it look good!' That's not what we think design is. It's not just what it looks like and feels like. *Design is how it works*.[25]

Suppose the 'it' of which Jobs speaks is a human system; its design, then, is to be found in how it works. More to the point, the *quality* of its design is seen in how *well* the system works.

Design is beginning, ever so timidly, to entertain work on the "more abstract systems" to which Sciamma refers, the epitome of which are, most assuredly, complex human systems. As design engineers Meinel and Leifer have noted:

> With the integration of design thinking into engineering education, a missing link has been created between the science-focused, context-independent part of

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[23] Dominique Sciamma (emphasis added). https://www.strate.education/gallery/news/design-definition. He adds: "[i]t is a very broad concept and its meaning can greatly vary from one field to another. It permeates many aspects of our lives and branches out into many different subgenres."

[24] The difference between design and design thinking is well captured here: "Design Thinking skills and practices…should be thought of as being *appropriate to all disciplines including design*. Design itself is a craft of deep specialized skills… . Each of these design specialties needs to know and practice their own specialized craft…while also knowing and practicing design thinking… . *It is the practice of design thinking by a team that leads to the opportunity for innovation and each discipline's unique contribution, including design, that fleshes it out and realizes the potential*." Designer Karel Vredenberg, at https://www.karelvredenburg.com/home/2016/8/29/design-vs-design-thinking-explained (accessed July 6, 2020)(emphasis added).

[25] Steve Jobs as *quoted by* Rob Walker, *The Guts of a New Machine* "New York Times Magazine" November 30, 2003. https://www.nytimes.com/2003/11/30/magazine/the-guts-of-a-new-machine.html. Walker continues: "So you can say that the iPod is innovative, but it's harder to nail down whether the key is what's inside it, the external appearance or even the way these work together. One approach is to peel your way through the thing, layer by layer."

> engineering and the human society focused, context-dependent aspect. The latter area has long been neglected, partly due to the uncertainty that comes with the unpredictability of human behavior.[26]

This observation could easily slide by unnoticed, so we will amplify. These two global thought leaders in science-focused design are telling us that *design thinking has long overlooked human systems, due in part to uncertainty in human behavior*. They go further to expressly recognize that the human behaviour aspect of design thinking is context-dependent, and *not* science-focused.[27]

The social sciences must stand in admiration of those physical scientists willing to speak out and identify areas of inquiry for which the physical sciences have proven suboptimal. Physicist John Ziman:

> What we ask of a science of society is a body of knowledge, *a guide to action*, that is significantly more reliable, significantly broader and deeper in scope, than the agglomerations of practical wisdom with which most of what we do is still decided.[28]

Too many policymakers have refused or failed to see this tendency towards mere agglomeration – and not always agglomerations of wisdom, as Ziman generously suggests. Science is of tremendous value when applied to a context for which it is well-suited, when it maps well over the substrate of investigative work. Indeed, the life sciences have been nothing short of astonishing in their applicability to the physical aspects of human beings. But the missing link noted by Meinel and Leifer evinces itself as we begin looking at the behavioural aspects of human beings, at the design of human systems. This philosophical diagnosis rings particularly true:

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[26] Christoph Meinel and Larry Leifer, "Manifesto: Design Thinking Becomes Foundational" in *Design Thinking Research* Hasso Plattner, ed. (Springer, 2016) p. 1. Christoph Meinel is the Director of the Hasso Plattner Institute for Digital Engineering (HPI) at University of Potsdam, Germany. Larry Leifer is the Founding Director of the Hasso Plattner Institute of Design at Stanford University.

[27] Adding to the argument that a "science-focused" approach to understanding human behaviour may be fundamentally flawed, sociologist Roberta Greene writes: "[h]uman behavior theory needs to be understood within the context of the history of scientific thought. That history suggests … more than twenty major theoretical approaches. Each theory stems from a particular paradigm … [and] each paradigm is a reconstruction of prior thinking…" Roberta Greene, *Human Behavior Theory and Social Work Practice*, 2nd Ed., (Aldine Transaction, 2009). p.3. Though beyond the scope of this paper, it may be useful to problematize the assumption of the science-based approach to human behaviour, given the blend of inherent uncertainty and the difficulty in imposing the controls necessary to generate meaningful results.

[28] John Ziman, *Reliable Knowledge: An Exploration of the Grounds for Belief in Science* (Cambridge, 1978) p. 6 (emphasis added).

> For better and for worse, philosophical thought has repeatedly been influenced by its close dealings with the specialized sciences. In the decades following World War II, the predominant influence on American philosophy came from the formal and physical sciences. ... The end result of this (and other factors too complex to guess at) was the very peculiar post-war spectacle of mainstream Anglo-American philosophy flowing along for decades with virtually no influx from the human sciences. Not only was it distinctive of analytic philosophy that after a century of development of the specialized modes of inquiry tailored to comprehending sociocultural phenomena, it all but ignored them except for persistent attempts to assimilate them to the natural sciences.[29]

The physical sciences, which is to say their methodology and bent for empiricism, have primarily defined the investigative paradigm for the social sciences. Science successfully attained a position of prominence in human thought, so much so that it fairly filled the field in a fashion well captured by Matsuda: "Power at its peak is so quiet and obvious in its place of seized truth that it becomes, simply, truth rather than power."[30] This is not pejorative of science *per se*, science as method. It is the application of science over inapt terrain that has extended its position of power, at least in many western societies, glazing it with the patina of broader truth. And, the physical sciences' position of power in the investigative model, whether in academic, government or private sector inquiry, is so fully accepted that it has, ironically, become the baseline against which the perceived failings of the social sciences are measured (by physical scientists!):

> The fundamental issue for the behavioral sciences is whether the theory-building process can produce a strong, sure, unambiguous framework of concepts and relations as reliable in its own domain as the physical and biological sciences are in theirs.[31]

Without digressing into the argument, let us nonetheless contest here the silent premise that the positive characteristics of the physical science framework – 'strong, sure, unambiguous' – are necessarily the right ones for the behavioural sciences.[32]

That said, and for now left safely aside the road for another day, the larger point is fair

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[29] Thomas McCarthy, *Philosophical Interventions in the Unfinished Project of Enlightenment* Honneth, McCarthy, Offe, and Wellmer, eds. (MIT Press, 1992) p. 242.

[30] Mari J. Matsuda, "Pragmatism and the False Consciousness Problem" 63 So. Cal. L. Rev. 1763, 1765.

[31] John Ziman, *Reliable Knowledge: An Exploration of the Grounds for Belief in Science* (Cambridge, 1978) at 6.

[32] "Assuming that humans are rational often makes it easier to construct a theory of how they act, but such a theory is often not very realistic. There, alas, is the chief flaw in much of today's social and behavioral science." Nobel Laureate Murray Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (Freeman, 1994) p. 323.

and honestly appreciated. The study of human behavioural systems has struggled, on many fronts, to produce a "framework of concepts and relations … reliable in its own domain." As noted, though several reasons adhere foremost among them is the uncertainty of human behaviour. Probabilistic uncertainty is familiar to every student; the uncertainty in predicting the location and speed of an object in motion at time *t*. Cognitive uncertainty stems directly from human thought. Gupta explicates probabilistic and cognitive thusly:

> No doubt, one can estimate the volume of snow or the heights of the mountains, or the frequencies of vibrating musical strings using statistical theory, but the conventional mathematical methods cannot be used to narrate logically the feelings and emotions associated with their perceptions.[33]

Even Stephen Hawking concurs: "Love, faith, and morality belong to a different category than physics. You cannot deduce how one should behave from the laws of physics."[34] The intellectual world is not zero-sum, and we must not make any categorical mistake to that effect, no matter how powerful one stripe of intellectual method has become in its position as seized truth. Intellectual space is not materially finite. Different ways of seeing the world, creative methods of analysis, and novel approaches to measurement and understanding possess equal claim to that space. "Non-scientific" is no longer pejorative.

Here is where we can come full circle, with the blessing of at least some of the physical scientists. We can engage a meaningful pragmatism and its recognition that science as theory may, for appropriate purposes, be relocated from its position of 'seized truth' to a stabilizing role 'running alongside worldly practice.'

> Pragmatism…does not erect Science as an idol to fill the place once held by God. It views science as one genre of literature – or, put the other way around, literature and the arts as inquiries, on the same footing as scientific inquiries.[35]

By relocating scientific inquiry on the same footing as literature or the arts, Rorty implicates another methodology, seemingly long dormant – interdisciplinarity. Fragments of interdisciplinary inquiry are found among the ancient Greek academics. But as a methodology

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[33] M.M. Gupta, "Intelligence, Uncertainty and Information" from *Analysis and Management of Uncertainty: Theory and Applications,* Ayyub, Gupta and Kanal, eds., (Elsevier Science, 1992) p. 5. Feynman once posited: "The next great awakening of human intellect may well produce a method of understanding the qualitative content of equations. Today we cannot." *The Feynman Lectures on Physics II-41-12,* Richard P. Feynman, Robert B. Leighton and Matthew Sands (Addison-Wesley, 1963).

[34] Steven Hawking, *Black Holes and Baby Universes and Other Essays* (Bantam, 1993) p. 173.

[35] Richard Rorty, *Consequences of Pragmatism* (University of Minnesota, 1982) p. xxxviii.

of post-modern import it lay unexamined until a well-deserved resurgence in the early 1990s. One notable proponent was world-renowned climatologist, Steven Schneider, who championed the burgeoning interdisciplinary academics as:

> ... a process that will become increasingly necessary to address real-world problems where they exist – not within the boundaries defined historically by disciplines, but in the overlapping domains defined by the problems themselves. This kind of work may be politically incorrect, uneconomic, hard to evaluate for quality or threatening to existing status hierarchies. Nevertheless, that is no excuse for an open-minded institution to shirk its responsibility to study the world as it is, rather than through the traditional structures of discipline-dominated institutions.[36]

The speed and spread of innovation and implementation in science and technology, and their infusion into virtually all human systems, are powerful forcing factors, well-nigh demanding that we 'address real-world problems where they exist…[in the] overlapping domains *defined by the problems themselves*.' If we accept that lawyers comprise society's general problem-solvers, then we cannot shirk Schneider's admonition *qua* prescription. And this means more than just a select few of the most curious law students exploring interdisciplinary space. Nor are just a few adventurous faculty enough to develop the coming generations of society's problem-solvers. The academy and all attendant institutions must embrace the world interdisciplinary. For it is only the institutions that can dissolve disciplinary boundaries and replace them with relationships that map more usefully over the tightly-blended fields of science, business, engineering, computing, design and, yes, law as they operate and innovate in worldly practice. Reluctance is not, alas, a viable option:

> Companies, professions, institutions that insist on clinging to obsolete techniques and habits look attractively stable/traditional for a while – tweed and pipes and solid oak desks, that sort of thing; then they look charming; then quaint; then ridiculous; then dead. The question is not whether we adjust … but whether, as a society, we do it enthusiastically and well.[37]

Any human system, especially one as complex as any society's body of law, policy and norms, that falters in the midst of this externally-driven phase transition will see competing social forces move rapidly to fill the vacuum. Those social forces, whether political or economic or

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[36] Stephen H. Schneider, "Climatologist Schneider Urges Blending Context, Content In Teaching Sciences" *Stanford Campus Report* April 5, 1995 p. 9.
[37] Meg Greenfield, *Newsweek* February 27, 1995 p. 84.

ideological, may not have the public interest at heart; even if they do, they may be too poorly constituted to hold the space. Even if they are, they may fall victim to the latent corruption encoded in the very power left unattended by said law, policy and norms.[38]

Though counter-intuitive, the correct response to rising substantive complexity in legal systems may need to be more complexity:

> Q: Most organizations try to simplify and streamline. But you seem to say that organizations should become more complicated.
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> A: It's the law of requisite variety, which says that if you want to make sense of a complex world, you've got to have an internal system that is equally complex.[39]

We in the law must ask ourselves whether we have fully embraced the coming change that the global technology diaspora is forcing into our human systems and, thereby, the practice, pedagogy and institutions of law. If not, the fault lay with us, a failing in our own roles as society's most experienced problem solvers. For the change wrought by technology has already arrived and, in a significant way, it is already ahead of us. It cares not a whit whether we accept the responsibility to solve for it.

The larger question is no longer if human systems are in the midst of technologically-mediated disruption. They are. The question is how, through our institutions – academic, governmental, corporate or religious – we will identify the disruptions, model the affected systems, design the requisite amendments and implement those solutions in ways that improve the operation of those systems. Nobel laureate Murray Gell-Mann offers a way to start:

> ... [W]e need to overcome the idea, so prevalent in both academic and bureaucratic circles, that the only work worth taking seriously is highly detailed research in a specialty. We need to celebrate the equally vital contribution of those who dare to take what I call 'a crude look at the whole.'[40]

This may well be the necessary starting point for truly interdisciplinary work in law.

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[38] It is worth documenting here that the United States is suffering this fate at this very moment in history.
[39] Karl Weick, Professor of Organizational Behavior *quoted by* John Geirland, *Wired* (April, 1996) p. 137.
[40] Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (Freeman, 1994) p. xiii-xvi.

III] Fuzzy Set Theory: From Boundary to Relationship

> The natural world … is a pervasive, nonquantitative world in which there are few sharp boundaries; one in which the transition from membership in one set to another is gradual rather than abrupt. It is a world in which fuzziness is the rule rather than the exception. … However, in dealing with this real world, whether by means of analytical models or actual systems, engineers, scientists, mathematicians, and others have largely ignored this fact. Far too frequently, they try to apply the precision of classical mathematics to this imprecise, nonquantitative pervasive world of ours; when failure resulted, they wondered what went wrong. Many still try.[41]

The Law of the Excluded Middle is an inviolable rule of traditional (crisp) set theory. Simply stated, it holds that an object must either be a member or a non-member of any given set. The definition for membership in the set can vary, but there will always be a bright-line threshold that completely separates members of the set from non-members of the set. Mathematician Lotfi Zadeh proposed a stark alternative to crisp set theory with a simple but fundamental thesis – that an object's membership need not be binary. There can be partial membership in a set. He called it 'fuzzy' set theory, in counterpoint to the existing crisp set theory.[42] And with fuzzy he created a new rule, the Law of the *Included* Middle.

Fuzzy set membership is straightforward. An object's partial membership in any given set is measured with a grade between 0.0 and 1.0. Moreover, an object can hold fuzzy membership in more than one set simultaneously. For example, a classic German beer stein might hold a 1.0 membership in the set of beer steins, by definition.[43] It could also have 0.75 membership in the set of pencil holders, have 0.60 membership in the set of champagne glasses *and* 0.15 membership in the set of flotation devices.

But this process, gradation, is not the end in itself. Rather, it is a tool for the dissolution of boundaries. Fuzzy sets help us fracture the concrete of boundaries, with which to construct relationships. Professor Minsky: "we are <u>always</u> changing boundaries! Where does an elbow start or end? Where does an ocean change into a sea? Why must our minds keep drawing lines

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[41] P.N. Nikiforuk, quoted in *Fuzzy Automata and Decision Processes*, Gupta, Saridis, and Gaines, Eds., at p. ix (Elsevier North, 1977).

[42] The term "fuzzy" came to be used derisively by some critics, descriptive not of the concept but rather the thinking of those who dared work with it. Zadeh later admitted a modicum of dismay about that name.

[43] Beyond the scope of this article is a deep dive into language and the inherent imprecision or inaccuracy in using words for qualitative measurement in fuzzy gradation.

to structure our reality?"[44] Indeed. Mathematicians, linguists and philosophers concur:

> The world does not consist simply of an endless array of objects, and the word "table" was not invented in order to bisect the universe into tables and non-tables. And if that is true of "table," it is true of "honor," and it is true of "love," and it is true, of course, of "mass" and "energy" and everything else.[45]

Let's look a more robust example. Imagine dumping the contents of your salt shaker into a heap on the kitchen table. Your task is to remove the grains of salt, one by one, from the heap on the table. At some point along the way, what was once a "heap" will cease to be such. It will become something else, not-a-heap. Crisp set theory says that we must draw a bright line boundary that separates the heap of salt from the non-heap of salt. That line will define every instance on one side as a member of set H (heap of salt) and every instance on the other side of the line as not-H (not a heap). We might draw that line when the heap comes to resemble a mound, or a pile, or just a spill of salt. There is a reasonable argument to be made for each such choice. The key point here is that crisp set theory mandates an inescapable, arguably immutable, boundary; more to our point, it requires a judgment to be made about where to place the bright line, about where the boundary shall fall.[46]

Fuzzy set theory sees this problem domain differently. It acknowledges that, as salt grains are removed from the heap one-by-one, there is a gradual transition away from being a 'heap' of salt, away from its original 1.0 membership in set H. Across that transition, the theorist must assign fuzzy grades of membership for those changing states. Suppose near the beginning of the grain-removal process we see a visible change in the shape of the heap of salt. We might then assign a grade of 0.88 membership in set H. Later there is quite a bit more shape change, further from the archetype, and we assign 0.61 membership. Far later in the process and the salt grains that remain have almost lost any "heap" characteristic; they look more like a small spill. We might assign a 0.25 grade in set-H. Then, with only a smattering of grains lying flat and separated on the table, we assign 0.05 membership, as it represents but a memory of a heap of salt.[47]

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[44] Marvin Minsky, *The Society of Mind* (Simon and Schuster, 1986) p. 134 (emphasis in the original).

[45] Jacob Bronowski, *The Origins of Knowledge and Imagination* (Yale University Press, 1978) p. 108-10.

[46] The heap of salt visualization comes from *Fuzzy Thinking: The New Science of Fuzzy Logic,* Bart Kosko (Hyperion, 1993). The descriptions and extrapolations here are my own, as are any errors therein.

[47] This point in gradation is explored by Kosko with the notion of a "fuzzy number zero." Given the idea of a singular point on the horizontal axis that holds 1.0 membership in the set "zero," Kosko argues that numbers immediately on either side of zero must share some graded membership in set "zero."

Fuzzy theory embraces the natural world, the world of ‘few sharp boundaries.’ And in the salt-heap example, no sharp boundary is to be found. The boundary is imposed by crisp set theory; fuzzy rejects it. For fuzzy, gradation steps up to obviate the need for a boundary. Gradation works *on the relationship* of each instance to every other graded instance, and each instance’s relationship to the heap of salt. By contrast, the crisp theorist is allowed but one grade, H or not-H, the quintessential binary measurement. This thought experiment neatly elucidates the pragmatist idea that “[fuzzy] theory runs alongside world practice, rather than ruling over it.”[48]

Each type of set theory has its strengths and weaknesses. No value judgment is made here, nor is it warranted. It is the context, the problem domain, that steers the designer in opting for one or the other. Returning to our heap of salt, notice that at the poles – at the beginning and at the end of the set membership inquiry – crisp and fuzzy theories are largely in agreement. The initial state of the heap of salt certainly holds membership in set H under crisp theory. As a result it is assigned a high grade of membership in set H under fuzzy. Likewise, when but a few grains remain, they are truly not-H under crisp theory, and they receive a very low grade of membership in set H from the fuzzy theorist. This is as it should be.

The interesting difference is in the middle. In figure 1 below, we draw the bright-line boundary of the crisp set theorist; call it the Crisp Boundary (CB). It separates, with absolute certainty, two sets: H and not-H. Object A, in set H, represents the original heap of salt; its distance from CB is furthest. Likewise, Object Z is furthest from the line on the opposite side; it represents the last few grains. Objects B and C, and their counterparts Objects X and Y, are relatively closer to the CB. But each of these four holds 100% membership in their respective crisp (c) sets, H or not-H, due to their location relative to CB. There is no uncertainty. This fact is not itself a criticism of method; quite the contrary, it is a full expression of the Law of the Excluded Middle, the fundamental characteristic of this theory.

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[48] Thomas C. Grey, “Hear The Other Side: Wallace Stevens and Pragmatist Legal Theory” 63 So .Cal. L. Rev. 1569.

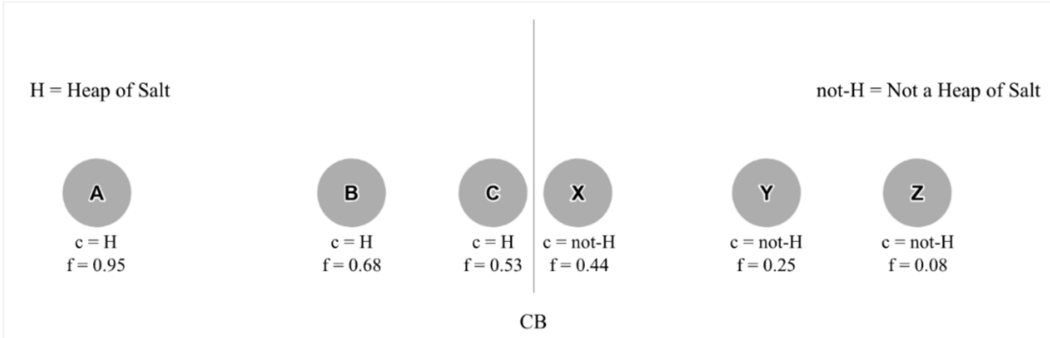

Figure 1.

Now, let us assign fuzzy grades. To Object A, we assign 0.95 fuzzy (f) membership in set H; Object B, 0.68 membership; Object C, 0.53; Object X, 0.44; Object Y, 0.25; and Object Z, 0.08. Notice what fuzzy gradation assesses. Each grade is the designer's qualitative measurement of the object's relationship to the original heap of salt and, by dint of that, to all the other objects. At no time does the designer assess an Object's relationship to CB; indeed, for the fuzzy designer, CB simply does not exist. By comparison, once the crisp designer has established CB, it is the heap of salt that recedes from view, as all crisp membership assignments thereafter relate solely to the boundary, drawn at CB. Every object on one side of CB is identical; the crisp designer need pay no further attention to any Object's relationship to the heap of salt. These differing approaches are not criticism of method. They are, simply, the full expression of each theory's foundational yet starkly different characteristic – the Law of the Excluded or Included Middle.

Fuzzy grades also represent the designer's certainty that the object meets, or does not meet, some pre-established definition or criteria for being a heap of salt. Fuzzy theory is not just embracing uncertainty, it endeavors to measure it. Where this embrace makes itself most apparent, in comparison to crisp theory, is near the Crisp Boundary. We can think of the fuzzy membership grade for each Object as including a small packet, an uncertainty grade, carried within the membership grade. Standing alone this may seem innocuous. But its relevance surfaces when we compare fuzzy objects to crisp objects. Imagine you are blindfolded. You are told that Objects A, B and C are each a (crisp) member of set H. This statement is true. But you have no way to assess these three Objects with respect to CB, or each other for that matter. There is no way to discern whether Object A is the same or different from Object C, even though Object C is substantively less a heap of salt than Object A. The information you are given, membership in Set-H, is thus somewhat artificial.

To be sure, it is perfectly accurate in relation to the crisp designer's selection of CB, but inaccurate as to the Object's native characteristic as a heap of salt. This inability to assess each Object's relationship to the heap of salt actually exacerbates the uncertainty inherent in this problem domain. Pragmatically speaking, crisp set theory has 'ruled over' the worldly practice at hand, and as such the designer selecting crisp theory has "preferred the solace of certainty to a grasp of uncertainty."[49]

Next, still blindfolded, you are given these same three Objects with their fuzzy membership grade: Object A has 0.95 membership in set H; Object B, 0.68 membership; Object C, 0.55. You now have more information about the Objects' relationships – to the heap of salt and to one another. By comparison, when these unique objects are assigned crisp membership in set H, they become thereby vulnerable to being seen and treated as fungible when, in fact, they are anything but. This embedded error could become problematic in subsequent analysis of the system. Fuzzy grades, however, provide more transparency and avoid the embedded error problem therefor.

Having dispensed with the obligation of creating a bright line boundary between H and not-H, the fuzzy theorist also dispenses with the uncertainty necessarily attached to that task. Where has that uncertainty gone? Rest assured, theory does not, and cannot, make uncertainty vanish. What occurs, as fuzzy theory runs alongside this practical work, is that the designer's choice of theory has moved the uncertainty to a different place.[50] In doing so, the designer has a better chance *in this domain* of finding, scoping and managing the uncertainty. The fuzzy designer's 'uncertainty curve' never arrives at the binary decision presented by crisp theory. The designer is never asked to make the completely exclusive judgment on membership in set H or not-H. Instead of forcing all of the uncertainty about set membership into a single judgment, fuzzy distributes uncertainty incrementally, within each separate membership grade given to each discrete object. The uncertainty is broken down into packets at each step. Each object has different characteristics than even its immediate neighbor, and fuzzy forthrightly treats each object accordingly. Crisp theory labels unique objects homogenously. And it does so by sheer force of theory, not through an understanding of the inherent nature of each object. Fuzzy not

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[49]Nikiforuk, quoted in, *Fuzzy Automata and Decision Processes* Gupta, Saridis, and Gaines, Eds., (Elsevier North, 1977) at p. ix.

[50] *Cf.*, Yale Law Professor Peter Schuck: "Open-ended, multi-factored or otherwise indeterminate legal standards ... do not really reduce conflict but simply <u>move the policy conflict from one rule-making locus to others.</u>" Schuck, "Legal Complexity: Some Causes, Consequences, and Cures" 42 Duke L.J. 1, (October 1992) p. 21 (emphasis added).

only recognizes each object's uniqueness, it evaluates this uniqueness when making each membership grade.

This stark difference between fuzzy and crisp is most apparent closest to the boundary. At the poles, under either approach, uncertainty could be said to run asymptotic to zero, towards absolute certainty. But for crisp theory, the uncertainty relating to a set membership judgment (H or not-H) increases as one approaches the boundary CB. The uncertainty piles up, as it were, as the crisp theorist approaches CB. Again, theory has not made uncertainty evaporate. It is just that fuzzy does not allow the uncertainty to accumulate because every grade carries a bit of the uncertainty load. The fuzzy designer confronts uncertainty earlier, more often, and more transparently than does the crisp, binary designer. And the payoff comes wherever the crisp designer decides to set CB. By having allocated packets of uncertainty incrementally, the fuzzy designer can grade Object C at 0.53 and Object X at 0.44 and just move on past the crisp designer, who is making the difficult judgment on exactly where to build their wall.

Comparing fuzzy and crisp Objects C and X illuminates another embedded error problem. The difference in their fuzzy grades is a mere 0.09. That is, these two objects are remarkably similar with respect to their heap*ness*. But their crisp membership assignments, set H and set not-H, force them to wear opposing labels vis-à-vis the natural world characteristic of heapness. The objects have tight similarity as a matter of actual fact, but they are *presented to the user* as diametric opposites. In this instance, theory actively conceals truth; it has 'ruled over worldly practice,' and forcefully so.

It might appear at this juncture that the multivalent (fuzzy) logic is superior to bivalent (crisp) logic.[51] However, there are far more *instances* of uncertainty in the fuzzy approach; there is uncertainty in each and every assigned fuzzy grade, and there may be dozens, if not hundreds, in any given problem analysis. Moreover, each grade assignment is utterly subjective; any five designers would generate five distinct grading patterns for the same objects. How, the critics ask, do fuzzy theoreticians benchmark the allocation of partial membership grades for various objects within a set, with no apparent touchstone other than the designer's subjective guess? The

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[51] Another term for binary logic is *bivalence;* for multi-valued logic, *multivalence.* If bivalence, the fundament of crisp set theory, fails to account for (or ignores) error (whether background, structural, human or embedded), then probabilism moves us further away from certainty as a result of the multiplication of uncertainties inherent in its various elements. "Bivalence: one times one times one times one ... equals one. Multivalence: one times .99 times .98 times .97 times .00001 equals a number very close to zero. The fuzzy product 'goes to zero' as the number of uncertainty factors increases to infinity." *Fuzzy Thinking: The New Science of Fuzzy Logic*, Bart Kosko (Hyperion, 1993) at pp. 95-96.

answer rests, in part, in fully embracing the notion that uncertainty exists, that we ought to embrace it as a real world fact, and thus should no longer pretend to rationalize it away:

> We often dread uncertainty. A common way of dealing with our knowledge of the uncertainty in life is to ignore it completely, or to invent some "higher rationale" to explain it, often a rationale that makes it more apparent then real.[52]

Crisp theory, it is argued, can avoid this problem entirely. As we have seen, the bivalent approach requires only one decision, where to place one boundary and in the doing thereby solves for all relevant uncertainty in the domain. Efficient, clear, arguably more objective therefor. In some problem domains bivalence may well be the best choice, especially where context ameliorates any embedded error problems. Michael Dertouzos, former Director of the MIT Laboratory for Computer Sciences describes this nifty demonstration:

> Analog systems are fine for many applications, but they are too imprecise and susceptible to fluctuations. To show this to my former sophomore classes, I would bring in a measuring cup and pour in 4.0 units. I would then jiggle the cup spastically, spilling some water to demonstrate how analog systems can be affected by heat or interruption from other signals. I would then ask a student to read the corrupted amount. Was it still 4.0 units, or 3.9, or 3.8? It was hard to tell. To represent the digital scheme, I would fill one glass and leave two empty, to represent the number 4 as 1-0-0. I would spill some water from the full glass, sometimes even into the empty glasses, and would ask the student to read the results. The answer would always be 1-0-0, because any amount above half-full would be read as a 1 and any amount below half-full would be read as a 0 – just as it is done inside a computer. The result is exactly 4, *with no uncertainty*.[53]

Dertouzos clarifies the difference between a bivalent (crisp) and multivalent (analog) approach to managing uncertainty. When error is introduced, the crisp result continues to be exactly four, even though we *know* the volume is no longer four. But in a domain where such error is of no moment, the binary approach demonstrates its stark advantages. No doubt, many such domains exist. Yet Dertouzos' demonstration proves up something else for us, rather plainly. Precisely because bivalence depends upon, nay, requires this foundational opacity to error, we must take extraordinary care in matching our problem domain to our choice of theory.[54]

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[52] Robyn M. Dawes, *Rational Choice in an Uncertain World* (Harcourt, 1988) p. 256.

[53] Michael L. Dertouzos, *What Will Be* (HarperEdge, 1997), p. 323-324 (emphasis added). 1 – 0 – 0 is the binary representation of the numeral four (4).

[54] This judgment must include the risk that data often find themselves ported 'elsewhere,' to a place where the original relationship of error-to-context is lost. Such information – stranded, naked and alone – can dangerously amplify error embedded yet obscured by the "solace of certainty." Recall Powers: "The loss of a great library to fire is a tragedy. But the surreptitious introduction of thousands of untraceable

The primary point is that *there is a design choice to be made* about applied theory, and that choice has ramifications. As pragmatists, we would treat such judgments as especially context-dependent: "sometimes one of the opposing modes of thought is appropriate, and sometimes the other, and no theory – only situated judgment – will tell us which one to adopt and when."[55] To do this well, the designer must possess sufficient information about the context. But even this is no longer enough, in a technical and multi-disciplinary world. The designer must also have the ability to *understand* that context, must have sufficient grounding in the disciplines comprising the domain.

Then there is the temporal element, *when* should the design choice be made. Assume three problem domains. Problem domain one (PD1) requires the designer to select their set membership theory *before* the first grain is removed from the heap of salt on the table. Here, the designer is stripped of the opportunity to observe as salt is removed, and with it information by which to judge the key metric of heap*ness.* Selecting crisp theory means placing a bet on receiving and developing reliable new information during the process that will point towards the best judgment for creating the boundary, CB. Selecting fuzzy theory means placing a bet on the designer's ability to ascertain the rate of change away from heap*ness* near the beginning of the grain removal process, as well as gauging fluctuations to that rate of change. Assume a PD2 that permits the designer's judgment on choice of theory to be postponed until later in the process, or even at the end of the process. The designer is freed up to gather a great deal more information relevant to their situated judgment challenge and, as a result, it is almost certain that their choice of theory will be superior to the PD1 scenario.[56]

Now hypothesize PD3, in which two designers, one fuzzy and crisp, have completed their set membership assignments. They are then told of an indisputably accurate mid-point for heapness, which happens to be 7% off of the placement of CB. We will draw a new line on the objective mid-point and call it CB_1. Thus, all objects residing within the space between CB and CB_1 are now revealed as having a crisp set membership assignments that are 100% incorrect.

errors into reliable books, errors picked up and distributed endlessly by tireless researchers, is nightmare beyond measure." Richard Powers, *The Goldbug Variations* (Harper, 1991) p. 495.

[55] Margaret Jane Radin, "The Pragmatist and the Feminist" 63 So. Cal. L. Rev. 1699, 1701.

[56] This is an example of one of the Core Design Abilities taught to design students, 'designing your design work.' As early as plausible in the process, the expert designer will be thinking about structural choices that enhance information gathering and postpone commitments until absolutely necessary. This is but one mark of a good design process, avoiding the preclusion of potentially desirable options downstream.

But *outside* that 7% band, in the rest of the domain, all crisp set assignments are now known to be 100% accurate. When we look at those same objects' fuzzy grade, we see the error quite differently. If, for example, within the 7% error band, an object's fuzzy grade was 0.44 when it should have been 0.50, the measurement error was only 0.06, as compared to crisp set error of 1.0. But, outside the 7% band, *every* object's fuzzy grade will require amendment precisely because each fuzzy grade was made in relation to a subjective assessment of heapness, and in relation to the other Objects' grades. So Object A's grade changes, say, from 0.95 to 0.88. This shows an advantage of the binary (digital) approach. To which we say, terrific, both theories demonstrate legitimate utility in different contexts, and sometimes those different contexts reside in the same problem domain. Both crisp (bivalent) and fuzzy (multivalent) methods "know" that there is uncertainty. Each has its own way of treating it, and each is preferable in certain contexts. The argument for multivalence is that it affirmatively focuses on the task of embracing the ambiguity at every possible locus. Bivalence has license to ignore uncertainty until the 'big red wall' appears on the horizon, presenting the designer with just one, albeit heavily-weighted, judgment – to assess the key metric accurately.

The difference between bivalence and multivalence is well-described here by David Brubaker; in deference to the elegance of this thought experiment, it is presented *in toto*:

> Suppose you've been lost in the desert for several days without water and you come upon two one-gallon glass jars. One is marked to indicate that the probability it contains pure water is 0.91. The other is marked that the degree of membership (a fuzzy measure) of the contents in the class "pure water" is 0.91. Which would you drink?
>
> The first, with 0.91 probability of being pure water stands a 9% chance of being some other clear liquid – turpentine, for example. The second, which has a degree of membership in the set "pure water," could be clear swamp water – not the most desirable drink, but worth drinking in a pinch.
>
> The difference becomes even clearer by considering what happens after observation. Suppose you happen to have a back-pocket chemical-analysis kit, and you determine that the liquid with 0.91 probability of pure water is pure water and that the other liquid is lake water. The contents of both jars are now known with 100% certainty (probability equals 1.0), but the liquid in the second jar still has 0.91 membership in the class "pure water."[57]

The bivalent, probabilistic approach measures the likelihood of truth for a certain datum; here, whether the jar *in fact* holds pure water. The number assigned is a *judgment about certainty*, <u>to</u>

[57] David I. Brubaker, "Electrical Design News" 38(7) (March 31, 1993) p. 103.

wit: how probable is it that a guess is correct. And for some analyses this is a prized characteristic.

Multivalence addresses something else. The fuzzy, possibilistic approach measures the likelihood that the fluid in the jar, whatever it might in fact be, possesses a characteristic more directly relevant to the problem domain – whether it is potable, 'worth drinking in a pinch.' Put differently, fuzzy doesn't play the "what is the liquid actually" game; instead, it plays the "will the liquid hurt me" game. It cares almost not at all about whether the jar contains pure water; it cares entirely about potability of the liquid. In this quintessentially pragmatic thought experiment, admittedly designed for this purpose, a notable fragility in probabilism is amplified because of the human risk factor.[58]

Now let us deploy Brubaker's back-pocket chemical-analysis kit, and this time determine that both jars contain lake water. This shows the crisp measurement of certainty – 91% chance that the "crisp" jar was pure water – to be incorrect. So, while the water in the crisp jar is in fact just as potable as the fuzzy jar, the user was required to assess a 9% chance that the jar might make them sick. This steers the rational user away from the crisp jar vis-à-vis the information presented for the fuzzy jar. In this domain of context-dependent judgment, the fuzzy grade was simply better, in that *it assured the user* that the jar contained water sufficient to meet the user's need.[59]

One last thought experiment, one that likely came to mind – Schrödinger's cat. We have all heard a version of the metaphor; some retellings are materially inaccurate, so it serves us well to revisit Schrödinger's original text, from 1935:

> A cat is penned up in a steel chamber, along with the following diabolical device (which must be secured against direct interference by the cat): in a Geiger counter there is a tiny bit of radioactive substance, *so* small that *perhaps* in the course of one hour one of the atoms decays, but also, with equal probability, perhaps none; if it happens, the counter tube discharges and through a relay releases a hammer which shatters a small flask of hydrocyanic acid. If one has left this entire system to itself for an hour, one would say that the cat still lives *if*

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[58]N.B.: a mixture of 91% pure water and 9% clear poison would not generate a good-faith 0.91 fuzzy grade of membership in the set of pure water. The importance of language again comes to the fore. When it comes to legal decision and policy making, this point must be made clear. For this reason, raw political compromise, the "making of the sausage," is almost always destined to fail to attain an optimal or even near-optimal result, save the occasional random accident.

[59]"Advantages of possibility theory are its simple rules, robustness, and insensitivity to the accumulation of error by repeated operations." G.J. Klir, "Probabilistic versus Possibilistic Conceptualization of Uncertainty" in Ayyub, Gupta and Kanal, eds., *Analysis and Management of Uncertainty: Theory and Applications* (Elsevier Science, 1992) p. 16 (emphasis added).

meanwhile no atom has decayed. The first atomic decay would have poisoned it. The ψ-function of the entire system would express this by having in it the living and dead cat (pardon the expression) mixed or smeared out in equal parts.[60]

The classical theory holds that the radioactive atom either does, or does not, shed a particle during the stated one hour timeframe. Quantum theory allows for the system to operate in superposition, meaning both possibilities co-exist at the same time. Thus the two possible states of the cat are "smeared out in equal parts" unless and until the probability wave function collapses the particle's position into one real-world state, or another. Schrödinger intended his thought experiment to be such a "ridiculous case" in order to highlight the quantum paradox; indeed, it was written in direct response to Einstein at the time superposition was being scrutinized theoretically. To explicate the limitation of the binary model, in which the particle must be in one place or the other, he simply replaced the state of the particle with the state of a cat-at-risk-of-instant-death. Superposition thus results in this cat-at-risk residing in the unfortunate "state" of being at once partly alive and partly dead – a state that crisp theory abhors but fuzzy theory embraces, and comfortably manages, by allowing us to *see* the cat as holding partial membership in the set-Alive and set-NotAlive. Most physicists have now come to accept the reality, if you will, of quantum superposition and, by extension, at least a partial rejection of crisp theory's Law of the Excluded Middle. In a joint article, Stephen Hawking and Roger Penrose write:

> The wave function of the system is a superposition of these two possibilities... But *why does our perception not allow us to perceive* macroscopic superposition, of states such as these, and not just the macroscopic alternatives "cat is dead" and "cat is alive"?[61]

This question, essentially the same question posed by fuzzy set theory – *why does our perception not allow us to perceive macroscopic superposition* – raises the bar for all of us working in human systems. The answer to "why" is that we have all been taught the theories, rules and explanations that grace us with the solace of certainty that comes with definitive, *macroscopic*

[60] (emphasis in the original). Erwin Schrodinger, "Die gegenwartige Situation in der Quantenmechanik," *Die Naturwissenschaften* 23: (1935), translated by Trimmer, John D., "The Present Situation in Quantum Mechanics: A Translation of Schrödinger's 'Cat Paradox' Paper." *Proceedings of the American Philosophical Society* 124(5) 1980, p. 323, 328. *JSTOR*, www.jstor.org/stable/986572 (accessed 28 Apr. 2020).

[61] Stephen W. Hawking and Roger Penrose, "The Nature of Space and Time" *Scientific American* July 1996 p. 63 (emphasis added).

alternatives.[62] Design thinking, fuzzy sets and interdisciplinary training serve as worthwhile 'antidotes,' in the pragmatist sense, to the conclusion that we need binary, set H or not-H comfort in the face of real uncertainty in a problem domain.

IV] Human Systems: Control

Some of the first applications of fuzzy were algorithms for product control – subways and elevators, rice cookers and washing machines.[63] Elevators and subways, notably, because both have straight-line acceleration and deceleration. The most famous experiment with fuzzy algorithms was the subway in Sendai, Japan. Fuzzy acceleration and braking controllers demonstrated remarkable improvement. A rider in the train could stand in the middle of a car with no hand hold, and easily maintain balance when the train smoothly accelerated from a dead stop and when it slowed to a full stop. The systems' feedback loops for control were simply better for the end user with the fuzzy algorithms.

Fuzzy theory seems not to have yet garnered serious attention for application in human systems, something Zadeh hoped for: "…my expectation was that most applications [of fuzzy theory] would be in the realm of 'humanistic systems.'"[64] This is just one of the innumerable examples of a more pervasive societal issue. Inventions and discoveries all too often find their first and oftentimes exclusive use as revenue-generators for private, for-profit corporations. Only much later, if ever, do they make their way into cost-centers serving the greater public good.[65]

Adaptive Control

Physicist Danah Zohar has introduced the concept of "adaptive evolution," a sort of accelerated evolutionary process seen in mechanically-induced degradations in organisms in the

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[62] *Cf.*, Lera Boroditsky, "Does Language Shape Thought?: Mandarin and English Speakers' Conceptions of Time" *Cognitive Psychology* 43(1): 1-22 (2001).

[63] "Acceptance of fuzzy logic as an alternative control paradigm has occurred at a faster pace in places far from where it was invented – here in the U.S. This is now likely to change." Frank J. Bartos, "Fuzzy Logic Widens Its Appeal To Industrial Controls" *Control Engineering* (June 1993) p. 67.

[64] Lotfi Zadeh, *Computer Design* 31(4), p. 126 (April 1992).

[65] Yet another topic for another day. A separate reason, linked to the issue of interdisciplinary studies, from Ramesh Jain: "I am afraid that the course of research in the field of fuzzy set theory seems to be following the path which conventional methods were following, i.e., researchers in this field are interested more in improving properties of fuzzy sets than in applying fuzzy sets to real world problems." Jain, R., *Fuzzyism in Real World Problems*, in Wang P.P., Chang S.K. (eds) *Fuzzy Sets* (Springer, Boston, MA 1980) at p. 130.

laboratory. She cites microbiologist John Cairns for demonstrating this adaptation in bacteria when confronting extinctive DNA damage. Zohar posits that this outcome is neither predicted nor explained by Darwin's evolutionary theory. She posits an "evolutionary principle selecting for life" that resides at a fundamental level of physics.[66]

Zohar and Cairns take an adaptive systems approach to physics and biology respectively. Their systems of inquiry exhibit a tendency towards adaptation, necessarily suggestive of self-organization. One remarkable example emerged within the DNA molecule:

> Scientists know that DNA is *stable precisely because it is constantly under repair*. … Research [shows] that the work of patching up its own mistakes is no occasional event – it is one of the most important transactions of DNA.[67]

Initially, the researchers hypothesized that destruction of segments on the strand resulted solely from externalities, such as ultraviolet light. They came to learn that some of the deterioration was sourced within the organism, from "the ordinary business of the cell." Metabolizing oxygen, for example, generates a free radical that can damage other aspects of the molecule. In response the molecule, it seems, had learned to adapt. Designers of human systems could well take a lesson from the DNA molecule: include error correction in system design and, where possible, create a mechanism for self-correction within the system to identify and solve for error on its own – "to patch up its own mistakes."

One place to start thinking about designing adaptive control into a human system is the fuzzy algorithm:[68]

> Fuzzy algorithms for control policy will gain increasing, though perhaps grudging, acceptance because conventional non-fuzzy algorithms cannot in general cope with complexity and ill-defined nature of large-scale systems. *Control theory must become less preoccupied with mathematical rigor and precision and more concerned with the development of qualitative or approximate solutions to pressing real world problems*.[69]

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[66] Danah Zohar and Ian Marshall, *The Quantum Society: Mind, Physics, And A New Social Vision* (William Morrow, 1994) p. 175.

[67] Janet Basu, "When The Blocks Break" *Stanford Observer* Spring 1995 p. 11 (emphasis added).

[68] A useful definition: "… an algorithm is a step-by-step method of reaching a result." Daniel McNeill and Paul Freiberger, *Fuzzy Logic* (Simon and Schuster, 1993) p. 104-105. Algorithms can be written in "English, pseudo-code, or actual code ..." Rumbaugh, *Object-Oriented Modeling and Design*, p. 131.

[69] Lotfi Zadeh, *Computer Design* 31(4) p. 126 (April 1992)(emphasis added). *Cf.*, "In a wider perspective, fuzzy control appears to be very useful when applied to the identification and control of ill-structured systems, where *e.g.* delinearity and time variance cannot be assumed, the process is characterized by significant transport lags, and is subject to random disturbances. These kind of systems are difficult to model from a conventional point of view." Hellendoorn H., Reinfrank M. "Fuzzy Control Research at Siemens Corporate R&D" in Kruse R., Siegel P. (eds) *Symbolic and Quantitative Approaches to Uncertainty* ECSQARU (Springer, Berlin, 1991) p. 206.

Fuzzy control as part of a design method for human systems is deserving of the closest examination by industry, government and academia, for the full scope of human systems. In law we are perhaps overly accustomed to working with models and methods already in full operating form. Practitioners, legislatures, courts and academics have constitutions, treaties, statutes, precedent, policy, rules and, yes, norms – in short, the entire legal system – laid out before us. We are quite settled in the routine of working on small pieces of any legal system from one of two, and often both, loci: (1) inside the system and (2) in the past. Problem-solving in many legal domains contains a strong backward-looking bias towards prior analyses or resolutions that serve, at minimum, as a touchstone for rules of inference but more often as the font of dispositive rules generative of the solution to the problem at hand. When a legal system looks for its core operating principles, it looks quite specifically inwards and into the past. Moreover, the older the principle the more authority we tend to attribute.

This is not critique, just observation. Both vectors are, to be sure, important and useful in many situations. But looking inward and backward for our most important principles must, at some point in time, become increasingly suspect. The verisimilitude we grant these beacons from deep in our legal history must be possessed of a discernable half-life, even if we choose not to see it. Just one example of this phenomenon is strict originalism as a theory of constitutional interpretation. The core of originalist theory rejects *ab initio* the possibility of any such half-life; rather, as time takes us inexorably further from the text in question, the originalists endow that passage of time as itself an aspect of infallibility. To do otherwise would be to admit the existence of a half-life, and that admission is the beginning of the end of originalist theory.

But the pragmatic reality is that we *can* learn to see the half-life attendant to legal principles extant, of whatever age, just as we can learn to perceive macroscopic superposition. As lawyers, we must re-examine our collective reliance on law, policy and norms developed before the Information Age, which arose from legal principles established before the airplane, which principles arose from philosophies concretized in times of imperialism and slavery. We all accept our respective legal systems much as we were taught, and we work with their sub-systems every day of our professional lives. We would do well, however, to occasionally elevate our gaze to the horizon and recognize that time operates on the law with the ubiquitous force of the cosmos. At ground level, our legal minds are focused on the stream of real-world facts and issues pouring forth onto us unbidden, by the hour, day, month, year. Yet time also operates, slowly and surreptitiously, to drive the code strings of existing law, policy and their norms ever more deeply into our legal systems. Time cares not whether we are paying attention. If we are not, we will never notice much less repair the defective rules, embedded error or detuned norms that shape the outflow we collectively produce from our legal systems. Adaptive control may be a useful quality to design into legal systems, a function that can identify if not also amend detuned rules resulting from the "ordinary business" of the legal system's daily operation, or from faulty design, or the impact of unforeseen externalities such as technology.[70]

As law and policy makers we must shrug off the comfort and habit of a paint-by-numbers model, repeating quotidian tasks in rote application of formalized processes. It is time to turn to re-designing our systems and their operation. The singular grace is that we are components of these systems. We are uniquely situated to design and control our "adaptive evolution." Indeed, we are applying this advantage by teaching machines to perform some of our more routine tasks. A worthwhile endeavor, if we do so wisely. Yet we seem at the same time wholly distracted from any effort to design the overarching systems within which these automated tasks will be but minor sub-systems. Automation for incremental efficiencies is a social good, and profit-motive no doubt accelerates this progress. But automation and machine learning are nowhere near delivering the ability to see even one of our legal systems holistically (much less in macroscopic superposition) and from there make context-dependent judgments about relationships amongst them or, for that matter, any ability to make adaptations for the larger social good. This we can do for ourselves, at whatever pace we may choose, for we have the unique power to "… teach ourselves what we're going to be."[71]

Autopoiesis

The Chilean biologist Humberto Maturana is credited with creating both the concept and word, autopoiesis.[72] It is generally understood as a characteristic of a closed system that develops its own mechanisms of control and maintenance. Economist Milan Zeleny leans away

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[70] "People tend to think that it's total control or no control. But the interesting place is in the middle of that." Brian Eno, *Wired* 3.05 (May 1995) p. 206. *Cf.*, The Law of the Included Middle.

[71] John Gardner, *The San Jose Mercury News* January 21, 1995 p. 1F.

[72] The term derives from the Greek root -*poiesis*, meaning "making or forming." *The Random House Dictionary of the English Language*, Unabridged, Second Edition, at p. 1439. "[A]utopoietic organization is defined as a unit through a network of constituents which (1) have a recursive effect on the network of the production of constituents which also produces these constituents, and (2) which realize the network of production as a unit in the same space in which the constituents are located." Humberto Maturana, *quoted by* Gunther Teubner, *Law as an Autopoietic System* (Bankowska and Adler, trans)(European University Institute Press, 1993) at p. 22

from the biological origin of Maturana's model, describing an autopoietic system this way:

> The idea of self-reference and autopoiesis presupposes that systems seek the fixed points of their mode of operation in themselves and … they look for these points in *a self-description which functions as a program of internal regulation*, organizing the system in such a way that it corresponds to this self-description.[73]

Perhaps it is something akin to Zohar's 'adaptive evolution' that sparks development of this emergent property, the self-regulatory function. No matter. Emergent properties are all around us:

> Life is an emergent phenomenon…emerging from chemistry by way of DNA. The Feigenbaum number is an emergent phenomenon, emerging from chaos by a route we have yet to describe… What it [emergence] does is help make respectable the idea that *a collection of interacting components can 'spontaneously' develop collective properties* that seem not to be implicit in any way in the individual pieces.[74]

Imagine a human system, say, a legal system. Suppose that a collection of interacting components (some humans) spontaneously develop a collective property that is not found (coded for) in the individual pieces (all humans). Might we, ourselves components of a legal system, be particularly well-situated to design with intention for emergent properties – norms – that are not otherwise encoded in the rest of the system (society)? Legal philosopher Gunther Teubner argues towards the idea that law itself can be seen as an autopoietic system:

> Society is not a bio-system, but *a system of meaning*. This opens the second way of applying autopoiesis to social science: by describing social systems as themselves emergent autopoietic systems.[75]

And if societal norms are a knock-on effect of law or policy, we can then see norms as an emergent autopoietic sub-system of law. The implication is not trivial. Norms are where most legal meaning will come to reside for the individual and, by extension, the societal systems in which they are members. In the United States, "free speech" is perhaps the most-cherished norm, steeped in meaning and national identity. Its legal parameters, however, are poorly understood by most citizens, just one example being the fact that said freedom applies only to a government's attempt to restrict one's speech. Thus, many if not most American citizens hold to

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[73] Milan Zeleny, *Autopoiesis: A Theory of Living Organization* (Elsevier, 1981) pp. 91-2 (emphasis added).

[74] Jack Cohen and Ian Stewart, *The Collapse of Chaos: Discovering Simplicity in a Complex World* (Viking, 1994) p. 232 (emphasis added).

[75] Gunther Teubner, *Law as an Autopoietic System* (Bankowska and Adler, trans)(European University Institute Press, 1993) p. 29 (emphasis added).

a broader interpretation of “free” speech than the law prescribes. The very American trait of tolerating even the most aggressive speech is surely a follow-on norm from a far narrower legal right. This norm is, alas, reinforced in every law student with the unfortunate meme that ‘the correct response to bad speech is more speech.’[76] Fraught though it is with adverse social effects emanating from odious abuse, free speech in the US is nonetheless an extraordinarily powerful and systemic norm, emergent from fundamental law and verily packed to the gunwales with meaning.

Law and policy can be designed with conscious awareness that such norms will follow. Put differently, setting social norms is part of the legal designer’s responsibility in law and policy making. By corollary, if law and policy are poorly designed, the consequent norms are likely to reflect those flaws. If true, then we must design our work in a way that allows subsequent amendment with minimal disruption to the relevant system in which they operate. How might we proceed?

> No single individual possesses the requisite knowledge of building a space shuttle. Yet the space shuttles get built. How? Where is the complete and requisite knowledge 'stored' and how? In order to deal with the problem of increasingly atomized and widely distributed knowledge, humans have evolved, quite spontaneously, complex coordinative hierarchies of management and command. It is these hierarchies which in their totality represent the requisite ‘social memory,’ the way of ‘coding and storing’ human knowledge about the wholes.[77]

As complex as it is, even the conceptual system that is part of the space shuttle system is relatively simple in comparison to a legal system, a societal system-of-meaning, a system that serves to inculcate values and define meaning for its constituent membership. Truly, no single person possesses anywhere close to the complete and requisite knowledge of any given legal system.[78] But their institutions do. These are the ‘complex coordinative hierarchies of

[76] This is a particularly good example of a rule becoming poorly-tuned by dint of losing touch with its origins, the now-famous words and intent of Justice Brandeis: “If there be time to expose through discussion the falsehood and fallacies, to avert the evil by the process of education, the remedy to be applied is more speech, not enforced silence.” *Whitney v. California*, 274 U.S. 357, 388 (1927)(concurrence), *overruled on other grounds* in *Brandenberg v. Ohio*, 395 U.S. 444 (1969).

[77] Milan Zeleny, “Parallelism, Integration, Autocoordination And Ambiguity in Human Support Systems” in *Fuzzy Logic in Knowledge-Based Systems, Decision and Control* M.M. Gupta and T. Yamakowa, eds., (Elsevier, 1988) pp. 118-119.

[78] Much of our social memory, context-dependent though it may be, is composed of language. More to the point, a social system of language. The linguists generally accept the model that human communication comprises distinct systems, such as written, oral and visual representations-of-meaning, each with well-developed norms and standards. *See, e.g.*, Noam Chomsky, *The Logical Structure of Linguistic Theory* (Springer, 1975); David Foster Wallace, “Authority and American Usage, or ‘Politics

management … which in their totality represent the … way of coding and storing human knowledge' about many a given human system. Notably, the hierarchies described for the space shuttle system 'quite spontaneously evolved' precisely because of 'the problem of increasingly atomized and widely distributed knowledge.' With the liberty of blending several of the ideas above, we might come to see that, in the face of enormous complexity, an increasingly atomized and distributed legal system that emanates behavioural norms would do well to possess an internal control mechanism to optimize the meaning those norms generate.

It is worth noting that a system-of-meaning implies, nay, requires the *transmission* of that meaning. From the most private level, two individuals whispering in a rainforest, to a consensus global proclamation on rules (and thus norms) for, say, managing a pandemic; all messaging is the transmission of meaning.[79] By whatever medium delivered, the message is no more but no less than its substance, authority and context at a given point in time. If the medium can mask or perturb any of these aspects of the message, meaning is degraded. If the medium masks authority, as happens on social media; or it omits necessary context, as the six-second sound bite does, then meaning is replaced by error. In the worst case scenario, just one example being the technology of 'deep fakes,' the message is wholly transmogrified. Intentional error *becomes* transmitted meaning. For a system-of-meaning, this is a fatal result – fatal to truth, and fatal to the Rule of Law therefor.

A critical legal system function, then, is the transmission of meaning among individuals in the system.[80] The fidelity of the transmission is dispositive of the quality of its meaning. Recall that the quality of a system's design is expressed in how well it works. Conversely, a legal system's dysfunction discloses the imperfections of its design. To solve for dysfunction, we improve the design.

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and the English Language is Redundant'" *Harper's Magazine* April 2001; Lera Boroditsky, "Linguistic Relativity" in *Encyclopedia of Cognitive Science* Nadel, Ed., London: Macmillan, (2003); David Bohm, *Thought as a System* (transcript of seminar, Routledge 1990).

[79] Perhaps Marshall McLuhan's infamous assertion that "the medium is the message" was altogether wrong. Perhaps it was correct at the time, but fifty years hence it is no longer correct; a classically time-worn, detuned societal norm. McLuhan, *Understanding Media: The Extensions of Man* (McGraw-Hill, 1964).

[80] One physicist famously wrote to politicians dealing with tensions in Africa and Europe, imploring them to: "stop viewing the Somalian and Serbian warlords as 'bad guys' and think of them instead as 'parameters' within a 'self-organizing complex adaptive system.'" Dr. Gottfried Mayer-Kress *quoted by* John Horgan, *The New York Times Book Review* October 1, 1995, p. 30.

V] Object-Oriented Design: Software

> As the systems which form the fabric of modern society become more complex and more interdependent, the need for understanding the behavior of such systems becomes increasingly more essential.[81]

Object-oriented design is a method for the development of software.[82] It reorganizes analytic work on complex problems for which software might provide a solution, but it does so before the developer begins coding.[83] This foundational premise makes it worth a close look for potential application to non-software projects including, as you will have surmised, human systems. OO design and its progeny have unequivocally proven their utility in the physical world of computing. There is every reason to believe that some of these utilities will port neatly over to conceptual (non-physical) systems such as legal systems, the making and managing of law, policy and their attendant norms.

"We have found that [object-modeling] helps the software developer visualize a problem without prematurely resorting to implementation."[84] Any help with visualizing a problem domain should resonate deeply with designers working within human systems loaded with complexity and uncertainty. The second point may also serve us well – patiently working the problem and iterating prototypes before beginning, which is to say "without prematurely resorting to," codification:

> ...Coding is the *last stage* in a process of development that includes stating a problem, understanding its requirements, planning a solution, and implementing a program in a particular language. A good design technique defers implementation details until later stages of design *to preserve flexibility*.[85]

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[81] Zadeh, L., "Symposium on Policy Analysis and Information Systems" *Fuzzy Sets Theory and Applications to Policy Analysis in Information Systems* eds. Wang P., Chang, S.K. (Plenum, 1980) p. v.

[82] Among its founders: Grady Booch, *Object-Oriented Analysis and Design* 2d ed. (Addison-Wesley, 1994); Ivar Jacobsen, *Object-Oriented Software Engineering* (Addison-Wesley, 1992); Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991).

[83] "What is needed, in our opinion, is a *suite of techniques* that allow us to tackle these problems in an early stage … rather than later when the structure of the system has been more or less made permanent and when changes are more difficult to bring about." Daniel Duffy, "Object-Oriented Requirements Analysis: Systems Responsibilities, Functional Modeling, and Scalability Issues" from Richard Wiener, ed., *The Wisdom of the Gurus* (SIGS, 1996) p. 119 (emphasis added).

[84] Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. ix-x. "Implementation" is the software development term for 'reducing to code,' rather appropriately coincident with the legal term, codification.

[85] Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. ix (emphasis added).

We see all too often policymaking and lawmaking that is front-loaded, lacking in the kind of analytic and design rigor that leads to a stable, self-regulating system that generates durable, quality output. Richard Haass, former Director of Policy Planning, US Department of State, confirms:

> Input and output. They are, one would think, the yin and yang of public policy. … But, alas, there's little yang for the yin. Especially in Washington, experts agree, policy makers pay far less attention to output – that is, what they're getting for their money. *Debate centers around decisions about how to spend, not…how the problems have been addressed.*[86]

Yale Law Professor and former General Counsel of the US Environmental Protection Agency, Donald Elliott concurs:

> [I]n practice, environmental policies, once established, have proved remarkably resistant to fundamental change. A failure of a statute to achieve its goals often becomes an argument for *more of the same*, rather than an occasion for fundamental reassessments of approaches to the problem.[87]

This 'more of the same' error can undermine the very objectives that the original law, policy and their consequent norms sought to solve: "If an existing system of moral and legal coercion does not suffice, our tendency is to assume that the solution lies in *more of the same*..."[88] The place to fracture a deleterious 'more of the same' feedback loop is at the design level.

Objects

The problem deconstruction process in object-oriented design begins with the isolation of the characteristic or essence of each element in a problem domain into an 'object' – a representative conceptual unit: "An object represents an individual, identifiable item, unit, or entity, either real or abstract, with a well-defined role in the problem domain."[89] Virtually every 'thing' in the problem domain (system), real or abstract, possesses discrete characteristics such that its nature and role can be identified as an object. Further, an object necessarily possesses these inherent characteristics: i) state, ii) behaviour and iii) identity; thus an object can have

[86] Richard Haass, "More Bang for the Buck" Vol. 23 *National Journal* No. 16 (April 20, 1991) p. 292 (emphasis added).
[87] E. Donald Elliott, "Global Climate Change and Regulatory Uncertainty" (1992) 9 The Arizona Journal of International and Comparative Law 259, 265 (emphasis added).
[88] John Rodman, "The Liberation of Nature?" (1977) *Inquiry* 20:1-4, 83-131, at p. 104 (emphasis added).
[89] Smith, M. and Tockey, S., *An Integrated Approach to Software Requirements Definition Using Objects* (Boeing Commercial Airplane Support Division, 1988) p. 132.

different roles in a system at different times.

Consider this problem. On the bar is a capped bottle of beer, a glass, and a bottle opener. Your job is to design the system for a user to drink the beer. One algorithm might be: 1) pick up the bottle; 2) open the bottle; 3) pour the beer into the glass; 4) drink. This would not be incorrect. Now, let's look at it from an object-modeling point of view. Object modeling asks us to see the problem holistically, and parse its contents.[90] It also looks beyond the physical aspects of objects; it assesses their function and their several possible roles within the system at any given point in time. Remember, an object can be thing, or an idea, or an action; it might even be the absence of such.

First, we break all constituent parts of the system apart, reducing them to their essence. This is called *abstracting to form.* These become the objects we defined above. Objects are seen as modular vis-à-vis one another as well as the system as a whole. So, for our beer problem, let's begin with this (non-exclusive) list of objects:

1	Bottle		11	The act of pouring
2	Potable liquid in the bottle		12	The flow of the liquid
3	Bottle opener		13	Vessel receiving liquid
4	The action of a bottle opener		14	Fullness of the vessel
5	Bottle with a cap		15	A spill of liquid
6	Bottle without a cap		16	Vessel of Potable Liquid
7	Bottle cap itself		17	Temperature
8	The act of grasping a bottle		18	Swallowing
9	The act of lifting a bottle		19	Thirst
10	The act of holding a bottle upright		20	Quenching of thirst

Right away one sees that some of these objects are the same thing in a different state or time.[91] For OO design the temporal factor takes its rightful, central place in the analysis of any system that functions across time, which is to say most every system. This is not the superficially temporal idea of "move fast, break things" nonsense. The designer must assess how objects and, more often, their relationships to each other, change as the system operates. For example,

[90] "Objects are the units into which we divide the world, the molecules of our models." Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 17.

[91] "In contemporary terms, we [also] call this process chunking." Booch, *Object-Oriented Analysis and Design* 2d ed. (Addison-Wesley, 1994), at p. 20. The judgment on whether to abstract, or chunk, an object is context-dependent. Here, for example, the color, or material, or shape of the bottle, while specific and knowable characteristics about the object, are less critical to this task, and thus have been passed over as candidates for this chunking exercise.

assuming that the bottle has been opened, consider the relationship among this subset of Objects:

2	Potable liquid in the bottle		11	The act of pouring
			12	The flow of the liquid
6	Bottle without a cap			
9	The act of lifting a bottle			

There are several relationships amongst these Objects at (t_0). As this sub-system begins to operate (t_{1-n}), the relationships will change. As O_9 & O_{11} proceed, liquid leaving the bottle causes it to become lighter, reducing energy being applied to the bottle. The reduction in liquid then involves O_{12}, as an increase in tilt of the bottle will be needed to maintain the flow of liquid. This simple example serves to highlight that designers attend to time as a central component of their work and (apologies) they do so early and often:[92]

> Temporal relationships are difficult to understand. A system can best be understood by first examining its static structure, that is, the structure of its objects and their relationships to each other at a single moment in time. Then we examine changes to the objects and their relationships over time.[93]

Abstraction to form is the heart and soul of object-oriented design. One challenge is the seemingly overwhelming number of candidate objects that abstraction presents to the designer for any given problem domain. The counterweight to this is encapsulation – the intentional hiding of select information within an object.

> Abstraction is a good thing, but in all except the most trivial applications, we may find many more different abstractions than we can comprehend at one time. *Encapsulation* helps manage this complexity by hiding the inside view of our abstractions.[94]

Abstraction isolates one specific facet of a concept into an object; encapsulation envelops the

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[92] Yale Law's Peter Schuck affirms the need to maintain a level of indeterminacy for legal standards, precisely because of this tendency towards change across time: "[Such] standards do not really reduce conflict but simply use delegated authority to move the policy conflict from one rule-making locus to others [later in the process], usually agencies and courts." Schuck, *Legal Complexity: Some Causes, Consequences, and Cures* 42 Duke L. J. 1, 18 (October 1992).

[93] Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 84. Again, underscoring the critical nature of the temporal dimension for designers: "Persistence is the property of an object through which its existence *transcends time* (i.e., the object continues to exist after its creator ceases to exist) *and/or space* (i.e., the object's location moves from the address space in which it was created)." Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) at p. 77 (emphasis added).

[94] Booch, *Object-Oriented Analysis and Design* 2d ed. (Addison-Wesley, 1994) p. 59 (emphasis added).

object with a kind of translucence that can regulate the object's interface with other objects.[95] The animal cell, seen as an object, is a good analog. Most cells have specialized functions – red blood cells carry oxygen, nerve cells transmit electro-chemical impulses, muscle cells contract. OO design can likewise encapsulate functions or concepts within discrete objects. An organelle in the cell is itself an object, nested within the cell object. The internal workings of the organelle are encapsulated from the cell's interior by a specialized membrane. The membrane controls "visibility" into the cell by regulating which molecules and ions pass the boundary, depending on time and context (salinity, pH, charge). This may be one of nature's finest examples of an apparent boundary showing itself as a finely-tuned relationship, one that is variable across time depending on context.[96] In short, we see an object with both fuzzy and pragmatic characteristics.

Encapsulation in object-oriented analysis is the designer's creation of such specialized membranes for each object – concealing some part of the object, while permitting visibility for select aspects of the object, at the appropriate time, to utilize its relationships as designed. Of course nature arrived at this elegance and sophistication through a highly time-consumptive evolutionary process. We humans are not similarly constrained. We are graced with the ability to make improvements more quickly. We have the capacity to design rapidly, if only we choose to use it. We are just now developing our knowledge and skill for the design and, more to our point re-design, of complex human systems. We know that human systems are amenable to design. There is little reason why we should not take advantage of the extraordinary gift we have been given, to design our own systems, to 'build and craft intentionally,' and to do so well.

Let's look now at encapsulation in our beer-pouring problem. We defined the liquid object, O_2, in a way that did not disclose the characteristics of the liquid – type, color, flavor, etc. Should we later choose, we could add (disclose) these characteristics, or even change out the type of liquid entirely (as we have, selecting beer). Ideally, our design will allow us to do so with the fewest possible amendments or "touches" to other objects and relationships. In short, good design also means that the need for amendment will have the least possible impact or interference on any other part of the system:

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[95] "Encapsulation is most often achieved through *information hiding*, which is the process of hiding all the secrets of an object that do not contribute to its essential characteristics; typically, the structure of an object is hidden, as well as the implementation of its methods." Booch, *Object-Oriented Analysis and Design* 2d ed. (Addison-Wesley, 1994) p. 49.

[96] "...[N]eurons are evidently objects with encapsulated behavior and which communicate by passing messages. What better than an object-oriented programming language to simulate such a system?" Ian Graham, *Object Oriented Methods* (Addison-Wesley, 1991) p. 114.

> No part of a complex system should depend on the internal details of any other part. Whereas abstraction helps people to think about what they are doing, encapsulation allows program changes to be reliably made with limited effort.[97]

At the initial stage of abstracting to form, almost all objects will have some information encapsulated; they will not be fully deconstructed. Just one example is our O_2, the PotableLiquidInBottle. We declared it to be beer, for our specific example, but in the object model we left the liquid's characteristics opaque, encapsulated. Suppose that after several runs of the liquid pouring example, the data show that O_{11}, the PourLiquid object, needs to slow its rate of pour down by at least half, because we quickly learn that the liquid is carbonated and thus spilling over the edge of the Vessel object. Here is one possible sub-system to amend:

			11	The act of pouring
2	Potable liquid in the bottle		12	The flow of the liquid
			13	Vessel receiving liquid
6	Bottle without a cap		14	Fullness of the vessel

We might decide to "open up" O_{11} and disclose the original setting for the rate of pouring liquid. We would create a rule, say, O_{11a} to set a new, slower rate of pour. But this is by no means the only option. We might consider opening up O_{12} and O_{14}. We could write a rule within O_{14} that measures fullness and passes that information back to O_{12}, where we have installed a simple controller to reduce FlowRate accordingly.

You can find your own possible solutions without much difficulty; a fundamental part of the design process is spending ample time "playing with" the universe of possible solutions before winnowing the field, much less ranking the candidate preferences. You might want to "move the locus of the problem" and create a test for carbonated liquid at O_2, or just after the bottle is opened at O_6. We could amend O_{13} to vastly increase the volume of the vessel vis-à-vis the volume of liquid, so the vessel can manage any possible carbonation-caused overflow. This is, perhaps, a less elegant solution for our small-scale scenario; but if the system is large-scale, say, a brewery where a vat could be upsized to some 5,000 hectoliters, increasing the size of the vessel might be an attractive fix. The designer's judgment is pragmatic, context-dependent.[98]

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[97] Gannon, Hamlet and Mills, Theory of Modules, *IEEE Transactions on Software Engineering*, Vol. SE 13(7) p. 820, July 1987.

[98] "We should note the obvious: *there is never a best or optimal design.* Different designers will produce different models and they may be equally suitable for their purpose." Ian Graham, *Object Oriented Methods* (Addison-Wesley, 1991) p. 216 (emphasis added).

In the end, some of the elegance that emerges from OO design is not with the designer but rather the very architecture itself, which is designed to reward clean changes in definitions, parameters, and rulesets with minimal impingement on the system:

> *Intelligent* encapsulation localizes design decisions that are likely to change. ... This ability to change the representation of an abstraction without disturbing any of its clients is the essential benefit of encapsulation.[99]

You will have by now also surmised that the essential nature of object-oriented design is modular. We analyze a problem domain by breaking it down into constituent parts, objects. We organize objects into modules with tools like encapsulation, and also something called class structure. An Object's membership in a Class is a lot like membership in a set. The bottle contains a potable liquid; thus, O_2 by definition resides in ClassPotableLiquid. A potable liquid "is a" thirst quencher; if beer, it "is an" alcoholic beverage. In a larger system, ClassThirstQuencher or ClassAlcoholicBeverage help with organization, with modularity. Objects can be nested within other objects, so we could see our O_{16} (vessel of potable liquid) object being defined as "part of" a reward for a hard day's work, or "part of" a meal, or "part of" a lively social setting. These multiple nesting scenarios arise most often when an object plays different roles at different times within a system. And, as you have now surely intuited, Class and Object memberships lend themselves neatly to fuzzy grading of such memberships, as the designer may deem useful:[100]

> The key elements in human thinking are not numbers, but labels of fuzzy sets; that is, classes of objects in which the transition from membership to non-membership is gradual rather than abrupt.[101]

Links and Associations

Modularity in complex systems requires the designer to focus on the relationships among modules, and maintaining those relationships' optimal status and operation, across time. Recall that inherent in fuzzy set theory is the transition from (rigid) boundaries to (graded) relationships

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[99] Booch, *Object-Oriented Analysis and Design* 2d ed. (Addison-Wesley, 1994) p. 53 (emphasis added).

[100] As applied to a business analysis: "Many business entities and functions are not static, however. They change over time, or they play different roles in the same system. For example, a particular Staff object might make sense as a member of the Management class in one role, and a member of the Employee class in another." Jim Veitch, "Intelligent Solutions for Today's Computers" *Objects in Business* (PCAI March, 1996) p. 28.

[101] Lotfi Zadeh, *quoted by* Di Nola, Sessa, Pedrycz, and Sanchez, *Fuzzy Relation Equations and Their Applications to Knowledge Engineering* (Kluwer, 1989) p. 3.

among objects. This concept marries well with our next step in object-oriented design: "…links and associations are the means for establishing relationships among objects and classes."[102]

A link is the relationship between objects. In our model, there is a physical link between the bottle cap opener and the bottle cap – the bottle cap opener acts as a lever on the bottle cap, a result of human design. The liquid acts as a thirst quencher for the end user, a result of biological design. These two links are wholly different from one another, and are thus not *associated* links. "An association describes a group of links with common structure and common semantics."[103] In our model, one particular vessel of liquid might quench one particular user's thirst. A bottle of cold spring water quenches the athlete's thirst for hydration; a carton of fruit juice quenches a kindergartener's thirst for attention (maybe also hydration, or taste); cups of hot tea quench the tension of an important meeting between strangers. These links *are* associated, and we see the pattern in these associated links: a PotableLiquid in a DrinkVessel meets a UserNeed.

There is a trickier level of association, called aggregation.[104] If we look at the bottle and bottlecap, we see a stronger association. The bottle and bottlecap can be seen as "tightly bound by a part-whole relationship."[105] We don't generally think of a bottlecap without a specific bottle to which that cap belongs, either by fit or markings. Indeed, the bottlecap can be considered "a-part-of" the bottle. Likewise, there is an aggregate relationship between a specific bottle and the liquid capped within it. So, for an entity we might call BottleBeer, we mean beer as part of that entity, the bottle as part of that entity, and the bottle cap as part of that entity.

The key definition for aggregation in OO design is transitivity.[106] The bottlecap is part of the bottle; the bottle is a part of the BottleBeer; thus, the bottlecap object is part of BottleBeer.

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[102] Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 27.

[103] Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 27 (emphasis in the original).

[104] "Aggregation is a special form of association… . If two objects are tightly bound by a part-whole relationship, it is an aggregation. If the two objects are usually considered as independent, even though they may often be linked, it is an association." Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 58.

[105] Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 36.

[106] "If A is part of B and B is part of C, then A is part of C. Aggregation is also antisymmetric, that is, if A is part of B, then B is not part of A." Rumbaugh, Blaha, Permerlani, Eddy and Lorensen, *Object-Oriented Modelling and Design* (Prentice-Hall, 1991) p. 37.

Transitivity includes the property of anti-symmetry: the bottlecap is part of the bottle, but the bottle is not part of the bottlecap. From our thirst-quenching example above, the "cold" in the cold bottle of water may be particularly satisfying for a particular UserNeed; say, for an American athlete. That is, the human body's dehydration (thirst) is fully satisfied by water, chilled or not, but Cold is a culturally relevant property for (most) Americans' UserNeed. An aggregation relationship can be posited between Cold, Drink and (American)ThirstQuenching – Cold is a-part-of ColdDrink, and ColdDrink is a-part-of (American)ThirstQuenching. In context, these objects have an aggregate relationship; transitive and anti-symmetric.

Booch teaches that a well-designed software system must have both a strong architectural vision and well-managed iterative development. Both factors suggest a holistic approach to *seeing* the problem domain, which must be wholly understood for any attempt at design to cohere.[107] Iterations in development must be spaced sufficiently closely to avoid conceptual lacunae. Blind alleys are still worthwhile, if they are relatively short, or infrequent. Blind alleys can, however, become consumptive dead-ends for the designer. Grasping system parameters in the design process, and doing so early, allows these obstacles to be seen more quickly. This is a significant benefit of the round-trip gestalt approach, in contrast to the piecemeal and linear approach that is unduly attractive to many law and policy makers. Working methodically to locate upfront all relevant issues in the problem domain releases a freedom that is most useful in the early stages of object-oriented analysis.[108]

"Object-oriented development is a conceptual process…[it is] fundamentally a new way of thinking and not a programming technique."[109] This approach is reminiscent of Cubism – explicating the notion of seeing a thing differently from the norm, from several different perspectives at the same time.[110] Because this way of *seeing* fractured a facet of the then-

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[107] "Object-oriented development is neither strictly top-down nor strictly bottom-up. … '**Round-trip gestalt design' is the foundation of the process of object-oriented design**." Booch, *Object-Oriented Analysis and Design* 2d ed. (Addison-Wesley, 1994) p. 232 (emphasis added). *Cf.*, "macroscopic superposition," supra.

[108] "[I]n the early stages of design, the developer has two primary tasks: (1) identify the classes and objects that form the vocabulary of the problem domain; (2) invent the structure whereby sets of objects work together to provide the behaviors that satisfy the requirements of the problem." Rumbaugh, Blaha, Premerlani, Eddy, and Lorensen, *Object-Oriented Modelling and Design* (Prentiss Hall, 1991) pp. 135-136.

[109] Rumbaugh, Blaha, Premerlani, Eddy, and Lorensen, *Object-Oriented Modelling and Design* (Prentiss Hall, 1991) p. 4. (emphasis added).

[110] "Cubism was an attack on the perspective that had been known and used for 500 years. It was the first big, big change. It confused people: they said, 'Things don't look like that!" David Hockney, 2012.

standard (normative) worldview, Cubism was subject to severe criticism. Picasso understood that his cubism was not mainly about the aesthetic of the image, but its peculiar abstractions, which thereafter developed a new aesthetic. He was famously loath to allow other artists into his studio, afraid that his preliminary sketches (abstractions to form) would clearly disclose the secret (design) of his work, which any competent artist could then express (implement).

Cubism was also seeking to strike a balance between the real and the abstract; between sight and seeing; between physical and nonphysical.[111] Object-oriented designers are likewise manipulating abstractions aesthetically: “A good designer knows how to find the appropriate balance between too much contracting, which produces fragmentation, and too little, which yields unmanageably large modules.”[112] Finding that balance is hard work. It can entice the unwary designer to strive for the kind of elegance mathematicians cherish as an inherently validating characteristic. Alas, it cannot be brute forced. It does, on occasion, present itself. From our example, let’s isolate these objects:

1	Bottle			
3	Bottle opener			
4	The action of a bottle opener		14	Fullness of the vessel
5	Bottle with a cap			
6	Bottle without a cap		16	Vessel of Potable Liquid
8	The act of grasping a bottle		18	Swallowing
9	The act of lifting a bottle		19	Thirst
			20	Quenching of thirst

We seek to build a subroutine to open the bottle, say, RemoveBottleCap. Fairly straightforward, it will surely involve at least O_1, O_3, O_4, O_5 and O_8. Assume we are happy with our design for RemoveBottleCap and wish to proceed toward UserNeed, O_{20}. Suddenly it strikes us that we might be able to treat O_6 as fully nested within O_{16} and, by applying O_9 and O_{18}, have the user drink the beer directly from the bottle!

https://www.telegraph.co.uk/culture/art/9081303/David-Hockney-interview.html (accessed 2 June 2020).

[111] “When we discovered Cubism, we did not have the aim of discovering Cubism. We only wanted to express what was in us.” Pablo Picasso. https://arthistoryproject.com/timeline/modernism/cubism/ (accessed 2 June 2020).

[112] Meyer, B., *Programming As Contracting* Report TR/EI/12-CO (Interactive Software Engineering, 1987) p. 4. “Contracting” is the object’s interface with its implementation.

But maybe the system needs to be more user-dependent. Where the PotableLiquid is alcoholic, the OpenBottle and BottleVessel objects would have to be translucent – it could only be seen by (and contract with) an AdultUser object, not with a ChildUser object. If the PotableLiquid is permissible for children, perhaps the vessel must be made of plastic. In this way we can deploy encapsulation under certain user conditions and not others; notably, we can modify the design fairly easily by changing rulesets within the relevant subsystems with little impact on contiguous modules.

System design is a creative process. There are almost always several ways to accomplish a particular function, and that number increases with complexity. Software designers agree on, and legal system designers must embrace, this maxim: "conceptual integrity is the most important consideration in system design."[113] The whole *is* greater than the sum of its parts. This is why designing from the perspective of the whole, from the outset and iteratively thereafter, is absolutely necessary. *This* is the “round-trip gestalt design” method we seek.

VI] Thinking About Thinking, Redux: Decisions, Policy, Design

Suppose the process we use to make decisions for ourselves is ill-suited for the process we (should) use to make policy for others. For this hypothesis, we will define decision-making as making a judgment or rule primarily for ourselves, alone. Policymaking, then, will be defined as making a judgment or rule for others, one that will be imposed on a third-party.

Looked at this way, the majority of judgments we make in any given day are no longer mere decisions, but policy. Consider a surgeon at a teaching hospital, a married mother of two young children. Every working day carries her back and forth between making decisions and making policy. On a normal workday morning, her first judgments are mostly for herself – decisions on when to rise, whether to exercise, what to wear, when to leave for work. Some decisions might include her spouse – who will make breakfast, pack lunches, drop off the children. These judgments *could* be seen as policy, as they do affect the children in some way. But for sake of this hypothetical we will treat those effects as non-material, and we will keep these judgments in our decision-making category; similarly, some decisions made for and sometimes with the children – what to wear, eat for lunch, do after school. Notably, however, other judgments she makes regarding the children, alone or with her spouse, are indisputably policy – the age thresholds for walking to school alone, getting a cellphone, dating, driving a car,

[113] Fred Brooks, *The Mythical Man-Month* (Addison-Wesley, 1975) p. 42.

staying in school, moving out of the house.

Upon arriving at work, our surgeon is presented with myriad new contexts for her judgment. On morning rounds, she leads a gaggle of anxious and inexperienced students. Her judgment on what to ask, how to answer, when to criticize – these surely deliver a material instruction or rule on each of the young doctors. In the operating room, in meetings with medical colleagues or hospital administrators, virtually every judgment has a direct, even life-or-death, effect on some third-party, perhaps dozens or hundreds of them. Ultimately, most of the judgments across her workday are policymaking.

At home after dinner, she edits the medical school budget while managing interruptions from family members and work emails. In this situation, perhaps more than the others, she shifts back and forth and back again between the personal and professional, decision and policy, with nary a conscious thought about how her mindset, her framework for judgment, is changing from one mode to the other. Lastly, let's add some reasonable complexity to her life by folding in service as a PTA member, kids' football referee, annual volunteer for Doctors Without Borders, stepmother to her husband's rebellious teenager, and caregiver to her own terminally-ill parent.

All of these inputs – unpredictable, disorganized, ill-defined – are blithely accepted as our normal state of existence, day in and day out. And not just for our surgeon, but for most every adult, in every community, everywhere in the world. The output is our judgments, made using whatever skills we've been taught or are lucky enough to possess natively, deployed in a context for which we may, or may not, have previously-developed schema. When viewed as policy, these judgments constitute the transmission of meaning from an individual *qua* object into the applicable human system. It is the very stuff of which human systems are made, as well as the stuff from which emergent properties arise, including norms.

When we make decisions for ourselves, the consequences are borne by us alone. When we make policy for others, the consequences are borne by others more so than ourselves. The importance of this reality cannot be understated. As lawyers, we are well-taught on the significance of our role as a legal agent acting on behalf of a third-party. Yet little time is spent on understanding the differences inherent in *the making of* these two types of judgment. Indeed, we are led to believe that the two processes are fungible. We are presented with the message that the process of making policy judgment *seems* just like the process of making decisions; indeed, one professor of policy admits as much:

1. politics and policy are primarily about problem solving;

2. policy-making is synonymous with decision-making.[114]

This hypothesis is not presented here to dive deeply into the differences; it is presented to make three specific, system-related points. First, many if not most judgments made by any given individual will deliver a non-trivial rule for others – they have made policy, and thereby have transmitted meaning. No doubt, there is a vast difference between policy made for a family, or a company, or a nation. These policies reside within entirely different human systems. Yet for each we would say, in object-oriented terms, that the individual *qua* object is imposing an operative ruleset upon linked or associated objects, from dozens to millions.[115]

Secondly, the fact that every individual is a member of so many discrete human systems surfaces forthrightly, along with the fact that we often function in those systems at the same time. While our surgeon is deep in her work in the operating room, she is surely a 1.0 member in the set of surgical team leader. Yet she may also be a 0.6 member in the set of medical school academics, taking photographs and dictating notes for an article. She may have no choice but to be, for a time, a 0.8 member in the set of female role models because there are five other women in the operating room and the young male anesthesiologist is expressing his sexism. And, because of a phone call that morning, she may be unable to avoid 0.2 membership in the set of caretaker daughters, worrying over the appropriate next steps for her sick parent. All at the same time.

Third, her skill in balancing these roles and making these judgments arises from but three platforms, expansively understood – her native intelligence, the totality of her education and training, and her accumulated life experience. Notably, a rather random 'agglomeration of practical wisdom' for one of the most important functions any human being will perform in society. These platforms are generically the same for almost every adult worldwide, despite significant variances in the quality or duration of each, largely the result of pure chance and circumstance.

This thought experiment by no means seeks to demonstrate how judgment-for-policy is functionally different from judgment-for-decisions. It *does* seek to suggest that we as lawyers may be operating sub-optimally as society's general problem-solvers, if we fail to *attend to* these

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[114] Robert V. Bartlett, "Evaluating Environmental Policy Success and Failure" from Vig and Kraft, ed., *Environmental Policy in the 1990s* (Congressional Quarterly Press, 1990) p. 175.

[115] A stark example is the Covid-19 Pandemic. In managing this public health crisis, the words uttered by each nation's singular leader carried enormous policy-weight-per-word, arguably more than any other speech, statement or edict in their respective histories.

functional differences. Failing to do so may perpetuate significant embedded error in our legal institutions' preparation of the next generations of lawyers.

Artificial intelligence, ironically, will quite likely call into question and thus raise our awareness about how lawyers make judgments that materially impact others. Of course there are similarities; surely the judgment function for both policy and decision making share certain psychological, intellectual and even neurological elements. Yet, even at the simplest level, it can be profoundly misleading simply to apply individual decision-making frames and techniques to the making of policy for others and expect consistently good results:

> Stubborn policy controversies pose the following epistemological predicament: what can possibly be the basis for resolving conflicts of frames when the frames themselves determine what counts as evidence and how evidence is interpreted?[116]

We need to know how and why these two processes <u>need</u> to differ – how and why there must be a <u>fundamental</u> difference between a legislator's personal desire to pay less in taxes, and said legislator's policy judgment for hundreds of millions of others on whether, and whose, tax rates should rise or fall.

There are no doubt some very good policymakers who have been trained, or trained themselves, to do their mental work and make their policy judgments through the lens of a true public servant. Any policymaker who rigorously subjects themselves to Rawls' 'veil of ignorance' would be an example. Alas, this is all too rare.[117] One of the benefits of seeing ourselves as objects operating within human systems is that it isolates and thus highlights this reality. The very act of transposing ourselves from one object definition in one human system to a differently composed object in another system discloses much. We are not well-prepared to think or operate this way, natively or educationally. Mathematician David Darling proposes one causative factor:

> The collective human psyche is in its infancy… . Not surprisingly, considering its immaturity, it responds erratically and often inappropriately to the information reaching its senses – of revolutions, of human and ecological disasters, of other happenings on the world stage. There are inconsistencies, for example, in our corporate approach to issues like global warming and economic growth. Individually, we may be capable of thinking such problems through and

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[116] J.M. Brison and B.C. Crosby, 20 *Environment in Planning B: Planning and Design* 175-176 (1993).

[117] "Strategic thinking itself is a creative act. For most of us, strategic thinking is not automatic. It is a divergence from business as usual and not easy, since it causes us to confront the large uncertainties associated with the future." James L. Adams, *The Care and Feeding of Ideas: A Guide to Encouraging Creativity* (Addison Wesley, 1986) p. 202.

> arriving at solutions in a coherent way. But *our collective mentality is so fresh and undeveloped that it naturally seems childlike by comparison*.[118]

Mathematician Lazlo Mero's analog is the chess master:

> A candidate master has essentially acquired the foundation of his profession. He knows and can apply several thousands of professional schemata, *his everyday and professional schemata are separated*, he can use the trade jargon, he can express himself with his professional schemata, and the two kinds of schemata are not mixed…He thinks analytically: *he solves his problems set by set by the aid of his schemata*.[119]

Compare, then, Mero's explanation of the markedly different way the grandmaster thinks, and sees (in macroscopic superposition!); moving beyond templates and even language, to analogy and intuition:

> A grand master knows several tens of thousands of professional schemata, most of which he cannot express by way of words or argumentation. In difficult debate he can express himself with the aid of apposite analogies, rather than direct professional arguments. His thinking is intuitive: he can put his finger on the crucial part of the problem without exact professional deductions and find the solution. His basic method of solving problems is not of deductions and systematic exclusion of the incorrect answers but of his insight sensing the correct solution.[120]

Intuition – authentically informed insight that senses the correct solution. Kant's *Mannigfältige der Anschauung,* the "varied contents of perception or intuition."[121] The *ne plus ultra* of expertise in problem-solving. How, we ask ourselves, might we get there from here; how might lawyers become grandmasters of problem-solving? How might we identify and separate out the personal decision-making process burned into our neural pathways long before university, and thereby free ourselves to develop the more difficult and less innate process of judgment that is the making of policy for others?

Design. More to the point, design thinking. This is, simply put, a method for seeing a

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[118] David Darling, *Equations of Eternity, Speculations on Consciousness, Meaning, and the Mathematical Rules that Orchestrate the Cosmos* (Hyperion, 1993) p. 163 (emphasis added).

[119] Lazlo Mero, *Ways of Thinking: The Limits of Rational Thought in Artificial Intelligence* (World Scientific, 1990) p. 120.

[120] Lazlo Mero, *Ways of Thinking: The Limits of Rational Thought in Artificial Intelligence* (World Scientific, 1990) p. 121.

[121] Immanuel Kant, *Critique of Pure Reason*, translated by J.M.D. Meiklejohn (Willey, 1900) pp. 3-4. Kant's referent, from the Old High German – *anschauen* – has been translated by Meiklejohn as "intuite." As is often the case in German, the verb is easily transformed to an noun, and thus Kant's phrase *das Mannigfältige der Anschauung* – "the varied contents of a perception or intuition."

problem domain from a profoundly human-centered perspective, including the objects and relationships within it. When we teach design thinking, one consistent push-off point is a model informally known as the Five Hexagons:

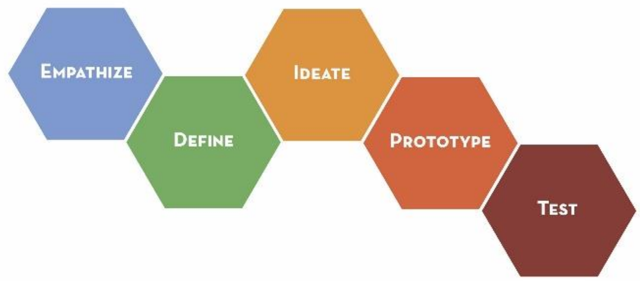

Fig. 2.[122]

We begin with empathy, the crux of human-centered design. There are various techniques for teaching and achieving the empathic component. But the objective at the initial stage is for the designer to intellectually and emotionally understand and feel the user's needs, wants and points-of-view with respect to the problem *they* face, the way *they* perceive it and seek a path forward that is satisfying to *them*. Only then may we even begin.

The hexagons are visually a bit misleading – the process is far from chronological, as a two-dimensional diagram almost necessarily suggests. Ideation, prototyping and testing are usually executed in rapid-fire cycles. There is constant 'tagging-up' on empathy, as well as problem definition, throughout. In short, each hexagon could be nested within any other at certain, or several, points across a design process. One could visualize this process as an amalgam of Moebius strip and Klein bottle, seamlessly iterative and foldable back into itself at most any point.

The Five Hexagons gained popularity in the realm of product development, and they work exceedingly well in that domain. For our work on the design of conceptual systems, however, they are just the beginning:

> Design thinking began as a way to improve the process of designing tangible products. But that's not where it will end. *Design-thinking principles have the potential to be even more powerful when applied to managing the intangible*

[122] Image reproduced by permission of The Hasso Plattner Institute of Design at Stanford University, pursuant to Creative Commons Attribution/Non-Commercial License 4.0.

challenges involved in getting people to engage with and adopt innovative new ideas and experiences.[123]

Recall that Meinel and Leifer saw a missing link between design and human systems, caused by the uncertainty inherent in human systems. Arising in part because of this structural lacuna in 'traditional' design thinking, a new approach emerged under the rubric of Design Abilities:

Fig. 3[124]

A legal designer will likely use all of these at some point in their analytic, modeling or policymaking work. Just by way of example, the fuzzy-grading process helps one navigate ambiguity, it requires exquisite synthesis of information, and toggling between the concrete and the abstract. Object-modeling even a basic human system requires designing one's design work, building with intention, and rapid experimentation. Making policy for others requires learning

[123] Tim Brown and Roger Martin, "Design for Action" *Harvard Business Review* September 2015 p. 64 (emphasis added). https://hbr.org/2015/09/design-for-action

[124] The 8 Design Abilities are the innovation of Carissa Carter, Director of Teaching and Learning at the Stanford d.school. https://dschool.stanford.edu/team-members/2017/1/6/carissa-carter. Her insightful views on their rationale and development is here: https://medium.com/stanford-d-school/lets-stop-talking-about-the-design-process-7446e52c13e8. For further reflections, d.school co-founder David Kelley speaks on podcast about the Design Abilities here: https://www.ideou.com/blogs/inspiration/david-kelley-on-the-8-design-abilities-of-creative-problem-solvers. Image reproduced by permission of The Hasso Plattner Institute of Design at Stanford University, pursuant to Creative Commons Attribution/Non-Commercial License 4.0.

the context of the problem domain,[125] deliberate and iterative communication with end users of the policy as well as those in the policy dialogue; [126] deft navigation of ambiguities, especially those that arise anew mid-process, and careful crafting of the policy design with an eye on emergent properties including, for legal systems, norm generation.

"When you design for meaning, good things will happen."[127] We in the law must ask whether our legal systems, as *systems-of-meaning*, have kept pace with the fundamental changes that technology has perforce imposed on all of global society, and thus on law, policy and norms. Universities have for centuries been operated as intergenerational institutions, slow to respond to the vicissitudes of the times. This characteristic serves well a core purpose of institutions, and for many reasons it must remain relatively undisturbed. That said, the last hundred years' technological development has undeniably and permanently changed the societies, the human systems, in and for which educational institutions function.[128] The next hundred years will not merely deliver more technological change but wholesale social paradigm shifts, of a kind we can barely imagine, some of which may land seismically.[129] Schneider called out the expanding chasm between the stationary, siloed academic disciplines and the volatile, cross-disciplinary admixture of real-world problems. He warned us that respect for institutional inertia is not an "excuse for an open-minded institution to shirk its responsibility to study the world as it is, rather than through the traditional structures of discipline-dominated institutions."[130]

Chief Justice of the Singapore Supreme Court, Sundaresh Menon brings this idea directly

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[125] "Virtually any problem will be easier to solve the more one learns about the context world in which that problem occurs." Minsky, *The Society of Mind* (Simon and Schuster, 1988) p. 177.

[126] "One of the major problems in description, essential to communication … is to reduce the necessary imprecision to a level of relative unimportance." Bellman, R.E., "On the Analytic Formalism of the Theory of Fuzzy Sets" 5 *Information Sciences* 149-157 (1973).

[127] Dr. Douglas Dietz, Chief Product Designer (MRI), General Electric Healthcare, Inc. See, http://newsroom.gehealthcare.com/from-terrifying-to-terrific-creative-journey-of-the-adventure-series (accessed April 16, 2020), and https://www.youtube.com/watch?v=jajduxPD6H4&feature=youtu.be

[128] "In the pool of knowledge at a university, professors are not the fish, but the pond. The water is not chlorinated, clear, precisely circumscribed, and inhabited by one kind of perfect goldfish. It is a muddied habitat with fuzzy edges and home to all sorts of people, including those who do not fit traditional scholarship. That is where new ideas come from." Nicholas Negroponte, Chairman Emeritus, MIT Media Lab, "Where Do New Ideas Come From?" *Wired* 4.01 (January 1996) p. 204.

[129] "[I]t is not the individual human ability to adapt that is the problem in the New Age. Rather, the problem is the ability of our human handiwork to do so: our institutions and economies in societies." Meg Greenfield, *Newsweek* February 27, 1995 p. 84.

[130] Stephen H. Schneider, *quoted in* "Climatologist Schneider Urges Blending Context, Content In Teaching Science" *Stanford Campus Report* April 5, 1995 p. 9 (emphasis added).

to ground for young lawyers:

> Abandon the assumption that all you need to know to become a good lawyer is simply the law. If that has ever been true, it certainly no longer is … In this age of change, we can only remain a 'learned profession' by becoming a profession of learners.[131]

Specific to law schools, Dean Brest warns that "…the traditional legal curriculum, with its focus on learning the law, is 'strikingly weak' in conveying the skills that lawyers need."[132] For our next generation of lawyers to succeed as society's general problem-solvers, they need to become interdisciplinary. That burden rests with the institution as much or more so than the individual. Ultimately, this is a core responsibility of the university as a whole, not just their schools of law.

VII] Conclusion

Unlike our companion physical and biological systems, constrained to evolve across the eons, we alone are graced with a unique agency – the power to design and build systems comprising ourselves, and at any scale and speed we may aspire. Yet we seem preternaturally blind to this grace. Some societies are riven by artificial and grandiloquent differences, on which we expend immeasurable energy accomplishing nothing. Some inherit mature systems of profound cultural depth, a bequest of extant but finite stability and productivity. And some are woefully broken, by forces corrupt and overpowering. But all these social systems, and thus each of us, are also members of one increasingly global society. And that unitary human system is rapidly and aggressively being subjected to complex transformations by technology, not all of which are desirable.

Social systems are inescapably subject to entropy, but also inherently amenable to intentional design. Legal systems may well be the nested autopoietic controllers for the systems-of-meaning that are our cultural, national and global societies. If this is even partly true, we are the creators and managers of the native code for every such system. We then become far more than just society's general problem-solvers – we become societies' designers for meaning.

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[131] Chief Justice Sundaresh Menon, Singapore Supreme Court, August 27, 2019. https://www.channelnewsasia.com/news/singapore/lawyers-legal-industry-tech-disruption-chief-justice-menon-11846370

[132] Paul Brest *quoted by* Mary Cage, *The Chronicle of Higher Education* September 13, 1996 p. A16.